# Identifying a Mechanism of Action for Early Stuttering Intervention

A thesis submitted in the fulfilment of the requirements for the degree of Master of Speech and Language Sciences (Research)

by

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## Certificate of Original Authorship

I, Monique Amato Maguire, declare that this conventional thesis, is submitted in fulfilment of the requirements for the award of Master of Speech and Language Sciences (Research), at the Australian Stuttering Research Centre at the University of Technology Sydney. This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis. This document has not been submitted for qualifications at any other academic institution. This research is supported by the Australian Government Research Training Program.

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# Abstract


Stuttering is a speech disorder that affects approximately 1 in 10 pre-school children by the age of 4. While some children recover naturally from stuttering, early intervention is recommended because: [1] stuttering is most tractable in the pre-school years, and [2] the adverse effects of stuttering begin from the onset of stuttering and increase by the time stuttering persists into adulthood.

A number of treatments exist that reduce stuttering in pre-school children. The Lidcombe Program has the most comprehensive research evidence of any early stuttering treatment program. Although the Lidcombe Program has been found to be an efficacious treatment when conducted individually, in groups, or via telehealth, the precise mechanisms of action underpinning the program are unknown.

The Lidcombe Program was developed in response to evidence that response contingent stimulation could reduce stuttering in young children. However, research that has focussed on the function of parent verbal contingencies in the Lidcombe Program has failed to confirm they are the mechanism of action. Therefore, it is worth exploring other variables which may be underpinning outcomes, in order to continue to optimise the Lidcombe Program.

One such variable identified in experimental research suggests that when adults model increased inter-turn speaker latency, they can reduce stuttering in young children. This feature is a suggested clinical component of RESTART-DCM, which is another evidence-based early stuttering intervention.

RESTART-DCM has been directly compared to the Lidcombe Program with a randomised controlled trial. The treatment outcomes for the two programs were similar. This indicates that either [1] the two treatments could be underpinned by different mechanisms of action that reduce stuttering, or [2] there could be mechanisms of action that are common to both treatments. Given the fact that increased inter-turn speaker latency is a procedure used in RESTART DCM, this variable warrants further investigation as a mechanism of action for the Lidcombe Program.

The specific research question of this thesis is: during Lidcombe Program clinic visits, do speech pathologists increase their inter-turn speaker latency when speaking to children compared with speaking to parents? This study utilised retrospective clinical

trial data for the Lidcombe Program. These data were obtained from audio recordings of Stage 1 Lidcombe Program clinic visits. A portion of these audio recordings was randomly selected and the inter-turn speaker latency of speech pathologists was measured using acoustic analysis software. This resulted in the analysis of 53 audio recordings pertaining to 20 unique participants who received Lidcombe Program treatment.

A comparison of the inter-turn speaker latency of speech pathologists with parents and with children showed statistically significant differences. This shows that these speech pathologists increased their inter-turn speaker latencies when speaking to children compared with speaking to parents during clinic visits. This suggests that inter-turn speaker latency may be a possible Lidcombe Program mechanism of action. Further experimental research is required to determine the clinical importance of this research.

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# Chapter 1: Stuttering Overview

## Synopsis

Chapter 1 provides an overview of stuttering. A discussion of three definitions of stuttering will be presented. This is followed by a review of the epidemiology of stuttering, including a discussion of the onset and natural recovery in the pre-school years. Stuttering causal models will then be presented. Finally, there is a discussion of the impact of stuttering across the lifespan.

## Definition of Stuttering

Ideally, stuttering definitions would distinguish people who stutter from people who do not. While a single definition that achieves this would be beneficial, rigorous debate in the late 20th century led to the formulation of three definition types: behavioural, internal and perceptual definitions.

Behavioural definitions, also known as symptomatic definitions, offer a description of the observable characteristics of stuttering. Wingate's widely cited behavioural definition of stuttering (1964, p. 488) includes characteristics such as "involuntary audible (or) silent repetition (or) prolongations in the utterance of short speech elements, namely, sound syllables and words of one syllable".

By contrast, Perkins (1984) proposed what is known as an internal or covert definition. This definition type incorporates the speaker's experience of stuttering, emphasising that stuttering is involuntary. Perkins defines stuttering as "temporary or overt loss of control of the ability to move forward fluently in the execution of linguistically formulated speech" (1984, p. 431).

Perceptual definitions, also known as consensus definitions, are based on the perception of whether a speaker does or does not stutter. Bloodstein first proposed the concept of a perceptual definition as being "whatever is perceived as stuttering by a reliable observer who has relatively good agreement with others" (1987, p. 9–10).

Each of the three definition types is useful in different contexts. Symptomatic definitions allow speech pathologists to describe stuttering behaviours. This is beneficial when training parents, educators or other health professionals to recognise the physical features of the disorder. Internal definitions are suitable in a clinical context when determining if recovery has occurred, as only the speaker can truly differentiate the experience of stuttering from stutter-free speech. Perceptual definitions are procedurally simple to implement both clinically and in research.

In some contexts a combination of definition types is useful. Onslow, Packman and Payne (2007) observed that studies of the pre-school population often combine behavioural and perceptual definitions. For example, during a prospective community cohort study by Reilly and colleagues (2009), parents of pre-school children were provided with a fridge magnet displaying a behavioural definition of stuttering. If a child exhibited stuttering behaviours, parents were encouraged to contact the research team. A speech pathologist then assessed the child using the perceptual definition to determine if stuttering was present.

## Prevalence and Incidence of Stuttering

It is widely accepted that between 1 and 2% of the global adult population will stutter at any one time (Bloodstein & Bernstein Ratner, 2008). Yairi and Ambrose (2013) observed that prevalence is higher in the pre-school years than at other times across the lifespan.

Four studies have investigated prevalence in the pre-school population (Okalidou & Kampanaros, 2001; Craig, Hancock, Tran, Craig, & Peters, 2002; Proctor, Yairi, Duff & Zhang, 2008; McKinnon, McLeod & Reilly, 2007). Of these, Proctor and colleagues (2008) captured the largest population sample (3,164 children) across a broad age range of 2 to 5 years. They calculated point prevalence as 2.5%.

Cumulative incidence of stuttering is often measured using prospective cohort studies. A large Australian community cohort study reported cumulative incidence of 11.2% by age 4 (Reilly et. al., 2013). The large differences between cumulative incidence (11.2%) and point prevalence (2.5%) in the pre-school years emphasises that some children may recover from stuttering.

## Onset, Natural Recovery and Tractability of Stuttering

The onset of stuttering can be gradual or sudden, across a single day or several months (Buck, Lees, & Cook, 2002; Reilly et al., 2009; Yairi & Ambrose, 2013). The onset of stuttering usually follows a period of typical language development (Onslow, 2004). In the majority of cases it occurs when a child’s language development is expanding (Reilly, et. al., 2009; Yairi, Ambrose, & Niermann, 1993).

It is widely accepted that some children who begin to stutter will recover naturally. Reilly and colleagues (2013) reported that only 6.3% of pre-school age children recovered naturally from stuttering in the first year post-onset. However, Yairi and Ambrose (1999) reported that natural recovery was most likely to occur in the first 3 years post-onset. This is aligned with three prospective longitudinal studies which estimated natural recovery rates of 71% by 5 years of age (Mansson, 2000), 79% by 6 years of age (Andrews & Harris, 1964), and 65% by 7 years of age (Kefalianos et al., 2017).

Researchers have speculated that natural recovery may occur due to therapeutic strategies that parents implement with their children (Dickson, 1971; Finn, 1996; Martin & Lindamood, 1986). Some reported strategies include encouraging children to slow down, to stop talking, or to start again (Martin & Lindamood, 1986). Other strategies may be more general, such as recommending that children think before speaking, speak more deliberately, or relax (Dickson, 1971; Finn, 1996).

Some studies have identified potential predictors of natural recovery from stuttering. Such predictors include a family history of natural recovery from stuttering, and being female (Ambrose, Cox & Yairi, 1997; Reilly et. al., 2009; Yairi & Ambrose, 1999; Yairi, Ambrose, Paden & Throneburg, 1996). However, it is impossible to predict which individual children will and will not recover naturally from stuttering.

It is widely accepted that stuttering is most tractable in the pre-school years. This is one reason why early intervention for stuttering is recommended, as it offers the best opportunity to help children overcome the disorder (Donaghy & Smith, 2016).

## The Cause of Stuttering

Several causal theories of stuttering exist (Bloodstein & Bernstein Ratner, 2008; Packman & Attanasio, 2017; Yairi & Seery, 2011). Two causal models are directly pertinent to explaining how some early stuttering treatments work. These two models are summarised below because they are relevant to the topic of this thesis. These two causal models are the 'Demands and Capacities Model' and the 'Packman and Attanasio Model'. Other causal models have been proposed and researched, such as the Interhemispheric Interference Model (Forster & Webster, 2001; Webster, 1998) and EXPLAN Model (Howell, 2004). However these are not discussed because they are beyond the scope of this thesis.

### Demands and Capacities Model

The Demands and Capacities Model is known as a multi-factorial causal model. Traditionally, multi-factorial models propose that stuttering has numerous causes that include environmental factors found in a child's day-to-day life. The Demands and Capacities Model identifies four domains that cause stuttering: speech-motor control, language development, social and emotional development and cognition (Adams, 1990; Peters & Starkweather, 1989; Starkweather & Gottwald, 1990).

The model suggests that when the environmental demands across the four domains exceed a child's capacity for fluent speech, stuttering will occur (Adams, 1990; Peters & Starkweather, 1989; Starkweather & Gottwald, 1990). Environmental demands might include parental speech rate, conversational turn-taking, language complexity and emotional stressors. Capacities required for fluent speech might include a child's speech-motor coordination, receptive and expressive language abilities, emotional regulation and reactivity, and cognitive abilities (Franken & Putker-de Bruijn, 2007).

Siegel (2000) has criticised the various versions of the Demands and Capacities Model. He did not dispute that the environmental demands that are identified within the model can be associated with stuttering moments. However, he highlighted that the capacities identified in the various versions of the Demands and Capacities Model are individually complex processes. Siegel argues that given these complexities, each identified child capacity would be difficult to clinically assess and measure directly. Another criticism of Demands and Capacities Models is that, due to their multi-factorial nature, the models are not empirically testable (Onslow, 2019; Packman & Attanasio, 2017).

### The Packman and Attanasio Three-Factor Model (P & A Model)

The P & A Model was developed specifically to bring together "what we know about stuttering into a cohesive causal explanation" (Packman & Attanasio, 2017, p. 93). What has resulted is a causal model that proposes three factors that need to be present for individual stuttering moments to occur (Packman, 2012). This is a departure from previous causal models of stuttering as it seeks only to explain the occurrence of stuttering moments in speech.

The first factor of the P & A Model is impaired neural processing for spoken language. Brain imaging research has identified differences in the structure, function and connectivity of the brains of adults who do and do not stutter (Etchell, Civier, Ballard & Sowman, 2017). Specifically, the P & A model discusses research by Cykowski, Fox, Ingham, Ingham and Robin (2010) that found evidence of underdeveloped myelination in the brains of 9- to 12-year-old children who stutter. This research could provide one explanation for the emergence of stuttering in children prior to the completion of brain myelination (Packman, 2012).

According to the P & A model, the second factor necessary for stuttering to occur is a trigger for a moment of stuttering. Such triggers include syllabic stress variation and linguistic complexity during speech. It is proposed that these triggers place higher demands on the underlying neural processing deficits in people who stutter during everyday speech and language tasks (Packman, 2012).

The third factor that is necessary for stuttering to occur is the presence of modulating factors. Such factors may include cognitive demands and physiological arousal, and are said to alter the threshold where stuttering is triggered. The triggers can differ from one person to the next as they are inherent in the individual (Packman & Attanasio, 2017).

The P & A Model accounts for how one early stuttering treatment, the Westmead Program, works to reduce stuttering in young children. The model proposes that stuttering can be triggered by the effort required to vary syllabic stress in connected speech. By reducing this variability, as occurs when employing the speech pattern used in the Westmead Program known as syllable-timed speech, the severity of stuttering reduces (Packman, Code & Onslow, 2007; Packman, Onslow, Richard & Van Doorn, 1996). Further detail regarding the Westmead Program can be found in Chapter 2.

## Impact of Stuttering

Over approximately the past two decades much research has measured the impact of stuttering on individuals. Five key themes have arisen including the impact of: negative attitudes and stereotypes, negative reactions, maladaptive behaviours, social anxiety, and reduced educational and vocational participation. The emergence of each factor in the pre-school years, as well the impact when stuttering persists into adulthood, will now be discussed.

### Negative attitudes and stereotypes about stuttering

In the pre-school years, negative attitudes to stuttering begin to emerge (Weidner, St. Louis, Burgess, & LeMasters, 2015). A study by Ezrati-Vinacour, Platzky and Yairi (2001) investigated the attitudes of pre-school and early school age children towards stuttering. The results indicated that 3-year-old children can identify stuttering. Further, the majority of 4-year-old children in their study preferred a friend who did not stutter. The majority of 5-year-old children in the study indicated that stuttering was “not good talking”.

By adulthood, many of the negative attitudes about stuttering are associated with personal attributes of people who stutter. Research identified that adults who stutter can be viewed as being shy, self-conscious, anxious, nervous or lacking confidence (Craig, Tran & Craig, 2003; Dorsey & Guenther, 2000). Such negative attitudes have been reinforced by film and book representations of stuttering. Johnson (2008) identified that characters who stutter are frequently presented in a negative light to “showcase a malady or humorous oddity” (p. 246”), to demonstrate that a character is “weak or nervous” (p. 247), has an “inability to be heroic” (p. 253), or that characters are “inhuman criminals (…) given physical/mental impediments and animalistic traits” (p. 256).

### Negative reactions to stuttering

In children, reactions to stuttering by peers begin to impact social interactions. Langevin, Packman and Onslow (2010) reported parent observations of negative reactions to their children who stutter. Such parent observations of their pre-school children who stuttered included: their sentences were interrupted or completed by others, they were not given ample opportunity to finish speaking, and that sometimes peers walked away when stuttering occurred. Additionally, pre-school children who stutter were found to experience teasing, or were intentionally ignored when trying to engage peers in play (Langevin, Packman & Onslow, 2009).

In a study by Hugh-Jones and Smith (1999), almost half of the adults surveyed were experiencing the long-term effects of school-yard bullying due to stuttering in childhood. However, bullying is also experienced by adults who stutter (Boyle, 2018). Other negative reactions experienced by adults who stutter are explored by Boyle (2018). More than 80% of the 324 adults who stuttered reported that people were unkind, would avoid eye contact in conversation, did not take them seriously, and laughed at them (Boyle, 2018).

### Maladaptive behaviours of people who stutter

Maladaptive behaviours as a consequence of stuttering begin from a young age. Parent reports indicate that children as young as 2 years of age react negatively to their own stuttering (Boey et al., 2009; Langevin et al., 2010). Findings identified that pre-school children react to their own stuttering by stopping speaking, avoiding speaking situations, expressing frustration or sadness, or seeking support to talk.

In adults, maladaptive behaviours are also well documented. Adults who stutter are known to avoid specific words to prevent stuttering, which reduces their ability to communicate in the way they intend (Jackson, Yaruss, Quesal, Terranova, & Whalen, 2015). Additionally, adults who stutter often avoid certain speaking situations (Craig, Blumgart and Tran, 2009; Kraaimaat, Vanryckeghem, & Van Dam-Baggen, 2002).

Adults who stutter may rely on safety behaviours to avoid negative outcomes if they participate in speaking situations where they are anxious (Helgadottir, Menzies, Onslow, Packman & O'Brian, 2014; Lowe et al., 2017). Safety behaviours are thinking patterns or behaviours, used by people who are socially anxious, to prevent negative outcomes from occurring (Lowe et al., 2017). Examples of safety behaviours include avoiding eye contact or rehearsing conversational exchanges (Wells et al., 1995). Researchers suggest that safety behaviours may maintain social anxiety disorder (Clark, 1999). If adults who stutter participate in speaking situations where they are anxious, they may also ignore positive social cues of the listener which have the potential to reduce negative beliefs about those situations (Lowe et al., 2012). Ignoring these positive situations can contribute to the maintenance of social anxiety (Horley, Williams, Gonsalvez & Gordon, 2004).

### Social Anxiety in people who stutter

Although social anxiety is common in adults who stutter, it is not known precisely when anxiety begins to emerge in children who stutter. A prospective community cohort of pre-school children who stutter found that they were no more likely than their non-stuttering peers to be anxious (Kefalianos, Onslow, Ukoumunne, Block & Reilly, 2014). However, in a study by McAllister (2016) parents reported that children who stuttered were more likely to have behavioural, emotional and social difficulties than their non-stuttering peers.

By the school years, Iverach and colleagues (2016) found that stuttering during childhood is associated with a higher rate of anxiety disorders in a clinical population. However, in a community cohort study Smith and colleagues (2017) found no evidence that a community sample of 11-year-old children who stuttered were more anxious than their non-stuttering peers. The differences reported across these studies may be due to the use of differing definitions and measures of anxiety.

By adulthood, it is well documented that people who stutter are significantly more likely to develop mental health disorders involving anxiety, and specifically social anxiety disorder, than are those who do not stutter (Iverach et al., 2009; Menzies, Onslow & Packman, 1999). In fact, Menzies and colleagues (2008) found that more than half of the 32 adults seeking treatment for stuttering qualified for a diagnosis of social anxiety disorder.

### Reduced educational and vocational participation or achievement

During the pre-school and early school years, stuttering can impact participation in educational settings. It is documented that stuttering can influence the ability of pre-school children to resolve conflicts with peers, or to lead and contribute ideas in play (Boey et al., 2009; Langevin et al., 2010).

Klompas and Ross (2004) reported that stuttering can also impact the development of student-teacher relationships, academic performance and the development of self-identity. Davis, Howell and Cooke (2002) further suggested that children who stutter may try not to stand-out in class by aligning their own behaviours with social groups that represented the largest proportion children. It was proposed that such assimilation with peers might have been to reduce the risk of experiencing negative peer reactions.

By adulthood, there is evidence that stuttering leads to lower educational and vocational achievement by people who stutter. Within the population of adults who stutter, O'Brian, Jones, Packman, Menzies and Onslow (2011) reported that lower educational attainment correlated with higher stuttering severity. Interviews with adults who stutter reveal many personal experiences of stuttering prohibiting participation in educational and professional settings (Cream, Onslow, Packman, & Llewellyn, 2003). Findings indicated that stuttering can have an impact on overall academic performance, employment prospects and promotion (Corcoran & Stewart, 1998; Klompas & Ross, 2004). In a study by Klein and Hood (2004), half of the adults who stuttered indicated that they sought jobs that required minimal verbal communication.

## Summary

Stuttering is a common speech disorder with approximately one in ten children presenting with the disorder by the age of 4. Early stuttering intervention is recommended because [1] stuttering is most tractable in the pre-school years, and [2] the adverse effects of stuttering that begin to develop by 3 years of age, increase by the time stuttering persists into adulthood.

# Chapter 2: Treatment of Early Stuttering

## Synopsis

Chapter 2 overviews stuttering treatments that are used with the pre-school population. The chapter commences with a discussion of the different treatment approaches that can be used to treat stuttering in pre-school children. This is followed by an overview of each of the early stuttering treatment programs that are supported by randomised clinical trial evidence. The chapter then concludes with a summary of other treatments that are used with the pre-school population but are not yet substantiated with randomised clinical trial evidence.

## Stuttering Treatment Programs for the Pre-school Population

A number of stuttering intervention programs have been developed for the pre-school population. This section provides an overview of three treatment programs where randomised clinical trial evidence exists for children under the age of 6 years.

Three treatment programs are summarised below and include: the Lidcombe Program, RESTART-DCM[1], and the Westmead Program. Each summary is presented in three sections: an overview of the treatment program procedures, the strongest level of research evidence supporting each program, and the mechanism of action that is said to underpin the program. A mechanism of action is the way in which behavioural changes might be affected by a treatment (Hart et al., 2019).

### The Lidcombe Program of Early Stuttering Intervention (the "Lidcombe Program")

#### Program overview

The Lidcombe Program is a behavioural intervention based on operant methods (Onslow et al., 2017). Parents are trained by a speech pathologist to provide feedback to their children to encourage stutter-free speech and discourage stuttering. This feedback is known as parent verbal contingencies of which five types exist. Table 2.1 provides an example of each type.

[1] The Rotterdam Evaluation Study of Stuttering Therapy – Demands and Capacities Model

*Table 2.1: Types of Parent Verbal Contingencies in the Lidcombe Program, with examples*

| Parent Verbal Contingency Type | Example |
|---|---|
| Acknowledging stutter-free speech | "That was smooth!" |
| Praising stutter-free speech | "Beautiful smooth words!" |
| Requesting self-evaluation of stutter-free speech | "Was that smooth?" |
| Acknowledging unambiguous stuttering | "Bumpy" |
| Request self-correction for unambiguous stuttering | "Can you say 'I' again?" |

The Lidcombe Program consists of two stages. During Stage 1, the parent and the child attend the clinic on a weekly basis for sessions with a speech pathologist of 45 to 60 minutes in duration. For the purposes of this thesis, these weekly sessions are known as clinic visits. Beyond the clinic, parents implement the treatment with their children each day for a minimum of 10 to 15 minutes. Beyond clinic treatment occurs in structured practice sessions and in natural conversations that occur in the child's everyday speaking environment.

Treatment outcomes are measured on a daily basis using the Lidcombe Program 10-point stuttering severity rating scale. According to the scale, 0= no stuttering, 1= extremely mild stuttering and 9= extremely severe stuttering. Once stuttering severity ratings are consistently low, two criteria need to be met to progress to Stage 2. These criteria are: [1] parent stuttering severity ratings of 0–1 during the week preceding the clinic visit with at least four of those seven stuttering severity ratings being 0, and [2] speech pathologist severity ratings of 0–1 during the clinic visit (Onslow, et al., 2017, p. 10).

Stage 2 of the program is a maintenance phase. During Stage 2, treatment is systematically withdrawn by the parent under the guidance of the speech pathologist. As such, the parent and child are required to maintain treatment outcomes for increasingly longer intervals between clinic visits. The aim of Stage 2 is to maintain the low levels of stuttering achieved during Stage 1 for the longer-term.

### Level of evidence

Several randomised controlled trials of the Lidcombe Program have demonstrated the significant effect the Lidcombe Program can have on stuttering severity in the pre-school population (Arnott et al., 2014; Bridgman, Onslow, O'Brian, Jones, & Block, 2016; Jones et al., 2005; Latterman, Euler & Neumann, 2008). These have not only been conducted for individual treatment (Jones et al., 2005; Latterman et al., 2008), but also for group delivered treatment (Arnott et al., 2014) and treatment delivered via telehealth (Bridgman et al., 2016). The reductions in stuttering severity achieved by the Lidcombe Program have also been maintained for between 2 and 7 years post-treatment, as demonstrated by follow-up studies (Lincoln & Onslow, 1997; Jones et al., 2008). The Lidcombe Program's replicability by different research groups has also been independently verified (Baxter, et al., 2015; Blomgren, 2013; Nye & Hahs-Vaughn, 2011; Nye, et al., 2013).

Results from two randomised controlled trials and two randomised controlled experiments of the Lidcombe Program were analysed to assess the program's effect size (Onslow, Jones, O'Brian, Packman & Menzies, 2012). Across all four studies the combined total of the treatment and control groups for whom follow-up data were available across was 134 children. This analysis found that 6.3 months post-randomisation, children who participated in Lidcombe Program treatment had 7.5 times greater odds of having no stuttering or almost no stuttering than the control participants who did not receive Lidcombe Program treatment.

### Mechanism of action

The Lidcombe Program development was based on experimental evidence that verbal response contingent stimulation could reduce stuttering in young children (Manning, Trutna & Shaw, 1976; Martin, Kuhl & Haroldson, 1972; Reed & Godden, 1977). Initial experimental research of the Lidcombe Program using parent verbal contingencies also resulted in reduced stuttering (Onslow, O'Brian, & Harrison, 1997; Onslow, Menzies & Packman, 2001). Hence, parent verbal contingencies were thought to be the mechanism of action underpinning the Lidcombe Program. However, recent studies have been unable to support this assumption (Carr Swift et al., 2011; 2016; Donaghy et al., 2015; Harrison, Onslow & Menzies, 2004). Chapter 3 provides additional information regarding these efforts to assess the functionality of parent verbal contingencies in the Lidcombe Program.

Bonelli, Dixon, Bernstein Ratner and Onslow (2000) investigated whether acoustic or linguistic variables are responsible for the positive effects of Lidcombe Program treatment. Data were drawn from two clinical trials of the Lidcombe Program. Data included pre- and post-treatment speech samples of nine children and their mothers.

Results showed no link between stuttering reduction and changes in articulation rate, inter-turn speaker latency, or language output. However, as they failed to explore the behaviour of speech pathologists during clinic visits, the design of the study does not allow for a thorough examination of these alternative mechanisms of action.

## The Rotterdam Evaluation Study of Stuttering Therapy-Demands and Capacities Model (RESTART-DCM)

A number of treatment programs are based on multi-factorial causal theory and, specifically, the Demands and Capacities Model. Since at least the 1990s, Demands and Capacities Model treatments have been used to treat pre-school children in the United States (Adams, 1990), the United Kingdom (Matthews, Williams & Pring, 1997), and the Netherlands (Franken & Putker-de Bruijn, 2007). Of these various treatments based on the Demands and Capacities Model, one is supported by randomised clinical trial evidence. That treatment is known as RESTART-DCM and will now be outlined.

### Program overview

RESTART-DCM is a parent-delivered stuttering treatment program for children up to the age of 6 years (de Sonneville-Koedoot, Stolk, Rietveld, & Franken, 2015). Parents and children attend weekly treatment sessions with a speech pathologist. Beyond the clinic, parents implement the treatment with their children during 15 minutes of "special time" and in the daily family activities for a minimum of 5 days a week. Parents record qualitative information each day in a logbook, based on the treatment activities set by the speech pathologist and the outcomes that the parents have observed.

There are five stages in the program: Evaluation Stage, Reducing Demands Stage, Capacities Training Stage, Direct Therapy Stage, and Tapering-off Treatment Stage. The RESTART-DCM program commences with the Evaluation Stage. During the Evaluation Stage many environmental aspects of the child's life are evaluated, as well as the child's speech-motor, linguistic, social-emotional and cognitive development.

Treatment then commences during the Reducing Demands Stage. The aim of this stage of the program is to have adults change their behaviours in order to lower environmental demands on the child who stutters. Parents are trained by a speech pathologist to alter a variety of environmental factors that are present in the child's life. The environmental factors that are said to sustain stuttering may be different for each child. Therefore, intervention is not the same for each child.

Some of the environmental factors that may be altered during the Reducing Demands Stage of the program include: reduction in parental speech rate, increase in parental conversational pausing, reduction in parental linguistic complexity or questioning, reduction in parental emotional reactions, reduction in parental perfectionistic tendencies, provision of age-appropriate knowledge of the world to the child (Franken & Putker-de Bruijn, 2007). Each factor is addressed in turn, first during daily special time where the parent practises with the child, and later throughout day-to-day life.

As the child progresses through the Reducing Demands Stage, treatment continues for each factor for the entirety of the program as new factors are introduced. New factors are first introduced during special time and then transferred to day-to-day life once they have been mastered. When all the required demand factors have been introduced, practice of these demand factors continues but focus is placed on the Capacities Training Stage.

The aim of the Capacities Training Stage is to increase the child's capacity for fluent speech. During this stage, parents are trained by the speech pathologist to build the child's capacity across the same four domains outlined in the previous stage, namely: speech-motor, linguistic, social-emotional and cognitive. Examples of the capacities that are addressed include: speech-motor training; language therapy addressing an imbalance in linguistic development; reinforcement of the child's sense of security, self-esteem and/or confidence; reinforcement of the concept of turn-taking in conversation (Franken & Putker-de Bruijn, 2007). Again, the domains are each addressed in turn, first during special time and later during day-to-day life. Treatment for each component that is introduced continues for the entirety of the program.

Once all capacity training has been introduced, treatment then transitions to the Direct Therapy Stage. The aim of this stage is to achieve "more fluent speech" (Franken & Putker-de Bruijn, 2007, p. 15). During this stage stuttering behaviours are modified rather than eliminated. Such modified behaviours include "more normal disfluencies [that are] (…) relaxed instead of tense (…) more repetitions rather than prolongations or blocks (…) more often single repetitions rather than multiple repetitions" (Franken & Putker-de Bruijn, 2007, p. 15). The speech pathologist trains the parent to model these desired behaviours for the child during play-based activities.

The Tapering-off Treatment Stage is the final stage of the program. It is implemented either following the Direct Therapy Stage, or at any point that the child is exhibiting "normal-fluent speech (…) or exhibits only incidental disfluencies that are minimally abnormal" (Franken & Putker-de Bruijn, 2007, p. 16). The Tapering-off Treatment Stage may also be introduced if early termination of the program is warranted due to family preferences or the speech pathologist's recommendation (Franken & Putker-de Bruijn, 2007). During this stage treatment is gradually reduced over a period of 24 months.

#### Level of evidence

A randomised controlled trial compared the effectiveness of RESTART-DCM treatment to the Lidcombe Program (de Sonneville-Koedoot et al., 2015). The study involved a sample of 199 children who stuttered. The primary outcome measure was percentage syllables stuttered, with children considered to be stutter-free when percentage of syllables stuttered was below 1.5%. The study found that there was no statistically significant difference in the low stuttering severity scores achieved by participants in each of the two treatment groups. At 18 months post-treatment onset, mean percentage of syllables stuttered was 1.2% for the Lidcombe Program and 1.5% for RESTART-DCM.

#### Mechanism of action

Multi-factorial treatments target various domains. The developers of the original Demands and Capacities Model identified "as many etiologies as there are stories of stuttering development" (Starkweather & Givens-Ackerman, 1997, p. 24). This implies that no single mechanism of action is responsible for treatment gains. A proponent of RESTART-DCM states that the "individualised approach to each child's profile" (Bernstein Ratner, 2018, p. 16) is consistent with the mechanism of action of the multi-factorial treatment. Regardless, two of the many potential mechanisms of action underpinning RESTART-DCM may be increased inter-turn speaker latency and reduced speech rates of parents during the course of treatment. This is because these two features are administered to all children who participate in RESTART-DCM treatment (Franken & Putker-de Bruijn, 2007).

### The Westmead Program

#### Program overview

The Westmead Program utilises a speaking pattern with children who stutter known as syllable-timed speech. This technique involves speaking as naturally as possible while providing equal stress to each syllable in connected speech. There is currently no treatment manual available that provides a detailed overview of the Westmead Program.

However, some details of the procedure are available in the research literature (Trajkovski et al., 2011; 2019).

The Westmead Program consists of two stages. In Stage 1 parents and their children attend weekly sessions with a speech pathologist in order to learn the syllable-timed speech technique. Parents and their children then adopt the speech technique in their everyday lives, six times each day for 5 to 10 minutes at a time.

During practice time, parents will prompt their children to adopt the technique. Once a parent and child are able to proficiently use the technique, sessions with the speech pathologist occur fortnightly. Treatment outcomes are recorded each day by the parent using a 10-point stuttering severity rating scale. Research regarding the Westmead Program has used a 1 to 10 scale where 1= no stuttering, 2= extremely mild stuttering and 10= extremely severe stuttering (Trajkovski et al., 2019). When the child has achieved average ratings of less than 2 over a period of 4 weeks, treatment progresses to Stage 2, the maintenance stage.

Stage 2 of the program involves gradual withdrawal of the treatment. Parents are instructed by the speech pathologist regarding the withdrawal of treatment practice sessions over a period of months. During this gradual withdrawal of treatment, parents will prompt children to use the syllable-timed speech technique when it is required for fluency. Stage 2 aims to maintain little or no stuttering over the course of a year.

### Level of evidence

The best research evidence supporting the Westmead Program is a pragmatic non-inferiority randomised controlled trial (Trajkovski et al., 2019). The study compared the Lidcombe Program to two variations of the Westmead Program. These variations included standard Westmead Program, and Westmead Program with the addition of parent verbal contingencies.

The study involved a total sample of 91 pre-school age children randomised to one of the three groups. The primary outcome measures were percentage syllables stuttered and stuttering severity ratings. Blind outcome assessments were conducted at 9 months randomisation.

Outcome measures indicated there was a slightly larger reduction in mean percentage of syllables at 9 months post-randomisation for Lidcombe Program participants (Lidcombe Program $M$= 1.35%, standard Westmead Program $M$= 2.02%, Westmead Program with parent verbal contingencies *M*= 1.99%). The results were similar for mean stuttering severity ratings on the 1 to 10 scale (where 1= no stuttering, 10= extremely severe stuttering) at 9 months post-randomisation (Lidcombe Program *M*= 1.50, standard Westmead Program *M*= 1.67, Westmead Program with parent verbal contingencies *M*= 2.40). These differences were not statistically significant.

Significant dropout rates may have impacted the interpretation of results, with greater numbers of dropouts in the Westmead Program groups than the Lidcombe Program group. Therefore, only a tentative conclusion can be made that either version of the Westmead Program was not inferior to the Lidcombe Program at reducing stuttering in pre-school children.

### Mechanism of action

The technique that underpins the Westmead Program, syllable-timed speech, is a well-recognised fluency inducing condition (Ingham 1984; Packman et al.,1996; Packman et al., 2007). It has been hypothesised that syllable-timed speech reduces the variability in syllabic stress during connected speech, thus reducing the motoric effort required to move from syllable to syllable (Packman et al., 2007). Syllable-timed speech can even lead to a reduction in stuttering in syllable-timed languages, such as Cantonese. It is hypothesised that although syllable-timing is inherent in the Cantonese language it is not as strong as when the syllable-timed speech pattern is purposefully implemented (Law et al., 2017).

## Other early stuttering treatment programs

Three additional programs are used in the pre-school population, but are not supported by randomised clinical trial evidence. The first two treatments are based on the multi-factorial causal model of stuttering (as outlined in Chapter 1). They are Palin Parent-Child Interaction therapy and Family-Focussed Treatment Approach. The third is called Gradual Increase in Length and Complexity of Utterance. All three are outlined below.

### Palin Parent-Child Interaction

Palin Parent-Child Interaction program is based on a multi-factorial causal model used to treat children under the age of 7 (Kelman & Nicholas, 2017; Millard, Edwards & Cook, 2009). The aim of the treatment “is not zero stuttering during intervention” (Onslow & Millard, 2012, p. 4). Rather, the aim of Palin Parent-Child Interaction is to “establish a decreasing trend in stuttering, reduced parental anxiety, and increased parental confidence in managing the stuttering” (Onslow & Millard, 2012, p. 4). Palin Parent-Child

Interaction has the capacity to combine both indirect and direct treatment across the three key “strands” of the program that get parents to focus modifying their interaction styles, implementing family strategies, and supporting their children with direct speech strategies (Millard, Edwards & Cook, 2009).

The highest level of evidence supporting Palin Parent-Child Interaction therapy is a single case series with randomised controls (Millard, Edwards & Cook, 2009). The sample size was six children who stuttered that received the Palin Parent-Child Interaction therapy and four children who stuttered that received no treatment. The four children who received treatment presented with a reduction in percentage of stuttered words of between 31% and 62% by the end of the 6 week treatment program. A recent retrospective file audit involved a larger sample size of 55 children who stuttered who obtained a mean reduction in stuttering frequency of 66% after 12 months post-treatment onset (Millard, Zebrowski, & Kelman, 2018).

### Family Focussed Treatment Approach

Family Focussed Treatment Approach is based on the Demands and Capacities Model. The aim of the approach is improving speech fluency while “simultaneously ensuring the development of healthy communication attitudes and effective communication skills” (Yaruss, Coleman & Hammer, 2006, p. 119). The program is said to combine direct and indirect treatment approaches for stuttering. A treatment manual is available for this treatment (Yaruss & Reardon-Reeves, 2017).

The best research evidence for Family-Focussed Treatment Approach is a retrospective file audit of 17 children who received one component of the program (Yaruss et al., 2006). Although many of the participants achieved speech described as “within normal limits” after this single treatment component, there is no indication as to what “within normal limits” meant in the context of stuttering.

### Gradual Increase in Length and Complexity of Utterance (GILCU)

Gradual Increase in Length and Complexity of Utterance Program, also referred to as GILCU, is a treatment used with children (including preschool children) and adults. The aim of the treatment is “normal fluent speech” (Ryan, 2012, p 221). The treatment is delivered across 54 Steps which are outlined in a dedicated textbook (Ryan, 1974; 2001). These Steps include reading, monologues or conversation, and require a child who stutters to gradually increase in complexity both in terms of the utterance length and linguistic difficulty. For example, in Step 1 the child is required to say single words fluently, for 10 consecutive words. By Step 18 the child is required to speak for 5 minutes fluently. Positive reinforcement is provided after each fluent word or sentence, using verbal feedback such as “Good” and through the provision of a reward token. If the child does not meet the task criterion, the child is told “Stop, speak fluently” (Ryan, 2001, p 115) and is required to restart the task

Evidence for the use of GILCU program with the pre-school population is based on a case study of a four year old child who received a variation of the program. Over the course of the 30 treatment sessions the participant’s stuttered words per minute reduced by 72% (Ryan, 2001).

## Summary

A number of treatment programs exist for stuttering during the pre-school years. The most extensive research evidence is for the Lidcombe Program. The Lidcombe program was developed from experimental evidence that verbal response contingent stimulation reduced stuttering in young children. A feature of the Lidcombe Program known as parent verbal contingencies, was therefore thought to be the mechanism of action underpinning the program. Studies pertaining to whether this is in fact the case are presented in Chapter 3.

# Chapter 3: The Need for This Research

## Synopsis

This chapter begins by discussing treatment theory and why research investigating mechanisms of action in pre-school stuttering treatment is critical. It then summarises the rationale for the Lidcombe Program's original design and development based on response contingent stimulation, and subsequent research that has failed to confirm it as the mechanism of action. This is followed by a summary of why this research focus has now shifted for the current study. The aims and objectives of the study that are the topic of this thesis are then discussed, and the specific research question is presented.

## Lidcombe Program Mechanism of Action

### Treatment theory and mechanisms of action

Treatment theories explain how treatments work (Whyte, 2014). According to Hart and colleagues (2019) treatment theories have three key treatment components: active ingredients, mechanisms of action, and treatment targets.

Active ingredients are the features of treatment that lead to a desired change (Hart et al., 2014). Active ingredients are always measurable and can include behaviours of a speech pathologist such as how knowledge and skills are taught (Sohlberg & Turkstra, 2011). A speech pathologist can administer ingredients in a variety of ways, such as explaining or demonstrating a task, or praising the performance of a client. Active ingredients can be replicated, or changed varied systematically, to observe the effects altered dosages or various ingredient combinations (Turkstra, Norman, Whyte, Dijkers & Hart, 2016).

Mechanisms of action are the process by which active ingredients take effect (Hart et al., 2014). Mechanisms of action are frequently hypothesised rather than known (Zanca et al., 2019). Speech pathologists' theories as to a treatment's mechanism of action can influence clinical decision making including choice of treatment targets that are pursued and active ingredients that are administered (Turkstra et al., 2016).

Treatment targets are the particular aspects of behaviour that are intended to be changed (Hart et al., 2014). Treatment targets are differentiated from treatment aims which are aspects of a person's functioning that change indirectly due to changes in the targets (Zanca et al., 2019). For example, a reduction in situation avoidance by an adult who stutters may come about because of a reduction in anxiety in the situation, or it may come about due to an increase in the person's fluency. Reduction in situation avoidance is an indirect change in the person's participation in social situations and therefore a treatment aim. The treatment target for the Lidcombe Program is to reduce stuttering.

There are a number of benefits of understanding treatment components and how treatments work. Such benefits will now be discussed.

## Benefits of determining the mechanisms of action of a treatment

Understanding the mechanisms of action underpinning a treatment can be beneficial for new or existing treatments. The two key advantages of understanding mechanisms of action of a treatment are [1] understanding critical components for treatment efficacy, and [2] identifying details that are critical for treatment replication (Zanca et al., 2019). These two benefits will now each be discussed.

### Understanding components critical for treatment efficacy

Understanding essential components of treatment efficacy can benefit existing treatments such as the Lidcombe Program. By understanding treatment components, treatments can be enhanced to become more effective, better suited to the characteristics of specific client characteristics or goals, and can become more efficient (Hart et al., 2014; Turkstra et al., 2016).

There are a number of ways that treatments can become more effective by understanding treatment components. One way is for speech pathologists to understand the connection between changes in a client's functioning and the specific steps taken to bring about such changes (Zanca et al., 2019). If components and their therapeutic effect can be identified and understood, these components can be better explained to parents participating in treatment. There is evidence that some mothers who have administered the Lidcombe Program to their children, experienced anxiety that they weren't delivering the treatment correctly (Goodhue, Onslow, Quine, O'Brian & Hearne, 2010). Understanding treatment components may therefore positively impact the emotional experiences of some parents when participating in Lidcombe Program treatment with their children, by providing a better understanding of the program.

By understanding treatment components, stuttering interventions can also become more effective by facilitating the clinical problem-solving of speech pathologists. This may be necessary when desired outcomes of treatment are not being achieved, or when parents have specific goals they wish to target during treatment (Zanca et al., 2019). In such instances the dosage of ingredients, the measurement of ingredients, or the ingredients themselves, can be altered to customise treatment for individual clients (Turkstra et al., 2016). There is evidence that some mothers experience a lack of progress when administering Lidcombe Program treatment to their children (Goodhue et al., 2010). By understanding treatment components of the Lidcombe Program, speech pathologists will be better equipped to problem solve these situations whilst retaining the integral components of the program.

Understanding treatment components may also lead to increases in treatment efficiency (Zanca et al., 2019). Increased treatment efficiency would be beneficial given pre-school children seeking stuttering intervention from Australian public health organisations often encounter wait times. In 2014, an Australian parliamentary inquiry investigated the prevalence of communication disorders, and the adequacy of speech pathology services (Commonwealth of Australia, Community Affairs References Committee, 2014). The Committee heading this enquiry identified that “where there is no intervention, or delayed intervention, the costs to the child and to society can be significant” (Commonwealth of Australia, Community Affairs References Committee, 2014, p 53).

The inadequacy of services to meet demand for early stuttering intervention was highlighted in an Australia wide survey of 154 parents. Parents of children “with a speech or language disorder” (Ruggero, McCabe, Ballard & Munro, 2012, p 341), were recruited into the study when seeking paediatric speech pathology services. Parents reported lengthy wait times to access services through public health organisations. Twenty-five percent of parents reported waiting more than 6 months, and 15% reported waiting more than 1 year for an assessment. Eighteen percent reported waiting more than 1 year after assessment to access treatment. If knowledge of treatment components can lead to the attainment of treatment efficiencies, for example by eliminating redundant aspects of treatment, there is a potential for wait times to reduce. This is because briefer treatments would take less time to implement and would logically allow children to progress through the service quicker, thus reducing wait times.

### Identifying details essential for treatment fidelity and replication

By understanding treatment components of the Lidcombe Program, speech pathologists can be made aware of the critical components for treatment fidelity and replication (Hart et al., 2014; Turkstra et al., 2016). Although the Lidcombe Program is based on a treatment guide that is freely available (Onslow et al., 2017), there are issues with speech pathologists adherence to the procedures contained in that guide, and also with the relevance of the details contained in the guide itself.

Research by Rousseau, Packman, Onslow, Dredge and Harrison, (2002), surveyed 400 speech pathologists with a 75% response rate. Of the community sample of 277 speech pathologists from across Australia who responded, only half of the speech pathologists administering the Lidcombe Program adhered to the procedures contained in the Lidcombe Program guide. Although many of the speech pathologists who indicated reduced adherence to the guide identified that this was due to workplace restrictions on service delivery, increased knowledge of treatment components is known to increase replicability of treatment procedures (Turkstra et al., 2016).

The Lidcombe Program treatment guide (Onslow et al., 2017) was written based on the premise that parent verbal contingencies are the sole mechanism of action underpinning the Lidcombe Program. As such, the Lidcombe Program treatment guide was developed to provide sufficient detail to implement this feature. However, research has failed to confirm that parent verbal contingencies are the mechanism of action. Therefore, the guide lacks detail regarding other ingredients and mechanisms of actions that speech pathologists need to consider when implementing Lidcombe Program treatment.

### Therapeutic design based on response contingent stimulation

Dunst, Raab, Hawks, Wilson and Parkey (2007) state that "response contingent stimulation involves the provision of stimulation contingent upon a child's behaviour" (p. 226). An example is the provision of praise to a child for demonstrating a desirable behaviour. Evidence based on experimental research during the 1970s indicated that verbal response contingent stimulation could reduce stuttering in young children (Manning et al., 1976; Martin et al., 1972; Reed & Godden, 1977).

The first experimental study to investigate the effects of response contingent stimulation on stuttering was by Martin and colleagues (1972). Martin and colleagues studied two child participants who received 27 and 41 experimental treatment sessions respectively. The session were 20 minutes in length and occurred weekly.

The experimental treatment sessions involved a talking puppet named Suzybelle. The experimental treatment procedure varied throughout the course of treatment and between the child participants. The main premise of the experimental treatment however was the response contingent stimulation delivered via the puppet. The Suzybelle puppet was mounted on a stage in the clinic room. Suzybelle would light-up and interact with the child. When a child participant stuttered, the stage lights would extinguish, and the puppet would remain motionless and silent for a period of 10 seconds. After the 10 seconds the stage would light up once more and the puppet would become interactive again

The number of moments of stuttering reduced completely for both children by the end of the experimental treatment sessions. Also, the number of words spoken by the children increased as the children progressed through treatment. Audio recordings of the children conversing with their parents within the clinic and also beyond the clinic were obtained. These recordings were used to confirm the generalisation of treatment gains to other situations, as well as the maintenance of treatment gains by 1 year post-treatment at less than 1% syllables stuttered.

Manning and colleagues (1976) conducted experimental research to investigate the use of tangible response contingent stimulation and verbal response contingent stimulation to reinforce fluent speech in three primary school-age children who stuttered. Although the participants were not pre-school age children, the results were still interesting.

Each participant was engaged in three, half-hour experimental sessions across 1 week. During two of the experimental sessions, each of the three children selected a topic they discussed with the researcher in conversation. If the child remained stutter-free for a pre-determined speech interval, the researcher provided either a tangible or a verbal reinforcement of the child’s choosing. The provision of reinforcement continued for the duration of the treatment conversation. If stuttering occurred, the time interval would restart. During the third and final experimental session, children were provided tangible and verbal reinforcement for stuttering.

The study found that tangible and/or verbal reinforcers for stutter-free speech led to an increase in the duration of fluent speech in all three participants. Positive reinforcement of stuttering led to an increase of stuttering behaviours. These results reinforced the thinking at the time that stuttering acts like an operant in that it can be modified with response contingent stimulation.

Reed and Godden (1977) also conducted experimental research to investigate the use of verbal punishment to reduce stuttering in young children. The aim of the study was to investigate the effect of an environmental stimulus that children may encounter outside the clinic environment as a verbal punishment procedure. The multiple baseline design included two pre-school age participants.

The two pre-school participants generally attended the clinic twice a week and received approximately 20 minutes of treatment on each occasion. For treatment, each child engaged in conversation individually with the researcher and was told to “slow down” when instances of stuttering occurred. Essentially, this instruction to “slow down” in response to stuttering acted as a punishment. The percentage of stuttered words for both children reduced following requests to slow down. Beyond clinic recordings were also obtained for each participant at various time points throughout the treatment. These beyond clinic recordings demonstrated a significant reduction in stuttering that was achieved and retained over a period of 8 months.

Given the experimental research described above, the Lidcombe Program was designed with the underlying assumption that stuttering may be brought under operant control. The program uses the provision of verbal response contingent stimulation by parents. As discussed in Chapter 2, speech pathologists train parents to provide verbal contingencies to their children as part of Lidcombe Program procedures. These parent verbal contingencies positively reinforce stutter-free speech and gently correct instances of stuttering. The verbal contingencies are provided to the child during practice sessions and during natural, everyday conversations. In the Lidcombe Program the parent verbal contingencies were presumed to be the mechanism of action that reduces stuttering in children.

### Unable to confirm the mechanism of action

Four studies have attempted to confirm parent verbal contingencies as the mechanism of action underpinning the Lidcombe Program. Harrison and colleagues (2004) began this quest by investigating whether parent verbal contingencies were an essential part of the Lidcombe Program. The study was a four cell design exploring the effects of two independent variables: [1] measuring stuttering severity, and [2] providing parent verbal contingencies. The study involved 38 children who stuttered and their parents.

Overall, half of the children in the study were administered Lidcombe Program with all verbal contingencies, and the other half were administered Lidcombe Program as per the treatment manual, with the verbal contingencies for stuttering removed. All participants were treated for a period of 4 weeks followed by a 4 week break. Outcome measures were obtained pre- and post-experimental treatment, and at 4 weeks following the completion of treatment.

Immediately post-treatment there was no difference between the percentage of syllables stuttered outcomes of the children who received parent verbal contingencies and the children who did not receive the verbal contingencies for stuttering. However, there were statistical trends at 4 weeks post-treatment that the stuttering of participants who had received parent verbal contingencies as part of their experimental treatment had continued to reduce post-treatment. This was in contrast to the participants who had not received parent verbal contingencies, whose stuttering had increased post-treatment. The difference between the two groups was not statistically significant due to insufficient power in the sample. The authors therefore indicate that results are inconclusive (Harrison et al., 2004).

Donaghy and colleagues (2015) continued to investigate the role of parent verbal contingencies in the Lidcombe Program, specifically the role of the verbal contingency request self-correction for unambiguous stuttering. Prior to this research, this verbal contingency was thought to be most potent of all verbal contingency types in the Lidcombe Program. This is because the verbal contingency acts differently to the other parent verbal contingencies. Not only does request for self-correction act as a verbal contingency for stuttering but it also prompts the child to repeat the utterance using stutter-free speech.

Half of the 34 participants in the randomised controlled experiment received standard Lidcombe Program and half received Lidcombe Program with request self-correction removed (Donaghy et al., 2015). All children were treated until stuttering reduced to a stable level at 50% of pre-treatment percentage of syllables stuttered or below. No statistically significant differences were found between the groups for the number of clinic visits to reach 50% reduction in pre-treatment percentage of syllables stuttered (11 visits for the standard Lidcombe Program group, 9 visits for the experimental group). Additionally, there was no statistically significant difference in severity rating scores at 50% reduction in percentage of syllables stuttered. Mean group results for standard Lidcombe Program and the experimental treatment group dropped from 5.7 and 5.1 respectively during the pre-treatment beyond clinic assessment, to 1.8 and 1.7 respectively (on a 10-point stuttering severity rating scale where 1=no stuttering and 10= extremely severe stuttering).

Two other studies have investigated the use of parent verbal contingencies in the Lidcombe Program. This research was completed to evaluate the accuracy of verbal contingencies delivered by parents (Carr Swift et al., 2011; 2016). Carr Swift and colleagues (2011) investigated the way parents delivered parent verbal contingencies to three children who stuttered. Each of the parents completed a diary and made beyond clinic recordings of treatment practice with their children. The audio recordings were later reviewed by the researchers to determine the accuracy of the delivery of parent verbal contingencies.

The results of the study indicated that each of the parents delivered parent verbal contingencies incorrectly at some point in the treatment process. For example, on at least one occasion each of the parents was observed to incorrectly provide verbal contingencies for stutter-free speech when in fact stuttering had occurred. Despite this, all three children responded to Lidcombe Program treatment as evidenced by a reduction in their stuttering.

Carr Swift and colleagues (2016) investigated the use of verbal contingencies by 40 parents when administering Lidcombe Program to their children at home. The study analysed audio recordings of parent delivery of the Lidcombe Program beyond the clinic environment. This included delivery of the program both during practice sessions and during natural conversations. Parents also collected additional qualitative and quantitative information on a template that was provided to the researchers. Information related to parent delivery of treatment on that day, for example the number of times parents gave feedback to the child regarding stuttering and the number of practice sessions conducted on that day.

The participants were 40 pre-school age children participating in Lidcombe Program treatment with their parents. Carr Swift and colleagues (2016) found that approximately 2.7% or a total of 257 out of 9,766 verbal contingencies were provided inaccurately by parents when administering the Lidcombe Program to their children. Of these errors, 89% were instances when verbal contingencies were provided for stutter-free speech when in fact stuttering had occurred.

Interestingly, the time taken to complete Stage 1 of the Lidcombe Program was not influenced by the parents’ accurate delivery of verbal contingencies. For example, there was no correlation between the time taken to complete Stage 1 and the number of verbal contingencies for stutter-free speech, the type of verbal contingency that was provided, or whether verbal contingencies were provided correctly. It was also notable in the Carr Swift and colleagues (2016) study that the provision of a higher mean number of parent verbal contingencies for stuttering during the first 4 weeks of treatment was a predictor of longer time taken to complete Stage 1. These findings indicated that parent verbal contingencies may not have the same therapeutic significance in the Lidcombe Program that was once thought (Carr Swift et al., 2011; 2016).

### Research shift: Investigating other mechanisms of action

Parent verbal contingencies were the assumed mechanism of action underpinning the Lidcombe Program. However, research so far has failed to confirm this to be the case. Given no other intended mechanisms of action exist, it is now time to shift this focus and investigate other features of the Lidcombe Program treatment that may be therapeutic. Features of interest include those that are not explicitly taught to parents as part of Lidcombe Program procedures. Logical features for investigation are behaviours of speech pathologists during Lidcombe Program clinic visits which may be observed by parents.

#### Learning through observation and imitation

It is widely known that adults may learn through observation and imitation. Bandura, Ross and Ross (1963) first discussed how observation and imitation could lead to the modification of behaviours exhibited by an observer. This finding was ground-breaking at the time of publication, as it extended learning theory beyond the established behavioural framework. The experimental research by Bandura and colleagues (1963) led to the creation of social cognitive theory in the 1980s.

Social cognitive theory recognised that learning in social contexts occurs through the dynamic interaction between a person, the environment and an observed or performed behaviour (Gibson, 2004). The theory recognises that people regulate their behaviour in order to achieve and maintain a behavioural goal over time (Bandura, 1989). Such behaviour regulation is achieved in a variety of ways including through observation and imitation (Carroll & Bandura, 1990).

Learning is demonstrated if the modelled behaviours are imitated. Imitation can occur even if the observer is unable to describe exactly what was observed (Fryling, Johnston and Hayes, 2011). The working memory of adults can only handle a very limited amount of auditory information, far less than what is required for intellectual activities (Paas, Renkl & Sweller, 2003). Therefore, learning that occurs using other methods such as learning by observing and imitating what other people say or do is a more effective and efficient way of gaining knowledge (Sweller, 2004; Sweller & Sweller, 2006).

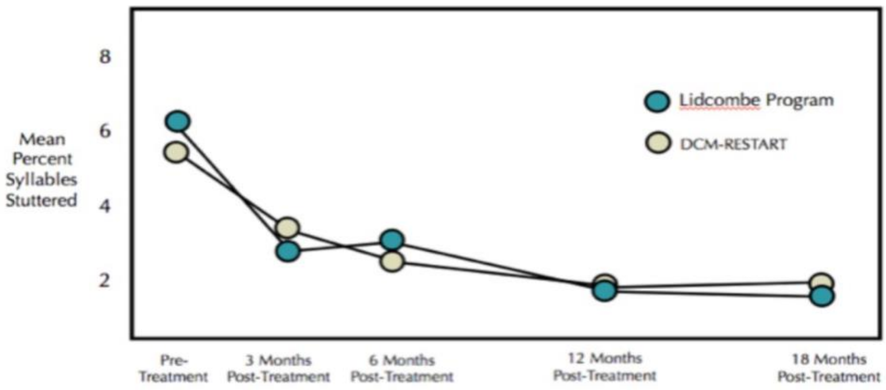
Research has indicated that learning from “expert” models, including by observing other people as they solve problems “live” is very effective for developing both motor and cognitive skills (Braaksma, Rijlaarsdam, Van den Bergh & Van Hout-Wolters, 2004). This has also been shown to be most effective for novice learners or people learning something for the first time (Kitsantas, Zimmerman & Cleary, 2000). However, the effectiveness of learning modelled behaviour does seem to depend on the abilities of the learner (Kalyuga Ayres, Chandler & Sweller, 2003).

The Lidcombe Program is a parent delivered treatment whereby speech pathologists train parents to implement treatment with their children by explanation and demonstration (Onslow et al., 2017). It is plausible that during treatment demonstration by speech pathologists, parents are observing and incidentally learning behaviours that speech pathologists exhibit. Parents may then replicate these behaviours with their children during treatment. It is also reasonable to consider that behavioural features, which could be a feature of the adult’s speech or interaction style, may be having a treatment effect.

### Influence of RESTART-DCM

When searching for potential mechanisms of action underpinning the Lidcombe Program, the mechanisms underpinning other pre-school stuttering treatments were considered. Of note was the randomised controlled trial where the Lidcombe Program was directly compared to another early stuttering treatment, RESTART-DCM (de Sonneville-Koedoot et al., 2015). The graphical representation of the outcome data demonstrates how remarkably similar the trajectory of the treatment results were when comparing the two treatments. That graphic is reproduced in Figure 3.1.

*Figure 3.1: Mean %SS of Lidcombe Program and RESTART-DCM 18 months post-treatment onset*




Source: reproduced with permission from Onslow, 2019.

Given the large number of participants in the study (*N*= 199) who were treated across 20 participating clinics by 24 speech pathologists, it would be unreasonable to suggest that the similarities between the treatment results occurred through chance alone. What is most probable is that either [1] the treatments are leading to the same treatment outcomes through different mechanisms of action, or [2] a mechanism of action or actions are common to both treatments.

It is possible that the treatment results could be due to different mechanisms of action underpinning each of the two treatment programs. This is logical given the Lidcombe Program utilises verbal response contingent stimulation, whereas RESTART-DCM treatment is a multifactorial treatment that works to reduce environmental demands on children who stutter (see Chapter 2). These very different procedures may be underpinned by different mechanisms of action that reduce stuttering in different ways.

Despite the Lidcombe Program and RESTART-DCM using very different treatment procedures, it is also possible that there are mechanisms of action that are common to both treatments. Researchers such as Asay and Lambert (1999), and Wampold (2015), have hypothesised that factors inherent in a clinician-client relationship are common to all treatments and can be therapeutic. Such factors include the therapeutic alliance between a clinician and a client, the expectations placed on the client by the clinician, and the empathy shown to the client (Asay & Lambert, 1999; Wampold, 2015). For the purposes of this thesis, only factors known to reduce stuttering are considered for further investigation.

The first feature that is introduced in the treatment procedures of RESTART-DCM, that is not a formal component of Lidcombe Program procedures, is the modelling of increased conversational pausing by adults (Franken & Putker-de Bruijn, 2007). This conversational pausing is also known as inter-turn speaker latency. As part of RESTART-DCM procedures, increased inter-turn speaker latency is modelled by adults when speaking with children who stutter. Despite RESTART-DCM being a multi-factorial treatment program, this feature is consistently provided to *all* children who participate in the treatment (Franken & Putker-de Bruijn, 2007). This behavioural feature is not a part of documented Lidcombe Program procedures. However, it is reasonable to consider that such a feature could be incidentally modelled by speech pathologists and imitated by parents when implementing treatment beyond the clinic. That is, speech pathologists may inadvertently increase their inter-turn speaker latency when speaking to children, compared with when speaking to parents during clinic visits.

### Influence of experimental research

There is emerging experimental evidence that increased inter-turn speaker latency, a feature of RESTART-DCM, can reduce stuttering. Winslow & Guitar (1994) used a single subject design to measure a child's stuttering during conversation that included structured turn-taking, and in conversation without structured turn-taking. Structured turn-taking is significant because it eliminates overlapping speech which increases overall inter-turn speaker latency. Audio recordings of 15 conversations were obtained of the child in the family home. A 300 word sample of each recording was analysed to identify the number of "disfluencies" in the sample. Results indicated that there was a weak correlation between structured turn-taking and a reduction in the frequency of "disfluencies". Additionally, the total number of disfluencies increased when structured turn-taking was not used. During the baseline condition, the total number of "stuttering-type dysfluencies" in a session was as high as 20, and during the turn-taking condition the total number of "stuttering-type dysfluencies" in a session was as low as 5.

Livingston, Flowers, Hodor and Ryan (2000) investigated the impact of modelling increased inter-turn speaker latency to children who stutter. The experimental design was a time series with experimental sessions lasting 40 to 60 minute each, occurring two or three times a week for 12 weeks. Three child participants were made to converse under several of five treatment conditions: [1] the researcher interrupting the participant's stuttering, [2] the researcher interrupting the participant's fluent speech, [3] the participant interrupting the researcher, [4] the researcher arranging for the participant and researcher to start speaking simultaneously, and [5] the researcher arranging for no interruption. Livingston and colleagues (2000) found that more stuttering occurred when overlapping speech occurred. That is, the children were either the interrupter or the interruptee. The condition of no interruption also reduced stuttering in one of two participants who experienced that condition. The participant's stuttering reduced from between 32 and 40 stuttered words per minute in the pre-treatment assessment, to as low as 13 stuttered words per minute during the "no interruption" condition.

As a result of the experimental evidence that adults modelling increased inter-turn speaker latency can reduce stuttering in some children, it is reasonable to consider that this feature could be unintentionally occurring during Lidcombe Program treatment and having a therapeutic effect. It would therefore be beneficial to investigate whether increased inter-turn speaker latency is [1] utilised by speech pathologists during the Lidcombe Program, [2] learned vicariously from speech pathologists, and [3] later imitated by parents when implementing Lidcombe Program treatment with their children.

## Aim of this Research

The aim of this research is to investigate one potential mechanism of action underpinning the Lidcombe Program, namely increased inter-turn speaker latency. This is important because identifying mechanisms for action will help speech pathologists to optimise Lidcombe Program procedures. The mechanism of action that will be investigated in this study is increased inter-turn speaker latency of speech pathologists when speaking to children, compared to when speaking to parents. The specific research question to be investigated, is: During Lidcombe Program clinic visits, do speech pathologists increase their inter-turn speaker latency when speaking to a child compared to a parent?

It is hypothesised that speech pathologists increase their inter-turn speaker latency when speaking to children compared to when speaking to parents. This is hypothesised as part of the quest to identify the mechanism of action underpinning the Lidcombe Program. This is because inter-turn speaker latency has shown to be potentially therapeutic for children who stutter, it is part of RESTART-DCM treatment, and it may demonstrated by speech pathologists and observed by parents. The reason speech pathologists were studied as opposed to parents is because parents learn to administer Lidcombe Program treatment through instruction and demonstration by speech pathologists. Zanca and colleagues (2019) state that the involvement of a speech pathologist is considered a crucial characteristic of what constitutes the treatment.

## Summary

The current study was driven by the need to identify mechanisms of action underpinning the Lidcombe Program. Although it is possible that the Lidcombe Program's mechanisms of action are distinctive from other treatment programs, it is also possible that the intervention shares common mechanisms of action with other early stuttering treatments. One possible feature of RESTART-DCM that warrants investigation in the Lidcombe Program is increased inter-turn speaker latency. It could be that speech pathologists are unknowingly demonstrating this behaviour and parents are vicariously learning to imitate this behaviour with their children.

The current study takes the first step towards determining if this feature is a mechanism of action in the Lidcombe Program. This study investigated whether speech pathologists are observed to increase their inter-turn speaker latency when speaking to children compared to a parents during Lidcombe Program clinic visits. If inter-turn speaker latency is a potential mechanism for action underpinning the Lidcombe Program, it is anticipated that results will indicate that speech pathologists increase their inter-turn speaker latency when speaking to children compared to parents.

# Chapter 4: Method

## Synopsis

The current study investigated whether speech pathologists increase their inter-turn speaker latency when speaking to children during Lidcombe Program clinic visits compared to when speaking with parents.

This chapter presents the methodology for the current study. It begins with a brief summary of the study design. Materials that were used in the study are then discussed, followed by the dependent measures. Finally, the procedures for data collection are outlined.

## Study Design

This study was an observational study using audio recordings of Lidcombe Program treatment. The study was approved by the Human Research Ethics Committee at the University of Technology Sydney (Project ID ETH18-3054). The ethics approval letter is presented in Appendix A.

## Materials

For the current study, audio recordings of Lidcombe Program clinic visits were analysed acoustically. Audio recordings were obtained from a clinical trial conducted by Trajkovski and colleagues (2019). This clinical trial will be referred to as the Trajkovski and colleagues (2019) study.

The Trajkovski and colleagues (2019) study was a three-arm randomized controlled trial. The study compared the Lidcombe Program to two variations of an experimental treatment known as the Westmead Program. Information regarding the Lidcombe Program and the Westmead Program can be found in Chapter 2. Only recordings of children treated with the Lidcombe Program were used in the current study.

The current study investigated Stage 1 of the Lidcombe Program. During Stage 1 of the Lidcombe Program, parents attend the clinic once a week with their children. This clinic attendance will be referred to as a clinic visit. As part of the Trajkovski and colleagues (2019) study, all Stage 1 clinic visits were audio recorded resulting in a total of 529 Lidcombe Program Stage 1 clinic visit recordings.

## Participants

In the Trajkovski and colleagues (2019) study, thirty-three child participants were allocated to the Lidcombe Program treatment group. These children were treated by five speech pathologists who worked in three research or community clinics in Melbourne and Sydney, Australia. Four additional speech pathologists participated in the clinical trial when, on rare occasions, one of the five primary speech pathologists was absent. Demographic data for these children are presented in Table 4.1.

*Table 4.1: Demographic information for the Lidcombe Program Participant sample of the Trajkovski and colleagues (2019) Study*

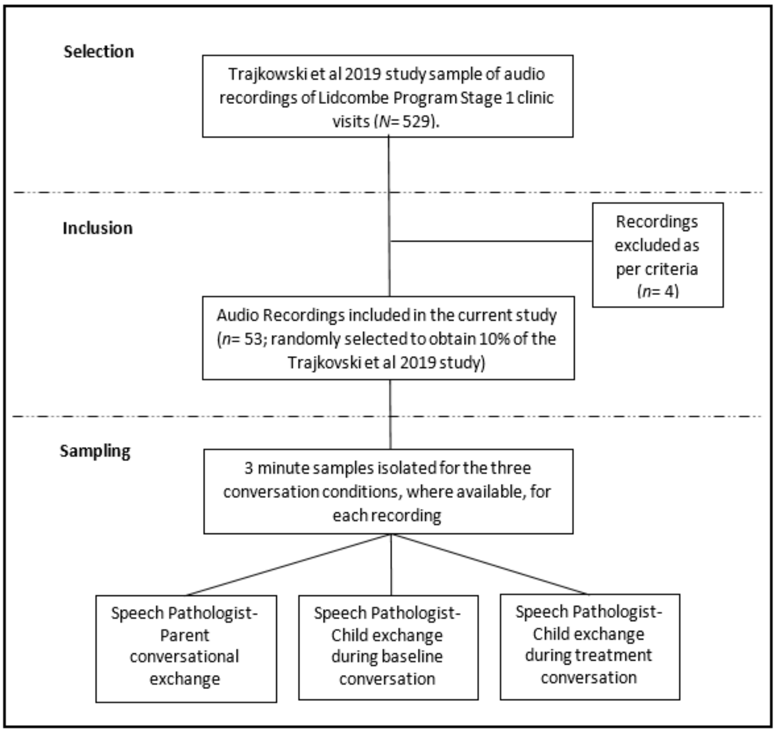
| | |
|---|---|
| Mean age in months (range) | 48.8 (30–70) |
| Number of Participants by Gender (%) | Girls: 9 (27%) |
| | Boys: 24 (73%) |
| Mean pre-treatment severity rating (range) | 4.9 (1–9) |

Participants of the current study were selected from this Lidcombe Program treatment group, and comprised the children, their parents, and the treating speech pathologists. Consent was obtained from all participant speech pathologists to analyse the recordings. The Participant Information Statement and Participant Consent Form are presented in Appendix B and C respectively. A waiver of consent was approved by the Human Research Ethics Committee for the child and parent participants from the Trajkovski and colleagues (2019) study. This was granted due to the age of records (the participants were recruited more than 6 years ago), the potential lack of up to date contact details of participants, the absence of identifying information on the recordings, and the fact that audio recordings were stored separately from any personal information regarding the participants.

## Inclusion, selection and sampling of audio recordings

This section discusses the inclusion criteria for audio recordings included in the current study. It also summarises the process for the selection of audio recordings, as well as for the sampling of audio recordings. The information that is contained in this section is visually displayed in Figure 4.1 and is expanded in the subsequent sections.

*Figure 4.1: Selection, Inclusion, and Sampling of Audio Recordings*




### Inclusion of audio recordings

The inclusion criteria for the current study was based on the contents of the audio recordings of the Lidcombe Program Stage 1 clinic visits. In order to answer the research question, the inclusion criteria were that an audio recording contained conversations between both [a] the speech pathologist and the child, and [b] the speech pathologist and the parent.

Based on these inclusion criteria, four recordings were excluded from the sample. On three occasions, interactions between the speech pathologist and the child did not take place due to exceptional circumstances within the session. Such circumstances included the session being abandoned prematurely due to a child's non-compliance, or the parent and the speech pathologist using the session to analyse beyond clinic recordings to inform treatment. There was one occasion where an audio recording did not meet the inclusion criteria due to a recording error.

### Random selection of audio recordings

For the current study audio recordings were selected using a random number generator. Ten percent of audio recordings, a total of 53, were analysed for the current study. This resulted in audio recordings from 20 different child participants and the five primary speech pathologists involved in the clinical trial. The mean number of recordings selected of each of the 20 child participants across the current study was 2.6 (range 1 to 6). Where audio recordings were excluded for the above reasons, subsequent recordings were randomly selected until the total number of 53 audio recordings was obtained. Appendix D provides information regarding the random selection of audio recordings.

### Sampling of audio recordings

In order to answer the research question, sample conversations between both [a] the speech pathologist and the child, and [b] the speech pathologist and the parent, needed to be obtained. Table 4.2 summarises the events that generally occur during a Lidcombe Program Stage 1 clinic visit, as well as who participates in each activity (as per the Lidcombe Program Treatment Manual; Onslow et al., 2017).

*Table 4.2: Activities that routinely occur in Lidcombe Program Stage 1 clinic visits, by participant*

| Activity | Speech Pathologist participates | Parent participates | Child participates |
|---|---|---|---|
| Child conversation to obtain severity rating (Referred to as the "baseline conversation") | Possibility ✓ | ✓ | ✓ |
| Check parent's ability to obtain a severity rating | ✓ | ✓ | |
| Discussion of progress from the previous week | ✓ | ✓ | |
| Parent demonstration of Verbal Contingencies and speech pathologist may demonstrate if required (Referred to as the "treatment conversation") | Possibility ✓ | ✓ | ✓ |
| Discussion of verbal contingencies demonstration | ✓ | ✓ | |
| Planning treatment changes for the coming week | ✓ | ✓ | |
| Summarise the plan for the coming week | ✓ | ✓ | |

### Speech pathologist-child conversation

As evident in Table 4.2, there are only two activities where speech pathologists routinely speak to children as part of Lidcombe Program procedures: the baseline conversation and the treatment conversation. Parents may participate in either of these activities without the involvement of speech pathologists, therefore speech pathologists participate in these activities at their own discretion.

For example, speech pathologists may participate in the baseline conversation with a child to ensure the sample of the child's speech is of an appropriate length, or incorporates conditions known to trigger stuttering in the child such as excitement. Speech pathologists may participate in the treatment conversation if they think that the parent would benefit from that kind of demonstration and instruction of the Lidcombe Program procedures. For each audio recording, a 3 minute sample was isolated during each of the baseline and the treatment conversation, using version 2.3.3 of audio editing software known as Audacity (Audacity® Team, n.d.).

Given a speech pathologist's involvement in the baseline and treatment conversations is optional, there were instances where the speech pathologists would only briefly enter either of those conversations as they occurred between the child and the parent. In such instances, an effort was made to ensure that the 3 minute audio sample captured the largest number of conversational exchanges between the speech pathologist and the child. Such audio samples were obtained as a continuous 3 minute sample for the baseline or treatment conversation, even if this meant that the sample included conversation between the child and the parent. If either a baseline or a treatment conversation was not obtained for a given audio recording, this generally indicated that the parent carried out that activity for that clinic visit, without the involvement of the speech pathologist. In such instances no audio sample was analysed for that specific condition.

Instances of speech pathologist-child treatment conversations were identified as beginning when there were intentional statements from the speech pathologist, or requests by the parent. This included utterances by the speech pathologist or parent respectively, "I'll show you what I mean", or "Can you show me what you mean?" which indicated the start of treatment practice. To obtain the primary outcome measure (discussed below), treatment conversation and baseline conversation results were combined. The mean total of all speech pathologist-child conversational turns measured per audio recording was 26 (range 3 to 64). Information regarding the audio recordings selected for inclusion in the study is included in Appendix D.

### Speech pathologist-parent conversation

A speech pathologist-parent conversation sample was defined as any speech with communication intent between the speech pathologist and the parent. As per Table 4.2, speech pathologists are conversing with parents for much of the session. From the first point in an audio recording where a speech pathologist carried out a conversation with a parent, a 3 minute audio sample was isolated.

The audio samples utilised in the study generally captured the speech pathologist and parent discussing the severity ratings obtained in the session. Otherwise, they contained a discussion of the beyond clinic treatment progress from the previous week. Speech pathologist-parent conversation samples included a mean of 26 utterances by speech pathologists per recording (range 5 to 47). These samples were used to obtain the primary outcome measure (discussed below), Information regarding the audio recordings included in the study is presented in Appendix D.

## Primary Outcome Measure: Inter-turn Speaker Latency

The research question relates to the inter-turn speaker latency of speech pathologists during Lidcombe Program clinic visits. Inter-turn speaker latency was defined as the silent period that occurs between when one speaker terminates an utterance and another speaker commences an utterance (Newman and Smit, 1989). The inter-turn speaker latency is assigned to the speaker whose utterance follows the silent period (Kelly & Conture, 1992).

For the current study, inter-turn speaker latency is the primary outcome measure. It was measured in seconds using version 6.0.43 of an acoustic analysis software known as PRAAT (Boersma & Weenink, n.d.). PRAAT software is widely used to measure inter-turn speaker latency (Chon, Kraft, Zhang, Loucks & Ambrose, 2013; Munson, Swenson, & Manthei, 2005; Smith, Ash, Xie, & Grossman,2018).

## Data Collection

### Selection of utterances for measurement

Appendix E contains the protocol used to select and measure speech utterances in PRAAT during the primary evaluation of data for this study. The inclusion criterion for the selection of an utterance for measurement was that the utterance had to be speech related and transcribable using the International Phonetic Alphabet (International Phonetic Association, n.d.).

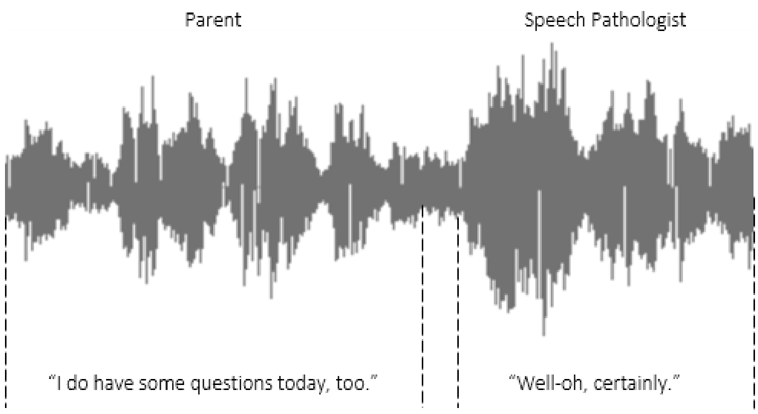
The exclusion criteria for disregarding utterances were: [1] it was unclear exactly who was talking, [2] background noise interfered with the ability to determine onset or end of inter-turn speaker latency, [3] overlapping talking occurred and it was unclear which speaker was the first to talk, or [4] during the speech pathologist-parent condition the conversation diverted to the child. For utterances that included non-speech phenomena such as laughing, coughing, tongue clicking, gulping, sighing, or squealing, just the non-speech was disregarded. The exception to this was if there were linguistic components, such as a person talking while coughing or laughing. In these instances the utterances were included.

The same data selection and measurement protocol that was used for the primary evaluation (Appendix E) was used when conducting the inter-rater reliability. This protocol was used to train the independent evaluator and as a reference document throughout the inter-rater reliability evaluation.

### Measuring inter-turn speaker latency in PRAAT

In order to collect inter-turn speaker latency data, each 3 minute audio sample of Lidcombe Program sessions was analysed individually using the PRAAT software. Upon uploading a 3 minute conversation sample into PRAAT, speech waveforms were generated by the software. Figure 4.2 presents a waveform of a 2.5 second conversational exchange between a parent and a speech pathologist.

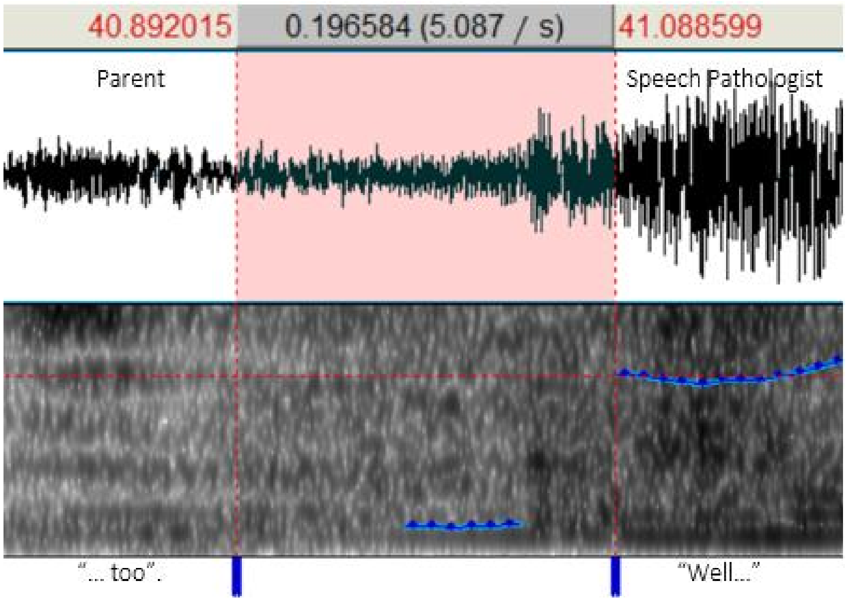
*Figure 4.2: Waveform representing speech pathologist-parent conversational exchange*




The same conversational exchange presented in Figure 4.2 is now presented in Figure 4.3 to demonstrate how inter-turn speaker latency is measured in the PRAAT software. Again, the portion of the speech exchange that is captured in the frame is labelled. Note however, the aspect in Figure 4.3 has been zoomed-in from Figure 4.2 in order to clearly show the inter-turn speaker latency measurement.

The pink shading in Figure 4.3 indicates the duration of the inter-turn speaker latency of the speech pathologist. It commences when the parent's speech utterance terminates and when the speech pathologist's utterance commences. In Figure 4.3 the inter-turn speaker latency that has been measured is 0.197 seconds. Note, the waveform is still visible during the period of speaker latency due to background noise that was occurring in the clinic room.

*Figure 4.3: Waveform and Spectrogram with Inter-turn Speaker Latency highlighted*




In addition to the waveform, PRAAT software also provides a spectrogram for the utterance. Such a spectrogram is displayed in Figure 4.3, immediately below the speech waveform. The spectrogram was used to support the visual interpretation of the speech waveform. However for the current study, given there was often background noise due to the child playing with toys in the clinic room, waveforms were largely interpreted by actively observing them while simultaneously listening to the speech output.

The protocol for selecting and measuring utterances in Appendix E outlines the procedure that was followed to ensure accurate and consistent measurement of inter-turn speaker latency for the current study. Note, as per the protocol (Appendix E), and common practice in research (Bonelli et al., 2000; Newman & Smit, 1989), where overlapping speech occurred the inter-turn speaker latency was recorded as zero.

## Data Analysis

Data were analysed using exploratory paired t-tests. Results are presented in Chapter 5.

## Data reliability

Ten percent of samples were selected using a random number generator. Samples were re-rated by the original evaluator, 1 month after the original data collection phase. The intra-rater reliability was calculated using Pearson's correlation. The correlation coefficient was 0.96 for the dependent variable.

Inter-rater reliability was also calculated. Ten percent of samples were selected using a random number generator and rated by an independent judge who was blind to the purpose and hypothesis of the study. The independent judge was a paediatric speech pathologist with more than 5 years of experience treating children who stutter. The independent judge received 3 hours of face-to-face training in the analysis protocol by the primary evaluator. The independent judge then had an opportunity to practise using PRAAT autonomously and asking questions of the original evaluator prior to commencing the data reliability.

The aim of training was to demonstrate the use of the PRAAT analysis software, to explain the data collection protocol, and ensure the judge understood the task required. The independent judge was kept blind to the research question and the fact that the voices in the audio recordings belonged to speech pathologists and parents and children participating in Lidcombe Program treatment.

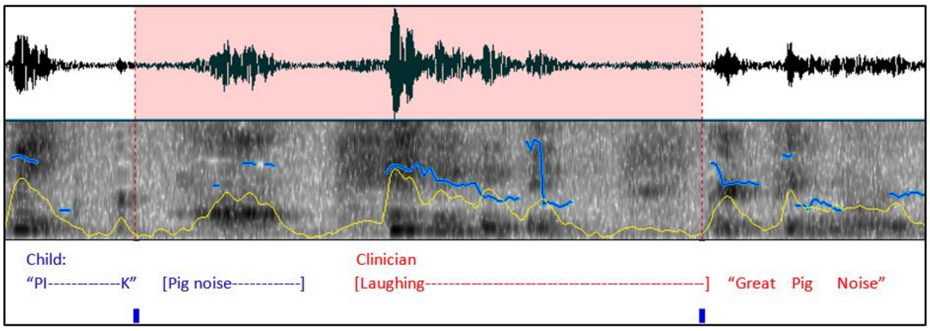
As discussed previously there was a large number of exclusion criteria for selecting conversational utterances. Additionally, for each recording a large number of utterances were measured (*M*= 53, min= 24, max= 92). As a result of these two factors, errors in data collection can occur. Outliers caused by data collection errors can be removed from samples prior to correlational analysis (Holmes Finch, 2012).

There are a number of methods utilised to identify outliers. One widely used approach is the standard deviation method which identifies outliers as being beyond 3 standard deviations from the mean (Leys, Delacre, Mora, Lakens & Ley, 2019). Tabachnik and Fidell (2007) discuss that removing outliers reduces the influence of extreme discrepancies on correlational statistics.

Data were therefore cleaned of outliers prior to the inter-rater correlational analysis. This occurred by first calculating the threshold of 3 standard deviations (0.66) and then identifying any outcome measures that sat outside of this. One value met this criterion and was therefore excluded from the sample. The inter-rater reliability was calculated for the remainder of the sample using Pearson’s correlation. The correlation coefficient was 0.87.

The outlier occurred because one evaluator included a conversational turn and the other did not. The conversational turn of the speech pathologist in the audio recording was unusual from a data analysis perspective given it followed the production of an animal sound by the child participant. The discrepancy resulting from the inclusion or exclusion of the turn was significant given the speaker latency for this utterance was measured as 1.74 seconds. This single data point was more than ten times the average latency provided to a child across the study. Figure 4.4 visually represents this utterance using acoustic analysis software, PRAAT. The inter-turn speaker latency is highlighted in red and the utterance is captioned.

*Figure 4.4: Acoustic Analysis of Eliminated Outlier*




## Summary

This observational study utilised audio recordings of Lidcombe Program Stage 1 clinic visits obtained during the Trajkovski and colleagues (2019) clinical trial. Inter-turn speaker latency of speech pathologists in seconds, was the primary outcome measure.

Measurements were collected using acoustic analysis software known as PRAAT. The data collected included the speaker latencies of speech pathologists speaking to parents, as well as the speaker latencies of speech pathologists speaking to children. The data were analysed to determine if speech pathologists increase their inter-turn speaker latency when speaking to children, compared to parents, during Lidcombe Program clinic visits. The intra-rater and inter-rater reliability were strong.

# Chapter 5: Results

## Synopsis

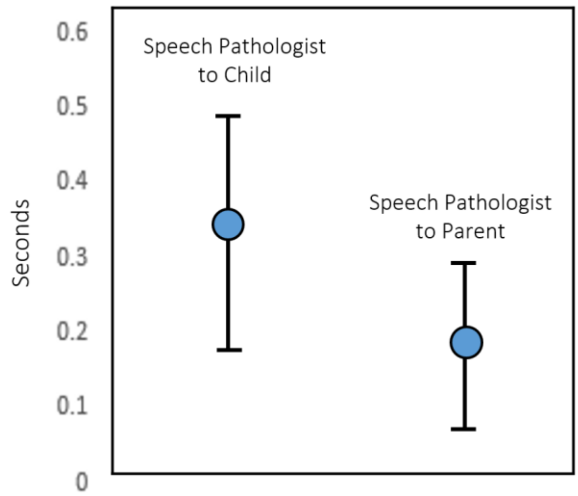
The study aimed to determine whether during clinic visits speech pathologists increase their inter-turn speaker latency when speaking to a child compared to a parent. As outlined in Chapter 4, audio recordings of Lidcombe Program Stage 1 clinic visits were acoustically analysed using PRAAT software. This current chapter presents the results of this acoustic analysis.

## Data Analysis

Data were collected for three conversational conditions: [1] the speech pathologist speaking to the child during baseline conversation, [2] the speech pathologist speaking to the child during demonstration of treatment, [3] the speech pathologist speaking to the parent. Results for each of the conversational conditions for each audio recording ($N$= 53) are included in Appendix F (Appendices F.1 to F.53).

The average inter-turn speaker latency for the situations [1] and [2] were identical to two decimal places ($M$= 0.32). Data for conversational conditions [1] and [2] were therefore pooled for each audio recording. This was deemed appropriate as both conditions are a formal part of Lidcombe Program treatment procedures presented in the Lidcombe Program treatment manual (Onslow et al., 2017). This also meant a direct comparison could be made between the average speaker latency of the speech pathologist to the child, versus the speech pathologist to the parent. These data are included in Appendix G and are presented in Figure 5.1. The means are represented by the circles and 1 standard deviation each side of the mean is represented by the horizontal lines.

*Figure 5.1: Speech Pathologist Mean Inter-turn Speaker Latency and 1 Standard Deviation*




The mean inter-turn speaker latency of a speech pathologist to a child was 0.313 seconds (*SD*= 0.166, min= 0, max= 0.8151). The mean inter-turn speaker latency of a speech pathologist to a parent was 0.167 seconds (*SD*= 0.105, min= 0, max= 0.5151). The mean difference between the speech pathologists' average inter-turn speaker latency to the child, compared to the parent, was 0.146 seconds (*SD*= 0.167, min= -0.2457, max= 0.6241).

A two-tailed paired t-test was performed which demonstrated a statistically significant increase in inter-turn speaker latency when speech pathologists spoke to children compared to when they spoke to parents $t(5.39)$, $p < .001$. Data relating to the t-test calculations are presented in Appendix H. Data were also grouped by unique child participant ($n$= 20) in order to confirm the statistical significance (see Appendix I). A two-tailed paired t-test was then performed on these data and a statistically significant result was again achieved $t(3.97)$, $p < .001$. Data relating to the t-test calculations are presented in Appendix J.

## Summary

Data were analysed acoustically and statistically significant results obtained. The intra-rater and inter-rater reliability were strong. This result indicates that speech pathologists increased their inter-turn speaker latency when speaking to a child as compared to a parent, during Lidcombe Program clinic visits.

# Chapter 6: Discussion

## Synopsis

The Lidcombe Program is a stuttering treatment for pre-school age children. The program is supported by the strongest level of research evidence of any early stuttering treatment. As discussed in Chapter 3, the aim of the current study was to investigate a potential mechanism of action underpinning the Lidcombe Program. Information regarding treatment components is useful to determine those that contribute to efficacy, and to provide critical details for replication of the treatment.

This chapter summarises the background to this research, the study aims, and the research findings. Attention then turns to exploring and interpreting the findings of the study. Finally, the clinical implications and future directions for this area of research are explored.

## Background to the study

The development of the Lidcombe Program was based on the results of experimental research that showed that response contingent stimulation could reduce stuttering in young children (Manning et al., 1976; Martin et al., 1972; Reed & Godden, 1977). During the initial stages of the program's development it was assumed that parent verbal contingencies were the sole mechanism of action underpinning the Lidcombe Program. However, more recent research has failed to support this hypothesis (Carr Swift et al., 2011; 2016; Donaghy et al., 2015; Harrison et al., 2004).

Consequently, the research focus has now shifted towards determining features that may be occurring incidentally during the implementation of the Lidcombe Program. Such features may be learned by parents through a process of observational learning. It may be that such features are demonstrated unknowingly by speech pathologists during implementation of the Lidcombe Program, and modelled by parents when administering treatment to their children.

When considering potential mechanisms of action, it was noted that outcome measures from a randomised controlled trial comparing RESTART-DCM to the Lidcombe Program demonstrated very similar trends (de Sonneville-Koedoot et al., 2015). One possible explanation for these remarkably similar results is that there are mechanisms that are common to both treatments.

One feature that is included in the treatment procedures of RESTART-DCM is increased inter-turn speaker latency by adults when speaking with children who stutter. This feature is of particular interest because it is the first variable to be introduced as part of RESTART-DCM treatment procedures, and it is one of only two features of the treatment that is provided to all children (Franken & Putker-de Bruijn, 2007). Additionally, there is some experimental evidence that this behaviour, known as conversational pausing in the RESTART-DCM treatment manual, can have a therapeutic effect on young children (Livingston et al., 2000; Winslow & Guitar, 1994). Therefore, this seemed like an avenue of research worth pursuing.

## Aim of the Study

The current study investigated whether speech pathologists increase their inter-turn speaker latency when speaking to children, compared with when speaking to parents, during Lidcombe Program clinic visits. The results of this study could add to the knowledge base of potential mechanism of action underpinning the Lidcombe Program, and in turn move closer towards optimising Lidcombe Program procedures.

## Study Findings and Interpretation

The five speech pathologists in the current study demonstrated increased inter-turn speaker latency across 83% of the 53 combined speech pathologist-child conversation samples. This was then compared with the speech-pathologist parent conversation samples. This difference in the inter-turn speaker latency of these five speech pathologists was statistically significant.

All five speech pathologists demonstrated this difference in inter-turn speaker latency across all 20 child participants throughout almost all the samples. This indicates that the effect appears particularly robust. The increased inter-turn speaker latency that the speech pathologists demonstrated when they spoke to children compared with when they spoke to parents is not an inherent component of the documented Lidcombe Program treatment procedures. These results are therefore fascinating because all five speech pathologists in the study inadvertently demonstrated an increased inter-turn speaker latency behaviour during Lidcombe Program Stage 1 clinic visits despite no requirement to do so.

It is interesting that the results from the speech pathologist-child conversational exchanges were drawn from audio recordings of two different conversational activities in Lidcombe Program Stage 1 clinic visits. When comparing the mean inter-turn speaker latencies across the two speech pathologist-child conversational conditions, namely the baseline conversation and treatment conversation, results were almost identical. This is interesting because these two conversational conditions serve very different functions within Lidcombe Program Stage 1 clinic visit procedures. This raises the question as to whether the five speech pathologists were in fact using increased inter-turn speaker latency with the child participants for the entire clinic visit.

It is plausible that increased inter-turn speaker latency may be a mechanism of action underpinning the Lidcombe Program. Although this feature is not a formal component of Lidcombe Program procedures, it is relatively simple for speech pathologists to model. It is logical that the inter-turn speaker latency of speech pathologists could easily be observed and imitated by a parent, even without knowing. As per observational learning theory, such learning can occur without conscious awareness of the learner.

The hypothesis that speech pathologists increase their inter-turn speaker latency when speaking with children as opposed to parents during Lidcombe Program Stage 1 clinic visits is in contrast to the conclusions drawn by Bonelli and colleagues (2000). The Bonelli and colleagues (2000) study also utilised acoustic analysis software, but measured the inter-turn speaker latency of parents and children before and after completing Lidcombe Program treatment. The study found no consistent evidence of a change in the inter-turn speaker latency of parents or children after participation in Lidcombe Program treatment.

Bonelli and colleagues concluded during their study that “the observed random fluctuations in this variable (…) do not suggest that this variable is a profitable source for future study.” (p. 442). Bonelli and colleagues (2000) argued that because of the variability in their results, inter-turn speaker latency was unlikely to be a mechanism of action underpinning the Lidcombe Program. Bonelli and colleagues (2000) also stated that there was no evidence to suggest that further research about inter-turn speaker latency as a mechanism of action was warranted.

This claim by Bonelli and colleagues (2000), that made inter-turn speaker latency is unlikely to be a mechanism of action underpinning the Lidcombe Program, was premature. This is because the outcomes were based only on pre- and post-treatment data. It is conceivable that inter-turn speaker latency may be a transient mechanism demonstrated by speech pathologists and parents during Lidcombe Program practice sessions. Such a mechanism of action could produce a reduction in stuttering throughout the program by potentially reducing the pressure on children to talk, or providing the child with more time to process the conversation.

It may be that any difference in inter-turn speaker latency that is modelled to children during Stage 1 Lidcombe Program clinic visits is undetectable after the program's completion. It is likely that a child's capacity for stutter-free speech increases over the course of participating in Lidcombe Program treatment. It could be argued that such longer speaker latencies are not required by the end of treatment and are therefore no longer demonstrated. The current study was designed to investigate if increased inter-turn speaker latency was observed actually within Lidcombe Program clinic visits throughout the course of Stage 1. The current study was therefore designed to fill this gap in available research data.

## Strengths & Limitations of the Study

A strength of the current study is that speech pathologists could not have been influenced by the researcher's knowledge of the research question. This was achieved through the use of a retrospective data-set. Another study strength was the random selection of data for inclusion in the study from 529 audio recordings of Lidcombe Program Stage 1 clinic visits. The random selection of audio recordings for the current study led to the inclusion of samples from a comprehensive set of time points in Lidcombe Program treatment. That is, from initial treatment sessions through to final Stage 1 Lidcombe Program clinic visits.

The sample size of the current study ($N$= 53) was relatively small, and only a sample of each recording was analysed. However, the statistically significant results were obtained across the 20 different child participants and the five different speech pathologist participants which indicates robust results.

## Clinical Implications

Increased inter-turn speaker latency may well be a mechanism of action underpinning the Lidcombe program, but further research is required to ascertain if this is the case. However, it is conceivable that increased inter-turn speaker latency by adults can reduce stuttering in young children. It could be that speech pathologists exhibit increased inter-turn speaker latency with children and as per social learning theory parents observe and imitate this with their children. This is particularly logical given the limitations of the working memories of adults and the vast amounts of information required to learn from speech pathologists during Lidcombe Program clinic visits. Such observational learning may even be occurring without the conscious awareness of parents.

Until research can establish that parents demonstrate increased inter-turn speaker latency with their children during the delivery of Lidcombe Program treatment, during both the within the clinic and beyond clinic treatment procedures, clinical application of this research cannot occur. It is possible that increased inter-turn speaker latency is occurring in the Lidcombe Program, even without observational learning from the speech pathologist.

It may be that increased inter-turn speaker latency is an instinctive behaviour that adults adopt when interacting with children who stutter, or even children in general. This is potentially evidenced by the fact that speech pathologists increased their inter-turn speaker latency when speaking to children as opposed to parents both during the baseline conversation, and during treatment practice. This is an important consideration because, for a feature of treatment to have a therapeutic effect, it would be implemented as part of treatment and would not likely be a pre-existing condition in a child's everyday speaking environment.

An alternative hypothesis is that the introduction of structured conversations in the Lidcombe Program encourages a more formal speaking occasion in which the parent naturally increases inter-turn speaker latency. It may be that such structured conversations are not part of the child's social environment before the introduction of the Lidcombe Program.

It could be argued that audio recording speech samples pre- and post-treatment may also produce a formal speaking occasion. The failure of Bonelli et al (2000) to identify differences in the inter-turn speaker latencies of parents during pre- and post-treatment audio recordings may simply be a reflection of longer latencies occurring in both recordings. No difference in inter-turn speaker latency may be observed when comparing pre- and post-treatment audio recordings because parents' interaction styles may be influenced by the presence of the recording device encouraging to become more formal.

At present, given all of these possibilities, it is difficult to determine the clinical utility of the findings of the current study. It is therefore recommended that speech pathologists continue to implement the Lidcombe Program as it is described in the Lidcombe Program treatment guide (Onslow et al., 2017).

## Future Directions

The results of the current study lead to more questions than answers. Research needs to establish whether parents increase their inter-turn speaker latency when delivering Lidcombe Program treatment to their children both in the clinic and at home during practice sessions and natural conversations.

If increased inter-turn speaker latency is implemented by parents during the course of Lidcombe Program treatment, it would be interesting to compare the impact of the Lidcombe Program delivered with short versus long speaker latencies. At present the length of such potential therapeutic latencies is not known, but such a study may be the only true way to establish if inter-turn speaker latency has a therapeutic effect on children who stutter in the Lidcombe Program.

Future research could continue to compare the delivery of Lidcombe Program treatment with formal procedures of RESTART-DCM. It would also be logical to investigate whether other therapeutic features of RESTART-DCM are incidentally present within Lidcombe Program. Such features may include the reduction of speech rate that is modelled by parents or speech pathologists, or the language complexity modelled by parents or speech pathologists. It is also possible that there may be a number of features that combine during the course of Lidcombe Program treatment that lead to a reduction in stuttering in young children, rather than there being a single mechanism of action. This seems logical given the search for a mechanism of action underpinning the Lidcombe Program has been unyielding, indicating that the mechanism may be more complicated than was once thought.

## Summary

The aim of the current study was to investigate a potential mechanism of action underpinning the Lidcombe Program. When considering potential mechanisms of action, clues were drawn from [1] other early stuttering treatments, and [2] experimental research evidence. The current study investigated whether speech pathologists increase their inter-turn speaker latency when speaking to children compared with parents during Lidcombe Program clinic visits.

Results indicated that speech pathologists increase their inter-turn speaker latency when speaking to children compared with parents, during Lidcombe Program clinic visits. It is therefore possible that increased inter-turn speaker latency may be a mechanism of action underpinning the Lidcombe program, however there is currently no evidence that confirms this to be the case. The most logical next step in continuing this research would be to establish whether parents increase their inter-turn speaker latency when delivering Lidcombe Program treatment to their children.

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# Appendix A

## Ethics Approval for the Current Study

**From:** Research.Ethics@uts.edu.au
**To:** Mark Onslow; Monique Amato Maguire; Research Ethics
**Subject:** HREC Approval Granted - ETH18-3054
**Date:** Wednesday, 13 March 2019 11:03:47 AM

Dear Applicant

[Transfer of ethics application: Human Reseach Ethics Committee 1, the University of Sydney. - External HREC approval number: 2018/169.

The UTS Human Research Ethics Expedited Review Committee reviewed your application titled, "Identifying agents of change in early intervention programs for stuttering", agreed that this application meets the requirements of the National Statement on Ethical Conduct in Human Research (2007) and has been approved on that basis. You are therefore authorised to commence activities as outlined in your application, subject to any conditions detailed in this document. I am pleased to inform you that your external ethics approval has been transferred. We will be writing to the original HREC to inform them that UTS HREC has accepted responsibility for the ethical oversight of this protocol.

You are reminded that this letter constitutes ethics approval only. This research project must also be undertaken in accordance with all UTS policies and guidelines including the Research Management Policy (http://www.gsu.uts.edu.au/policies/research-management-policy.html).

Your approval number is UTS HREC REF NO. ETH18-3054.

Approval will be for a period of five (5) years from the date of this correspondence subject to the submission of annual progress reports.

The following standard conditions apply to your approval:

- Your approval number must be included in all participant material and advertisements. Any advertisements on Staff Connect without an approval number will be removed.

- The Principal Investigator will immediately report anything that might warrant review of ethical approval of the project to the Ethics Secretariat (Research.Ethics@uts.edu.au).

- The Principal Investigator will notify the UTS HREC of any event that requires a modification to the protocol or other project documents, and submit any required amendments prior to implementation. Instructions can be found at https://staff.uts.edu.au/topichub/Pages/Researching/Research%20Ethics%20and%20Integrity/Human%20research%20ethics/Post-approval/post-approval.aspx#tab2.

- The Principal Investigator will promptly report adverse events to the Ethics Secretariat (Research.Ethics@uts.edu.au). An adverse event is any event (anticipated or otherwise) that has a negative impact on participants, researchers or the reputation of the University. Adverse events can also include privacy breaches, loss of data and damage to property. Any cases of serious adverse event (SAE), adverse drug reaction (ADR), or serious unexpected suspected adverse reaction (SUSAR) must be reported to the Sponsor within 24 hours of becoming aware of the event, and to the CTSC within 72 hours of becoming aware of the event, using the appropriate reporting form. Refer to https://staff.uts.edu.au/topichub/Pages/Researching/Research%20Ethics%20and%20Integrity/Human%20research%20ethics/Clinical%20trials/clinical-trials.aspx#tab4 for more information.

- The Principal Investigator will report to the UTS HREC annually and notify the HREC when the project is completed at all sites. The Principal Investigator will notify the UTS HREC of any plan to extend the duration of the project past the approval period listed above through the progress report.

- The Principal Investigator will obtain any additional approvals or authorisations as required (e.g. from other ethics committees, collaborating institutions, supporting organisations).

- The Principal Investigator will notify the UTS HREC of his or her inability to continue as Principal Investigator including the name of and contact information for a replacement.

I also refer you to the AVCC guidelines relating to the storage of data, which require that data be kept for a minimum of 5 years after publication of research. However, in NSW, longer retention requirements are required for research on human subjects with potential long-term effects, research with long-term environmental effects, or research considered of national or international significance, importance, or controversy. If the data from this research project falls into one of these categories, contact University Records for advice on long-term retention.

You should consider this your official letter of approval. If you require a hardcopy please contact Research.Ethics@uts.edu.au.

If you have any queries about your ethics approval, or require any amendments to your research in the future, please do not hesitate to contact Research.Ethics@uts.edu.au.

Yours sincerely,

A/Prof Beata Bajorek
Chairperson
UTS Human Research Ethics Committee
C/- Research & Innovation Office
University of Technology Sydney
E: Research.Ethics@uts.edu.au

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**Research Integrity & Ethics Administration**
Human Research Ethics Committee

Monday, 9 July 2018

Prof Mark Onslow
Aust Stuttering Research Centre; Faculty of Health Sciences
Email: mark.onslow@sydney.edu.au

Dear Mark

The University of Sydney Human Research Ethics Committee (HREC) has considered your application.

After consideration of your response to the comments raised your project has been approved.

Approval is granted for a period of four years from **9 July 2018** to **9 July 2022.**

| | |
|---|---|
| **Project title:** | **Identifying agents of change in early intervention programs for stuttering** |
| **Project no.:** | **2018/169** |
| **First Annual Report due:** | **9 July 2019** |
| **Authorised Personnel:** | **Onslow Mark; Amato Maguire Monique; Kokolakis Artemi; Lowe (nee Thompson) Robyn Wendy; Menzies Ross;** |

**Documents Approved:**

| Date Uploaded | Version number | Document Name |
|---|---|---|
| 29/06/2018 | Version 1 | Participant Consent Form - Identifying agents of change |
| 29/06/2018 | Version 1 | Participant Info Statement - Identifying agents of change |

**Condition/s of Approval**

- Research must be conducted according to the approved proposal.
- An annual progress report must be submitted to the Ethics Office on or before the anniversary of approval and on completion of the project.
- You must report as soon as practicable anything that might warrant review of ethical approval of the project including:
  - Serious or unexpected adverse events (which should be reported within 72 hours).
  - Unforeseen events that might affect continued ethical acceptability of the project.
- Any changes to the proposal must be approved prior to their implementation (except where an amendment is undertaken to eliminate *immediate* risk to participants).
- Personnel working on this project must be sufficiently qualified by education, training and experience for their role, or adequately supervised. Changes to personnel must be reported and approved.

- Personnel must disclose any actual or potential conflicts of interest, including any financial or other interest or affiliation, as relevant to this project.

- Data and primary materials must be retained and stored in accordance with the relevant legislation and University guidelines.

- Ethics approval is dependent upon ongoing compliance of the research with the *National Statement on Ethical Conduct in Human Research*, the *Australian Code for the Responsible Conduct of Research*, applicable legal requirements, and with University policies, procedures and governance requirements.

- The Ethics Office may conduct audits on approved projects.

- The Chief Investigator has ultimate responsibility for the conduct of the research and is responsible for ensuring all others involved will conduct the research in accordance with the above.

This letter constitutes ethical approval only.

Please contact the Ethics Office should you require further information or clarification.

Sincerely

**Associate Professor Stephen Assinder**
**Chair, Human Research Ethics Committee (HREC 1)**

**The University of Sydney HRECs are constituted and operate in accordance with the National Health and Medical Research Council's (NHMRC) National Statement on Ethical Conduct in Human Research (2007) and the NHMRC's Australian Code for the Responsible Conduct of Research (2007).**

# Appendix B

## Participant Information Statement

UTS

**Professor Mark Onslow**
Director
Australian Stuttering Research Centre
Graduate School of Health
15 Broadway, Ultimo NSW 2007

T: +61 2 9514 5314
M: +61 (0) 405 255 126
Mark.Onslow@uts.edu.au

PO Box 123
Broadway
NSW 2007 Australia
www.uts.edu.au

UTS CRICOS PROVIDER CODE 00099F

**Identifying agents of change in early intervention programs for stuttering**

**PARTICIPANT INFORMATION STATEMENT**

**(1) What is this study about?**

The aim of this study is to determine if speech pathologists and parents make changes to their speech during Lidcombe Program treatment sessions, such as slowing their speech rate or pausing. This study seeks to acoustically analyse recordings obtained when you provided treatment in the study: 'A randomised controlled trial comparing the Westmead Program and the Lidcombe Program treatments for preschool children who stutter'.

This 'Participant Information Statement' tells you about the research study. Knowing what is involved will help you decide if you will provide consent for your audio recording to be analysed in this study. Please read the information carefully and ask questions about anything that you don't understand or want to know more about.

By giving your consent to take part in this study you are telling us that you:
- Understand what you have read.
- Agree to take part in the research study as outlined below.
- Agree to the use of your personal information as described.

You will be given a copy of this 'Participant Debriefing Statement' to keep.

**(2) Who is running the study?**

The study is being carried out by the following researchers:
- Professor Mark Onslow, Australian Stuttering Research Centre, The University of Technology Sydney.
- Associate Professor Robyn Lowe, Australian Stuttering Research Centre, University of Technology Sydney.
- Professor Ross G. Menzies, Australian Stuttering Research Centre, University of Technology Sydney.

Monique Amato Maguire is conducting this study as the basis for the degree of Master of Speech and Language Science (Research) at University of Technology Sydney. This study will be conducted under the supervision of Professor Mark Onslow, Associate Professor Robyn Lowe and Professor Ross G. Menzies, Australian Stuttering Research Centre, University of Technology Sydney.

**(3) What will the study involve for me?**

The study will involve the retrospective analysis of the audio recordings of Lidcombe Program treatment sessions during the study 'A randomised controlled trial comparing the Westmead Program and the

Lidcombe Program treatments for preschool children who stutter'. These recordings will be analysed using acoustic analysis software. You are not required to complete any tasks as part of this research study.

The use of your data for the study is voluntary and you may withdraw your participation from the study at any time, and withdraw any data that you have provided to that point. There are no penalties for withdrawing from this study.

**(4) How much of my time will the study take?**

No time.

**(5) Who can take part in the study?**

All original research participants and the speech pathologists who provided treatment.

**(6) Do I have to be in the study? Can I withdraw from the study once I've started?**

Being in this study is completely voluntary and you do not have to take part. Your decision whether to participate will not affect your current or future relationship with the researchers or anyone else at University of Technology Sydney, including the Australian Stuttering Research Centre.

If you decide to take part in the study and then change your mind later, you are free to withdraw at any time. You can do this by emailing Dr Robyn Lowe (robyn.lowe@uts.edu.au).

**(7) Are there any risks or costs associated with being in the study?**

We do not expect that there will be any risks or costs associated with taking part in this study.

**(8) Are there any benefits associated with being in the study?**

We cannot guarantee that you will receive any direct benefits from being in the study.

**(9) What will happen to information about me that is collected during the study?**

By providing your consent, you are agreeing to us collecting personal information about you for the purposes of this research study. Your information will only be used for the purposes outlined in this Participant Information Statement, unless you consent otherwise.

Your information will be stored securely and your identity/information will be kept strictly confidential, except as required by law. Study findings may be published, but you will not be individually identifiable in these publications.

**(10) Can I tell other people about the study?**

Yes, you are welcome to tell other people about the study.

**(11) What if I would like further information about the study?**

When you have read this information, Dr Robyn Lowe will be available to discuss it with you further and answer any questions you may have, or if you would like to know more at any stage during the study.

**(12) Will I be told the results of the study?**

You have a right to receive feedback about the overall results of this study. You may nominate how you wish to receive feedback on the 'Participant Consent Form'. This feedback will be available after the study is finished and the results have been analysed.

**(13) What if I have a complaint or any concerns about the study?**

Research involving humans in Australia is reviewed by an independent group of people called a Human Research Ethics Committee (HREC). As part of this process, we have agreed to carry out the study according to the National Statement on Ethical Conduct in Human Research (2007). This statement has been developed to protect people who agree to take part in research studies.

This study has been approved by the University of Technology Sydney Human Research Ethics Committee (UTS HREC). If you have any concerns or complaints about any aspect of the conduct of this research, please contact the Ethics Secretariat on +61 2 9514 2478 or research.ethics@uts.edu.au, and quote UTS HREC reference number ETH18-3054. Any matter raised will be treated confidentially, investigated, and you will be informed of the outcome.

**This information sheet is for you to keep**

# Appendix C

## Participant Consent Form

**Professor Mark Onslow**
Director
Australian Stuttering Research Centre
Graduate School of Health
15 Broadway, Ultimo NSW 2007

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UTS CRICOS PROVIDER CODE 00099F

**Identifying agents of change in early intervention programs for stuttering**

**PARTICIPANT CONSENT FORM**

I, ..................................................................................... [PRINT NAME], agree to take part in this research study.

In giving my consent I state that:

- I understand the purpose of the study, what I will be asked to do, and any risks/benefits involved.
- I have read the Participant Information Statement and have been able to discuss my involvement in the study with the researchers if I wished to do so.
- The researchers have answered any questions that I had about the study and I am happy with the answers.
- I understand that being in this study is completely voluntary and I do not have to take part. My decision whether to be in the study will not affect my relationship with the researchers or anyone else at the Australian Stuttering Research Centre, University of Technology Sydney now or in the future.
- I understand that I can withdraw from the study at any time.
- I understand that personal information about me that is collected over the course of this project will be stored securely and will only be used for purposes that I have agreed to. I understand that information about me will only be told to others with my permission, except as required by law.
- I understand that the results of this study may be published, and that publications will not contain my name or any identifiable information about me.

# Appendix D

## Random Selection of Participant Recordings

| Audio File ID | Participant Number | Notes | Number of Available Utterances In Respective Audio Recordings | |
|---|---|---|---|---|
| | | | Speech Pathologist-Parent Conversation | Combined Speech Pathologist-Child Conversations |
| 88* | C040 | Excluded; no SP-child conversation on audio | N/A | N/A |
| 83* | C040 | Excluded; no SP-child conversation on audio | N/A | N/A |
| 389* | F027 | Excluded; no SP-child conversation on audio | N/A | N/A |
| 361 | F020 | Excluded; recording error, 19s duration | N/A | N/A |
| 301 | C065 | | 34 | 29 |
| 74 | C040 | | 14 | 33 |
| 199 | C058 | | 27 | 25 |
| 46 | A270 | Final Stage 1 Clinic Visit For Participant | 39 | 14 |
| 125 | C055 | | 5 | 61 |
| 131 | C055 | | 19 | 61 |
| 264 | C046 | | 28 | 23 |
| 66 | C040 | | 10 | 28 |
| 207* | C063 | | 31 | 19 |
| 309 | C065 | | 7 | 35 |
| 291 | C065 | Final Stage 1 Clinic Visit For Participant | 26 | 36 |
| 187 | C058 | | 19 | 15 |
| 306 | C065 | | 18 | 6 |
| 40 | A270 | | 43 | 3 |
| 159 | C058 | | 19 | 23 |
| 143 | C055 | | 20 | 21 |
| 239 | C066 | | 32 | 27 |
| 57 | A278 | | 35 | 33 |
| 110 | C049 | | 19 | 43 |
| 139 | C055 | | 15 | 41 |
| 267 | C046 | | 14 | 24 |
| 305 | C065 | | 23 | 26 |
| 182* | C058 | | 6 | 24 |
| 160 | C058 | | 21 | 19 |
| 245 | C066 | | 44 | 3 |
| 293 | C065 | | 29 | 33 |
| 75 | C040 | | 16 | 15 |
| 236 | C066 | | 19 | 16 |
| 453 | F034 | | 33 | 42 |
| 452 | F034 | | 29 | 3 |
| 475 | F001 | | 25 | 26 |
| 204 | C058 | | 16 | 46 |
| 358 | F020 | | 30 | 23 |
| 354 | F020 | | 30 | 48 |
| 390 | F027 | | 29 | 6 |
| 441 | F034 | | 30 | 47 |
| 433 | F033 | | 30 | 9 |
| 315 | F035 | First Stage 1 Clinic Visit For Participant | 28 | 29 |
| 327 | F035 | | 26 | 40 |
| 314 | F035 | | 32 | 10 |
| 344 | F020 | | 28 | 64 |
| 341 | F020 | | 32 | 17 |
| 439 | F034 | | 33 | 21 |
| 214 | C063 | | 30 | 27 |
| 540 | A172 | | 42 | 19 |
| 419 | F029 | | 47 | 26 |
| 460 | F036 | First Stage 1 Clinic Visit For Participant | 33 | 21 |
| 426 | F029 | | 29 | 14 |
| 449 | F034 | | 27 | 25 |
| 34 | A270 | | 44 | 9 |
| 536 | A172 | | 40 | 44 |
| 489 | 006.MTS | | 11 | 21 |
| 212 | C063 | | 39 | 40 |
| Average | | | 27 | 27 |
| Min | | | 5 | 3 |
| Max | | | 47 | 64 |

* Audio recording randomly selected twice.

N/A^ specific speech pathologist-child interaction did not take place during the clinic visit

# Appendix E

## Protocol for Selecting and Measuring Utterances in PRAAT

| INTER-TURN SPEAKER LATENCY DATA COLLECTION: PROCOTCOL FOR DATA SELECTION & MEASURMENT IN PRAAT | |
|---|---|
| **Research topic** | • The research measures the inter-turn speaker latency (conversational pausing) of speech pathologists and parents. |
| **Definitions** | • **Conversational turn:** a conversation occurs when people are talking on a shared topic. People in a conversation take turns in speaking. A turn occurs when one person stops talking and the next person starts talking.<br>• **Inter-turn speaker latency (ITSL):** is the pause between the conversational turns of two people. It is measured from the moment one person stops talking and the next person starts talking.<br>• **Over-lapping talking:** talking over the top of another speaker.<br>• **Non-speech vocalisation:** laughing, gulping, clicking tongue, sigh, coughing, heavy inhalation or exhalation.<br>• **Speech-related utterance:** any utterance that include speech sounds that could be transcribed using the phonetic alphabet but do not include non-speech vocalisations.<br>• **Situation of interest:** for the purposes of this study it is the conversation that is being measured.<br>• **Person of interest:** the person whose ITSL is being measured in the speech sample.<br>• **Conversation partner:** the other person in the situation of interest that is being measured, that the person of interest's ITSL is being measured against. |
| **Method of analysis** | • Audio recordings have been analysed using an acoustic analysis software package known as 'PRAAT'. Using this software, inter-turn speaker latency is calculated manually.<br>• Three-minutes of conversational speech are analysed across two speaking situations:<br>    • The clinician speaking with the parent.<br>    • The clinician speaking with the child. |
| **Sample of recordings** | • A total of 15, 3-minute recordings will be evaluated as part of the data reliability analysis. |
| **Selecting conversational turns for analysis** | • For each sample, you will be provided with:<br>    • The first few sentences that are uttered by the person whose ITSL you are to measure on the recording (person of interest).<br>    • The situation of interest that is being measured. |

<table>
<tr>
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<ul>
<li>Provide yourself with the opportunity to become attuned to each speakers' speech so you can aurally discriminate the voices on the recording.</li>
<li>The sentences that are provided are merely to allow you to determine who the person is that you are measuring. Those sentences may or may not be turns that are to be measured, you will need to determine this independently.</li>
<li>Conversational turns are selected when the conversation partner in the situation of interest stops talking and the person of interest starts talking, if the following criteria are met:
<ul>
<li>The utterance is a speech-related utterance.</li>
<li>NOTE if an utterance commences with a non-speech utterance (e.g. laughing, gulping, clicking tongue, sighing, coughing, heavy breathing), that part of the utterance is disregarded and ITSL is measured from when speech-related utterance commences. If the child speaks and the adult first responds with laughter then talking the ITSL is taken from the moment the child stops talking until the adult starts talking, the period of laughter is disregarded.</li>
<li>NOTE non-speech vocalisations that include language ARE included. For example, if the person of interest laughs while talking this utterance IS included.</li>
</ul>
</li>
<li>Do not include an utterance if:
<ul>
<li>You are unsure exactly who is talking. It may be that you can't tell the difference between the adults in the room for an utterance, or it may be that the two parties speak simultaneously in response to the conversation partner. In either case, if you are unsure who spoke/ spoke first, disregard the utterances.</li>
<li>Background noise interferes with your ability to accurately determine the precise start or end of an utterance in order to accurately measure ITSL.</li>
<li>When overlapping talking has occurred and you are unsure exactly who spoke first.</li>
<li>If situation of interest is between the clinician and parent and the conversation diverts to the child, don't measure the ITSL of clinician to parent for that period of time while they are in conversation with the child.</li>
<li>It is fine if the situation of interest is between the clinician and the child and the parent is involved in the conversation as well. Continue to rate the ITSL as normal.</li>
</ul>
</li>
</ul>
</td>
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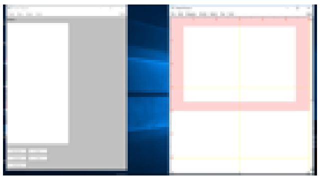
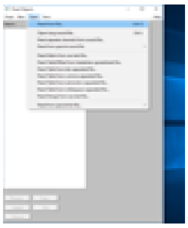
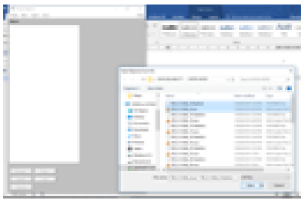
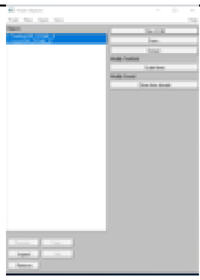
</table>

<table>
<tr>
<td>Measuring speaker latency using PRAAT</td>
<td>• Open PRAAT<br><br><br>• Both the “objects” and the “pictures” screens will open, you can close the “pictures” screen (pink), it is not required.<br><br>• Open audio and text files in PRAAT by selecting “open”, “read from file”.<br><br>• You can select all the files you want to open at once by holding the “Ctrl” key as you select files.<br><br>• Once open, select the text and sound file (by holding “Ctrl” and clicking both the files so they are highlighted). Ensure the two files are for the same recording. Then “view and edit” from the options on the right (the top button).</td>
</tr>
</table>



- The sound wave will open.

- Press the "Tab" key to start and stop playing the audio.
- Number utterances where ITSL starts, including overlapping speech.
    - For ITSL input the start and end points (i.e. starting point is where the child finishes talking, end point is where the adult starts talking).
    - This is done by putting a grey vertical line in the white text grid (which is indicated by a red hand pointing to the number one), by clicking in the desired point in the waveform itself.
    - The grey vertical line can then be dragged in the text grid space until it is in precisely the desirable position.
        - When putting vertical points in PRAAT use a combination of aural and visual information to determine the most appropriate places for the end of the child utterance and the start of the adult utterance.
        - If unsure of the precise point listen to the audio preceding and following the possible point to determine the exact place.
    - For overlapping talking, only where child or parent were speaking first and the clinician spoke second and overlapping the other party, only a single line is placed and labelled (the precise placement of this line is less significant as ITSL is recorded as 0).

| | |
|---|---|
| | • Once the vertical line is in a desirable position click the blue circle outline at the top of the grey vertical line to turn it into a blue line.<br>• The line turns red when you are clicked onto the line which allows you to label the line with a descriptor.<br>▪ For the purposes of this study the label you are to assign is simply the number of the utterance.<br>• Measure ITSL by clicking on the ITSL start point and noting the vertical broken red line that appears in the waveform space. Drag this red vertical line in the waveform space until it is in the middle point of the ITSL end point line that has been placed in the text grid space.<br>• Input the ITSL/overlapping talking into the excel spreadsheet. For ITSL record to the 6th decimal place, you may need to zoom in by pressing "in" in order to see the number in its entirety. |
| **Data management** | • Two files exist for each 3-minute audio sample:<br>• A text file.<br>• An audio file<br>• All files have been named using specific naming conventions. Please maintain the integrity of these naming conventions at all time, there is no need to change the names of files. |

# Appendix F.1

## Inter-turn Speaker Latency Analysis for Audio Recording 1

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.000 | 0.082 | 0.361 |
| 2 | 0.469 | 0.000 | 0.034 |
| 3 | 0.063 | 0.006 | 0.000 |
| 4 | 0.415 | 0.000 | 0.000 |
| 5 | 0.707 | 0.142 | 0.000 |
| 6 | 0.649 | 0.000 | 0.132 |
| 7 | 0.123 | 0.000 | 0.186 |
| 8 | 0.235 | 0.046 | 0.020 |
| 9 | 0.000 | 0.872 | 0.000 |
| 10 | 0.525 | 0.292 | 0.091 |
| 11 | 0.979 | 0.204 | 0.241 |
| 12 | 0.000 | 0.514 | 0.342 |
| 13 | 0.364 | | 0.252 |
| 14 | 0.000 | | 0.000 |
| 15 | 0.162 | | 0.000 |
| 16 | 0.629 | | 0.000 |
| 17 | 0.170 | | 0.000 |
| 18 | | | 0.054 |
| 19 | | | 0.000 |
| 20 | | | 0.034 |
| 21 | | | 0.000 |
| 22 | | | 0.000 |
| 23 | | | 0.000 |
| 24 | | | 0.000 |
| 25 | | | 0.212 |
| 26 | | | 0.000 |
| 27 | | | 0.107 |
| 28 | | | 0.000 |
| 29 | | | 0.000 |
| 30 | | | 0.097 |
| 31 | | | 0.000 |
| 32 | | | 0.115 |
| 33 | | | 0.000 |
| 34 | | | 0.000 |
| Average | 0.323 | 0.180 | 0.067 |

# Appendix F.2

## Inter-turn Speaker Latency Analysis for Audio Recording 2

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.000 | 1.859 | 0.404 |
| 2 | 0.159 | 0.270 | 0.000 |
| 3 | 0.270 | 1.652 | 0.000 |
| 4 | 0.152 | 2.104 | 0.180 |
| 5 | 0.252 | 0.616 | 0.087 |
| 6 | 0.409 | 0.148 | 0.000 |
| 7 | 0.170 | 1.558 | 2.619 |
| 8 | 0.000 | 0.666 | 0.455 |
| 9 | 0.200 | 0.295 | 1.212 |
| 10 | 0.000 | 0.356 | 0.045 |
| 11 | 0.792 | 0.439 | 0.000 |
| 12 | 0.305 | | 0.447 |
| 13 | 0.087 | | 0.671 |
| 14 | 0.044 | | 1.234 |
| 15 | 0.842 | | |
| 16 | 0.466 | | |
| 17 | 0.095 | | |
| 18 | 2.315 | | |
| 19 | 0.352 | | |
| 20 | 0.592 | | |
| 21 | 1.836 | | |
| 22 | 0.000 | | |
| Average | 0.424 | 0.906 | 0.525 |

# Appendix F.3

## Inter-turn Speaker Latency Analysis for Audio Recording 3

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.476 | 0.880 | 0.000 |
| 2 | 0.267 | 0.538 | 0.436 |
| 3 | 0.343 | 0.505 | 0.335 |
| 4 | 0.123 | 0.101 | 0.166 |
| 5 | 0.000 | 0.000 | 0.325 |
| 6 | 0.000 | | 0.000 |
| 7 | 0.000 | | 0.067 |
| 8 | 0.227 | | 0.000 |
| 9 | 0.060 | | 0.184 |
| 10 | 0.296 | | 0.096 |
| 11 | 0.572 | | 0.068 |
| 12 | 4.228 | | 0.000 |
| 13 | 2.035 | | 0.693 |
| 14 | 0.289 | | 0.786 |
| 15 | 0.000 | | 0.000 |
| 16 | 0.303 | | 0.485 |
| 17 | 0.000 | | 0.000 |
| 18 | 0.108 | | 0.000 |
| 19 | 0.083 | | 0.087 |
| 20 | 0.182 | | 0.126 |
| 21 | | | 0.216 |
| 22 | | | 0.018 |
| 23 | | | 1.140 |
| 24 | | | 0.121 |
| 25 | | | 0.060 |
| 26 | | | 0.000 |
| 27 | | | 0.000 |
| Average | 0.480 | 0.405 | 0.200 |

# Appendix F.4:

## Inter-turn Speaker Latency Analysis for Audio Recording 4

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.000 | | 0.000 |
| 2 | 0.880 | | 0.227 |
| 3 | 0.335 | | 0.000 |
| 4 | 0.260 | | 0.000 |
| 5 | 0.785 | | 0.000 |
| 6 | 0.035 | | 0.000 |
| 7 | 0.022 | | 0.000 |
| 8 | 0.473 | | 0.269 |
| 9 | 0.000 | | 0.134 |
| 10 | 0.185 | | 0.060 |
| 11 | 0.600 | | 0.000 |
| 12 | 0.372 | | 0.000 |
| 13 | 0.970 | | 0.073 |
| 14 | 0.612 | | 0.000 |
| 15 | | | 0.000 |
| 16 | | | 0.000 |
| 17 | | | 0.000 |
| 18 | | | 0.000 |
| 19 | | | 0.000 |
| 20 | | | 0.000 |
| 21 | | | 0.000 |
| 22 | | | 0.158 |
| 23 | | | 0.368 |
| 24 | | | 0.348 |
| 25 | | | 0.000 |
| 26 | | | 0.000 |
| 27 | | | 0.000 |
| 28 | | | 0.304 |
| 29 | | | 0.000 |
| 30 | | | 0.000 |
| 31 | | | 0.000 |
| 32 | | | 0.000 |
| 33 | | | 0.000 |
| 34 | | | 0.205 |
| 35 | | | 0.000 |
| 36 | | | 0.000 |
| 37 | | | 0.000 |
| 38 | | | 0.000 |
| 39 | | | 0.014 |
| Average | 0.395 | N/A | 0.055 |

# Appendix F.5

## Inter-turn Speaker Latency Analysis for Audio Recording 5

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.256 | 0.000 | 0.000 |
| 2 | 0.085 | 0.000 | 0.430 |
| 3 | 0.909 | 0.184 | 0.153 |
| 4 | 0.276 | 0.119 | 0.083 |
| 5 | 0.941 | 0.191 | 0.000 |
| 6 | 0.513 | 0.519 | |
| 7 | 0.237 | 0.404 | |
| 8 | 0.269 | 0.346 | |
| 9 | 1.157 | 0.375 | |
| 10 | 0.234 | 0.321 | |
| 11 | 0.195 | 0.144 | |
| 12 | 0.000 | 0.215 | |
| 13 | 0.042 | 0.036 | |
| 14 | 0.000 | 1.558 | |
| 15 | 0.223 | 0.090 | |
| 16 | 0.083 | 0.574 | |
| 17 | 1.631 | 0.563 | |
| 18 | 0.333 | 0.271 | |
| 19 | 1.224 | 0.113 | |
| 20 | 1.203 | 0.491 | |
| 21 | 0.162 | 0.303 | |
| 22 | 0.697 | 0.400 | |
| 23 | 1.210 | 0.314 | |
| 24 | 0.191 | 0.114 | |
| 25 | 0.205 | 0.223 | |
| 26 | 0.311 | 0.023 | |
| 27 | 0.984 | 0.215 | |
| 28 | 0.580 | 0.559 | |
| 29 | 2.725 | 0.141 | |
| 30 | 0.559 | | |
| 31 | 0.479 | | |
| 32 | 0.824 | | |
| Average | 0.586 | 0.304 | 0.133 |

# Appendix F.6

## Inter-turn Speaker Latency Analysis for Audio Recording 6

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.260 | 0.372 | 0.000 |
| 2 | 0.339 | 0.325 | 0.000 |
| 3 | 0.000 | 0.180 | 0.317 |
| 4 | 0.000 | 0.056 | 0.000 |
| 5 | 0.000 | 0.379 | 0.639 |
| 6 | 0.076 | 0.000 | 0.274 |
| 7 | 0.035 | 0.000 | 0.035 |
| 8 | 0.055 | 0.462 | 0.130 |
| 9 | 0.314 | 0.000 | 0.000 |
| 10 | 0.539 | 1.162 | 0.117 |
| 11 | 0.606 | 0.000 | 0.037 |
| 12 | 0.361 | 0.000 | 0.096 |
| 13 | 0.131 | 0.000 | 0.188 |
| 14 | 0.657 | 0.137 | 0.777 |
| 15 | 3.276 | 0.072 | 0.725 |
| 16 | 0.783 | 0.361 | 0.000 |
| 17 | 0.239 | 0.000 | 0.112 |
| 18 | 0.000 | 0.000 | 0.956 |
| 19 | 3.088 | 0.750 | 0.000 |
| 20 | 2.377 | 0.121 | |
| 21 | 0.124 | 0.418 | |
| 22 | 0.000 | 0.096 | |
| 23 | 0.000 | 0.000 | |
| 24 | 1.616 | 0.361 | |
| 25 | 0.575 | 0.675 | |
| 26 | 0.000 | 0.064 | |
| 27 | | 0.000 | |
| 28 | | 0.469 | |
| 29 | | 0.000 | |
| 30 | | 0.382 | |
| 31 | | 0.119 | |
| 32 | | 0.000 | |
| 33 | | 0.087 | |
| 34 | | 0.000 | |
| 35 | | 0.213 | |
| Average | 0.594 | 0.207 | 0.232 |

# Appendix F.7

## Inter-turn Speaker Latency Analysis for Audio Recording 7

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.027 | 0.151 | 0.000 |
| 2 | 0.086 | 0.654 | 0.128 |
| 3 | 0.061 | 0.000 | 0.000 |
| 4 | 0.247 | 0.076 | 0.000 |
| 5 | 0.040 | | 0.000 |
| 6 | 0.129 | | 0.287 |
| 7 | 0.826 | | 0.199 |
| 8 | 0.029 | | 0.057 |
| 9 | 0.571 | | 0.000 |
| 10 | 0.704 | | 0.427 |
| 11 | 0.116 | | 0.000 |
| 12 | 0.490 | | 0.179 |
| 13 | 0.285 | | 0.000 |
| 14 | 0.293 | | 0.108 |
| 15 | 0.114 | | 0.561 |
| 16 | 0.000 | | 0.102 |
| 17 | 0.347 | | 0.300 |
| 18 | 0.537 | | 0.153 |
| 19 | 0.027 | | 0.000 |
| 20 | | | 0.037 |
| 21 | | | 0.000 |
| 22 | | | 0.055 |
| 23 | | | 0.000 |
| 24 | | | 0.036 |
| 25 | | | 0.000 |
| 26 | | | 0.000 |
| 27 | | | 0.381 |
| 28 | | | 0.522 |
| Average | 0.259 | 0.220 | 0.126 |

# Appendix F.8

## Inter-turn Speaker Latency Analysis for Audio Recording 8

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.635 | 0.887 | 0.808 |
| 2 | 0.000 | 3.117 | 0.245 |
| 3 | 1.717 | 0.180 | 0.000 |
| 4 | 0.649 | 3.203 | 0.000 |
| 5 | 0.498 | 1.053 | 0.000 |
| 6 | 1.537 | 1.674 | 0.595 |
| 7 | 0.433 | 0.794 | 0.000 |
| 8 | 0.152 | 0.245 | 0.000 |
| 9 | 0.442 | 0.574 | 1.908 |
| 10 | 0.000 | 0.046 | 1.594 |
| 11 | 0.631 | 0.078 | |
| 12 | 0.862 | | |
| 13 | 0.089 | | |
| 14 | 0.216 | | |
| 15 | 0.000 | | |
| 16 | 0.000 | | |
| 17 | 0.354 | | |
| Average | 0.483 | 1.077 | 0.515 |

# Appendix F.9

## Inter-turn Speaker Latency Analysis for Audio Recording 9

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.089 | 0.613 | 0.000 |
| 2 | 0.655 | 0.436 | 0.000 |
| 3 | 0.057 | 0.271 | 0.000 |
| 4 | 0.491 | 0.263 | 0.000 |
| 5 | 0.429 | | 0.101 |
| 6 | 0.375 | | 0.000 |
| 7 | 0.091 | | 0.000 |
| 8 | 0.346 | | 0.000 |
| 9 | 0.631 | | 0.000 |
| 10 | 0.620 | | 0.000 |
| 11 | 0.321 | | 0.000 |
| 12 | 0.193 | | 0.000 |
| 13 | 0.245 | | 0.000 |
| 14 | 0.529 | | 0.115 |
| 15 | 0.222 | | 0.000 |
| 16 | | | 0.000 |
| 17 | | | 0.000 |
| 18 | | | 0.488 |
| 19 | | | 0.783 |
| 20 | | | 0.039 |
| 21 | | | 0.000 |
| 22 | | | 0.010 |
| 23 | | | 0.000 |
| 24 | | | 0.000 |
| 25 | | | 0.000 |
| 26 | | | 0.100 |
| 27 | | | 0.000 |
| 28 | | | 0.161 |
| 29 | | | 1.924 |
| 30 | | | 2.856 |
| 31 | | | 0.231 |
| Average | 0.353 | 0.396 | 0.220 |

# Appendix F.10

## Inter-turn Speaker Latency Analysis for Audio Recording 10

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.433 | 0.447 | 0.000 |
| 2 | 0.285 | 0.246 | 0.328 |
| 3 | 0.000 | 0.184 | 0.260 |
| 4 | 0.171 | 0.114 | 0.000 |
| 5 | 1.277 | 0.183 | 0.180 |
| 6 | 0.548 | 0.303 | 0.087 |
| 7 | 0.830 | 0.041 | 0.729 |
| 8 | 0.418 | 0.103 | |
| 9 | 0.310 | 0.116 | |
| 10 | 0.096 | 0.073 | |
| 11 | 0.447 | 0.156 | |
| 12 | 0.779 | 0.384 | |
| 13 | 1.057 | 0.384 | |
| 14 | 0.602 | 0.590 | |
| 15 | 0.149 | 0.471 | |
| 16 | 0.703 | 0.649 | |
| 17 | 1.367 | 0.276 | |
| 18 | | 0.519 | |
| Average | 0.557 | 0.291 | 0.226 |

# Appendix F.11

## Inter-turn Speaker Latency Analysis for Audio Recording 11

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.184 | | 0.000 |
| 2 | 0.092 | | 0.166 |
| 3 | 0.326 | | 0.000 |
| 4 | 0.541 | | 0.173 |
| 5 | 1.479 | | 0.023 |
| 6 | 0.851 | | 0.000 |
| 7 | 0.483 | | 0.012 |
| 8 | 0.581 | | 0.000 |
| 9 | 0.736 | | 0.041 |
| 10 | 0.505 | | 0.556 |
| 11 | 0.260 | | 0.372 |
| 12 | 1.573 | | 0.050 |
| 13 | 1.053 | | 0.267 |
| 14 | 1.227 | | 0.000 |
| 15 | 0.339 | | 0.040 |
| 16 | 0.750 | | 0.000 |
| 17 | 0.577 | | 0.142 |
| 18 | 0.093 | | 0.000 |
| 19 | 0.227 | | 0.664 |
| 20 | 1.248 | | 0.047 |
| 21 | 0.794 | | 0.000 |
| 22 | 0.155 | | 0.000 |
| 23 | 0.498 | | 0.000 |
| 24 | 0.462 | | 0.000 |
| 25 | 0.000 | | 0.000 |
| 26 | 1.082 | | 0.000 |
| 27 | 1.010 | | |
| 28 | 0.321 | | |
| 29 | 0.198 | | |
| 30 | 0.685 | | |
| 31 | 0.000 | | |
| 32 | 0.269 | | |
| 33 | 0.758 | | |
| 34 | 0.000 | | |
| 35 | 0.390 | | |
| 36 | 0.828 | | |
| Average | 0.572 | N/A | 0.098 |

# Appendix F.12

## Inter-turn Speaker Latency Analysis for Audio Recording 12

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.343 | | 0.000 |
| 2 | 2.121 | | 0.000 |
| 3 | 1.015 | | 0.197 |
| 4 | 0.382 | | 0.000 |
| 5 | 1.472 | | 0.534 |
| 6 | 0.801 | | 0.382 |
| 7 | 0.026 | | 0.123 |
| 8 | 0.178 | | 0.498 |
| 9 | 1.497 | | 0.393 |
| 10 | 0.189 | | 0.061 |
| 11 | 0.000 | | 0.173 |
| 12 | 0.000 | | 0.000 |
| 13 | 0.000 | | 0.000 |
| 14 | 0.191 | | 0.000 |
| 15 | 0.292 | | 0.166 |
| 16 | | | 0.000 |
| 17 | | | 0.000 |
| 18 | | | 0.000 |
| 19 | | | 0.000 |
| Average | 0.567 | N/A | 0.133 |

# Appendix F.13

## Inter-turn Speaker Latency Analysis for Audio Recording 13

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.013 | | 0.000 |
| 2 | 0.097 | | 0.000 |
| 3 | 0.052 | | 0.000 |
| 4 | 0.458 | | 0.346 |
| 5 | 0.000 | | 0.106 |
| 6 | 0.177 | | 0.000 |
| 7 | | | 0.000 |
| 8 | | | 0.135 |
| 9 | | | 0.251 |
| 10 | | | 0.177 |
| 11 | | | 0.000 |
| 12 | | | 0.000 |
| 13 | | | 0.000 |
| 14 | | | 0.000 |
| 15 | | | 0.000 |
| 16 | | | 0.000 |
| 17 | | | 0.000 |
| 18 | | | 0.097 |
| Average | 0.133 | N/A | 0.062 |

# Appendix F.14

## Inter-turn Speaker Latency Analysis for Audio Recording 14

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.404 | | 0.043 |
| 2 | 0.170 | | 1.799 |
| 3 | 0.000 | | 0.862 |
| 4 | | | 1.763 |
| 5 | | | 0.000 |
| 6 | | | 0.139 |
| 7 | | | 0.000 |
| 8 | | | 0.021 |
| 9 | | | 0.000 |
| 10 | | | 0.000 |
| 11 | | | 0.000 |
| 12 | | | 0.000 |
| 13 | | | 0.141 |
| 14 | | | 0.000 |
| 15 | | | 0.000 |
| 16 | | | 0.000 |
| 17 | | | 0.000 |
| 18 | | | 0.000 |
| 19 | | | 0.000 |
| 20 | | | 0.000 |
| 21 | | | 0.079 |
| 22 | | | 0.056 |
| 23 | | | 0.000 |
| 24 | | | 0.000 |
| 25 | | | 0.000 |
| 26 | | | 0.090 |
| 27 | | | 0.000 |
| 28 | | | 0.000 |
| 29 | | | 0.000 |
| 30 | | | 0.198 |
| 31 | | | 0.287 |
| 32 | | | 0.000 |
| 33 | | | 0.000 |
| 34 | | | 0.000 |
| 35 | | | 0.000 |
| 36 | | | 0.000 |
| 37 | | | 0.000 |
| 38 | | | 0.000 |
| 39 | | | 0.519 |
| 40 | | | 0.000 |
| 41 | | | 0.158 |

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 42 | | | 0.000 |
| 43 | | | 0.239 |
| Average | 0.191 | N/A | 0.149 |

# Appendix F.15

## Inter-turn Speaker Latency Analysis for Audio Recording 15

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.330 | 0.000 | 0.227 |
| 2 | 0.000 | 0.177 | 0.000 |
| 3 | 0.096 | 0.620 | 0.000 |
| 4 | 0.000 | 0.000 | 0.545 |
| 5 | 0.629 | 0.000 | 0.253 |
| 6 | 1.216 | 0.000 | 0.000 |
| 7 | 0.470 | | 0.198 |
| 8 | 0.000 | | 0.000 |
| 9 | 0.153 | | 0.073 |
| 10 | 0.000 | | 0.000 |
| 11 | 0.348 | | 0.175 |
| 12 | 0.587 | | 0.000 |
| 13 | 0.018 | | 0.000 |
| 14 | 0.021 | | 0.000 |
| 15 | 0.483 | | 0.000 |
| 16 | 0.000 | | 0.000 |
| 17 | 0.000 | | 0.000 |
| 18 | | | 0.000 |
| 19 | | | 0.065 |
| Average | 0.256 | 0.133 | 0.081 |

# Appendix F.16

## Inter-turn Speaker Latency Analysis for Audio Recording 16

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.011 | 0.887 | 0.574 |
| 2 | 0.265 | 0.173 | 1.173 |
| 3 | 0.162 | | 0.089 |
| 4 | 0.324 | | 0.000 |
| 5 | 0.299 | | 1.018 |
| 6 | 0.710 | | 0.000 |
| 7 | 0.076 | | 0.245 |
| 8 | 0.125 | | 0.389 |
| 9 | 0.000 | | 0.158 |
| 10 | 0.601 | | 0.289 |
| 11 | 0.343 | | 0.000 |
| 12 | 0.000 | | 0.116 |
| 13 | 0.144 | | 0.851 |
| 14 | 0.278 | | 0.260 |
| 15 | 0.209 | | 1.528 |
| 16 | 0.113 | | 0.000 |
| 17 | 0.301 | | 0.000 |
| 18 | 0.364 | | 0.063 |
| 19 | 0.254 | | 0.000 |
| 20 | | | 0.000 |
| Average | 0.241 | 0.530 | 0.338 |

# Appendix F.17

## Inter-turn Speaker Latency Analysis for Audio Recording 17

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.440 | 0.332 | 0.433 |
| 2 | 0.273 | 0.649 | 0.033 |
| 3 | 0.000 | 0.078 | 0.231 |
| 4 | 0.671 | 0.548 | 0.794 |
| 5 | 0.042 | 0.620 | 0.107 |
| 6 | 0.722 | 0.000 | 0.045 |
| 7 | 0.506 | 0.090 | 0.126 |
| 8 | 0.214 | 0.786 | 0.328 |
| 9 | 0.130 | 0.132 | 0.125 |
| 10 | 0.173 | 0.516 | 0.000 |
| 11 | 0.557 | 0.790 | 0.168 |
| 12 | 0.000 | | 0.066 |
| 13 | 0.149 | | 0.133 |
| 14 | 0.498 | | 0.000 |
| 15 | 0.214 | | 0.000 |
| 16 | 0.295 | | 0.206 |
| 17 | | | 0.707 |
| 18 | | | 0.295 |
| 19 | | | 0.158 |
| 20 | | | 0.070 |
| 21 | | | 0.000 |
| 22 | | | 0.141 |
| 23 | | | 0.097 |
| 24 | | | 0.350 |
| 25 | | | 0.010 |
| 26 | | | 0.000 |
| 27 | | | 0.141 |
| 28 | | | 0.000 |
| 29 | | | 0.307 |
| 30 | | | 0.000 |
| 31 | | | 0.000 |
| 32 | | | 0.000 |
| Average | 0.305 | 0.413 | 0.159 |

# Appendix F.18

## Inter-turn Speaker Latency Analysis for Audio Recording 18

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.000 | 0.341 | 0.000 |
| 2 | 0.162 | 0.377 | 0.000 |
| 3 | 0.000 | 0.444 | 0.000 |
| 4 | 0.473 | 0.755 | 0.000 |
| 5 | 0.106 | 1.230 | 0.000 |
| 6 | 0.000 | 0.078 | 0.000 |
| 7 | 0.906 | 0.000 | 0.000 |
| 8 | 0.000 | 0.000 | 0.000 |
| 9 | 0.069 | 0.283 | 0.000 |
| 10 | 0.055 | 1.966 | 0.000 |
| 11 | | 0.000 | 0.000 |
| 12 | | 1.172 | 0.000 |
| 13 | | 0.286 | 0.000 |
| 14 | | 0.291 | 0.119 |
| 15 | | 0.000 | 0.000 |
| 16 | | 0.183 | 0.000 |
| 17 | | 0.146 | 0.000 |
| 18 | | 0.268 | 0.000 |
| 19 | | 0.170 | 0.000 |
| 20 | | 0.140 | 0.000 |
| 21 | | 0.040 | 0.000 |
| 22 | | 0.170 | 0.000 |
| 23 | | 0.356 | 0.000 |
| 24 | | | 0.000 |
| 25 | | | 0.000 |
| 26 | | | 0.000 |
| 27 | | | 0.000 |
| 28 | | | 0.000 |
| 29 | | | 0.000 |
| 30 | | | 0.000 |
| 31 | | | 0.000 |
| 32 | | | 0.000 |
| 33 | | | 0.000 |
| 34 | | | 0.000 |
| 35 | | | 0.071 |
| Average | 0.177 | 0.378 | 0.005 |

# Appendix F.19

## Inter-turn Speaker Latency Analysis for Audio Recording 19

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.426 | 0.000 | 0.000 |
| 2 | 0.037 | 0.030 | 0.000 |
| 3 | 0.338 | 1.108 | 0.053 |
| 4 | 0.688 | 0.027 | 0.633 |
| 5 | 0.476 | 0.053 | 0.045 |
| 6 | 0.958 | 0.011 | 0.185 |
| 7 | 0.017 | 1.012 | 0.000 |
| 8 | 0.467 | 0.213 | 0.094 |
| 9 | 0.024 | 0.133 | 0.000 |
| 10 | 0.273 | 0.153 | 0.000 |
| 11 | 0.212 | 0.362 | 0.317 |
| 12 | 1.734 | 0.013 | 0.000 |
| 13 | 0.000 | 0.113 | 0.000 |
| 14 | 0.655 | 0.031 | 0.400 |
| 15 | 0.000 | 0.214 | 0.000 |
| 16 | 0.053 | 0.022 | 0.000 |
| 17 | 0.209 | 0.719 | 0.000 |
| 18 | 0.000 | 0.000 | 0.000 |
| 19 | 0.249 | 0.688 | 0.000 |
| 20 | 0.195 | 0.000 | |
| 21 | 0.029 | 0.111 | |
| 22 | 0.105 | | |
| Average | 0.325 | 0.239 | 0.091 |

# Appendix F.20

## Inter-turn Speaker Latency Analysis for Audio Recording 20

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.411 | 0.734 | 0.000 |
| 2 | 0.185 | 0.073 | 0.000 |
| 3 | 0.117 | 1.097 | 0.000 |
| 4 | 0.000 | 0.000 | 0.000 |
| 5 | 0.287 | 0.000 | 0.000 |
| 6 | 0.000 | 0.000 | 0.000 |
| 7 | 0.000 | 0.462 | 0.000 |
| 8 | 0.312 | 0.161 | 0.941 |
| 9 | 0.974 | 0.000 | 0.000 |
| 10 | 0.282 | 1.378 | 0.000 |
| 11 | 0.075 | 0.000 | 0.000 |
| 12 | 0.869 | 0.234 | 0.000 |
| 13 | 0.851 | | 0.163 |
| 14 | 0.110 | | 0.000 |
| 15 | 0.000 | | 1.039 |
| 16 | 0.000 | | |
| 17 | 0.260 | | |
| 18 | 0.743 | | |
| 19 | 1.356 | | |
| 20 | 1.068 | | |
| 21 | 0.020 | | |
| 22 | 0.186 | | |
| 23 | 0.325 | | |
| 24 | 0.491 | | |
| 25 | 0.599 | | |
| 26 | 0.081 | | |
| 27 | 1.129 | | |
| 28 | 1.281 | | |
| 29 | 0.101 | | |
| Average | 0.418 | 0.345 | 0.143 |

# Appendix F.21

## Inter-turn Speaker Latency Analysis for Audio Recording 21

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.000 | 0.000 | 0.216 |
| 2 | 0.020 | 0.000 | 0.000 |
| 3 | 0.176 | 0.509 | 0.000 |
| 4 | 0.126 | 0.000 | 0.142 |
| 5 | 0.205 | 0.354 | 0.434 |
| 6 | 0.000 | 0.000 | 1.243 |
| 7 | 0.047 | 0.137 | 0.805 |
| 8 | 0.000 | | 1.490 |
| 9 | 0.352 | | 0.000 |
| 10 | 0.000 | | 0.000 |
| 11 | 0.000 | | 0.000 |
| 12 | 0.144 | | 0.000 |
| 13 | 0.040 | | 0.188 |
| 14 | 0.044 | | 0.000 |
| 15 | 0.000 | | |
| 16 | 0.032 | | |
| 17 | 0.037 | | |
| Average | 0.072 | 0.143 | 0.323 |

# Appendix F.22

## Inter-turn Speaker Latency Analysis for Audio Recording 22

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.000 | 1.123 | 0.000 |
| 2 | 0.964 | 2.124 | 0.000 |
| 3 | 0.786 | 0.227 | 0.000 |
| 4 | 0.000 | 0.259 | 0.000 |
| 5 | 0.264 | 0.096 | 0.032 |
| 6 | | 1.113 | 0.000 |
| 7 | | 0.000 | 0.144 |
| 8 | | 0.180 | 0.000 |
| 9 | | 0.180 | 0.245 |
| 10 | | 0.022 | 0.000 |
| 11 | | 0.041 | 0.000 |
| 12 | | 0.382 | 0.000 |
| 13 | | 0.457 | 0.000 |
| 14 | | 1.026 | 0.000 |
| 15 | | 0.000 | 0.128 |
| 16 | | 0.475 | 0.592 |
| 17 | | 0.281 | 0.227 |
| 18 | | 0.000 | 1.498 |
| 19 | | 0.196 | 0.051 |
| 20 | | 0.605 | 0.106 |
| 21 | | 0.374 | 0.038 |
| 22 | | | 0.000 |
| 23 | | | 0.033 |
| Average | 0.403 | 0.436 | 0.135 |

# Appendix F.23

## Inter-turn Speaker Latency Analysis for Audio Recording 23

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.181 | 0.524 | 0.446 |
| 2 | 0.416 | 0.017 | 0.274 |
| 3 | 0.902 | 1.167 | 0.202 |
| 4 | 1.278 | 0.655 | 0.389 |
| 5 | 0.734 | 0.403 | 0.053 |
| 6 | 0.045 | 0.734 | 0.000 |
| 7 | 0.590 | 0.131 | |
| 8 | 0.172 | 0.886 | |
| 9 | 0.315 | 2.441 | |
| 10 | 1.758 | | |
| 11 | 2.811 | | |
| 12 | 0.194 | | |
| 13 | 0.208 | | |
| 14 | 1.692 | | |
| 15 | 2.209 | | |
| Average | 0.900 | 0.773 | 0.227 |

# Appendix F.24

## Inter-turn Speaker Latency Analysis for Audio Recording 24

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.000 | 0.049 | 0.000 |
| 2 | 2.143 | 0.193 | 0.306 |
| 3 | 0.029 | 0.101 | 0.350 |
| 4 | 0.188 | 0.497 | 0.494 |
| 5 | 2.749 | 0.011 | 0.029 |
| 6 | 0.092 | 0.480 | 0.258 |
| 7 | | 0.444 | 0.030 |
| 8 | | 0.000 | 0.079 |
| 9 | | 0.224 | 0.426 |
| 10 | | 0.618 | 0.054 |
| 11 | | 0.812 | 0.000 |
| 12 | | 0.105 | 0.310 |
| 13 | | 0.294 | 0.187 |
| 14 | | | 0.000 |
| 15 | | | 0.119 |
| 16 | | | 0.017 |
| 17 | | | 0.026 |
| 18 | | | 0.570 |
| 19 | | | 0.141 |
| 20 | | | 0.053 |
| 21 | | | 0.000 |
| Average | 0.867 | 0.294 | 0.164 |

# Appendix F.25

## Inter-turn Speaker Latency Analysis for Audio Recording 25

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.096 | 0.013 | 0.000 |
| 2 | 0.129 | | 0.146 |
| 3 | | | 0.000 |
| 4 | | | 0.063 |
| 5 | | | 0.595 |
| 6 | | | 0.000 |
| 7 | | | 0.010 |
| 8 | | | 0.000 |
| 9 | | | 0.000 |
| 10 | | | 0.202 |
| 11 | | | 0.019 |
| 12 | | | 0.000 |
| 13 | | | 0.092 |
| 14 | | | 0.176 |
| 15 | | | 0.021 |
| 16 | | | 0.336 |
| 17 | | | 0.417 |
| 18 | | | 0.000 |
| 19 | | | 0.528 |
| 20 | | | 0.000 |
| 21 | | | 0.184 |
| 22 | | | 0.000 |
| 23 | | | 0.026 |
| 24 | | | 0.000 |
| 25 | | | 0.230 |
| 26 | | | 0.000 |
| 27 | | | 0.000 |
| 28 | | | 0.000 |
| 29 | | | 0.036 |
| 30 | | | 0.093 |
| 31 | | | 0.000 |
| 32 | | | 0.000 |
| 33 | | | 0.000 |
| 34 | | | 0.129 |
| 35 | | | 0.000 |
| 36 | | | 0.051 |
| 37 | | | 0.146 |
| 38 | | | 0.148 |
| 39 | | | 0.085 |
| 40 | | | 0.000 |
| 41 | | | 0.816 |

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 43 | | | 0.097 |
| 44 | | | 0.073 |
| Average | 0.113 | 0.013 | 0.107 |

# Appendix F.26

## Inter-turn Speaker Latency Analysis for Audio Recording 26

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.354 | 1.356 | 0.000 |
| 2 | 0.090 | 1.154 | 0.000 |
| 3 | 0.000 | 0.215 | 0.000 |
| 4 | 0.000 | 0.361 | 0.000 |
| 5 | 0.000 | 0.046 | 0.000 |
| 6 | 0.575 | 0.193 | 0.000 |
| 7 | 0.246 | 0.097 | 0.000 |
| 8 | 0.513 | 1.068 | 0.112 |
| 9 | 0.461 | 0.667 | 0.000 |
| 10 | 0.364 | 2.164 | 1.538 |
| 11 | 0.123 | 1.645 | 0.000 |
| 12 | 0.004 | 0.000 | 0.000 |
| 13 | 0.000 | 0.008 | 0.000 |
| 14 | | 0.131 | 0.000 |
| 15 | | 0.000 | 0.347 |
| 16 | | 0.361 | 0.000 |
| 17 | | 0.137 | 0.000 |
| 18 | | 0.374 | 0.000 |
| 19 | | 0.292 | 0.055 |
| 20 | | 1.528 | 0.158 |
| 21 | | | 0.100 |
| 22 | | | 0.000 |
| 23 | | | 0.000 |
| 24 | | | 0.000 |
| 25 | | | 0.000 |
| 26 | | | 0.010 |
| 27 | | | 0.000 |
| 28 | | | 0.000 |
| 29 | | | 0.004 |
| Average | 0.210 | 0.590 | 0.080 |

# Appendix F.27

## Inter-turn Speaker Latency Analysis for Audio Recording 27

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 1.082 | 0.236 | 0.000 |
| 2 | 1.075 | 0.000 | 0.260 |
| 3 | 0.000 | 0.000 | 0.231 |
| 4 | 0.866 | 0.050 | 0.014 |
| 5 | 0.000 | 0.074 | 0.257 |
| 6 | 0.000 | | 0.625 |
| 7 | 0.682 | | 0.000 |
| 8 | 0.043 | | 0.194 |
| 9 | 0.588 | | 0.000 |
| 10 | 0.000 | | 0.000 |
| 11 | | | 0.131 |
| 12 | | | 0.058 |
| 13 | | | 0.107 |
| 14 | | | 1.737 |
| 15 | | | 0.094 |
| 16 | | | 0.000 |
| Average | 0.434 | 0.072 | 0.232 |

# Appendix F.28

## Inter-turn Speaker Latency Analysis for Audio Recording 28

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 1.955 | 0.156 | 0.000 |
| 2 | 0.000 | 0.316 | 0.000 |
| 3 | 0.056 | 0.000 | 0.000 |
| 4 | 0.368 | 0.420 | 0.000 |
| 5 | 0.450 | | 0.094 |
| 6 | 0.058 | | 0.874 |
| 7 | 0.033 | | 0.301 |
| 8 | 0.000 | | 0.000 |
| 9 | 0.000 | | 0.000 |
| 10 | 1.400 | | 0.000 |
| 11 | 0.097 | | 0.000 |
| 12 | 0.364 | | 0.000 |
| 13 | | | 0.094 |
| 14 | | | 0.000 |
| 15 | | | 0.151 |
| 16 | | | 0.000 |
| 17 | | | 0.090 |
| 18 | | | 0.121 |
| 19 | | | 0.123 |
| Average | 0.399 | 0.223 | 0.097 |

# Appendix F.29

## Inter-turn Speaker Latency Analysis for Audio Recording 29

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.179 | 0.189 | 0.000 |
| 2 | 0.020 | 0.156 | 0.481 |
| 3 | 0.135 | 0.076 | 0.000 |
| 4 | 0.141 | 0.000 | 0.000 |
| 5 | 0.000 | 0.129 | 0.000 |
| 6 | 0.262 | 0.118 | 0.100 |
| 7 | 0.721 | 0.559 | 0.000 |
| 8 | 0.000 | 0.244 | 0.216 |
| 9 | 0.023 | 0.000 | 0.270 |
| 10 | 0.326 | 0.000 | 0.128 |
| 11 | 0.000 | 0.507 | 0.000 |
| 12 | 0.000 | 0.260 | 0.000 |
| 13 | 0.093 | 0.000 | 0.000 |
| 14 | 0.000 | 0.334 | 0.000 |
| 15 | 0.275 | 0.000 | 0.000 |
| 16 | 0.000 | | 0.000 |
| 17 | 0.000 | | 0.000 |
| 18 | 0.000 | | 0.000 |
| 19 | 0.211 | | 0.177 |
| 20 | 0.000 | | 0.197 |
| 21 | 0.027 | | 0.267 |
| 22 | 0.129 | | 0.000 |
| 23 | 0.129 | | 0.000 |
| 24 | 0.000 | | 0.000 |
| 25 | 0.000 | | 0.000 |
| 26 | 0.804 | | 0.058 |
| 27 | 0.059 | | 0.065 |
| 28 | | | 0.000 |
| 29 | | | 0.000 |
| 30 | | | 0.170 |
| 31 | | | 0.068 |
| 32 | | | 0.032 |
| 33 | | | 0.238 |
| Average | 0.131 | 0.172 | 0.075 |

# Appendix F.30

## Inter-turn Speaker Latency Analysis for Audio Recording 30

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.296 | | 0.222 |
| 2 | 0.000 | | 0.156 |
| 3 | 0.394 | | 0.172 |
| 4 | | | 0.000 |
| 5 | | | 0.290 |
| 6 | | | 0.000 |
| 7 | | | 0.224 |
| 8 | | | 0.117 |
| 9 | | | 0.000 |
| 10 | | | 0.073 |
| 11 | | | 0.491 |
| 12 | | | 0.021 |
| 13 | | | 0.159 |
| 14 | | | 0.000 |
| 15 | | | 0.000 |
| 16 | | | 0.000 |
| 17 | | | 0.065 |
| 18 | | | 0.117 |
| 19 | | | 0.000 |
| 20 | | | 0.000 |
| 21 | | | 0.023 |
| 22 | | | 0.245 |
| 23 | | | 0.000 |
| 24 | | | 0.061 |
| 25 | | | 0.000 |
| 26 | | | 0.000 |
| 27 | | | 0.184 |
| 28 | | | 0.009 |
| 29 | | | 0.000 |
| Average | 0.230 | N/A | 0.091 |

# Appendix F.31

## Inter-turn Speaker Latency Analysis for Audio Recording 31

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0 | | 0 |
| 2 | 0.007722 | | 0.108221 |
| 3 | 0.026604 | | 0.184653 |
| 4 | 0 | | 0 |
| 5 | 0 | | 0.023082 |
| 6 | 0.007215 | | 0 |
| 7 | 0.048474 | | 0 |
| 8 | 0.234498 | | 0 |
| 9 | 0.149706 | | 0.108319 |
| 10 | 0.023899 | | 0 |
| 11 | 0.202013 | | 0 |
| 12 | 0.073052 | | 0 |
| 13 | 0 | | 0 |
| 14 | 0 | | 0.020159 |
| 15 | 0 | | 0 |
| 16 | 0 | | 0 |
| 17 | 0.046896 | | 0.303294 |
| 18 | 0.157823 | | 0 |
| 19 | 0.095596 | | 0 |
| 20 | 0.182173 | | 0 |
| 21 | 0.154215 | | 0.086355 |
| 22 | 1.919126 | | 0 |
| 23 | 0.256124 | | 0 |
| 24 | 0.149706 | | 0.168497 |
| 25 | 0.238989 | | 0 |
| 26 | 0 | | |
| Average | 0.152839654 | N/A | 0.0401032 |

# Appendix F.32

## Inter-turn Speaker Latency Analysis for Audio Recording 32

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.271 | 0.707 | 0.090 |
| 2 | 0.000 | 0.000 | 0.305 |
| 3 | 0.318 | 0.011 | 0.583 |
| 4 | 0.483 | 0.333 | 0.000 |
| 5 | 0.652 | 0.103 | 0.173 |
| 6 | 0.000 | 0.000 | 0.101 |
| 7 | 0.262 | 0.085 | 0.312 |
| 8 | 1.260 | 0.241 | 0.308 |
| 9 | 0.233 | 0.024 | 0.026 |
| 10 | 0.137 | 0.000 | 0.000 |
| 11 | 0.176 | 0.135 | 0.242 |
| 12 | 0.000 | 0.014 | 0.141 |
| 13 | 0.225 | 0.014 | 0.523 |
| 14 | 0.970 | 0.631 | 0.476 |
| 15 | 0.131 | 0.000 | 0.000 |
| 16 | 0.000 | 0.000 | 0.000 |
| 17 | 0.304 | 0.137 | |
| 18 | 0.000 | 0.000 | |
| 19 | | 0.000 | |
| 20 | | 0.000 | |
| 21 | | 0.133 | |
| 22 | | 0.000 | |
| 23 | | 0.098 | |
| 24 | | 0.119 | |
| 25 | | 0.088 | |
| 26 | | 0.086 | |
| 27 | | 0.258 | |
| 28 | | 0.366 | |
| Average | 0.301 | 0.128 | 0.205 |

# Appendix F.33

## Inter-turn Speaker Latency Analysis for Audio Recording 33

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 2.482 | 0.095 | 0.000 |
| 2 | 0.463 | 0.215 | 0.000 |
| 3 | 0.048 | | 0.000 |
| 4 | 0.000 | | 0.000 |
| 5 | 0.000 | | 0.000 |
| 6 | 0.916 | | 0.000 |
| 7 | 0.000 | | 0.000 |
| 8 | 0.044 | | 0.000 |
| 9 | 0.170 | | 0.177 |
| 10 | 0.065 | | 0.066 |
| 11 | 0.032 | | 0.164 |
| 12 | 0.011 | | 0.000 |
| 13 | 0.174 | | 0.174 |
| 14 | 0.310 | | 0.200 |
| 15 | 0.000 | | 0.000 |
| 16 | 0.202 | | 0.174 |
| 17 | 0.102 | | 0.447 |
| 18 | 0.044 | | 0.000 |
| 19 | 0.000 | | 0.000 |
| 20 | 0.412 | | 0.541 |
| 21 | 0.000 | | 0.414 |
| 22 | | | 0.160 |
| 23 | | | 0.008 |
| 24 | | | 0.011 |
| 25 | | | 0.000 |
| 26 | | | 0.008 |
| 27 | | | 0.165 |
| 28 | | | 0.103 |
| 29 | | | 0.023 |
| 30 | | | 0.000 |
| Average | 0.261 | 0.155 | 0.094 |

# Appendix F.34

## Inter-turn Speaker Latency Analysis for Audio Recording 34

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.048 | 0.418 | 0.000 |
| 2 | 0.108 | 0.083 | 0.000 |
| 3 | 0.184 | 0.040 | 0.025 |
| 4 | 0.014 | 0.157 | 0.000 |
| 5 | 0.058 | 0.018 | 0.032 |
| 6 | 0.000 | 0.274 | 0.000 |
| 7 | 0.310 | 0.447 | 0.000 |
| 8 | 0.207 | 0.505 | 0.000 |
| 9 | 0.200 | 0.060 | 0.000 |
| 10 | 0.108 | 0.000 | 0.092 |
| 11 | 0.006 | 0.491 | 0.743 |
| 12 | 0.018 | 0.000 | 0.489 |
| 13 | 0.000 | 0.000 | 0.000 |
| 14 | 1.255 | 0.121 | 0.000 |
| 15 | 0.159 | 0.000 | 0.000 |
| 16 | 0.116 | 0.000 | 0.000 |
| 17 | 0.000 | 0.000 | 0.043 |
| 18 | 0.000 | 0.025 | 0.325 |
| 19 | 0.088 | 0.455 | 0.007 |
| 20 | 0.000 | 0.000 | 0.000 |
| 21 | 0.092 | 0.000 | 0.245 |
| 22 | 0.096 | 0.000 | 0.462 |
| 23 | 0.177 | 0.005 | 0.180 |
| 24 | 0.039 | | 0.000 |
| 25 | 0.473 | | 0.967 |
| 26 | | | 0.000 |
| 27 | | | 0.000 |
| 28 | | | 0.137 |
| 29 | | | 0.000 |
| 30 | | | 0.000 |
| Average | 0.150 | 0.135 | 0.125 |

# Appendix F.35

## Inter-turn Speaker Latency Analysis for Audio Recording 35

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.000 | 0.301 | 0.000 |
| 2 | 0.227 | 0.000 | 2.511 |
| 3 | | 1.147 | 0.046 |
| 4 | | 0.365 | 0.138 |
| 5 | | | 0.050 |
| 6 | | | 0.000 |
| 7 | | | 0.000 |
| 8 | | | 0.000 |
| 9 | | | 0.103 |
| 10 | | | 0.000 |
| 11 | | | 0.000 |
| 12 | | | 0.000 |
| 13 | | | 0.000 |
| 14 | | | 0.068 |
| 15 | | | 0.000 |
| 16 | | | 0.028 |
| 17 | | | 0.444 |
| 18 | | | 0.193 |
| 19 | | | 0.410 |
| 20 | | | 0.000 |
| 21 | | | 0.000 |
| 22 | | | 0.040 |
| 23 | | | 0.044 |
| 24 | | | 0.000 |
| 25 | | | 0.106 |
| 26 | | | 1.481 |
| 27 | | | 0.000 |
| 28 | | | 0.096 |
| 29 | | | 0.279 |
| Average | 0.114 | 0.453 | 0.208 |

# Appendix F.36

## Inter-turn Speaker Latency Analysis for Audio Recording 36

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.120 | 0.141 | 0.000 |
| 2 | 0.065 | 0.121 | 0.124 |
| 3 | 0.159 | 0.008 | 0.000 |
| 4 | 0.055 | 0.000 | 0.146 |
| 5 | 0.010 | 0.000 | 0.011 |
| 6 | 0.462 | 0.133 | 0.657 |
| 7 | 0.091 | 0.126 | 0.088 |
| 8 | 0.141 | 0.160 | 0.349 |
| 9 | 0.079 | 0.008 | 0.141 |
| 10 | 0.177 | 0.008 | 0.191 |
| 11 | 0.000 | 0.249 | 0.042 |
| 12 | 0.023 | 0.082 | 0.000 |
| 13 | 0.000 | 0.090 | 0.000 |
| 14 | 0.000 | 0.070 | 0.380 |
| 15 | 0.000 | 0.000 | 0.000 |
| 16 | 0.000 | 1.005 | 0.000 |
| 17 | 0.051 | 0.000 | 0.253 |
| 18 | 0.213 | 0.000 | 0.319 |
| 19 | 0.032 | 0.000 | 0.091 |
| 20 | 0.060 | 0.065 | 0.000 |
| 21 | 0.000 | | 0.088 |
| 22 | 0.519 | | 0.000 |
| 23 | 0.096 | | 0.000 |
| 24 | 0.281 | | 0.000 |
| 25 | 0.222 | | 0.000 |
| 26 | 0.000 | | 0.000 |
| 27 | 0.027 | | 0.000 |
| 28 | | | 0.011 |
| 29 | | | 2.910 |
| 30 | | | 0.385 |
| Average | 0.107 | 0.113 | 0.206 |

# Appendix F.37

## Inter-turn Speaker Latency Analysis for Audio Recording 37

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.177 | | 0.000 |
| 2 | 0.000 | | 0.000 |
| 3 | 0.338 | | 0.031 |
| 4 | 0.187 | | 0.000 |
| 5 | 0.218 | | 0.012 |
| 6 | 0.175 | | 0.000 |
| 7 | 0.075 | | 0.360 |
| 8 | 0.028 | | 0.000 |
| 9 | 0.116 | | 0.207 |
| 10 | | | 0.000 |
| 11 | | | 0.000 |
| 12 | | | 0.000 |
| 13 | | | 0.000 |
| 14 | | | 0.011 |
| 15 | | | 0.140 |
| 16 | | | 0.000 |
| 17 | | | 0.028 |
| 18 | | | 0.000 |
| 19 | | | 0.344 |
| 20 | | | 0.668 |
| 21 | | | 0.180 |
| 22 | | | 0.173 |
| 23 | | | 0.054 |
| 24 | | | 0.000 |
| 25 | | | 0.000 |
| 26 | | | 0.000 |
| 27 | | | 0.000 |
| 28 | | | 0.054 |
| 29 | | | 0.008 |
| 30 | | | 0.000 |
| Average | 0.146 | N/A | 0.076 |

# Appendix F.38

## Inter-turn Speaker Latency Analysis for Audio Recording 38

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.121 | 0.534 | 0.063 |
| 2 | 0.873 | 0.037 | 0.000 |
| 3 | 0.278 | 0.000 | 0.000 |
| 4 | 0.238 | 0.128 | 0.082 |
| 5 | 0.128 | 0.020 | 0.377 |
| 6 | 0.848 | 0.349 | 0.130 |
| 7 | 0.056 | 0.000 | 0.175 |
| 8 | 0.000 | 0.179 | 0.009 |
| 9 | 0.080 | 0.063 | 0.117 |
| 10 | 0.422 | 0.090 | 0.128 |
| 11 | | 0.029 | 0.106 |
| 12 | | 0.132 | 0.124 |
| 13 | | 0.000 | 0.000 |
| 14 | | 0.345 | 0.000 |
| 15 | | 0.332 | 0.159 |
| 16 | | 0.254 | 0.036 |
| 17 | | 0.158 | 0.011 |
| 18 | | 0.601 | 0.124 |
| 19 | | 0.000 | 0.000 |
| 20 | | | 0.170 |
| 21 | | | 0.053 |
| 22 | | | 0.000 |
| 23 | | | 0.086 |
| 24 | | | 0.000 |
| 25 | | | 0.073 |
| 26 | | | 0.251 |
| 27 | | | 0.519 |
| 28 | | | 0.000 |
| Average | 0.304 | 0.171 | 0.100 |

# Appendix F.39

## Inter-turn Speaker Latency Analysis for Audio Recording 39

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.047 | 0.216 | 0.409 |
| 2 | 0.000 | 0.000 | 0.000 |
| 3 | 1.147 | 0.088 | 0.123 |
| 4 | 1.952 | 0.000 | 0.317 |
| 5 | 0.718 | 0.548 | 0.000 |
| 6 | 0.902 | 0.714 | 0.619 |
| 7 | 0.702 | 0.815 | 0.349 |
| 8 | 0.040 | | 0.202 |
| 9 | 0.699 | | 0.079 |
| 10 | 0.403 | | 0.177 |
| 11 | 0.000 | | 0.272 |
| 12 | 0.000 | | 0.012 |
| 13 | 0.847 | | 0.000 |
| 14 | 0.876 | | 0.000 |
| 15 | 0.209 | | 0.334 |
| 16 | 0.470 | | 0.000 |
| 17 | 0.186 | | 0.087 |
| 18 | 2.269 | | 0.000 |
| 19 | 0.000 | | 0.097 |
| 20 | 0.049 | | 2.554 |
| 21 | 0.102 | | 0.000 |
| 22 | 0.174 | | 0.136 |
| 23 | 0.241 | | 0.309 |
| 24 | 0.000 | | 0.778 |
| 25 | 0.352 | | 0.224 |
| 26 | 0.325 | | 0.059 |
| 27 | 0.000 | | |
| 28 | 0.100 | | |
| 29 | 0.186 | | |
| 30 | 1.103 | | |
| 31 | 0.145 | | |
| 32 | 0.318 | | |
| 33 | 0.000 | | |
| Average | 0.441 | 0.340 | 0.275 |

# Appendix F.40

## Inter-turn Speaker Latency Analysis for Audio Recording 40

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.368 | 1.483 | 0.000 |
| 2 | 0.473 | 0.183 | 2.106 |
| 3 | 0.206 | 1.392 | 0.331 |
| 4 | 0.270 | 0.148 | 0.239 |
| 5 | 0.679 | | 0.000 |
| 6 | 0.136 | | 0.000 |
| 7 | | | 0.000 |
| 8 | | | 0.096 |
| 9 | | | 0.300 |
| 10 | | | 0.000 |
| 11 | | | 0.021 |
| 12 | | | 0.071 |
| 13 | | | 0.000 |
| 14 | | | 0.010 |
| 15 | | | 0.082 |
| 16 | | | 0.000 |
| 17 | | | 0.321 |
| 18 | | | 0.739 |
| 19 | | | 0.129 |
| 20 | | | 0.574 |
| 21 | | | 0.000 |
| 22 | | | 0.012 |
| 23 | | | 0.000 |
| 24 | | | 0.101 |
| 25 | | | 0.071 |
| 26 | | | 0.093 |
| 27 | | | 1.576 |
| 28 | | | 0.197 |
| 29 | | | 0.223 |
| 30 | | | 0.195 |
| 31 | | | 0.000 |
| 32 | | | 0.070 |
| Average | 0.355 | 0.801 | 0.236 |

# Appendix F.41

## Inter-turn Speaker Latency Analysis for Audio Recording 41

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.429 | 0.026 | 0.000 |
| 2 | 0.000 | 0.011 | 0.491 |
| 3 | 0.039 | 0.101 | 0.088 |
| 4 | 0.006 | 0.032 | 0.092 |
| 5 | 0.229 | 0.020 | 0.224 |
| 6 | 0.003 | 0.452 | 0.227 |
| 7 | 0.235 | 0.289 | 0.000 |
| 8 | 0.000 | 0.195 | 5.267 |
| 9 | 0.030 | 0.000 | 0.117 |
| 10 | 0.030 | 0.000 | 0.000 |
| 11 | 0.041 | 0.371 | 0.152 |
| 12 | 0.028 | 0.000 | 0.000 |
| 13 | 0.012 | 0.120 | 2.395 |
| 14 | 0.910 | 0.022 | 0.022 |
| 15 | 0.000 | 0.013 | 0.000 |
| 16 | 0.182 | 0.000 | 0.105 |
| 17 | 0.169 | 0.732 | 0.137 |
| 18 | 0.039 | 0.390 | 0.112 |
| 19 | 0.000 | 0.158 | 0.393 |
| 20 | 0.173 | 0.000 | 0.092 |
| 21 | 0.125 | 0.214 | 0.000 |
| 22 | 0.144 | 0.020 | 0.141 |
| 23 | 0.135 | 0.137 | 0.000 |
| 24 | 0.822 | 0.241 | 0.115 |
| 25 | 0.060 | 0.000 | 0.132 |
| 26 | 0.333 | 0.399 | 0.000 |
| 27 | 0.169 | 0.011 | 0.606 |
| 28 | 0.116 | 0.000 | 0.095 |
| 29 | 0.012 | 0.046 | |
| 30 | | 0.029 | |
| 31 | | 0.000 | |
| 32 | | 0.000 | |
| 33 | | 0.015 | |
| 34 | | 0.065 | |
| 35 | | 0.837 | |
| Average | 0.154 | 0.141 | 0.393 |

# Appendix F.42

## Inter-turn Speaker Latency Analysis for Audio Recording 42

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.000 | | 0.000 |
| 2 | 0.285 | | 0.548 |
| 3 | 0.025 | | 0.005 |
| 4 | 0.018 | | 0.238 |
| 5 | 0.104 | | 0.195 |
| 6 | 0.046 | | 0.007 |
| 7 | 0.000 | | 0.300 |
| 8 | 0.105 | | 0.014 |
| 9 | 0.029 | | 0.029 |
| 10 | 0.000 | | 0.609 |
| 11 | 0.411 | | 0.000 |
| 12 | 0.000 | | 1.479 |
| 13 | 0.000 | | 0.467 |
| 14 | 0.044 | | 0.059 |
| 15 | 0.029 | | 0.009 |
| 16 | 0.317 | | 0.000 |
| 17 | 0.173 | | 0.000 |
| 18 | | | 0.000 |
| 19 | | | 0.000 |
| 20 | | | 0.132 |
| 21 | | | 0.032 |
| 22 | | | 0.000 |
| 23 | | | 0.058 |
| 24 | | | 0.100 |
| 25 | | | 0.000 |
| 26 | | | 0.011 |
| 27 | | | 0.013 |
| 28 | | | 0.005 |
| 29 | | | 0.000 |
| 30 | | | 0.406 |
| 31 | | | 0.077 |
| 32 | | | 0.110 |
| Average | 0.093 | N/A | 0.153 |

# Appendix F.43

## Inter-turn Speaker Latency Analysis for Audio Recording 43

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.000 | | 0.828 |
| 2 | 0.202 | | 0.279 |
| 3 | 0.550 | | 0.141 |
| 4 | 0.014 | | 0.000 |
| 5 | 0.238 | | 0.246 |
| 6 | 0.000 | | 0.326 |
| 7 | 0.000 | | 0.000 |
| 8 | 0.000 | | 0.317 |
| 9 | 0.016 | | 0.000 |
| 10 | 0.007 | | 0.177 |
| 11 | 0.206 | | 0.035 |
| 12 | 0.063 | | 0.000 |
| 13 | 0.000 | | 0.173 |
| 14 | 0.721 | | 0.000 |
| 15 | 0.346 | | 0.041 |
| 16 | 0.426 | | 0.000 |
| 17 | 0.177 | | 0.200 |
| 18 | 0.119 | | 0.083 |
| 19 | 0.581 | | 0.216 |
| 20 | 0.120 | | 0.000 |
| 21 | 0.144 | | 0.045 |
| 22 | | | 0.268 |
| 23 | | | 0.752 |
| 24 | | | 1.916 |
| 25 | | | 0.200 |
| 26 | | | 0.138 |
| 27 | | | 0.000 |
| 28 | | | 0.000 |
| 29 | | | 0.000 |
| 30 | | | 2.024 |
| 31 | | | 0.000 |
| 32 | | | 0.000 |
| 33 | | | 0.235 |
| Average | 0.187 | N/A | 0.262 |

# Appendix F.44

## Inter-turn Speaker Latency Analysis for Audio Recording 44

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.021 | | 0.144 |
| 2 | 0.237 | | 0.043 |
| 3 | 0.000 | | 0.000 |
| 4 | 0.124 | | 0.142 |
| 5 | 0.310 | | 0.000 |
| 6 | 0.000 | | 0.000 |
| 7 | 0.316 | | 0.622 |
| 8 | 0.345 | | 0.288 |
| 9 | 0.090 | | 0.848 |
| 10 | 0.443 | | 0.337 |
| 11 | 0.436 | | 0.189 |
| 12 | 0.171 | | 0.177 |
| 13 | 0.541 | | 0.217 |
| 14 | 0.270 | | 0.272 |
| 15 | 0.284 | | 0.039 |
| 16 | 0.302 | | 0.043 |
| 17 | 0.000 | | 0.096 |
| 18 | 0.058 | | 0.675 |
| 19 | 0.875 | | 0.129 |
| 20 | 1.124 | | 0.000 |
| 21 | 0.156 | | 0.773 |
| 22 | 0.113 | | 0.017 |
| 23 | 0.000 | | 0.000 |
| 24 | 0.000 | | 0.000 |
| 25 | 0.273 | | 0.107 |
| 26 | 0.341 | | 0.090 |
| 27 | 0.230 | | 0.000 |
| 28 | | | 0.000 |
| 29 | | | 0.041 |
| 30 | | | 0.319 |
| Average | 0.262 | N/A | 0.187 |

# Appendix F.45

## Inter-turn Speaker Latency Analysis for Audio Recording 45

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.238 | 0.225 | 0.000 |
| 2 | 0.123 | 0.463 | 0.000 |
| 3 | 0.260 | 0.108 | 0.130 |
| 4 | 0.152 | | 0.295 |
| 5 | 0.094 | | 0.422 |
| 6 | 0.128 | | 0.158 |
| 7 | 0.173 | | 0.000 |
| 8 | 0.000 | | 0.056 |
| 9 | 0.249 | | 0.076 |
| 10 | 0.543 | | 0.059 |
| 11 | 0.188 | | 0.000 |
| 12 | 1.169 | | 0.012 |
| 13 | 0.000 | | 0.000 |
| 14 | 0.411 | | 0.000 |
| 15 | 0.550 | | 0.088 |
| 16 | 0.050 | | 0.025 |
| 17 | | | 1.019 |
| 18 | | | 3.024 |
| 19 | | | 0.074 |
| 20 | | | 0.199 |
| 21 | | | 0.130 |
| 22 | | | 0.000 |
| 23 | | | 0.000 |
| 24 | | | 0.034 |
| 25 | | | 0.000 |
| 26 | | | 0.131 |
| 27 | | | 0.000 |
| 28 | | | 0.000 |
| 29 | | | 0.000 |
| 30 | | | 0.007 |
| 31 | | | 0.000 |
| 32 | | | 0.201 |
| 33 | | | 0.063 |
| 34 | | | 0.000 |
| 35 | | | 0.045 |
| 36 | | | 0.000 |
| 37 | | | 0.128 |
| 38 | | | 0.124 |
| 39 | | | 0.000 |
| 40 | | | 0.000 |
| 41 | | | 0.000 |

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
| --- | --- | --- | --- |
| 42 | | | 0.000 |
| Average | 0.270 | 0.265 | 0.155 |

# Appendix F.46

## Inter-turn Speaker Latency Analysis for Audio Recording 46

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | | 0.000 | 0.052 |
| 2 | | 0.000 | 0.000 |
| 3 | | 0.330 | 0.000 |
| 4 | | 0.170 | 0.000 |
| 5 | | 0.000 | 0.026 |
| 6 | | 0.000 | 0.000 |
| 7 | | 0.000 | 0.000 |
| 8 | | 0.000 | 0.000 |
| 9 | | 0.000 | 0.270 |
| 10 | | 0.000 | 0.315 |
| 11 | | 0.011 | 0.000 |
| 12 | | 0.162 | 0.335 |
| 13 | | 0.115 | 0.000 |
| 14 | | 0.009 | 0.000 |
| 15 | | 0.100 | 0.045 |
| 16 | | 0.087 | 0.099 |
| 17 | | 0.024 | 0.077 |
| 18 | | 0.063 | 0.000 |
| 19 | | 0.000 | 0.006 |
| 20 | | 0.024 | 0.221 |
| 21 | | 0.104 | 0.021 |
| 22 | | 0.649 | 0.000 |
| 23 | | 0.036 | 0.000 |
| 24 | | 0.000 | 0.054 |
| 25 | | 0.449 | 0.000 |
| 26 | | 0.000 | 0.049 |
| 27 | | | 0.141 |
| 28 | | | 0.026 |
| 29 | | | 0.000 |
| 30 | | | 0.000 |
| 31 | | | 0.090 |
| 32 | | | 0.208 |
| 33 | | | 0.000 |
| 34 | | | 0.203 |
| 35 | | | 0.028 |
| 36 | | | 0.000 |
| 37 | | | 0.063 |
| 38 | | | 0.000 |
| 39 | | | 0.051 |
| 40 | | | 0.184 |
| 41 | | | 0.018 |

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 42 | | | 0.013 |
| 43 | | | 0.000 |
| 44 | | | 0.145 |
| 45 | | | 0.154 |
| 46 | | | 0.056 |
| 47 | | | 0.000 |
| Average | N/A | 0.090 | 0.063 |

# Appendix F.47

## Inter-turn Speaker Latency Analysis for Audio Recording 47

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.204 | 0.000 | 0.298 |
| 2 | 0.000 | 0.000 | 0.152 |
| 3 | | 0.076 | 0.152 |
| 4 | | 0.231 | 0.148 |
| 5 | | 0.124 | 0.369 |
| 6 | | 0.175 | 0.167 |
| 7 | | 0.000 | 0.010 |
| 8 | | 0.331 | 0.000 |
| 9 | | 0.013 | 0.335 |
| 10 | | 0.249 | 0.000 |
| 11 | | 0.639 | 0.000 |
| 12 | | 0.040 | 0.007 |
| 13 | | 0.169 | 0.167 |
| 14 | | 0.007 | 0.105 |
| 15 | | 0.000 | 0.041 |
| 16 | | 0.859 | 0.102 |
| 17 | | 0.007 | 0.070 |
| 18 | | 0.352 | 0.432 |
| 19 | | 0.050 | 0.000 |
| 20 | | | 0.100 |
| 21 | | | 0.137 |
| 22 | | | 0.192 |
| 23 | | | 0.000 |
| 24 | | | 0.000 |
| 25 | | | 0.181 |
| 26 | | | 0.041 |
| 27 | | | 0.019 |
| 28 | | | 0.087 |
| 29 | | | 0.109 |
| 30 | | | 0.292 |
| 31 | | | 0.011 |
| 32 | | | 0.157 |
| 33 | | | 0.249 |
| Average | 0.102 | 0.175 | 0.125 |

# Appendix F.48

## Inter-turn Speaker Latency Analysis for Audio Recording 48

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.000 | | 0.000 |
| 2 | 0.101 | | 0.000 |
| 3 | 0.000 | | 0.000 |
| 4 | 0.024 | | 0.000 |
| 5 | 0.118 | | 0.292 |
| 6 | 2.446 | | 0.606 |
| 7 | 0.124 | | 0.184 |
| 8 | 0.422 | | 0.000 |
| 9 | 0.455 | | 0.083 |
| 10 | 0.134 | | 0.017 |
| 11 | 0.000 | | 0.038 |
| 12 | 0.000 | | 0.000 |
| 13 | 0.682 | | 0.000 |
| 14 | 0.272 | | 0.283 |
| 15 | | | 0.186 |
| 16 | | | 0.707 |
| 17 | | | 0.382 |
| 18 | | | 0.600 |
| 19 | | | 0.000 |
| 20 | | | 0.078 |
| 21 | | | 0.042 |
| 22 | | | 0.458 |
| 23 | | | 0.000 |
| 24 | | | 0.029 |
| 25 | | | 0.159 |
| 26 | | | 0.000 |
| 27 | | | 0.000 |
| 28 | | | 0.037 |
| 29 | | | 0.108 |
| Average | 0.341 | N/A | 0.148 |

# Appendix F.49

## Inter-turn Speaker Latency Analysis for Audio Recording 49

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.214 | 0.238 | 0.120 |
| 2 | 0.045 | 0.000 | 0.000 |
| 3 | 0.401 | 0.228 | 0.148 |
| 4 | 0.436 | 0.279 | 0.421 |
| 5 | 0.283 | 0.000 | 0.047 |
| 6 | 0.007 | 0.706 | 0.154 |
| 7 | | 0.163 | 0.442 |
| 8 | | 0.545 | 0.000 |
| 9 | | 1.433 | 0.117 |
| 10 | | 0.265 | 0.000 |
| 11 | | 0.961 | 0.000 |
| 12 | | 0.198 | 0.081 |
| 13 | | 0.000 | 0.141 |
| 14 | | 0.234 | 0.080 |
| 15 | | 0.460 | 0.000 |
| 16 | | 0.060 | 0.000 |
| 17 | | 0.119 | 0.362 |
| 18 | | 0.667 | 0.082 |
| 19 | | 0.000 | 0.060 |
| 20 | | | 0.915 |
| 21 | | | 0.000 |
| 22 | | | 0.000 |
| 23 | | | 0.000 |
| 24 | | | 0.267 |
| 25 | | | 0.132 |
| 26 | | | 0.354 |
| 27 | | | 0.074 |
| Average | 0.231 | 0.345 | 0.148 |

# Appendix F.50

## Inter-turn Speaker Latency Analysis for Audio Recording 50

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.577 | 0.721 | 0.011 |
| 2 | 0.895 | 0.115 | 0.000 |
| 3 | 1.287 | 0.312 | 0.000 |
| 4 | 0.393 | | 0.127 |
| 5 | 0.616 | | 0.000 |
| 6 | 0.187 | | 0.000 |
| 7 | | | 1.272 |
| 8 | | | 0.053 |
| 9 | | | 0.000 |
| 10 | | | 0.000 |
| 11 | | | 0.275 |
| 12 | | | 0.000 |
| 13 | | | 0.000 |
| 14 | | | 0.000 |
| 15 | | | 0.000 |
| 16 | | | 0.295 |
| 17 | | | 0.000 |
| 18 | | | 0.000 |
| 19 | | | 0.064 |
| 20 | | | 0.000 |
| 21 | | | 0.000 |
| 22 | | | 0.000 |
| 23 | | | 0.356 |
| 24 | | | 0.093 |
| 25 | | | 0.000 |
| 26 | | | 0.215 |
| 27 | | | 0.000 |
| 28 | | | 0.000 |
| 29 | | | 0.000 |
| 30 | | | 0.030 |
| 31 | | | 0.100 |
| 32 | | | 0.000 |
| 33 | | | 0.129 |
| 34 | | | 0.473 |
| 35 | | | 0.000 |
| 36 | | | 0.000 |
| 37 | | | 0.000 |
| 38 | | | 0.021 |
| 39 | | | 0.321 |
| 40 | | | 0.000 |
| 41 | | | 0.186 |

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 42 | | | 0.347 |
| 43 | | | 0.000 |
| 44 | | | 0.000 |
| Average | 0.659 | 0.383 | 0.099 |

# Appendix F.51

## Inter-turn Speaker Latency Analysis for Audio Recording 51

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.000 | 0.177 | 0.512 |
| 2 | 0.390 | 0.000 | 0.007 |
| 3 | 0.391 | 0.072 | 0.127 |
| 4 | 0.000 | 0.000 | 0.009 |
| 5 | 0.269 | 0.303 | 0.000 |
| 6 | 0.245 | 0.332 | 0.000 |
| 7 | 0.447 | 0.584 | 0.026 |
| 8 | 0.325 | 1.198 | 0.747 |
| 9 | 0.346 | 0.068 | 0.318 |
| 10 | 0.447 | 0.063 | 0.000 |
| 11 | 0.440 | 0.000 | 0.236 |
| 12 | 0.398 | 0.263 | 0.000 |
| 13 | 0.000 | 0.005 | 0.000 |
| 14 | 0.392 | 0.140 | 0.000 |
| 15 | 0.206 | 0.109 | 0.000 |
| 16 | 0.247 | 0.368 | 0.057 |
| 17 | 0.529 | 0.000 | 0.096 |
| 18 | 0.192 | 0.049 | 0.749 |
| 19 | 0.558 | 0.049 | 0.974 |
| 20 | 0.000 | 0.170 | 0.105 |
| 21 | | 0.000 | 1.320 |
| 22 | | 0.099 | 0.197 |
| 23 | | 0.118 | 0.000 |
| 24 | | 0.476 | 0.000 |
| 25 | | | 0.299 |
| 26 | | | 0.110 |
| 27 | | | 0.000 |
| 28 | | | 0.188 |
| 29 | | | 0.072 |
| 30 | | | 0.000 |
| 31 | | | 0.418 |
| 32 | | | 0.000 |
| 33 | | | 1.356 |
| 34 | | | 0.054 |
| 35 | | | 0.505 |
| 36 | | | 0.000 |
| 37 | | | 0.000 |
| 38 | | | 0.000 |
| 39 | | | 0.000 |
| 40 | | | 0.000 |
| Average | 0.291 | 0.193 | 0.212 |

# Appendix F.52

## Inter-turn Speaker Latency Analysis for Audio Recording 52

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.088 | | 0.000 |
| 2 | 0.032 | | 0.000 |
| 3 | 0.170 | | 0.312 |
| 4 | 0.177 | | 0.000 |
| 5 | 0.005 | | 0.000 |
| 6 | 0.179 | | 0.812 |
| 7 | 0.000 | | 0.000 |
| 8 | 0.131 | | 0.097 |
| 9 | 0.017 | | 0.000 |
| 10 | 0.830 | | 0.000 |
| 11 | 0.072 | | 0.144 |
| 12 | 0.721 | | |
| 13 | 0.244 | | |
| 14 | 0.013 | | |
| 15 | 0.035 | | |
| 16 | 0.249 | | |
| 17 | 0.095 | | |
| 18 | 0.159 | | |
| 19 | 0.181 | | |
| 20 | 0.170 | | |
| 21 | 0.328 | | |
| Average | 0.185 | N/A | 0.124 |

# Appendix F.53

## Inter-turn Speaker Latency Analysis for Audio Recording 53

| Utterance | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Parent Conversation |
|---|---|---|---|
| 1 | 0.606 | 0.523 | 0.000 |
| 2 | 0.160 | 0.102 | 0.000 |
| 3 | 0.031 | 0.299 | 0.396 |
| 4 | 0.744 | 1.553 | 0.250 |
| 5 | 0.363 | 0.194 | 0.000 |
| 6 | 0.499 | 0.180 | 0.000 |
| 7 | 0.501 | 0.022 | 0.181 |
| 8 | 0.049 | 0.123 | 0.000 |
| 9 | 0.177 | 0.073 | 0.168 |
| 10 | 0.075 | 0.146 | 0.025 |
| 11 | 1.261 | 0.040 | 0.486 |
| 12 | 0.303 | 0.303 | 0.185 |
| 13 | 0.306 | 0.205 | 0.043 |
| 14 | 0.442 | 0.125 | 0.000 |
| 15 | 0.265 | 0.000 | 0.179 |
| 16 | 0.153 | 0.030 | 0.062 |
| 17 | 0.422 | 0.000 | 0.185 |
| 18 | 0.160 | 0.229 | 0.000 |
| 19 | 0.233 | | 0.131 |
| 20 | 0.000 | | 0.000 |
| 21 | 0.027 | | 0.000 |
| 22 | 0.000 | | 0.000 |
| 23 | | | 0.000 |
| 24 | | | 0.168 |
| 25 | | | 0.065 |
| 26 | | | 0.433 |
| 27 | | | 0.190 |
| 28 | | | 0.000 |
| 29 | | | 0.000 |
| 30 | | | 0.000 |
| 31 | | | 0.000 |
| 32 | | | 0.231 |
| 33 | | | 0.310 |
| 34 | | | 0.088 |
| 35 | | | 0.000 |
| 36 | | | 0.345 |
| 37 | | | 0.519 |
| 38 | | | 0.457 |
| 39 | | | 0.000 |
| Average | 0.308 | 0.230 | 0.131 |

# Appendix G

## Mean Inter-turn Speaker Latency by Audio Recording

| Sample | Participant ID | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Child - Total | Speech Pathologist-Parent Conversation | Difference |
|---|---|---|---|---|---|---|
| 1 | 65 | 0.323 | 0.180 | 0.264 | 0.067 | 0.197 |
| 2 | 40 | 0.424 | 0.906 | 0.523 | 0.525 | -0.003 |
| 3 | 58 | 0.480 | 0.405 | 0.465 | 0.200 | 0.264 |
| 4 | 270 | 0.395 | N/A | 0.395 | 0.055 | 0.340 |
| 5 | 55 | 0.586 | 0.304 | 0.445 | 0.133 | 0.312 |
| 6 | 55 | 0.594 | 0.207 | 0.398 | 0.232 | 0.166 |
| 7 | 46 | 0.259 | 0.220 | 0.253 | 0.126 | 0.126 |
| 8 | 40 | 0.483 | 1.077 | 0.717 | 0.515 | 0.202 |
| 9 | 63 | 0.353 | 0.396 | 0.362 | 0.220 | 0.142 |
| 10 | 65 | 0.557 | 0.291 | 0.420 | 0.226 | 0.194 |
| 11 | 65 | 0.572 | N/A | 0.572 | 0.098 | 0.473 |
| 12 | 58 | 0.567 | N/A | 0.567 | 0.133 | 0.434 |
| 13 | 65 | 0.133 | N/A | 0.133 | 0.062 | 0.071 |
| 14 | 270 | 0.191 | N/A | 0.191 | 0.149 | 0.043 |
| 15 | 58 | 0.256 | 0.133 | 0.224 | 0.081 | 0.143 |
| 16 | 55 | 0.241 | 0.530 | 0.279 | 0.338 | -0.059 |
| 17 | 66 | 0.305 | 0.413 | 0.350 | 0.159 | 0.191 |
| 18 | 278 | 0.177 | 0.378 | 0.315 | 0.005 | 0.309 |
| 19 | 49 | 0.325 | 0.239 | 0.283 | 0.091 | 0.192 |
| 20 | 55 | 0.418 | 0.345 | 0.396 | 0.143 | 0.253 |
| 21 | 46 | 0.072 | 0.143 | 0.094 | 0.323 | -0.229 |
| 22 | 65 | 0.403 | 0.436 | 0.429 | 0.135 | 0.295 |
| 23 | 58 | 0.900 | 0.773 | 0.851 | 0.227 | 0.624 |
| 24 | 58 | 0.867 | 0.294 | 0.485 | 0.164 | 0.321 |
| 25 | 66 | 0.113 | 0.013 | 0.073 | 0.107 | -0.035 |
| 26 | 65 | 0.210 | 0.590 | 0.438 | 0.080 | 0.358 |
| 27 | 40 | 0.434 | 0.072 | 0.306 | 0.232 | 0.074 |
| 28 | 66 | 0.399 | 0.223 | 0.350 | 0.097 | 0.252 |
| 29 | 34 | 0.131 | 0.172 | 0.146 | 0.075 | 0.071 |
| 30 | 34 | 0.230 | N/A | 0.230 | 0.091 | 0.139 |
| 31 | 1 | 0.153 | N/A | 0.153 | 0.040 | 0.113 |
| 32 | 58 | 0.301 | 0.128 | 0.197 | 0.205 | -0.008 |
| 33 | 20 | 0.261 | 0.155 | 0.248 | 0.094 | 0.154 |
| 34 | 20 | 0.150 | 0.135 | 0.143 | 0.125 | 0.018 |
| 35 | 27 | 0.114 | 0.453 | 0.326 | 0.208 | 0.118 |
| 36 | 34 | 0.107 | 0.113 | 0.110 | 0.206 | -0.097 |
| 37 | 33 | 0.146 | N/A | 0.146 | 0.076 | 0.070 |
| 38 | 35 | 0.304 | 0.171 | 0.218 | 0.100 | 0.119 |
| 39 | 35 | 0.441 | 0.340 | 0.422 | 0.275 | 0.147 |
| 40 | 35 | 0.355 | 0.801 | 0.541 | 0.236 | 0.305 |
| 41 | 20 | 0.154 | 0.141 | 0.147 | 0.393 | -0.246 |
| 42 | 20 | 0.093 | N/A | 0.093 | 0.153 | -0.060 |
| 43 | 34 | 0.187 | N/A | 0.187 | 0.262 | -0.075 |
| 44 | 63 | 0.262 | N/A | 0.262 | 0.187 | 0.075 |
| 45 | 172 | 0.270 | 0.265 | 0.269 | 0.155 | 0.115 |
| 46 | 29 | N/A | 0.090 | 0.090 | 0.063 | 0.027 |
| 47 | 36 | 0.102 | 0.175 | 0.165 | 0.125 | 0.040 |
| 48 | 29 | 0.341 | N/A | 0.341 | 0.148 | 0.193 |
| 49 | 34 | 0.231 | 0.345 | 0.315 | 0.148 | 0.167 |

| Sample | Client ID | Speech Pathologist-Child Baseline Conversation | Speech Pathologist-Child Treatment Conversation | Speech Pathologist-Child - Total | Speech Pathologist-Parent Conversation | Difference |
|---|---|---|---|---|---|---|
| 50 | 270 | 0.659 | 0.383 | 0.559 | 0.099 | 0.460 |
| 51 | 172 | 0.291 | 0.193 | 0.238 | 0.212 | 0.026 |
| 52 | 6 | 0.185 | N/A | 0.185 | 0.124 | 0.061 |
| 53 | 63 | 0.308 | 0.230 | 0.273 | 0.131 | 0.142 |
| Average | | 0.323 | 0.321 | 0.313 | 0.167 | 0.146 |
| Stand Dev | | | | 0.166 | 0.105 | 0.167 |
| Min | | | | 0.073 | 0.005 | -0.246 |
| Max | | | | 0.851 | 0.525 | 0.624 |

# Appendix H

## Two-Tailed Paired T-Test Results Comparing Mean Inter-turn Speaker Latencies of Speech Pathologist-Parent with Speech Pathologist-Child Conversations, by Audio Recording

*Results*

| $Mean_a - Mean_b$ | t | df | P | | |
|---|---|---|---|---|---|
| 0.1458 | +5.39 | 104 | | one-tailed | <.0001 |
| | | | | two-tailed | <.0001 |

For independent samples, these results pertain to the "usual" t-test, which assumes that the two samples have equal variances.

*F-Test for the Significance of the Difference between the Variances of the Two Samples*

| $df_1$ | $df_2$ | F | P |
|---|---|---|---|
| 52 | 52 | 2.49 | 0.000642 |

*[Applicable only to independent samples.]*
P>.05 indicates no significant difference detected between the variances of the two samples.

*t-Test Assuming Unequal Sample Variances*
*[Applicable only to independent samples.]*

| $Mean_a - Mean_b$ | t | df | P | | |
|---|---|---|---|---|---|
| 0.1458 | 5.39 | 87.98 | | one-tailed | <.0001 |
| | | | | two-tailed | <.0001 |

| | | Confidence Intervals | |
|---|---|---|---|
| | Observed | 0.95 | 0.99 |
| $Mean_a$ | 0.3128 | ± 0.0459 | ± 0.061 |
| $Mean_b$ | 0.167 | ± 0.0291 | ± 0.0386 |
| $Mean_a - Mean_b$ [Assuming equal sample variances.] | 0.1458 | ± 0.0538 | ± 0.0711 |
| $Mean_a - Mean_b$ [Assuming unequal sample variances.] | 0.1458 | ± 0.0538 | ± 0.0711 |
| | Independent Samples | | |

*For purposes of significance tests and calculation of confidence intervals, values of df associated with the unequal-variance condition are rounded to the nearest integer.*

Calculated using: vasserstats.net

# Appendix I

## Mean Inter-turn Speaker Latency by Unique Child Participant

| Participant ID | Combined Speech Pathologist-Child Conversations | Speech Pathologist-Parent Conversation | Difference |
|---|---|---|---|
| 1 | 0.153 | 0.040 | 0.113 |
| 6 | 0.185 | 0.124 | 0.061 |
| 20 | 0.156 | 0.246 | -0.091 |
| 27 | 0.326 | 0.208 | 0.118 |
| 29 | 0.178 | 0.095 | 0.083 |
| 33 | 0.146 | 0.076 | 0.070 |
| 34 | 0.173 | 0.157 | 0.015 |
| 35 | 0.362 | 0.213 | 0.148 |
| 36 | 0.165 | 0.125 | 0.040 |
| 40 | 0.580 | 0.405 | 0.174 |
| 46 | 0.171 | 0.192 | -0.021 |
| 49 | 0.283 | 0.091 | 0.192 |
| 55 | 0.392 | 0.237 | 0.155 |
| 58 | 0.420 | 0.163 | 0.257 |
| 63 | 0.289 | 0.175 | 0.114 |
| 65 | 0.421 | 0.094 | 0.326 |
| 66 | 0.333 | 0.123 | 0.211 |
| 172 | 0.247 | 0.183 | 0.065 |
| 270 | 0.431 | 0.103 | 0.328 |
| 278 | 0.315 | 0.005 | 0.309 |
| Average | 0.286 | 0.153 | 0.133 |
| Stand Dev | 0.122 | 0.087 | 0.135 |
| Min | 0.146 | 0.005 | |
| Max | 0.580 | 0.405 | |

# Appendix J

## Two-Tailed Paired T-Test Results Comparing Mean Inter-turn Speaker Latencies of Speech Pathologist-Parent with Speech Pathologist-Child Conversations, by Unique Child Participant

*Results*

| $Mean_a - Mean_b$ | t | df | P | | |
|---|---|---|---|---|---|
| 0.1335 | +3.97 | 38 | | one-tailed | 0.0001545 |
| | | | | two-tailed | 0.000309 |

For independent samples, these results pertain to the "usual" t-test, which assumes that the two samples have equal variances.

*F-Test for the Significance of the Difference between the Variances of the Two Samples*

| $df_1$ | $df_2$ | F | P |
|---|---|---|---|
| 19 | 19 | 1.95 | 0.077276 |

*[Applicable only to independent samples.]*
P>.05 indicates no significant difference detected between the variances of the two samples.

*t-Test Assuming Unequal Sample Variances*
*[Applicable only to independent samples.]*

| $Mean_a - Mean_b$ | t | df | P | | |
|---|---|---|---|---|---|
| 0.1335 | 3.97 | 34.43 | | one-tailed | 0.0001745 |
| | | | | two-tailed | 0.000349 |

| | Observed | Confidence Intervals | |
|---|---|---|---|
| | | 0.95 | 0.99 |
| $Mean_a$ | 0.2862 | ± 0.0571 | ± 0.0781 |
| $Mean_b$ | 0.1528 | ± 0.0409 | ± 0.0559 |
| $Mean_a - Mean_b$ [Assuming equal sample variances.] | 0.1335 | ± 0.0678 | ± 0.091 |
| $Mean_a - Mean_b$ [Assuming unequal sample variances.] | 0.1335 | ± 0.0682 | ± 0.0917 |
| | Independent Samples | | |

*For purposes of significance tests and calculation of confidence intervals, values of df associated with the unequal-variance condition are rounded to the nearest integer.*

Calculated using: vasserstats.net