How simple can a treatment for early stuttering be? A proposed two-factor early intervention

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Abstract

Purpose: In this paper we draw attention to the need for immediate intervention shortly after stuttering onset. More than half of stuttering onsets occur before 3 years of age. We argue that existing interventions for preschool children who stutter require varying levels of cognitive engagement from children; hence, they are not suitable for children of that age. For this reason, we argue, there is no clinical trials evidence for treatment efficacy with children younger than 3 years of age.

Conclusion: There are many recommended parent strategies that do not require any active participation from children, which, therefore, may be suitable for immediate stuttering intervention. Two of these have laboratory support in their favor: parent speech rate reduction and increased interturn speaker latency. Therefore, we developed a clinical protocol based on those two parent strategies and showed the clinical viability of the protocol with three children who stuttered. We argue that automation of our proposed treatment with lifelike AI-generated avatar clinicians will make it globally viable, and a suitable target for future Phase I–IV clinical trials.

Quality of life and illness burden of stuttering

Stuttering occurs in all cultures and languages. Based on predominantly Western cultures, Bloodstein et al. (2021) conclude that lifetime incidence is 10% with a prevalence of 1–2%. At the time of writing, this prevalence suggests that 80–160 million people stutter globally. The condition is associated with significant quality-of-life impairment in the range of that reported for diabetes, cardiovascular disease, and HIV (Norman et al., 2024). Presumably, this is because, unlike those conditions, stuttering begins during early childhood and its effects are experienced throughout the lifespan. Stuttering is associated with substantive cost of illness. Norman et al. (2024) showed that in direct terms, willingness to pay for effective treatment can be 2–4 times the family annual income, and 61% of families report a financial strain because of an adolescent who stutters. Indirect costs of illness are social, involving failure of those who stutter to attain their full occupational potential, which has been shown in several cohort studies (Gerlach et al., 2018; Jacobs et al., 2025; McAllister et al., 2012). Failure to attain occupational potential may be partly related to childhood educational disadvantage because of stuttering (Berchiatti et al., 2020; Boyle et al., 1994; Williams et al., 1969).

The lifetime effects of stuttering include speech-related anxiety. Social anxiety scores of those who stutter are nearly a standard deviation above nonstuttering controls (Craig & Tran, 2014). Compared with controls, those who stutter have greatly increased odds for social anxiety disorder (Iverach et al., 2009). During childhood, 24% of 7–12-year-old children who stutter may be diagnosed with social anxiety disorder in comparison to 4.6% of control children (Iverach et al. 2016). There is evidence that this anxiety originates early in life during the pre-school years (Briley et al., 2019; McAllister, 2016; Tığrak et al., 2020). Possibly, this is a reason why quality-of-life impairment has been measured during the preschool years (Norman et al., 2024).

A Consensus About Early Stuttering Intervention

The quality-of-life and illness burden of stuttering, and its beginnings during childhood, seem to have prompted a consensus in the field that early intervention is an optimal management strategy. A report of 264 speech-language pathologists (SLPs) from 10 countries indicated that they gave waiting list priority to children who stutter; they prioritized childhood stuttering above all other developmental speech and language disorders (McGill et al., 2021). Eighteen Australian SLPs conveyed a similar perspective (Erickson et al., 2022), indicating that stuttering is "more debilitating than other communication disorders with the potential for long-term consequences to be more significant for clients" (p. 5). A consensus statement from participants at a conference with researchers and clinicians from 29 countries established that "current evidence … clearly tells us the risks of early stuttering are certain and that they can be serious and potentially lifelong" (Lowe et al., 2021, p. 9).

Neuroplasticity and Early Stuttering Intervention

A large body of brain imaging research shows one causal factor for stuttering to be anomalies in the networking of brain regions involved with spoken language (Neef & Chang, 2024). Hence, the potential for neuroplastic change to produce lasting clinical benefits has been recognized (Chang et al., 2025). From a neuroscience perspective, it seems that there is a window of clinical opportunity during early childhood for stuttering to resolve. That neuroscience perspective is supported by randomized trials of early stuttering intervention (Sjøstrand et al., 2019). Although that evidence has limitations, it documents a large effect size from early stuttering intervention (with the Lidcombe Program) in relation to no-treatment controls. That effect size is associated with improvements in quality of life, attitude to communication, and psychological health (De Sonneville-Koedoot et al., 2015; Woods; 2002). The clinical window during early stuttering begins to close as speech-related brain networking becomes clinically intractable with advancing age during childhood (Chang 2014; Neef & Chang, 2024; Shenker et al., 2023; Venkatagiri, 2005). Neuroplastic change during early intervention is a commonly accepted explanation for its reported success (Chang, 2014). Indeed, in the case of the Lidcombe Program, it seems that effectiveness decreases markedly during late childhood (Johnson et al., 2024). Hence, the international consensus about the need for early intervention is well justified in terms of a limited opportunity to prevent lifetime quality-of-life and illness burden.

Barriers to Intervention Immediately After Onset

Participation of children in the treatment process

At present, various stages of the treatment processes of early interventions that have been studied with randomized trials—the Westmead Program (Andrews et al., 2023), the Lidcombe Program (Onslow et al., 2025), and RESTART-DCM (Franken et al., 2025)—require children to be involved and to participate in treatment activities. The Westmead Program requires children to speak in syllable-timed speech. The Lidcombe Program treatment process requires children to attend to parent feedback about their speech. Likewise, for some of its treatment components, RESTART-DCM requires cognitive development and cooperation from children. For example, during Phase II of the treatment, procedures include Riley and Riley's (1985) 14-step speech motor training program. Children also learn variations of speech restructuring: "relaxed versus tense stuttering, repetitions versus prolongations/blocks, single repetitions versus multiple, glide sounds versus multiple repetitions" (Franken et al., 2025, p. 31). The Franken et al. (2025) manual also describes procedures where children intentionally stutter. Other recommended early interventions that are not supported by randomized trials commonly incorporate variants of speech restructuring (Kelman & Nicholas, 2020; Waelkens, 2018; Yaruss et al., 2006).

The procedures described above require cognitive engagement from children, yet the majority of stuttering onset occurs at a time when such cognitive involvement is clinically unrealistic for many children. The mean age of stuttering onset has been established from two prospective cohort studies to be in the range of 25–30 months (Ambrose & Yairi, 2015; Yairi, 1983; Yairi & Ambrose, 1992), with a median of 31 months (Reilly et al., 2013). This means that more than half, and perhaps even the majority, of stuttering onset will occur before 3 years of age. A substantial number of those onsets are as early as 18 months (Reilly et al., 2013). Considering the need for children to actively participate in current treatment, it is not surprising, then, that there has been no randomized trial of children younger than 3 years of age (Onslow & Lowe, 2019; Sjøstrand et al., 2019).

The challenges of existing early interventions

Ideally, an immediate intervention would be as simple as possible to maximize its global uptake. Yet, the Lidcombe Program and RESTART-DCM are challenging treatments to administer. Although the Lidcombe Program's clinical principal is simple—parent verbal contingencies applied to stutter-free speech and stuttering—the application of those principles needs to be designed individually for every child and family. This presents many clinical challenges, and problem-solving is a routine part of the treatment process. One publication (Van Eerdenbrugh et al., 2018) detailed 124 clinical challenges that occur with the Lidcombe Program and outlined clinical responses to them. RESTART-DCM is based on the demands and capacities model of early stuttering (Packman et al., 2004). As such, there are more than 60 clinical procedures for the clinician to consider for use with children (Onslow & Lowe, 2019). These include not interrupting the children when talking, reducing the number of questions asked, speaking with a calm voice, not imposing linguistic demands, and having an unhurried lifestyle.

Limited speech-language pathology resources

Regardless of the need and the potential benefits of immediate intervention after stuttering onset, the international SLP workforce is not equipped to deal with a disorder that has a prevalence of 1–2%. This has been confirmed by international government reports in the United Kingdom and Australia (I CAN, & Royal College of Speech and Language Therapists, 2018; Senate Community Affairs Committee Secretariat, 2014). The extent of this problem worldwide can be derived from the American Speech-Language Hearing Association, the world's largest professional SLP group, which indicates that, at the time of writing, there are around 2,000 SLPs in the United States currently accepting referrals for fluency (https://www.asha.org/profind/; Select: "Find a SLP"; search term: "fluency"; 2025, September). Although that figure is likely to be an underestimate, it illustrates the extent of the problem, equating to around one SLP for every 1,700 people who stutter in that country, based on a population of 340 million. Those data are for a country with well-developed SLP services, but most children who stutter live in countries where the profession is comparatively under-resourced. For example, Caldera et al. (2023) reported that the United States, United Kingdom, and Australia have, respectively, 57.7, 35.9, and 23.7 SLPs per 10,000 population, but the figures for India, Malaysia, and Sri Lanka are 0.17, 0.95, and 0.44. In short, no country appears to have adequate SLP resources to deal with the public health issue of treating very young children who stutter.

Searching for a new early intervention

In summary, immediate intervention after stuttering onset has potential to influence the global health issue of chronic stuttering. Yet, empirically supported interventions are not suitable for children shortly after onset, who are mostly younger than 3 years, because those interventions require involvement from the children and because they are clinically challenging. These problems are compounded by limited SLP resources for stuttering globally. The search for a solution to these problems may be found in treatments such as RESTART-DCM, which incorporate many indirect strategies, as suggested by the demands and capacities model. These strategies recur in modern publicly available sources of advice to parents from professional associations and health services (Whelan, 2019; Whittington Health NHS Trust, 2020). These include many of the 60-plus procedures in RESTART-DCM treatment, as described earlier. Most of those strategies have no empirical clinical support, and one of them— reducing the number of questions asked to children—has been empirically refuted (Garbarino & Bernstein Ratner, 2022). However, there is direct experimental laboratory evidence that two of them may reduce early stuttering, as outlined below.

Speech rate reduction

A review of five laboratory experiments where parents reduced their speech rate with children who stutter concluded that reductions in stuttering severity of around 50% were observed overall (Davidow et al., 2016). For example, three single-subject experiments with preschoolers confirmed this effect (LaSalle, 2015), as did a study of 27 children in three laboratory sessions (Sawyer et al., 2017).

Increased interturn speaker latency (pausing between speaking turns)

Data from experimental laboratory studies show that when parents increase their interturn speaker latencies it reduces childhood stuttering. Interturn speaker latency is when a child says something to a parent, the parent pauses briefly before responding (Livingston et al., 2000; Winslow & Guitar, 1994). One of these experimental studies with a preschooler involved increased interturn speaker latency for 15 sessions at the family dinner table over a 7-week period, with results indicating that the technique was responsible for a 40–50% reduction in stuttering (Winslow & Guitar, 1994).

A two-factor treatment protocol

Based on the data above for parent speech rate reduction and pausing between speaking turns, we have designed the treatment protocol described below. In designing the protocol, we sought input from an advisory group comprising a representative from Speech Pathology Australia and treatment end-users (SLPs and parents of children who stutter). That input involved a 2-hour informal meeting, providing user and clinician perspectives on the clinical viability of the treatment and perspectives about ways to enhance compliance. Subsequently, the treatment protocol was developed after extensive discussions among the authors. The research was approved by the University of Technology Sydney Human Research Ethics Committee ETH23-8378.

Before the treatment protocol was administered, parents received a standard SLP assessment for early stuttering. That assessment included exploring parent understanding of stuttering causality, dealing with any misinformation, and providing a full explanation of current knowledge about the nature of early stuttering and its childhood onset. Care is taken to ensure that parents know they are not responsible for the child's stuttering. The methods of the treatment protocol are presented within the context of the demands and capacities model, with an explanation that two evidence-based strategies would be used. Because the treatment protocol is simple, short 20-minute video telehealth consultations are sufficient to administer it. The protocol does not require the child to be present during clinical consultations, nor does the treatment require any active involvement from the child. In fact, the child will usually not even be aware the treatment is occurring.

Step 1

The clinician uses role play with the parent to demonstrate reducing speech rate by around one third and pausing for around half a second after each child utterance before replying. Those speech changes are demonstrated regardless of the parent's usual speech rate and pausing when speaking with the child. The values of one third speech rate reduction and half a second pausing were determined during consultation with the advisory group (see above), guided by clinical judgement about their practical feasibility.

Step 2

The parent uses these speaking techniques with the child twice per day for 5–10 minutes each time, but only in the home environment. The parent records one of these interactions for around 5 minutes using a digital audio recording device such as a mobile phone. During weekly video telehealth consultations, the clinician reviews a 5-minute recording of the parent implementing the techniques and discusses any issues the parent may have encountered with using the techniques.

Step 3

When the parent is comfortable using the speaking techniques, the parent uses them as much as is practicable in and outside the home environment. The parent keeps a diary of their use. During the weekly consultations, the clinician reviews the diarized information and a 5-minute recording of the parent implementing the techniques outside the home environment.

An SLP used our trial protocol to teach the strategies to parents of three preschoolers who stuttered, who were younger than 3 years of age (one parent for each child). The three parents signed their consent after reading a participant information statement. None had consulted a SLP previously about their child's stuttering, and none had attempted any treatment. The parents successfully learned to use the simple techniques in a similar manner during a 12-week trial period. Consistent with the laboratory research reviewed above, and the theoretical soundness of the procedures, there was a suggestion of possible treatment effects, as shown in Figure 1. The data in the figure are daily parent-assigned severity ratings using scale where 0 = *no stuttering*, 1 = *extremely mild stuttering*, 10 = *extremely severe stuttering*. Child 1 was a girl (2 years 7 months) with moderate–severe stuttering, whose parents reported that she had been stuttering for a couple of weeks. Her observable stuttering involved mainly repetitions, with some blocks. Child 2 was a girl (2 years 11 months) with moderate stuttering who had reportedly been stuttering for 6 months. Her observable stuttering involved mainly repetitions, with some blocks. Child 3 was a girl (3 years 0 months) with mild stuttering, who had reportedly been stuttering for 8–9 months. Her observable stuttering involved repetitions, prolongations, and blocks. The stuttering severity of Child 1 and Child 2 improved over the 12 weeks of treatment, with trendlines suggesting continued improvement toward severity rating scores of 0 (no stuttering) if the treatment continues. Possibly because of a floor effect from extremely mild stuttering, Child 3 showed only slight reduction of stuttering severity during the 12 weeks of treatment.

These suggestions of a treatment effect are theoretically consistent with a mechanism of action involving neuroplastic change in response to reduced parent speech rate and increased pausing (see *Neuroplasticity and Early Stuttering Intervention*, above). An alternative explanation would be that reduced parent speech rate and increased pausing invoke similar speech changes in children's speech, which in turn control their stuttering. On the face of it, this seems to be a plausible explanation, particularly in the case of reduced speed rate, which has long been known to reduce stuttering severity (Andrews et al., 1982; Johnson et al., 1937). However, available data cast doubt on such an explanation, with the bulk of studies showing no clear relationship between the speech rate of parents and children who stutter (Cardman, & Ryan, 2007; Guitar & Marchinkoski, 2001; Ratner, 1992; Sawyer et al., 2017; Stephenson-Opsal, & Ratner, 1988; Yaruss & Conture, 1995; Zebrowski et al., 1996). In fact, two studies showed an inverse relationship (Dehqan et al., 2008; Meyers & Freeman, 1985), and only one study showed a positive relationship where children's speech rate decreased in response to parent speech rate decrease (LaSalle, 2015).

INSERT FIGURE 1 ABOUT HERE

We propose this protocol as a basis for Phase I clinical trialling, with potential for further development during Phase II–IV trial evaluation. The latter trials would establish how long a two-factor treatment would take to establish treatment benefits, and they would evaluate the merits of the procedure, comparing it to existing treatments and comparing it to no-treatment controls to take account of variables such as natural recovery and parent speech attention. For that program of research, outcome measures would include stuttering severity, social anxiety, quality of life, and attitude to communication.

Conclusion: Potential benefits of this two-factor early stuttering intervention

Potential automation

A stuttering treatment comprising speech rate reduction and pausing between speaking turns has the advantage of simplicity and that active involvement of children is not required. An additional advantage to such a treatment is that its simplicity lends itself to website-based automation, alleviating any demand on under-resourced global SLP healthcare services. A state-of-the-art automated web version of the treatment could be constructed (Arachchi et al., 2023), with a clinical interface of lifelike AI-generated avatar SLPs. Using role play, the AI-generated avatar clinicians would demonstrate how to slow the speaking rate and how to pause between speaking turns. We envisage that the avatar clinicians would engage with parents using natural language processing to provide guidance through the treatment. The web-based treatment would incorporate advanced speech signal processing techniques to capture key speech features such as power spectrum (Molau et al., 2001) and provide feedback for speech rate reduction with acoustic measures of syllables spoken per second and feedback for pausing with acoustic measures of intervocalic intervals in milliseconds. Fast Fourier transform and advanced filtering techniques would remove unwanted noise to ensure that analyses focus correctly on the relevant speech signals. Because children who stutter may have parents who stutter (Darmody et al., 2022), such feedback will need to accommodate parent stuttering. Although speech signal processing is not yet fully able to recognize stuttering moments, progress is being made toward that being a realistic prospect (Mujtaba & Mahapatra, 2028; Shen & Zhang, 2025; Yawatkar et al., 2025).

The avatar clinicians would ensure that parents have learned the speaking techniques and understood the acoustically analyzed outcome. This objective feedback would overcome the inherent limitation of clinician perception. During Step 3 of the protocol, when parents use the speaking techniques in everyday conversations with their child, they would log in to the treatment site once per week and upload a 5-minute audio recording of their conversation with the child. They would diarize information about their use of the techniques, and log daily severity ratings of their child's stuttering. The avatar clinicians would provide feedback, recommendations, and encouragement based on this information.

Preventing therapist drift

Therapist drift is when a clinician deviates from delivering a treatment exactly the way it was designed and is manualized (Waller, 2009). This can occur intentionally or unintentionally, and may involve altering or omitting core treatment components, applying techniques inconsistently, or adapting a treatment to a personal style or perceived client needs. Therapist drift may occur for many reasons, such as clinical time constraints, fatigue, and burnout. During current best-practice early stuttering intervention with the Lidcombe Program, therapist drift has been shown to be a negative influence (Carr Swift et al., 2011). However, automation of our proposed treatment would make therapist drift impossible. AI-generated avatar SLPs would provide objective and consistent treatment to parents about their use of the speech techniques. Consequently, parents and children globally—eventually in many languages—would have constant access to standardized health care for early stuttering.

Cultural transferability

The simplicity of this treatment maximizes the likelihood of it being uniquely culturally transferable. This would be an advance on existing early interventions that have been developed in Western cultures. An example is the Lidcombe Program, which relies on parents praising children for not stuttering. As such, there are reports of this aspect of it not being suitable for other cultures where the idea of praising children openly can feel unnatural and inappropriate, such as in Malaysia and Kuwait (Al-Khaledi et al., 2017; Vong et al., 2010). Another issue is that many non-Western cultures are not open about disability, perceiving it as a source of shame that should remain private. However, all current early interventions involve direct attention to the child's speech. For example, in the Lidcombe Program, parents ask the child to repeat some utterances that are stuttered, and in the Westmead Program, children are encouraged to use rhythmic speech. With RESTART-DCM treatment, "now and again, the parent will casually speak using the disfluencies/stutterings the child makes, with the aim of lessening the child's sensitivity to this" (Franken et al., 2025, p. 24). These approaches are not universally culturally appropriate. In principle, the proposed two-factor treatment of parents reducing speech rate and pausing between speaking turns potentially bypasses these issues because it does not focus on children in any way, and they may not even know that it is occurring.

Stepped care intervention immediately after onset

There is a genetic link with stuttering. Based on available genetic modelling, family aggregation data, and a review of family pedigrees (Darmody et al., 2022), stuttering will occur with 60–70% of children who have a first- or second-degree relative who stutters. Such children in the community could be identified by family history and monitored for stuttering onset. As soon as stuttering onset occurs, immediate two-factor intervention could be administered. This approach could introduce a stepped-care model to early stuttering intervention. The stepped-care model provides the simplest health care that is effective. Clients escalate to more resource-intensive and more expensive models of health care only as needed (Bower & Gilbody, 2005). The two-factor treatment is ideal as a first intervention in a stepped-care approach, particularly for an automated version. It can be used immediately after stuttering onset because it requires no active involvement from the child, it requires no clinician, and it is cost-free. Parents and children would escalate to the more resource-intensive and costly health care with a real clinician only if stuttering persists. Should Phase I–IV clinical trials support our proposed two-factor early intervention, adoption of that model by SLP associations worldwide would be a significant and transformative change to practice and policy of stuttering treatment. Cost-free early stuttering intervention could be made available to families globally, regardless of their location or socioeconomic status, alleviating any demand on under-resourced global SLP healthcare services.

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Data Availability Statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

References

Al-Khaledi, M., Lincoln, M., McCabe, P., & Alshatti, T. (2017) The Lidcombe Program: A series of case studies with Kuwaiti preschool children who stutter. *Speech, Language, and Hearing*, *21*, 224–235. https://doi.org/10.1080/2050571X.2017.1370523

Ambrose, N. G., Yairi, E., Loucks, T. M., Seery, C. H., & Throneburg, R. (2015). Relation of motor, linguistic and temperament factors in epidemiologic subtypes of persistent and recovered stuttering: Initial findings. *Journal of Fluency Disorders, 45,* 12–26. https://doi.org/10.1016/j.jfludis.2015.05.004

Andrews, G., Howie, P., Dosza, M., & Guitar, B. J. (1982). Stuttering: Speech pattern characteristics under fluency-inducing conditions. *Journal of Speech and Hearing Research*, *25*(2), 208–216. https://doi.org/10.1044/jshr.2502.208

Andrews, C., Trajkovski, N., O’Brian, S., & Onslow, M. (2023). *The Westmead Program treatment guide (Ver. 1.3)* Retrieved from https://www.uts.edu.au/asrc/resources/westmead-Program

Arachchi, B. B., Sanjeewa J. M. I. P., Wijesooriya H. M. A. H., Chandrasena M. C., Kishara J., Kelegama, T., & Rajapakse V. M. (2023, December). StutterAI: Virtual assistant for stutter detection and analysis through machine learning and natural language processing approaches. In *2023 5th International Conference on Advancements in Computing (ICAC)* (pp. 525-530). IEEE.

Berchiatti, M., Badenes-Ribera, L., Ferrer, A., Longobardi, C., & Gastaldi, F. G. M. (2020). School adjustment in children who stutter: The quality of the student-teacher relationship, peer relationships, and children’s academic and behavioral competence. *Children and Youth Services Review*, *116*(1), Article 105226. http://dx.doi.org/10.1016/j.childyouth.2020.105226

Bloodstein, O, Bernstein Ratner, N., & Brundage, S. B. (2021). *A handbook on stuttering* (7th ed.). Plural Publishing.

Bower, P., & Gilbody, S. (2005). Stepped care in psychological therapies: Access, effectiveness, and efficiency. *British Journal of Psychiatry, 186,* 11–17. https://doi.org/10.1192/bjp.186.1.11

Boyle, C. A., Decoufle, P., & Yeargin-Allsopp, M. (1994). Prevalence and health impact of developmental disabilities in US children. *Pediatrics*, *93*(3), 399–403.

Briley, P. M., O'Brien, K., & Ellis, C. (2019). Behavioral, emotional, and social well-being in children who stutter: Evidence from the National Health Interview Survey. *Journal of Developmental and Physical Disabilities*, *31*(1), 39–53. https://doi.org/10.1007/S10882-018-9625-X

Caldera, A. V., Wickremasinghe, R., Munasinghe, T. U., Perera, K. M. N., Muttiah, N., Tilakarathne, D., Peiris, M. K. R. R., Thamilchelvan, E., Sooriyaarachchi, C., Nasma, M. N. and Manamperige, R. M. (2023). Availability of rehabilitation services for communication disorders in Sri Lanka: a cross-sectional survey. *BMJ Open*, *13*(4), e071620. https://doi.org/10.1136/bmjopen-2023-071620

Cardman, S., & Ryan, B. P. (2007). Experimental analysis of the relationship between speaking rate and stuttering during mother–child conversation II. *Journal of Developmental and Physical Disabilities*, *19*(5), 457–469. https://psycnet.apa.org/doi/10.1007/s10882-007-9063-7

Carr Swift, M., O'Brian, S., Hewat, S., Onslow, M., Packman, A., &. Menzies, R. (2011). Investigating parent delivery of the Lidcombe Program. *International Journal of Speech Language Pathology*, *13*(4), 308–316. https://doi.org/10.3109/17549507.2011.550692

Chang, S. E. (2014). Research updates in neuroimaging studies of children who stutter. *Seminars in Speech and Language*, *35*(2), 67–79. https://doi.org/10.1055/s-0034-1382151

Chang, S. E., Jackson, E. S., Santayana, G., Zavos, G., & Onslow, M. (2025). Contemporary clinical conversations about stuttering: What does brain imaging research mean to clinicians? *International Journal of Speech-Language Pathology*, *27*(2), 265–271. https://doi.org/10.1080/17549507.2024.2327472

Craig, A., & Tran, Y. (2014). Trait and social anxiety in adults with chronic stuttering: Conclusions following meta-analysis. *Journal of Fluency Disorders*, *40*, 35–43. https://doi.org/10.1016/j.jfludis.2014.01.001

Darmody, T., O'Brian, S., Rogers, K., Onslow, M., Jacobs, C., McEwen, A., Lowe, R., Packman, A., & Menzies, R. (2022). Stuttering, family history and counselling: A contemporary database. *Journal of Fluency Disorders*, *73*, Article 105925. https://doi.org/10.1016/j.jfludis.2022.105925

Davidow, J. H., Zaroogian, L., & A Garcia-Barrera., M. A. (2016). Strategies for teachers to manage stuttering in the classroom: A call for research. *Language, Speech, and Hearing Services in Schools*, *47*(4), 283–296. https://doi.org/10.1044/2016_lshss-15-0057

Dehqan, A., Bakhtiar, M., & Panahi, M. (2008). Relationship between stuttering severity in children and their mother's speaking rate. *São Paulo Medical Journal, 126*(1), 29–33. https://doi.org/10.1590/S1516-31802008000100006

De Sonneville-Koedoot, C., Stolk, E., Rietveld, T., & Franken, M. -C. (2015). Direct versus indirect treatment for preschool children who stutter: The RESTART randomized trial. *PLoS One*, *10*, Article e0133758. https://doi.org/10.1371/journal.pone.0133758

Erickson, S., Bridgman, K., & Furlong, L. (2022). Australian speech-language pathologists' experiences and perceptions of working with children who stutter: A qualitative study. *Journal of Fluency Disorders*, *75*, Article 105944. https://doi.org/10.1016/j.jfludis.2022.105944

Franken, M. -C., Laroes, E., van Ormondt, J., de Smit, F., & Stipdonk, L. (2025). *RESTART-DCM method* (Rev. ed). https://restartdcm.nl/wp-content/uploads/2025/02/RestartDCM-Method-2025.pdf

Garbarino, J., & Bernstein Ratner, N. (2022). What is the role of questioning in young children's fluency? *American Journal of Speech-Language Pathology*, *31*(5), 2061–2077. https://doi.org/10.1044/2022_AJSLP-21-00209

Gerlach, H., Totty, E., Subramanian, A., & Zebrowski, P. (2018). Stuttering and labor market outcomes in the United States. *Journal of Speech, Language, and Hearing Research*, *61*(7), 1649–1663. https://doi.org/10.1044/2018_JSLHR-S-17-0353

I CAN, & Royal College of Speech and Language Therapists. (2018). *Bercow: Ten Years on*. Retrieved from http://www.bercow10yearson.com/

Iverach, L, Jones, M. McLellan, L. F., Lyneham, H. J., Menzies, R. G., Onslow, M., & Rapee, R. M. (2016). Prevalence of anxiety disorders among children who stutter. *Journal of Fluency Disorders*, *49*, 13–28. https://doi.org/10.1016/j.jfludis.2016.07.002

Iverach, L., O'Brian, S., Jones, M., Block, S., Lincoln, M., Harrison, E., Hewat, S., Menzies, R. G., & Onslow. M. (2009). Prevalence of anxiety disorders among adults seeking speech therapy for stuttering. *Journal of Anxiety Disorders*, *23*(7), 928–934. https://doi.org/10.1016/j.janxdis.2009.06.003

Jacobs, M., Gerlach-Houck, H., & Briley, P. (2025). Differential impacts of anticipated success on employment outcomes among adults who stutter. *American Journal of Speech-Language Pathology*, *34*(1), 246–260. https://doi.org/10.1044/2024_AJSLP-24-00202

Johnson, G., Onslow, M., Carey, B., Jones, M., & Kefalianos, E. (2024). Lidcombe Program telehealth treatment for children 6-12 years of age: A Phase II trial. *Journal of Fluency Disorders*, *80*, Article 106057. https://doi.org/10.1016/j.jfludis.2024.106057

Johnson, W., & Rosen, L. (1937). Studies in the psychology of stuttering: VII: Effect of certain changes in speech pattern upon frequency of stuttering. *Journal of Speech Disorders*, *2*(2), 105–110. https://doi.org/10.1044/jshd.0202.105

Kelman, E., & Nicholas, A. (2020). *Palin parent-child interaction therapy for early childhood stammering*. Routledge.

Kessler, R. C., Berglund, P., Demler, O., Jin, R., Merikangas, K. R., & Walters, E. E. (2005). Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey Replication. *Archives of General Psychiatry*, *62*(6), 593–602. https://doi.org/10.1001/archpsyc.62.6.593

LaSalle, L. R. (2015). Slow speech rate effects on stuttering pre- schoolers with disordered phonology. *Clinal Linguistics & Phonics*, *29*(5), 354–377. https://doi.org/10.3109/02699206.2014.1003970

Livingston, L. A., Flowers, Y. E., Hodor, B. A., & Ryan, B. P. (2000). The experimental analysis of interruption during conversation for three children who stutter. *Journal of Developmental and Physical Disabilities*, *12*, 235–266. https://doi.org/10.1023/A:1009465828258

Lowe, R., Jelčić Jakšić, S., Onslow, M., O'Brian, S., Vanryckeghem, M., Millard, S., Kelman, E., Block, S., Franken, M. -C., Van Eerdenbrugh, S., Menzies, R., Shenker, R., Byrd, C., Bosshardt, H. -G., del Gado, F., & Lim, V. (2021). Contemporary issues with stuttering: The Fourth Croatia Stuttering Symposium. *Journal of Fluency Disorders*, *70*, Article 105844. https://doi.org/10.1016/j.jfludis.2021.105844

Guitar, B., & Marchinkoski, L. (2001). Influence of mothers' slower speech on their children's speech rate. *Journal of Speech, Language, and Hearing Research*, *44*(4), 853–861. https://doi.org/10.1044/1092-4388(2001/067)

McAllister, J. (2016). Behavioural, emotional and social development of children who stutter. *Journal of Fluency Disorders*, *50*, 23–32. https://doi.org/10.1016/j.jfludis.2016.09.003

McAllister, J., Collier, J., & Shepstone, L. (2012). The impact of adolescent stuttering on educational and employment outcomes: Evidence from a birth cohort study. *Journal of Fluency Disorders*, *37*(2), 106–121. https://doi.org/10.1016/j.jfludis.2012.01.002

McGill, N., McLeod, S., Crowe, K., Wang, C., Hopf, S. C. (2021). Waiting lists and prioritization of children for services: Speech-language pathologists' perspectives. *Journal of Communication Disorders*, *91*, Article 106099. https://doi.org/10.1016/j.jcomdis.2021.106099

Meyers, S. C., & Freeman, F. J. (1985). Mother and child speech rates as a variable in stuttering and disfluency. *Journal of Speech, Language, and Hearing Research*, *28*(3), 436–444. https://doi.org/10.1044/jshr.2803.444

Molau, S., Pitz, M., Schluter, R., & Ney, H. (2001, May). Computing mel-frequency cepstral coefficients on the power spectrum. In *2001 IEEE international conference on acoustics, speech, and signal processing. Proceedings (cat. No. 01CH37221)* (Vol. 1, pp. 73-76). IEEE.

Mujtaba, D., & Mahapatra, N. (2025). Fine-tuning ASR for stuttered speech: Personalized vs. generalized approaches. *arXiv:2506.00853v1 [cs.SD]*. https://doi.org/10.48550/arXiv.2506.00853

Neef, N. E., & Chang, S. E. (2024). Knowns and unknowns about the neurobiology of stuttering. *PLos Biology*, *22*(2), Article e3002492. https://doi.org/10.1371/journal.pbio.3002492

Norman, A., Lowe, R., Onslow, M., O'Brian, S., Packman, A., Menzies, R., & Schroeder, L. (2023). Cost of illness and health-related quality of life for stuttering: Two systematic reviews. *Journal of Speech, Language, and Hearing Research*, *66*(11), 4414–4431. https://doi.org/10.1044/2023_JSLHR-23-00072

Onslow, M., & Lowe, R. (2019). After the RESTART trial: Six guidelines for clinical trials of early stuttering intervention. *International Journal of Language and Communication Disorders*, *54*(4), 517–528. https://doi.org/10.1111/1460-6984.12463

Onslow, M., Webber, M., Harrison, E., Arnott, S., Bridgman, K., Carey, B., Sheedy, S., O’Brian, S., MacMillan, V., Lloyd, W., Santayana, G., Hodes, G., Smith, K., & Hearne, A. (2025). *The Lidcombe Program Treatment Guide* (Version 1.7c, August 2025). Lidcombe Program Trainers Consortium. https://www.uts.edu.au/research/centres/australian-stuttering-research-centre/resources/lidcombe-program

Packman, A., & Onslow, M., & Attanasio, J. (2004). The Demands and Capacities Model: Implications for evidence-based practice in the treatment of early stuttering. In A. K. Bothe (Ed.), *Evidence-based treatment of stuttering: Empirical issues and clinical implications* (pp. 65–79). Lawrence Erlbaum Associates.

Packman, A., Onslow, M., Richard, F., & Van Doorn, J (1996). Syllabic stress and variability: A model of stuttering. *Clinical Linguistics and Phonetics*, *10*(3), 235–263. https://doi.org/10.3109/02699209608985174

Ratner, N. B. (1992). Measurable outcomes of instructions to modify normal parent-child verbal interactions: Implications for indirect stuttering therapy. *Journal of Speech, Language, and Hearing Research*, *35*(1), 14–20. https://doi.org/10.1044/jshr.3501.14

Reilly, S., Onslow, M., Packman, A., Cini, E., Conway, L., Ukoumunne, O. C., Bavin, E. L., Prior, M., Eadie, P., Block, S., & Wake, M. (2013). Natural history of stuttering to 4 years of age: A prospective community-based study. *Pediatrics*, *132*(3), 460–467. https://doi.org/10.1542/peds.2012-3067

Riley, G., & Riley, J. (1985). *Oral motor assessment and treatment: Improving syllable production*. Pro-Ed.

Ryan, B. P. (2000). Speaking rate, conversational speech acts, interruption, and linguistic complexity of 20 pre-school stuttering and non-stuttering children and their mothers. *Clinical Linguistics and Phonetics*, *14*(1), 25–51. https://doi.org/10.1080/026992000298931

Sawyer, J., Matteson, C., Ou, H., & Nagase, T. (2017). The effects of parent-focused slow relaxed speech intervention on articulation rate, response time latency, and fluency in preschool children who stutter. *Journal of Speech, Language, & Hearing Research*, *60*(4), 794–809. https://doi.org/10.1044/2016_JSLHR-S-16-0002

Senate Community Affairs Committee Secretariat (2014, September). Commonwealth of Australia. https://www.aph.gov.au/-/media/Committees/Senate/committee/clac_ctte/speech_pathology/report/report.pdf

Shen, J., & Zhang, X. (2025). Individual-independent and cross-language detection of speech disfluencies in stuttering based on multi-adversarial tasks and self-training. *Biomedical Signal Processing and Control*, *100*(C), Article 107051. https://doi.org/10.1016/j.bspc.2024.107051

Shenker, R., Rodgers, N., Guitar, B., & Onslow, M. (2023). Contemporary clinical conversations about stuttering: Neurodiversity and ableism. *Journal of Fluency Disorders*, *78*, Article 106014. https://doi.org/10.1016/j.jfludis.2023.106014

Sjøstrand, Å., Kefalianos, E., Hofslundsengen, H., Guttormsen, L. S., Kirmess, M., Lervåg, A., & Bottegaard Naess, K. -A. (2019). Non-pharmacological interventions for stuttering in children six years and younger. *Cochrane Database of Systematic Reviews*, *9*, Article CD013489. https://doi.org/10.1002/14651858.CD013489.pub2

Stein, M. B., Baird, A., & Walker, J. R. (1996). Social phobia in adults with stuttering. *American Journal of Psychiatry*, *153*(2), 278–280. https://doi.org/10.1176/ajp.153.2.278

Stephenson-Opsal, D., & Ratner, N. B. (1988). Maternal speech rate modification and childhood stuttering. *Journal of Fluency Disorders*, *13*(1), 49–56. https://doi.org/10.1016/0094-730X(88)90027-7

Tığrak, T. K., Kayıkcı, M. E. K., Kirazlı, M. Ç., & Tığrak, A. (2020). Emotional and behavioural problems of children and adolescents who stutter: Comparison with typically developing peers. *Logopedics Phoniatrics Vocology*, *46*(4), 186–192. https://doi.org/10.1080/14015439.2020.1855472

Van Eerdenbrugh, S., Packman, A., Onslow, M., O'Brian, S. (2018). Challenges and strategies for speech-language pathologists using the Lidcombe Program for early stuttering. *American Journal of Speech-Language Pathology*, *27*(3S), 1259–1272. https://doi.org/10.1044/2018_AJSLP-ODC11-17-0185

Venkatagiri, H. S. (2005). Recent advances in the treatment of stuttering: A theoretical perspective. *Journal of Communication Disorders*, *38*(5), 375–393. https://doi.org/10.1016/j.jcomdis.2005.03.001

Vong, E., Wilson, L., McAllister, L., & Lincoln, M. (2010). Malaysian parents' use of positive reinforcement: A descriptive study and implications for the Lidcombe Program. *Asia Pacific Journal of Speech, Language and Hearing*, *13(2)*, 87–108. https://doi.org/10.1179/136132810805335119

Waelkens, V. (2018). *Mini-KIDS—Direct therapy for young children who stutter*. Veerle Waelkens.

Waller, G. (2009). Evidence-based treatment and therapist drift. *Behaviour Research and Therapy, 47*(2), 119–127. https://doi.org/10.1016/j.brat.2008.10.018

Whelan, A. (2019, May 19). 5 tips to share with parents of preschoolers who stutter. *The ASHA LeaderLive*. Retrieved from https://leader.pubs.asha.org/do/10.1044/5-tips-to-share-with-parents-of-preschoolers-who-stutter/full/

Whittington Health NHS Trust (2020). *Tips for parents*. Retrieved from https://www.whittington.nhs.uk/default.asp?c=29567

Williams, D. E., Melrose, B. M., & Woods, C. L. (1969). The relationship between stuttering and academic achievement in children. *Journal of Communication Disorders, 2(2),* 87–98. https://doi.org/10.1016/0021-9924(69)90032-X

Winslow, M., & Guitar, B. (1994). The effects of structured turn-taking on disfluencies: A case study. *Language, Speech, and Hearing Services in Schools*, *25*(4), 251–257. https://doi.org/10.1044/0161-1461.2504.251

Woods, S., Shearsby, J., Onslow, M., & Burnham, D. (2002). Psychological impact of the Lidcombe Program of early stuttering intervention. *International Journal of Language and Communication Disorders*, *37*(1), 31–40. https://doi.org/10.1080/13682820110096670

Yairi, E. (1983). The onset of stuttering in two- and three-year-old children: A preliminary report. *Journal of Speech and Hearing Disorders*, *48*(2), 171–177. https://doi.org/10.1044/jshd.4802.171

Yairi, E., & Ambrose, N. (1992). Onset of stuttering in preschool children: Selected factors. *Journal of Speech and Hearing Research*, *35*(4), 782–788. https://doi.org/10.1044/jshr.3504.782

Yaruss, J. S., Coleman, C., & Hammer, D. (2006). Treating preschool children who stutter: Description and preliminary evaluation of a family-focused treatment approach. *Language, Speech, and Hearing Services in Schools*, *37*(2), 118–136. https://doi.org/10.1044/0161-1461(2006/014)

Yaruss, J. S., & Conture, E. G. (1995). Mother and child speaking rates and utterance lengths in adjacent fluent utterances: Preliminary observations. *Journal of Fluency Disorders*, *20*(3), 257–278. https://doi.org/10.1016/0094-730X(94)00013-J

Yawatkar, V., Chow, H. M., & Usler, E. (2025). Automatic temporal analysis of speech: A quick and objective pipeline for the assessment of overt stuttering. *Behavior Research Methods*, *57*(8), Article 228. https://doi.org/10.3758/s13428-025-02733-z

Zebrowski, P. M., Weiss, A. L., Savelkoul, E. M., & Hammer, C. S. (1996). The effect of maternal rate reduction on the stuttering, speech rates and linguistic productions of children who stutter: Evidence from individual dyads. *Clinical Linguistics and Phonetics*, *10*(3), 189–206. https://doi.org/10.3109/02699209608985171

Captions

Figure 1: Daily parent-assigned severity ratings over 12 weeks for the three children in our trial protocol. The figure includes a trendline for the severity ratings.