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Intervention Approaches for Childhood Apraxia of Speech: An Overview of Prevailing Treatment Methods

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by

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This paper aims to describe the theory and methods of select intervention approaches for childhood apraxia of speech so readers may better understand current treatment techniques. Covered in this paper are Rapid Syllable Transitions (ReST), Dynamic Temporal and Tactile Cueing (DTTC), Prompts for Restructuring Oral Muscular Phonetic Targets (PROMPT), as well as supplemental techniques such as augmentative and alternative communication (AAC) and ultrasound biofeedback. Also covered briefly are instances of CAS treatment in languages other than English.

Keywords: Childhood apraxia of speech, intervention, speech sound disorders, motor programming, principles of motor learning

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Childhood apraxia of speech (CAS) is a severe childhood speech sound disorder characterized by deficits in the motor planning required for speech production. The position statement issued by the American Speech-Language-Hearing Association (ASHA) Ad Hoc Committee on Apraxia of Speech in Children classifies children diagnosed with CAS as generally demonstrating a combination of three notable features, “(a) inconsistent errors on consonants and vowels in repeated productions of syllables or words, (b) lengthened and disrupted coarticulatory transitions between sounds and syllables, and (c) inappropriate prosody, especially in the realization of lexical or phrasal stress” (2007). Although the child knows what they would like to say, there is a breakdown in the ability to plan the fine, rapid movements required for speech production. A preliminary population estimate indicates that CAS may occur in one to two children per thousand (Shriberg et al., 2007). CAS may occur due to neurological

impairment associated with neurobehavioral disorders of known or unknown origin or as an idiopathic neurogenic speech sound disorder (ASHA, 2007). For more on behavioral markers of CAS and an overview of typical and atypical speech development, see the ASHA's technical report on CAS (2007).

Despite developments in the community's understanding of CAS, it remains difficult to differentially diagnose CAS from other speech sound disorders (Murray et al., 2015). In a survey of speech-language pathologists (SLPs) attending a continuing education workshop sponsored by the Indiana Speech-Language-Hearing Association in February 2000, 75 respondents indicated 50 different characteristics to diagnose CAS (Forrest, 2003). Given the debate surrounding diagnostic criteria for CAS, intervention methods are varied. As a result, children with CAS may be at risk of receiving an intervention inconsistent with evidence-based practice (EBP; Gomez et al., 2019). Historically there has been a dearth of evidence for effective treatments (Morgan & Vogel, 2008), which has resulted in eclectic combinations of elements from treatment approaches aimed at other disorders (e.g., Gomez et al., 2018).

There is also a great need for research on CAS treatment in languages other than English. Single-case experimental design studies on monolingual treatment have been conducted in Swedish (Lunderborg & McAllister, 2007), Finnish (Martikainen & Korpilahti, 2011), Hindi (Singh & Trivedi, 2016, as cited in Olivares, 2020), German (Leonhartsberger et al., 2021), and Italian (Scarcella et al., 2021) and bilingual Spanish-English intervention (Gildersleeve-Neumann & Goldstein, 2015; Olivares, 2020). Vashdi (2013) conducted a non-experimental case study of CAS intervention in Hebrew.

The following literature review is not an exhaustive list of the available treatment approaches used by SLPs, and it is not intended as a comparative analysis. Treatment methods vary, and interventions with higher levels of empirical evidence have been researched using well-designed and controlled treatment studies focusing on maintenance and generalization of treatment (Murray et al., 2014). Approaches that have demonstrated evidence for clinical application include Rapid Syllable Transitions (ReST; Murray et al., 2015), Dynamic Temporal and Tactile Cueing (DTTC; Strand, 2020), and Prompts for Restructuring Oral Muscular Phonetic Targets (PROMPT;

Hayden et al., 2010). Supplemental techniques employed in dual paradigm treatment approaches include augmentative and alternative communication (AAC; Allen et al., 2017) and ultrasound biofeedback (Preston et al., 2013).

Motor Programming Approaches

The following approaches incorporate the principles of motor learning (PML), which have been shown to facilitate long-term maintenance and transfer of trained motor skills in both limb and speech systems (Maas et al., 2008; Wulf et al., 2010; Bislick et al., 2012). In essence, certain practice and feedback conditions (practice amount, distribution, variability, and schedule; feedback type, frequency, and timing) enhance the learning of nonspeech motor skills that are built on a knowledge of the desired movement outcome, the current location of body parts, motor commands, and sensory feedback of results (see Maas et al., 2008 for review).

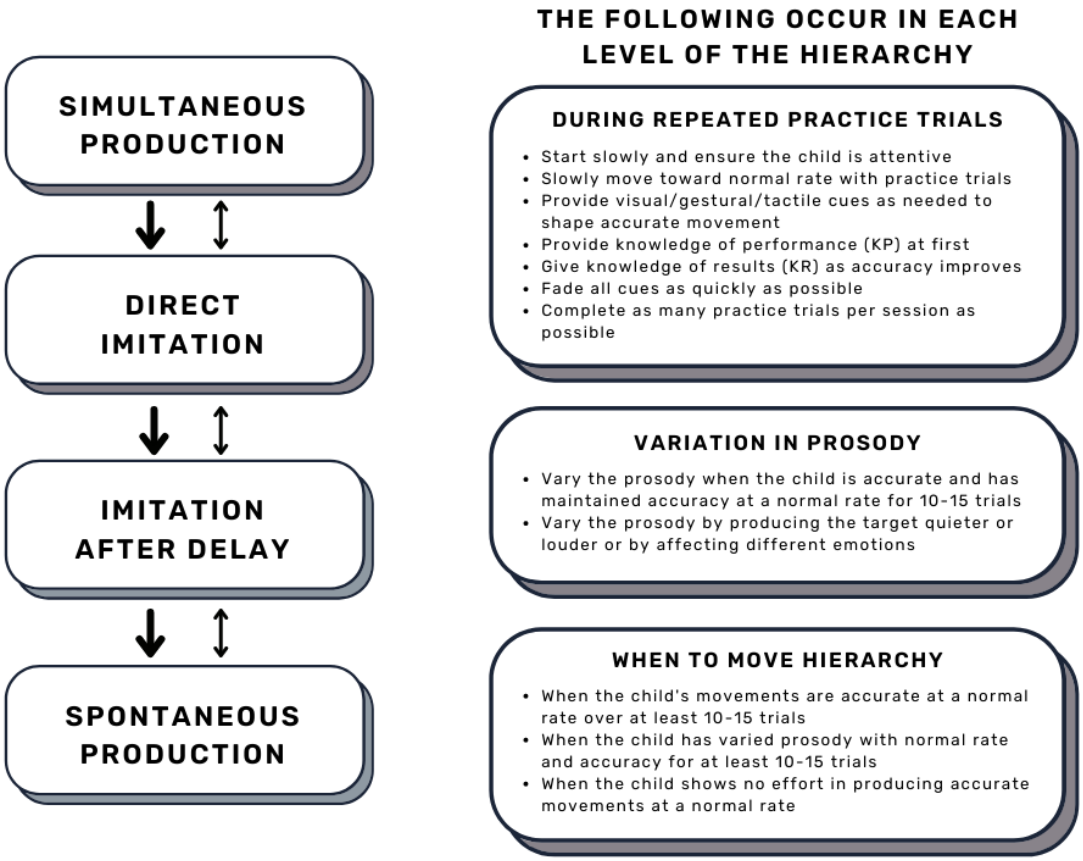
Dynamic Temporal and Tactile Cueing

Dynamic Temporal and Tactile Cueing (DTTC) is a bottom-up motor-learning approach designed for severe childhood apraxia of speech. The primary goal of DTTC is to improve the efficiency of neural processing for the development and refinement of sensorimotor planning and programming through carefully timed feedback and cues and by facilitating more accurate movement for specifically chosen stimuli (Strand, 2020). Feedback should be provided immediately after inaccurate attempts and gradually withdrawn once the child's accuracy improves; this ensures that incorrect movements are not reinforced via negative practice.

The approach's name indicates the adaptability of the method; the level of scaffolding provided by the clinician is gradually withdrawn or reapplied as needed based on a *temporal hierarchy* that grows more complex as the child progresses. Because DTTC is a type of integral stimulation (IS), it involves a *listen to me/watch me/do what I do* method, a key feature of IS. This connection can be noted in the four stages of the temporal hierarchy: 1) simultaneous production, 2) direct imitation, 3) imitation after a delay, and 4) spontaneous production in response to a question. Figure

1 illustrates the progression through the hierarchy and examples of dynamic cues used by clinicians working with children with CAS. Strand (2020) recommends employing a modified block practice design that transitions from shorter blocks to random practice, which is consistent with findings by Shea et al. (1990) and Wulf and Shea (2002).

Figure 1. General hierarchy of Dynamic Temporal and Tactile Cueing. The bidirectional arrows show the fluid nature of cueing back and forth between the hierarchy levels. Procedures on the right are guidelines for clinicians at each stage.



Note: Adapted from Strand, E. A. (2020). Dynamic temporal and tactile cueing: A treatment strategy for childhood apraxia of speech. *American Journal of Speech-Language Pathology*, *29*(1), 30–48. https://doi.org/10.1044/2019_ajslp-19-0005

Evidence supports beginning with frequent, short sessions (Strand et al., 2006; Edeal & Gildersleeve-Neumann, 2011) with consistent and repeated movement early in practice that transitions to variability once the client is accurate at each level of the temporal hierarchy, as supported by Rosenbek et al.'s (1973) work with adults with acquired apraxia of speech. For background on dynamic temporal and tactile cueing methods and rationales, see Strand (2020), and for more on integral stimulation, see Maas et al. (2012, 2019).

Given the intensity and time commitment required of CAS therapy, studies examining the viability of parent delivery indicate that it is stressful and logistically challenging (Lim et al., 2017; Thomas et al., 2017). However, in a single case design study of two children with CAS, Lim et al. (2019) demonstrated that when provided by a trained teaching assistant, DTTC was effective in eliciting a large treatment effect in both children. The teaching assistants reported an overall positive experience using DTTC with their students once they were familiar with the temporal hierarchy and cueing strategies. It is worth noting that although this study showed the applicability of teaching strategies for non-clinician providers, the results did not reflect any functional changes in the participants' intelligibility or communication.

Although evidence of treatment efficacy for the use of DTTC with children with severe CAS (Baas et al., 2008; Strand et al., 2006) and moderate CAS (Maas et al., 2012, 2019) support this method, continued research with larger sample sizes and across groups is needed. Baas et al. (2008) and Strand et al. (2006) used a single subject with multiple baselines across behaviors approach to examine one child and four children, respectively. Maas et al. (2012, 2019) used an alternating-treatments single subject with multiple baselines across behaviors design to examine four and six children, respectively.

Rapid Syllable Transitions

Rapid Syllable Transitions (ReST) is a motor-based treatment approach designed to address segmental consistency through improved accuracy of lexical stress and rapid, fluent transitions between segments or syllables by applying the principles of motor learning (PML). Pseudowords (e.g.,/sɛbitu/) are used to emulate novel word learning

(Gierut et al., 2010) and allow children to practice new speech patterns while targeting the three key features of CAS as designated by ASHA (2007).

ReST treatment sessions have two components: pre-practice and practice. During the pre-practice phase, the clinician introduces the targeted skills and stimuli and provides the child with opportunities to attempt them with support and knowledge of performance (KP) feedback after every production. Pseudoword stimuli used in treatment focus on weak-strong (CVCV) and strong-weak (CVCV) lexical stress and strong (/i/) or weak (/ə/) final syllables at either two-syllable (CVCV) or three-syllable (CVCVCV) level initially. The practice phase makes up the majority of the session; it involves a high number of trials (≥100), variable practice, random presentation of the stimulus, and low-frequency feedback on knowledge of results (KR; accuracy only) after a brief pause to allow for self-evaluation. The production goal in this stage is 80% accuracy with no cues given across 100 trials. For a tutorial, see McCabe et al. (2020). Findings from a three-person within-participant study with multiple baselines across participants and behaviors (Ballard et al., 2010) and a 26-person randomized control trial comparing ReST and Nuffield Dyspraxia Programme, Third Edition (Murray et al., 2012) support the efficacy of ReST. Likewise, a single-case experimental design study with two monolingual Italian-speaking children with CAS concluded that treatment in Italian was feasible and warranted further research (Scarcella et al., 2021).

Prompts for Restructuring Oral Muscular Phonetic Targets

Prompts for Restructuring Oral Muscular Phonetic Targets (PROMPT) is a tactile kinesthetic-based treatment approach developed and refined over the past three decades (Chumpelik, 1984; Hayden, 2004, 2006). Dale and Hayden (2013) distinguish this approach from other treatment methods for CAS in that it does not focus on phonemes or phonological processes or use successive approximations to develop the motor plan. Instead, the focus is on the normalization of a contextually relevant and age-appropriate dynamic speech movement.

This approach focuses on applying external tactile, kinesthetic, and proprioceptive input to the articulators to support the child in producing desired speech patterns, controlling the direction and degree of articulatory movements, and regulating

the timing of the motor pattern involved in coarticulation. Other core elements of the PROMPT approach include a) determination of a communication focus for treatment (e.g., activities of daily living, play skills, prelinguistic skills); b) determination of the uses of PROMPT (e.g., map cognitive-linguistic concepts, develop speech subsystems, determine sensory modalities for treatment); c) development of goals that embody the functions of communication (e.g., reciprocal turn-taking, choice-making, cognitively appropriate words); d) distributed mass practice using prompts for accuracy of production in naturalistic settings. For a summary, see Hayden et al. (2010).

Research on the efficacy of PROMPT has demonstrated notable treatment effects as an intervention method for CAS (Dale & Hayden, 2013; Kadis et al., 2013; Fiori et al., 2021) and severe speech motor delay (Namasivayam et al., 2020). Dale and Hayden (2013) conducted an alternating-treatments single subject with multiple baselines across behaviors design to examine four children, Kadis et al. (2013) conducted a multiple baselines across behaviors cohort design study involving 28 children, and Fiori et al. (2021) reported a case series comparing two treatment methods in ten children.

Supplemental Approaches

The following methods have been used to enhance other treatment approaches and address the additional communication needs of children with CAS; they are not meant to stand alone; rather, they are additional tools in the clinician’s toolbox.

Ultrasound Biofeedback

Biofeedback refers to the feedback on an individual’s performance of a physiological function, usually by providing visual information. A biofeedback approach lends itself to motor learning principles through real-time feedback on articulators' placement and knowledge of performance (KP). Biofeedback approaches that use spectrograms and electropalatography have been used in intervention for children with speech sound disorders (Shuster et al., 1995; Carter & Edwards, 2004; Byun & Hitchcock, 2012). However, the expense and availability of necessary instrumentation and training for

these methods may limit their use. Given its widespread availability and use, ultrasound has been explored as a more feasible option to assist in SSD intervention, with success in combination with treatment programs for CAS (Preston et al., 2013, 2015, 2016, 2017; Cleland et al. 2019).

The ultrasound biofeedback approach can be used in conjunction with elements of other methods selected by the clinician, including tactile cueing, modeling, and drill-play activities. Generally, an ultrasound transducer is held in place beneath the child's chin or secured to a stand that the child then leans on, and a sagittal or coronal view of the tongue is shown, depending on the nature of the targeted sound sequence. The child acclimates to the transducer and orients to the image before beginning primary treatment, wherein the clinician gives verbal cues for lingual gestures.

Augmentative and Alternative Communication

Augmentative and alternative communication techniques range from low-tech pen and paper to high-tech devices and applications. AAC is augmentative when used to supplement existing speech and alternative when used in place of speech that is absent or not functional (American Speech-Hearing-Language Association, n.d.). AAC strategies can address immediate and long-term functional communication needs and help facilitate improved receptive and expressive language abilities by reducing the challenges associated with natural speech (Weitz et al., 1997; Branson & Demchak, 2009; Allen et al., 2017). When used to supplement other speech therapy approaches, AAC strategies can help improve communication repair, topic initiation, message length, and complexity (Binger, 2007), reduce frustration (Oommen & McCarthy, 2015), and enhance speech and functional communication skills (Cumely & Swanson, 1999).

In a survey conducted by Oommen and McCarthy (2015), eight participants who had at least five years of clinical experience and significant experience providing AAC intervention to children and direct intervention services to children with CAS were asked to contribute to discussion questions. Responses were grouped into the following themes included: 1) treatment philosophy, history, and rationale; 2) benefits; 3) challenges in simultaneous treatment; 4) key decision-making factors; 5) therapy goals, strategies, and activities; 6) generalization through collaboration with team members; 7)

recommendations for new clinicians. Clinicians were generally motivated to ease frustration and improve communication outcomes using a dual paradigm approach. Participants also believed that providing alternative means of communication helped replace negative behaviors in children with CAS. However, the therapists reported issues with adequate AAC training, generalizing isolated productions into meaningful utterances in naturalistic settings, and their clients' motivation to use AAC tools simultaneously with natural speech therapy. Furthermore, the participants indicated that parental preferences for natural speech were deciding factors guiding treatment direction. Regardless, therapists in the survey offered recommendations for AAC use, the frequency and duration of goals targeting natural speech, strategies for generalization, and suggestions for collaboration with team members and family.

Conclusions

Evidence-based practice is a priority in the speech-language-hearing field; therefore, staying up-to-date on treatment goals and approaches for childhood apraxia of speech is essential. Chief desired outcomes discussed in the literature are intelligibility of speech, generalization, and maintenance of results. Given the number of investigated approaches to treating CAS, this paper aims to contribute to the discussion about proven methods and those that show promising results, with particular attention given to publications in the last decade. The limitations of this research include a lack of information on linguistic approaches and meticulous details on the author's method. Furthermore, there is an ongoing need for high-quality exhaustive information on the differences in approaches in languages other than English and bilingual populations. The need for a greater understanding of the manifestations and treatment of CAS is vital in creating rigorously supported intervention methods.

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