

FEATURE

Treatment for Childhood Apraxia of Speech

A Description of Integral Stimulation and Motor Learning

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A diagnosis of childhood apraxia of speech (CAS) doesn't mean the same thing to everyone, making it difficult to discuss effective treatment measures. In fact, when surveyed on what they thought were the three defining features of CAS, 75 speech-language-pathologists identified 50 different characteristics (Forrest, 2003). Fortunately, differential diagnosis of CAS has become more straightforward with ASHA's recently released position statement (2007a) and technical report (2007b). ASHA defines CAS as a "neurological childhood (pediatric) speech sound disorder in which the precision and consistency of movements underlying speech are impaired in the absence of neuromuscular deficits," noting that "the core impairment in planning and/or programming spatiotemporal parameters of movement sequences results in errors in speech sound production and prosody" (ASHA, 2007a, p. 1).

ASHA identifies three features that differentiate CAS from other speech sound disorders (ASHA, 2007a, p. 2):

- Inconsistent errors on consonants and vowels in repeated productions of syllables and words
- Lengthened coarticulatory transitions between sounds and syllables
- Inappropriate prosody, especially in the realization of lexical or phrasal stress

The following discussion focuses on integral stimulation therapy. To provide an understanding of this approach, I describe integral stimulation and the motor learning principles that are its foundation. Integral stimulation has been shown effective in the treatment of CAS in controlled research designs (Strand & Debertine, 2000; Strand, Stoeckel, & Baas, 2006). Both the intensity and the use of techniques that align closely with the core CAS deficit in motor planning and programming make integral stimulation an excellent treatment choice for children with CAS (ASHA 2007b).

Speech as a Motor Skill

The complexity of the speech motor act is easy to overlook because of its automaticity in adults. Adults are expert in the programming and preplanning necessary for successful speech, speaking rapidly and with relatively infrequent mistakes. In reality, speech acquisition is a complex, slow process even in the typically developing child, with 9-year-olds still not adult-like in aspects of speech production. Initially, infant vocalizations require little planning and preprogramming, with babbling and first words primarily consisting of highly constrained consonant-vowel strings, slowly becoming more independently planned and accurately produced utterances. Over the years, children produce longer words and utterances, matching the needed increase in motor planning and preprogramming with greater linguistic and cognitive capacity and motoric skill.

When you work with a child with CAS, you gain a greater respect for the complexity of the speech task and why an understanding of motor learning theory is invaluable for treatment. What appears a straightforward natural progression toward complex motor movements in speech for the typically developing child is a much more effortful, slow, and inexact process for the child with CAS.

Treatment using integral stimulation requires knowledge of motor learning theory (see Magill, 1998; Schmidt, 2004). Understanding the type of motor task helps determine optimal practices for treatment. For instance, speech is a serial motor task, defined by a series of discrete movements; the order of motor movements is crucial. Speech is more like a complex gymnastics routine, in which many movements must be produced in a certain order, than like a repetitive movement such as walking, riding a bike, or repeating a syllable. For children with CAS, the planning and/or preprogramming necessary for the speech "routine" is a core deficit, likely resulting in a lack of generalization of repetitive movements to longer utterances. Thus, when possible, treatment goals should target facilitation of longer speech routines, rather than mastery of simple repetitive movements.

Cognitive Planning and Motor Execution

Both cognitive planning and motor execution are necessary for success of the speech movement. Speech movement is unlike many other motor tasks, in which motor or cognitive elements are of greater importance. For example, one can think about and preplan a golf swing, but it is only the quality of the swing itself that defines the golfer's success. To gain skill in movements in which the motor execution defines the success, repeated practice of the movement is necessary. In contrast, primarily cognitive motor movements (such as a chess move) are successful because of intellectual function and strategizing prior to the movement; the actual precision of the movement is far less important.

Speech requires both rapid and continuous decision-making prior to and during speaking, as well as relatively precise movements during speech. For this reason, treatment for children with CAS, for whom difficulties with motor tasks are central, should include a great deal of practice to gain experience with the new task. In addition, the cognitive planning necessary for speech suggests that treatment for CAS should involve a variety of speech tasks, in a variety of settings, so that children get ample practice and gain skills in the planning necessary for a variety of speech movements.

Like other open movement skills, in which the motor movement is too rapid for on-line perceptual feedback (Schmidt & Lee, 2005), speech is characterized by unpredictability and instability of movement from utterance to utterance. Becoming an expert at open skills requires the ability to respond to unexpected demands—diversifying the task to meet the needs of the situation—rather than perfecting a particular series of movements. The open nature of speech movements is a core challenge for children with CAS because of their programming deficit. A perfect production of "sh" in syllables does not transfer easily to successful running speech using "sh," particularly for children with CAS. Instead, the ability to produce an "sh" in changing ways and in a variety of words and phrases that require novel motor programming with each utterance should be targeted early on in treatment.

Integral Stimulation and Cognitive Motor Learning

Integral stimulation is an excellent treatment choice for CAS, given the complexity of the speech movement and the difficulty it may create for children with motor planning deficits. Integral stimulation was originally applied to acquired apraxia of speech by Rosenbek et al. (1973). The use of integral stimulation with children with CAS has grown primarily because of the encouragement and research of Strand and colleagues (Strand & Skinder, 1999; Strand & Debertine, 2000; Strand, Stoeckel, & Baas, 2006). Integral stimulation is based on principles of cognitive motor learning in building a hierarchical approach to clinical intervention. It is often considered the "watch me, listen, do as I do" approach, using multimodal cues to teach the client the new information.

Integral stimulation was founded on a multi-step hierarchy of strategies for treatment. This hierarchy aids the clinician in determining what level of support to provide to children with CAS to achieve their goals. To facilitate learning in children with CAS—who are likely demonstrating profound difficulty in planning motor tasks independently—the steps provide clinician supports for eliciting stimuli, with decreasing levels of support as children achieve success.

Six steps relevant to treatment of children with CAS are as follows:

1. The child watches and listens and simultaneously produces the stimulus with the

clinician.

2. The clinician models, then the child repeats the stimulus while the clinician simultaneously mouths it.
3. The clinician models and provides cues and the child repeats.
4. The clinician models and the child repeats with no cues provided.
5. The clinician elicits the stimulus without modeling, such as by asking a question, with the child responding spontaneously.
6. The child produces stimuli in less-directed situations with clinician encouragement, such as in role-play or games.

This hierarchy of strategies can be useful for determining the level of support for individual stimuli. The continuum of supports should be fluid, with daily and even minute-by-minute changes, particularly since accuracy levels can differ dramatically with the unpredictable nature of CAS.

Although integral stimulation was loosely built on the above hierarchy, its treatment as adapted for children primarily emphasizes cognitive motor learning strategies (see Schmidt & Wrisberg, 2004). Application of these strategies in the design of treatment for CAS allows one to best match motor learning to the current level of motor skill.

Four Principles of Motor Learning

Integral stimulation for children requires reflection of four motor learning principles in the design of successful treatment for CAS: precursors to motor learning, conditions of practice, feedback, and effects of rate (see Strand & Skinder, 1999). Application of these principles, allows goals to be targeted at the appropriate level and in the most efficacious manner for the individualized and ever-changing needs of a child.

1. Precursors to Motor Learning

Children vary in their readiness for motor learning. To understand how motor learning will occur and to design the most effective treatment, an SLP must consider precursors to motor learning, or what the child brings to the treatment session that enhances or deters motor learning. Client motivation, family situation, the child's attitude toward treatment, and individual factors such as developmental delay or attention deficit can all have an effect on learning; the clinician should optimize these factors when possible for greatest treatment success.

For learning to occur, the child with CAS must be invested in the treatment. The child's belief that treatment will work may be the ultimate determinant in whether or not it is successful. When one considers that generalization of learning is difficult for the child with CAS, providing the child as much support

as possible in maximizing the precursors is crucial. Ways to maximize precursors include motivating the child, working when attention can be maximized, helping the child focus on treatment tasks, clarifying with the child why you're doing what you're doing, and providing the child with early success so that his or her trust in you and treatment grows.

2. Conditions of Practice

The second consideration in designing optimal treatment for cognitive motor learning is conditions of practice. The clinician must decide whether mass (long but infrequent) or distributed (shorter, more frequent) treatment will be more effective for maximal treatment response. For children with CAS, it is thought that distributed treatment is more likely to result in transfer of the new skills (Strand & Skinder, 1999). Another condition of practice is format—blocked or random. Blocked treatment, in which the target sound is repeated in a string of utterances (e.g., /k/ targeted in cow, cookie, car, cup), results in better short-term performance and is useful when first targeting a new goal (Wulf & Schmidt, 1997) or for a child with very little verbal output (Strand & Skinder, 1999). However, motor learning is more likely to be achieved with random treatment, in which target-goal utterances are interspersed with non-target words (e.g., /k/ targeted in cow, toe, boo, cookie, mom, car). The randomized list requires more motor planning and cognitive involvement than the blocked list and is more likely to facilitate generalization to novel situations (Schmidt & Wisberg, 2004; Strand & Skinder, 1999; Wulf & Schmidt, 1997).

The motor learning literature, therefore, suggests that in-session performance or mastery of a specific movement is enhanced by mass and block treatment, whereas learning is enhanced by distributed and random treatment. For CAS, treatment should be designed to move from conditions that maximize performance to those that enhance learning as quickly as possible.

3. Feedback

The third principle of motor learning requires clinicians to think of the type of feedback they provide, moving from extrinsic feedback (clinician-provided) to intrinsic feedback (client self-awareness). At the most basic level, extrinsic feedback is divided into knowledge of results (awesome, way to go) and knowledge of performance (you brought your lips together in the middle and slowed down and "homework" was very clear), with knowledge of performance resulting in greater learning. In addition, self-monitoring skills are emphasized in integral stimulation so that the client learns to provide his or her own feedback.

To encourage learning, clinicians are encouraged to consider the amount of feedback they provide, decreasing the amount as accuracy increases. Summary feedback (providing less-frequent but summative information) and bandwidth

feedback (only when level of acceptable response decreases beyond that accepted) are other considerations as the clinician attempts to increase the client's learning of target information. Research suggests that too much feedback too soon disrupts the client's own feedback loop, diminishing the child's ability to gauge success (Swinnen, Schmidt, Nicholson, & Shapiro, 1990).

4. Effects of Rate

The fourth motor learning principle to consider in planning treatment is effects of rate. Slowing down the rate of speech is particularly important with CAS, because motor planning is thought to be the major area of impairment. The client should be encouraged to slow down to provide additional time to plan and program. In addition, the clinician should slow down to model and facilitate a slower rate for the client.

The overall focus of integral stimulation treatment needs to be on learning how to make the speech movement, rather than absolute success on individual sounds or isolated syllables. The clinician should constantly increase the complexity of the motor planning task as the child has success at a given level. For instance, practice with a sound or syllable shape should not continue until 80% accuracy is achieved. Rather some success in a simpler syllable shape should lead to attempts at the sound or sound combination in longer strings of utterances, requiring more complex motor planning. For example, a child who is learning to produce /s/ could practice /si/ a few times and then be encouraged to attempt /s/ in "I see," then "I see Emma," then "I see Emma in a boat," practiced at a reduced rate. Whether this progression occurs in one session or over many sessions will depend on many individual factors; it is up to the clinician to decide the pace of progression.

A clinician must decide the best application of motor learning principles to facilitate learning of speech in a child with CAS. In-treatment performance may be the focus in the beginning, but it should shift to learning as quickly as possible. To achieve motor learning, experts suggest that extensive practice and experience with the new information is necessary, emphasizing that hundreds of target stimuli be elicited in a treatment session and underscoring that stimuli be designed for practice in functional situations outside of the treatment room (Strand & Skinder, 1999).

Clinicians can consult excellent resources on CAS, including ASHA's new definition and three key features for diagnosing CAS. This information establishes a benchmark for future advances in the understanding of this disorder. In addition, this information aids us in furthering research on treatment for CAS, an area of research that is sorely lacking.



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