Top Lang Disorders
Vol. 40, No. 4, pp. 312–325

Treatment Approach Considerations for Children With Speech Sound Disorders in School-Based Settings

Kathryn L. Cabbage and Shari L. DeVeney

Clinicians providing intervention for pediatric speech sound disorders (SSDs) have many treatment approach options from which to select. Because treatment needs vary across children based on many factors including the error type(s) present and patterns of deficit noted, these factors need to be considered early in the therapeutic process to find the best-suited approach. In this article, the authors describe and contrast a traditional motor articulatory-based approach with phonologically-based approaches including cycles, contrast therapies (e.g., minimal pairs, maximal oppositions, and multiple oppositions), and complexity through presentation of hypothetical case studies, updated summaries of the evidence base for each, and a summary of current research limitations for informing clinical practice. Although children with SSDs are ubiquitous in pediatric clinical caseloads, familiarity or lack thereof with the evidence base supporting different approaches potentially limits speech production outcomes for children receiving speech services. Even so, limitations in the evidence base constrain practical application of a given approach to daily therapeutic interactions. **Key words:** *complexity*, *contrast therapy*, *cycles*, *maximal oppositions*, *minimal pairs*, *multiple oppositions*, *school-age*, *speech sound disorders*, *traditional articulation approach*, *treatment of the empty set*

SPEECH SOUND DISORDERS (SSDs) are one of the most common types of pediatric communication disorders (American Speech-Language-Hearing Association [ASHA], 2018). Over the past 12 years, on average, over 90% of school-based speech–language pathologists (SLPs) reported treating SSDs (ASHA, 2018). Having an SSD places children, including preschoolers and school-aged students, at increased risk for difficulties with academic performance (Felsenfeld et al., 1994; Overby et al., 2007), literacy acquisition (Lewis et al., 2019; Overby et al., 2012), social/interpersonal skill development (McCormack et al., 2011; Overby et al., 2007), and later employment opportunities (Felsenfeld et al., 1994). As such, it is imperative school-based SLPs are well versed in a variety of evidence-based intervention approaches to effectively remediate speech production of children with SSD.

Although informed treatment decisions are critical to therapeutic success, there is no simple, universal solution because of individualized variabilities associated with client profiles (Kamhi, 2006). However, decisions regarding which approach to take need to occur early in the intervention process and influence SSD treatment effectiveness (i.e., the outcome of different approaches in varied real-world settings and speaking conditions).

Author Affiliation: *Department of Communication Disorders, McKay School of Education, Brigham Young University, Provo, Utah (Dr Cabbage); and Department of Special Education and, Communication Disorders, University of Nebraska at Omaha (Dr DeVeney).*

The authors have indicated that they have no financial and no nonfinancial relationships.

Corresponding Author: *Kathryn L. Cabbage, PhD, CCC-SLP, Department of Communication Disorders, McKay School of Education, Brigham Young University, 161 TLRB, Provo, UT 84602 (kcabbage@byu.edu).*

DOI: 10.1097/TLD.0000000000000229

Children with SSD have a wide range of speech production abilities, which is a particular challenge when deciding what kind of approach is best for each child. Speech sound disorder subtypes vary widely according to severity and underlying etiology, including those with motor programming deficits (e.g., childhood apraxia of speech) or those associated with sensory or anatomic differences (e.g., SSD secondary to hearing impairment or cleft palate). The majority of children with SSD, however, exhibit speech production errors with no known etiology or origin (Broomfield & Dodd, 2004; Shriberg et al., 1999), including those with articulation-based errors (i.e., substitutions or distortions on a small number of phonemes without significant impact on intelligibility) or phonologically-based errors (i.e., errors affecting multiple phonemes across phoneme classes with the potential for significant impact on intelligibility). It is these children that comprise the bulk of children with SSD served by school-based SLPs, and thus they are the focus in this article. Although the articulation-versus-phonology dichotomy is commonly used in clinical practice, some have suggested that these children may more accurately be classified along a continuum of phonological deficit rather than in two mutually exclusive categories (Farquharson, 2019; Fey, 1992).

Even with our current conceptualization of articulation-based and phonologically-based error types, clinicians must be aware that treatment needs will vary across children. In this article, we consider the importance of analyzing the types of errors children with SSDs are producing and how patterns of deficits may be used to inform treatment decisions to tailor treatment approaches that may maximize speech production outcomes for these children. We discuss empirical support regarding common treatment approaches for SSD intervention for children with articulation-based and phonologically-based errors and limitations regarding the comparative effectiveness of intervention approaches. Discussion of alternative approaches for those with inconsistent speech sound errors or motor programming deficits is beyond the scope of this article, and we refer the reader elsewhere for additional information regarding treatment approaches for these children (Strand, 2020; Williams et al., 2010).

We first present some hypothetical cases that represent the types of children with SSDs of no known etiology commonly found on caseloads of school-based SLPs. We will return to these cases later for a discussion of treatment recommendations.

CASE #1: LUCAS, 1ST GRADE

Lucas is in first grade and was recently referred to the SLP by his teacher regarding concerns about his speech skills. An assessment revealed that Lucas produces lateralized productions of fricatives /s, z, ʃ, ʒ/. During the assessment, Lucas was stimulable for appropriate placement of /s/ and /z/. An oral mechanism examination revealed structures and function adequate for speech sound production. Lucas' language skills are in the high–average range and he is meeting grade-level expectations for reading. He gets along well with his peers and excels in the classroom although his teacher reports that his "mushy" speech can make it difficult to understand him when he is excited or speaking very quickly.

CASE #2: JASMINE, KINDERGARTEN

Jasmine is a kindergartner who exhibits some use of phonological processes including final consonant deletion and she substitutes a number of different phonemes with /t/ (e.g., "see," "seen," "sheep", "queen," and "green" all sound like "tea"). Other than use of /t/, she has a very restricted phonemic inventory that includes only vowels and the consonants /m, n, h, w/. An examination of her oral mechanism indicated typical structures and function. Jasmine was not identified for speech services until entry into kindergarten. She has age-appropriate language

skills, but is largely unintelligible to both familiar and unfamiliar listeners.

CASE #3: TERRELL, 1ST GRADE

Terrell entered preschool with very low intelligibility and has been receiving speech therapy services since that time when he was diagnosed with a severe phonological impairment and expressive language delay. He is now in first grade and his speech is characterized by the persistent usage of multiple phonological patterns including velar fronting (t/k, d/g), palatal fronting (s/ʃ, z/ʒ), deaffrication (s/tʃ, z/dʒ), cluster reduction, gliding, vowelization, and fricative simplification (f/θ, d/ð). An examination of his oral mechanism showed structures and function adequate for speech sound production. At his last assessment, his language skills were judged to fall in the low-average range. Terrell gets along well with his peers, but recently reported that some children have started teasing him and saying he "sounds like a baby" when he talks.

It is evident that in these cases, speech therapy services would be appropriate for each child, but the type of treatment should vary based on their individual profiles. As there is heterogeneity in children with SSD, there is also heterogeneity in the approaches used for intervention. Determining the right "match" between child and intervention approach based on evidence-based practices (EBPs) involves not only a review of the best scientific evidence, but also a consideration of that evidence in the context of care including the practitioner's knowledge and clinical skills and the client/caregiver values, preferences, and expectations (Dollaghan, 2004). Although clinician knowledge and skill level and individual child circumstances will naturally vary, we provide here a brief overview of the current scientific evidence to address the research arm of EBP, as it relates to pediatric SSD intervention (see Table 1 for summary). We will revisit the case studies above with recommendations for intervention (see Table 2).

TRADITIONAL MOTOR-BASED APPROACH

The traditional articulation, or motor-based, approach is reportedly one of the most commonly used SSD treatment approaches employed in clinical practice (Brumbaugh & Smit, 2013; McLeod & Baker, 2014). The approach is well suited for production errors resulting from articulation (i.e., phonetic) deficits, given its emphasis on the establishment of articulatory placement and movement, but not for errors that are phonologically based (Klein, 1996). This approach is grounded in the sensory–motor framework and universal principles of motor learning and practice (Schmidt, 1991; Van Riper & Irwin, 1959). Although this approach has undergone several iterations since its introduction in the late 1930s, because it appears to affect change in performance, it has withstood the test of time through continued clinical application (Kamhi, 2006). This is despite limitations to standardized implementation and the lack of efficiency data, data which indicate cost-effective treatment options based on empirical evidence.

Although guidelines are available that describe general implementation (e.g., Hoffman & Schuckers, 1984), there is no standard format in terms of the reinforcement schedule, criteria for mastery, or data collection system associated with this approach. However, lack of treatment component standardization is arguably the case for many SSD intervention approaches and not unique to the motor-based approach. Most available evidence regarding the success of the traditional articulation approach represents weak empirical support in terms of its scientific rigor and quality for EBP (Dollaghan, 2004; Oxford, 2011). The evidence base primarily consists of case studies and clinical descriptions (e.g., Bessas & Trimmis, 2016; McDonald, 1964; Powers, 1971; Van Riper & Irwin, 1959). There is certainly merit to the use of case studies and single-subject experimental designs. These types of studies can lead to the identification of individual characteristics that

Table 1. Overview of approaches reviewed

Approach	Appropriate for Use	Examples of the Scientific Evidence	Principal Limitations in the Evidence
Traditional articulation (motor-based) approach (Van Riper & Irwin, 1959)	Articulation errors across wide variety of ages Stimulable sounds preferred	Bessas and Trimmis (2016) McDonald (1964) Powers (1971) Van Riper and Irwin (1959)	Weak evidence for its use (i.e., only case studies and clinical descriptions) Undetermined efficiency and relative effectiveness to other approaches
Cycles phonological remediation approach (Hodson & Paden, 1983)	Children with multiple phonological errors who are highly unintelligible	Hassink and Wendt (2010) Mota et al. (2007) Rudolph and Wendt (2014)	Weak evidence for its use (i.e., only case studies and correlational designs without control groups) Undetermined efficiency and relative effectiveness to other approaches
Minimal pairs (Cooper, 1968) including *minimal oppositions* (Blache et al., 1981; Weiner, 1981)	Children with mild–moderate, consistent phonological deficits	Barlow and Geirut (2002) Crosbie et al. (2005) Ferrier and Davis (1973) Forest et al. (1997) Saben and Ingham (1991) Tyler et al. (1987)	Limitations in implementation consensus Undetermined relative effectiveness of different implementation procedures
Maximal oppositions (Gierut, 1989) and *treatment of the empty set* (Gierut, 1992)	Children with phonological deficits, phonetic inventory with omission of six or more phonemes	Alsaad et al. (2019) Mota et al., (2005) Topbas and Unal (2010)	Weak evidence for its use (i.e., only single-case investigations and case studies) Few practicing clinicians familiar with it, limiting opportunities for clinical research partnerships
Multiple oppositions (Williams, 2000a, 2000b)	Children with moderate-to-severe phonological deficits characterized by use of a preferred phoneme	Pagliarin et al. (2009) Sugden et al. (2020)	Undetermined efficiency and relative effectiveness to other approaches Few practicing clinicians familiar with it, limiting opportunities for clinical research partnerships
Complexity (Gierut, 2001, 2007; Gierut & Hulse, 2010; Powell et al., 1991)	Children with moderate-to-severe phonological impairments, low intelligibility, and limited phonemic inventories	Gierut et al. (1996) Mota et al. (2005)	Little known about factors affecting efficacy in clinical practice Conflicting evidence for its relative effectiveness to other approaches

Table 2. Approach recommendations for presented case studies

Case	Summary of Errors Exhibited	Recommended Approach	Rationale
Lucas	Lateralized production of fricatives /s, z, ʃ, ʒ/ Stimulable for /s, z/ productions	Traditional articulation (motor-based)	Articulatory nature of errors produced Stimulable for some target sounds
Jasmine	Use of phonological processes including final consonant deletion Use of /t/ as preferred phoneme Limited phonetic inventory	Contrast therapy: multiple oppositions	Moderate-to-severe phonological deficits exhibited Use of preferred phoneme (phoneme collapse present)
Terrell	Multiple phonological patterns in use (e.g., fronting, deaffrication, cluster reduction, gliding, vowelization, and fricative simplification)	Complexity approach	Many errors across sound classes Moderate-to-severe disorder exhibited and intelligibility negatively impacted Maximize generalization to untreated phonemes

influence treatment outcomes unobscured by group averaging effects and, as such, can provide practical recommendations for clinical decision-making regarding individual clients (Graham et al., 2012; Rvachew & Matthews, 2017). Additionally, single-subject experimental designs represent a foundational research methodology for the field of communication sciences and disorders and can be particularly feasible for use with low-incidence populations. However, without replication of these study findings in larger sample experiments, sources of variability in children's therapy outcomes remain undetermined and the efficiency of the approach is unknown as its comparison to other approaches has not been systematically studied (Kamhi, 2006). Because of this, the relative effectiveness of traditional articulation therapy for targeting articulation-based SSDs remains untested, but its long history, wide use in clinical practice, and case study support provide some testament to its effectiveness even in the absence of more rigorous investigation.

COGNITIVE–LINGUISTIC APPROACHES

A traditional motor-based approach, as described earlier, is often used for children producing errors on a small number of phonemes who need systematic intervention to increase the articulatory accuracy of phoneme production from less complex (e.g., isolation) to more complex contexts (e.g., conversation). In the latter part of the twentieth century, a paradigmatic shift occurred in the field of articulation therapy when researchers and clinicians alike realized the importance of attending to *patterns* of deficit occurring in children's speech rather than focusing only on individual phoneme errors (Hodson & Paden, 1983; Ingram, 1976). Such patterns are systematic, rule-governed, and affect the phonological structure of language (e.g., replacing all fricatives with stops). In shifting focus to the systematic phonological process errors some children produce, it became apparent that a systematic approach to speech production

intervention may effectively remediate errors in an entire class of sounds, which was proven more effective for children producing erroneous phonological processes than focusing on remediating a child's speech errors one phoneme at a time (Elbert & Gierut, 1986; Hodson & Paden, 1983).

Cognitive–linguistic approaches are a set of approaches that are specifically designed to address the child's phonological system as a whole, rather than one phoneme at a time. The goal is to draw the child's attention to how their current phonological production is not sufficient to distinguish meaning in their native language. For example, a child who fronts velar phonemes (i.e., the phonological process of fronting) produces the target /ti/ to represent both "tea" and "key," unaware that this production is ambiguous for listeners. Thus, cognitive–linguistic approaches seek to address how the child is thinking (cognitive) about how sounds in words affect meaning (linguistic). We discuss a variety of cognitive–linguistic approaches to phonological intervention designed to help children who produce phonological patterns of errors successfully to eliminate their usage and, in the process, acquire correct phoneme usage in their speech. An exhaustive review of all cognitive–linguistic approaches is beyond the scope of this article, but we highlight several that are appropriate for use in school-based settings and provide a brief review of the evidence base for each.

The cycles phonological remediation approach

The cycles phonological remediation approach (Hodson & Paden, 1983; Prezas & Hodson, 2010) was designed for children with highly unintelligible speech who consistently use multiple phonological processes. This approach was borne out of the observation that, in typical development, children acquire speech gradually and do not master one phoneme before beginning to acquire a new one (Hodson & Paden, 1983; Ingram, 1976). With this in mind, the cycles approach involves systematically exposing a child who produces multiple phonological process errors to a variety of intended targets gradually in a cyclical fashion, without expectation that the child will master production before cycling to the next target. Consistent with a developmental approach to speech sound error intervention, the clinician chooses targets that the child is stimulable for but not yet producing independently in connected speech. Stimulability refers to errors the child is able to immediately modify when given a verbal model (Powell & Miccio, 1996).

To implement, a clinician first identifies the phonological patterns needing remediation. Hodson and Paden (1983) recommend that phonological processes (e.g., velar fronting, stopping, and cluster reduction) occurring in 40% or more of opportunities are eligible candidates for intervention. All phonological processes meeting this threshold are then prioritized according to both phonological and child characteristics (Hodson et al., 2002; Prezas & Hodson, 2010). For example, phonological processes involving omission errors are prioritized over substitution errors, and stimulable targets are prioritized over nonstimulable targets. The cycles approach begins with the selection of a stimulable target phoneme within a targeted phonological process. This target becomes the initial focus of treatment, which is then followed by a new stimulable target phoneme within the phonological process in the following intervention session. Next, the clinician may either select another stimulable target phoneme within that phonological pattern or shift the focus to a new phonological process. Phonological processes are then recycled if correct production for that process used has not yet emerged in conversation.

The cycles approach, or at least modified versions of it, is relatively well-known and one of the most common cognitive-linguistic approaches implemented by clinicians (Brumbaugh & Smit, 2013; Kamhi, 2006). Procedures for the cycles approach are well-described in the literature (Hodson & Paden, 1983; Prezas & Hodson, 2010) and Kamhi (2006) surmised its wide

implementation may be due to being "broad-based, combining an efficient goal-attack strategy with traditional speech therapy and metaphonological activities" (p. 275). However, the bulk of the available evidence for the efficacy of the cycles approach stems from nonexperimental case studies and correlational designs that often do not include control groups or demonstrate high levels of control for potential confounds (Hassink & Wendt, 2010; Rudolph & Wendt, 2014). Moreover, studies implementing the cycles approach often modify procedures such that the integrity of the approach as it was designed may be compromised (Almost & Rosenbaum, 1998; Culatta et al., 2005), although this is as yet an untested claim. Several studies have reported gains in phonological outcomes for children who undergo the cycles approach, but it is not clear whether these gains are more than what would be achieved with other phonological approaches (Mota et al., 2007). Despite its clinical popularity, further research is needed to investigate both its efficacy, the establishment of a clear cause–effect relationship between the treatment and improvement in targeted skills, and its efficiency relative to other approaches.

Contrast approaches

Approaches other than cycles also align with a cognitive–linguistic framework. A group of them, often referred to as "contrast therapies," capitalize on contrastive word pairings to emphasize that differences in sound production confer differences in word meaning. These include: minimal pairs, minimal oppositions, maximal oppositions, and multiple oppositions.

Minimal pairs

The minimal pair contrasts approach has been studied and in use since the late 1960s (Cooper, 1968; Ferrier & Davis, 1973). It involves feature (e.g., place–manner–voice) contrasts across pairs of words that differ by only one phoneme and signal a change in meaning (Barlow & Gierut, 2002). According to Barlow and Gierut (2002), this approach is based on the concept that once a feature difference is introduced to a child, the child then will generalize the targeted distinction to other sound pairs in words (e.g., targeting a stopped /s/ will generalize to correcting a stopped /z/ because the child is acquiring frication). This approach seems to work well for children with mild-to-moderate, consistent phonological deficits (Crosbie et al., 2005; Ferrier & Davis, 1973; Forest et al., 1997; Tyler et al., 1987).

Use of minimal pairs to drive change in children's phonological systems has been widely studied for effectiveness with over 40 published studies (for an expanded summary of research evidence support, see Baker, 2010; Baker & McLeod, 2011). Most of these investigations targeted the efficacy of minimal pairs, with its ability to produce a desired change in speech sound production evident in these studies. However, little is known about the relative effectiveness of minimal pairs in terms of how well this approach works in affecting system-wide phonological change compared with other approaches (Baker, 2010). An additional limitation to minimal pair use, highlighted by Saben and Ingham (1991), involves a lack of consensus and transparency across researchers in how minimal pair intervention is implemented. Baker (2010) attempted to address this implementation issue through description of two suggested procedures, one involving early introduction of minimal pairs to create communication breakdowns associated with lack of sound production contrast and the other involving introduction to minimal pair productions following explicit instruction and practice of target sounds. Little is known about the relative efficiency of these implementation procedures.

Minimal oppositions

Using contrast therapies, clinicians can strategically emphasize changes in word meanings that result from differing speech sound productions to establish contrasts not present in the child's phonological system (Baker, 2010; Blache et al., 1981; Weiner,

1981). For instance, using pairs of words that differ by only one phoneme involving a single distinctive feature include contrasts like "*c*ape" versus "*t*ape" in which the manner of production and voicing are consistent, but the place of articulation has changed. Of the contrast therapies, the minimal opposition pairs approach is considered to be one of the oldest, most well-known, and widely used (Baker, 2010; McLeod & Baker, 2017) and appears to be best suited for children with mild-to-moderate phonologically based SSD, particularly those with multiple substitution errors or errors of omission (e.g., final consonant deletion; Baker, 2010; Williams, 2000a).

Maximal oppositions

Additional contrasting word pair approaches include maximal oppositions and treatment of the empty set. Both of these approaches, described by Gierut (1989) and Gierut (1992), respectively, theoretically differ from minimal opposition pairs in key ways, including the number and dimensions of distinctive feature differences between the contrast pairs and the relationship of the targeted phonemes to children's existing phonological knowledge. According to Gierut (1989), there is greater potential to effect system-wide change in children's phonological systems by targeting contrasting phonemes with maximally different production features and major class distinctions than by contrasting phonemes that are more similar to one another.

The theoretical underpinning of this notion is that, initially, young children are better able to attend to and differentiate between more global, extreme, and broad distinctions than those that are localized and more subtle. An example of a maximally opposed pairing would be "chain" versus "main" because /tʃ/ is a voiceless lingua-palatal affricate and an obstruent and, by contrast, /m/ is a voiced bilabial nasal and a sonorant. For maximal oppositions, clinicians are advised to use pairs of words in which one phoneme is in the child's repertoire (i.e., known and produced by the child) and the contrasting phoneme is not known or used appropriately by the child (Gierut, 1989). Maximal oppositions contrast therapy including treatment of the empty set is recommended for children with phonologically based SSD whose phonemic inventory indicates omission of at least six or more phonemes (Gierut, 1989) as well as for those with mild–moderate phonological impairments (Mota et al., 2005).

Gierut (1989, 1992) specified a variation of maximal oppositions known as *treatment of the empty set*, wherein pairs of words contain two maximally opposing sounds that do not occur in a child's phonemic repertoire. Thus, the contrast focus is on target phonology that has not yet been learned (Gierut, 1989, 1992). General guidelines for implementation include the creation of novel or nonsense words assigned meaning within the context of storytelling activities to familiarize the child with the target words. The word pairings are then taught through imitation with modeling and cues before spontaneous use is encouraged (Gierut, 1992).

Although empirical evidence supporting the use of maximal oppositions continues to emerge, much of what is currently available in the literature consists of single-subject experimental investigations (e.g., Gierut, 1989, 1992; Topbas & Unal, 2010) and case studies (e.g., Alsaad et al., 2019; Mota et al., 2005). Additionally, few practicing clinicians report use of or familiarity with maximal oppositions as a therapeutic approach for treating pediatric SSD (Brumbaugh & Smit, 2013). Taken together, this may limit the potential utility of this approach as well as opportunities for clinical–research partnerships geared toward its study.

Multiple oppositions

Another type of contrast therapy, developed by Williams (2000a, 2000b), systematically addresses children's use of phoneme collapse, when a child uses a preferred phoneme as a substitute for a number of other phonemes absent from their repertoire. These collapses result in homonymy, two or more words pronounced the same, but with

different meanings (Williams, 2000b). To address this unwanted homonymy that may lead to speaker frustration and listener confusion, the multiple oppositions approach addresses the fundamental organization of the sound system as a whole and is not limited to an isolated aspect of the sound system like a single phoneme or sound class (Williams, 2000b). Rather, according to Williams (2000a, 2000b), intervention for children using phoneme collapses is best addressed through an individualized and systematically selected contrastive set of words that are modeled and compared with the preferred phoneme simultaneously, not as a series of singleton minimal pairs. The phonemes in the treatment set are selected to reflect maximal distinction with each other as well as with the substituting phoneme to facilitate learning for system-wide phonological reorganization and revised production strategies (Williams, 2010). For example, a child may collapse fricatives, affricates, and s-clusters to /t/ such that the words "sue," "shoe," "zoo," "choo," and "stew" are all produced as /tu/. Using multiple oppositions, the child is presented with sets of words contrasted with the substituted pattern (e.g., Sue-two, shoe-two, zoo-two, choo-two, and zoo-two) to promote widespread phonological change. Williams (2010) offers guidelines for implementation which include four general phases of intervention (i.e., imitation, spontaneous production of trained words, spontaneous production of untrained words, and conversational recasts) along with a detailed treatment paradigm outlining criteria for successive intervention phases.

Multiple oppositions seem to be best suited for children exhibiting moderate–severe and severe phonological impairments characterized by phoneme collapses and who have limited intelligibility (Pagliarin et al., 2009; Williams, 2010). However, according to McLeod and Baker (2017), this approach is not well-suited for children with severe phonological impairments characterized predominantly by syllable structure simplification patterns (e.g., weak syllable deletion and cluster reduction).

Williams (2010) surmised that, based on the current evidence base, multiple oppositions was a "promising intervention with probable efficacy" (p. 82) and specific directives regarding recommended treatment intensity and dosage are noted for clinical implementation (Williams, 2000a, 2012). Williams also noted that more support for efficacy and relative efficiency compared with other phonological approaches was needed (Williams, 2010). Uniquely, this contrast therapy has been studied regarding its implementation by parents and SLPs (Sugden et al., 2020). Sugden et al. (2020) found a combined parent- and SLP-delivery of this contrast therapy was effective for the majority of children studied and they outlined parent training procedures for at-home implementation of phonological intervention. However, few practicing clinicians report use of or familiarity with multiple oppositions as a therapeutic approach for treating pediatric SSD (Brumbaugh & Smit, 2013).

COMPLEXITY APPROACH TO PHONOLOGICAL INTERVENTION

A primary goal of intervention for children with phonologically based errors is to efficiently induce system-wide change across a variety of phonemes. A complexity approach to phonological intervention achieves system-wide change by prioritizing phoneme targets that will result in generalization to untargeted phonemes (Gierut, 2007). Thus, this approach is designed to reduce the number of phonemes that need to be directly targeted in therapy while still maximizing phonological change. This approach is designed for children with moderate-to-severe phonological impairments with low intelligibility and limited phoneme inventories. Several investigators have sought to determine which characteristics of target phonemes induce generalization to untargeted phonemes. For example, Powell and colleagues (1991) found that targeting nonstimulable phonemes led to the acquisition of both targeted and nontargeted phonemes, but generalization to

nonstimulable phonemes did not occur when targeting stimulable phonemes.

Gierut et al. (Gierut, 2007; Gierut et al., 1996; Gierut & Hulse, 2010) pioneered efforts to explore other forms of phonological complexity when choosing targets for intervention that maximize generalization to untaught phonemes. Although an exhaustive review of a complexity approach to target selection is beyond the scope of this article, we share principles of this approach and resources for additional guides to implementation (Gierut, 2001; Gierut & Hulse, 2010; Storkel, 2018). In essence, phoneme targets that will promote the most phonological generalization are prioritized. This includes phonemes that are nonstimulable and later-developing (Gierut & Hulse, 2010; Storkel, 2018). Additionally, linguistically marked phonemes are prioritized over unmarked phonemes. Markedness refers to linguistic implicational universals that dictate a hierarchical relationship between the presence/absence of particular phonemes within a language. That is, the presence of some phonemes implies the presence of others, because of the relationship between them. For example, there are some languages that have stops *and* fricatives. And there are some languages that have stops, but not fricatives. However, there are no languages that have fricatives but not stops. In this case, the presence of fricatives *implies* the presence of stops, but the reverse is not true (Gierut & Hulse, 2010; Storkel, 2018). In sum, when selecting treatment targets using a complexity approach, the following target phonemes are prioritized: (1) later developing, (2) linguistically marked, (3) least accurately produced, and (4) not stimulable (Gierut & Hulse, 2010; Storkel, 2018).

Research evidence for a complexity approach supports its efficacy in treating targeted phonemes and that this type of approach also results in generalization to untargeted phonemes, which is one of the central justifications for its use among supporters (Gierut et al., 1996). Although some researchers claim a complexity approach is more efficient than other phonological approaches, others have disputed this claim and have reported either no difference between a complexity approach and others (Mota et al., 2005) or that it is less efficient than targeting stimulable and earlier-developing phonemes (Rvachew & Nowak, 2001). In addition, there is a paucity of discussion in the literature about other factors (e.g., child motivation and resilience) that may influence the effectiveness of using this approach in clinical practice (Baker & Williams, 2010).

LIMITATIONS

Although we have reviewed the evidence base of the most commonly used motor-based articulation approach and several cognitive–linguistic approaches for phonological intervention, we caution that this review is not exhaustive. The approaches discussed here focus on production-based treatment that are feasibly implemented in school settings. We acknowledge, however, the importance of attending to input-oriented procedures not discussed here. For example, children with SSD are more likely to exhibit speech perception deficits, particularly for phonemes they do not produce correctly (see Hearnshaw et al., 2019). Thus, incorporating speech perception into SSD treatment may be helpful for these children (Rvachew, 1994). We also refer readers to other comprehensive resources for helpful reviews of additional approaches school-based SLPs may find beneficial for the children they serve (see Baker & McLeod, 2011; Williams, 2010).

Although there are a growing number of studies investigating SSD intervention approaches, there are some methodological limitations to the current evidence base (Baker & McLeod, 2011; Hassink & Wendt, 2010). Baker and McLeod (2011) conducted a narrative review of 134 intervention research studies for children with SSD. They noted the majority of intervention research comprises single-subject experimental designs and individual case studies, which is expected given the inherent heterogeneity between clients with communication disorders,

including children with SSD. There is a significant need in our field to study the evidence base of various intervention approaches using even more rigorous experimental designs, such as randomized control trials and quasi-experimental group research designs. Fortunately, single-subject experimental designs provide valuable evidence regarding efficacy for individual children with a wide variety of needs, and may provide ecological validity that is difficult to attain in randomized control trials for children with SSD (see Rvachew & Matthews, 2017, for further discussion on the benefits of single-subject research designs). Further research is needed to document clinical utility of theoretically driven approaches, including those that have proven effective in research settings. Although several approaches discussed here have an evidence base demonstrating their efficacy, only a few have addressed the comparative efficiency of different approaches. As a result, although there is evidence to support their use, it is as yet unclear whether specific approaches are *more* effective than others.

CASE STUDIES REVISITED

We have highlighted the distinctive characteristics, the central tenets, and the current evidence base of several SSD intervention approaches. At the beginning of this article, we presented three case examples representing children commonly found on the caseloads of school-based SLPs. As summarized in Table 2, we recommend a treatment approach appropriate for each child and accompanying rationale for each decision. In each case, we carefully considered the profile of the child and the characteristics of the approach to optimize a match that will yield positive speech production outcomes. For Lucas, his distorted sound productions indicated an articulatory-based SSD. In addition, given his stimulability for sound production, limited number of sounds in error, and intact language skills, we recommended the traditional articulation motor-based approach. For Jasmine, her consistent use of /t/ as a substitute for a wide variety of other phonemes resulted in word production homonymy that severely limited her intelligibility. This indicated implementation of a multiple oppositions approach, which emphasizes system-wide phonological reorganization by treating multiple targets simultaneously and seemed particularly well suited for her erroneous productions. For Terrell, his use of multiple phonological patterns and limited intelligibility could make him an appropriate candidate for either the cycles or complexity approach. We advocate for the use of the complexity approach with him, given its research support for maximizing generalization of untreated phonemes and, consequently, its potential to reduce the number of phonemes requiring direct intervention, thus allowing for more focused clinical interactions.

Importantly, there is not a single correct intervention decision for each case and another clinician may justifiably choose a different approach than we have selected here. By attending closely to the characteristics and evidence base of each intervention approach, carefully considering the goals of treatment for an individual child, and bearing in mind their own clinical skills, SLPs can successfully identify an appropriate treatment approach to maximize outcomes for each individual child.

REFERENCES

Almost, D., & Rosenbaum, P. (1998). Effectiveness of speech intervention for phonological disorders: A randomized controlled trial. *Developmental Medicine and Child Neurology*, *40*, 319–325.

Alsaad, M., McCabe, P., & Purcell, A. (2019). The application of the maximal opposition therapy approach to an Arabic-speaking child. *Journal of Communication Disorders*, *81*, 1–10.

American Speech-Language-Hearing Association. (2018). *Schools survey report: Caseload characteristics trends, 2004–2018*. www.asha.org

Baker, E. (2010). Minimal pair intervention. In A. L. Williams, S. McLeod, & R. J. McCauley (Eds.), *Interventions for speech sound disorders in children* (pp. 41–72). Brookes Publishing.

Baker, E., & McLeod, S. (2011). Evidence-based practice for children with speech sound disorders: Part 1 narrative review. *Language, Speech, and Hearing Services in Schools*, *42*(4), 102–139.

Baker, E., & Williams, A. L. (2010). Complexity approaches to intervention. In A. L. Williams, S. McLeod, & R. J. McCauley (Eds.), *Interventions for speech sound disorders in children* (pp. 95–115). Brookes Publishing.

Barlow, J., & Gierut, J. (2002). Minimal pair approaches to phonological remediation. *Seminars in Speech and Language*, *23*(1), 57–67.

Bessas, A., & Trimmis, N. (2016). The effectiveness of traditional treatment of articulation disorders in preschool children. *Journal of International Scientific Publications*, *14*, 273–286.

Blache, S., Parsons, C. L., & Humphreys, J. M. (1981). A minimal word-pair model for teaching the linguistic significance of distinctive feature properties. *Journal of Speech and Hearing Disorders*, *46*, 291–296.

Broomfield, J., & Dodd, B. (2004). Children with speech and language disability: Caseload characteristics. *International Journal of Language and Communication Disorders*, *39*(3), 303–324.

Brumbaugh, K. M., & Smit, A. B. (2013). Treating children ages 3–6 who have speech sound disorder: A survey. *Language, Speech, and Hearing Services in Schools*, *44*, 306–319.

Cooper, R. (1968). The method of meaningful minimal contrasts in functional articulation problems. *Journal of the Speech and Hearing Association of Virginia*, *10*, 17–22.

Crosbie, S., Holm, A., & Dodd, B. (2005). Intervention for children with severe speech disorder: A comparison of two approaches. *International Journal of Language and Communication Disorders*, *40*(4), 467–491.

Culatta, B., Setzer, L., & Horn, P. (2005). Meaning-based intervention for a child with speech and language disorders. *Topics in Language Disorders*, *25*(4), 388–401.

Dollaghan, C. A. (2004). Evidence-based practice in communication disorders: What do we know, and when do we know it? *Journal of Communication Disorders*, *37*, 391–400.

Elbert, M., & Gierut, J. A., (1986). *Handbook of clinical phonology: Approaches to assessment and treatment*. College-Hill Press.

Farquharson, K. (2019). It might not be "just artic": The case for the single sound error. *Perspectives of the ASHA Special Interest Groups*, *4*, 76–84.

Felsenfeld, S., Broen, P. A., & McGue, M. (1994). A 28-year follow-up of adults with a history of moderate phonological disorder: Educational and occupational results. *Journal of Speech and Hearing Research*, *37*, 1341–1353.

Ferrier, E. E., & Davis, M. (1973). A lexical approach to the remediation of final sound omissions. *Journal of Speech and Hearing Disorders*, *38*, 126–130.

Fey, M. E. (1992). Articulation and phonology: Inextricable constructs in speech pathology. *Language, Speech, and Hearing Services in Schools*, *23*(3), 225–232.

Forest, K., Dinnsen, D. A., & Elbert, M. (1997). Impact of substitution patterns on phonological learning by misarticulating children. *Clinical Linguistics & Phonetics*, *11*, 63–76.

Gierut, J. A. (1989). Maximal opposition approach to phonological treatment. *Journal of Speech and Hearing Research*, *54*, 9–19.

Gierut, J. A. (1992). The conditions and course of clinically induced phonological change. *Journal of Speech and Hearing Research*, *35*, 1049–1063.

Gierut, J. A. (2001). Complexity in phonological treatment: Clinical factors. *Language, Speech, and Hearing Services in Schools*, *32*, 229–241.

Gierut, J. A. (2007). Phonological complexity and language learnability. *American Journal of Speech-Language Pathology*, *16*(1), 6–17.

Gierut, J. A., & Hulse, L. E. (2010). Evidence-based practice: A matrix for predicting phonological organization. *Clinical Linguistics and Phonetics*, *24*(4-5), 323–334.

Gierut, J. A., Morrisette, M. L., Hughes, M. T., & Rowland, S. (1996). Phonological treatment efficacy and developmental norms. *Language, Speech, and Hearing Services in Schools*, *27*, 215–230.

Graham, J., Karmarkar, A., & Ottenbache, K. (2012) Small sample research designs for evidence-based rehabilitation: Issues and methods. *Archives of Physical Medicine and Rehabilitation*, *93*(8), S111-S116.

Hassink, J. M., & Wendt, O. (2010). Remediation of phonological disorders in preschool age children: Evidence for the cycles approach. *EBP Briefs*, *5*(2), 1–7.

Hearnshaw, S., Baker, E., & Munro, N. (2019). Speech perception skills of children with speech sound disorders: A systematic review and meta-analysis. *Journal of Speech, Language, and Hearing Research*, *62*, 3771–3789.

Hodson, B. W., & Paden, E. P. (1983). *Targeting intelligible speech: A phonological approach to remediation*. College-Hill.

Hodson, B. W., Scherz, J. A., & Strattman, K. H. (2002). Evaluating communicative abilities of a highly unintelligible preschooler. *American Journal of Speech-Language Pathology*, *11*, 236–242.

Hoffman, P. R., & Schuckers, G. H. (1984). Articulation remediation treatment models. In R. G. Daniloff (Ed.), *Articulation assessment and treatment issues* (pp. 1–17). College-Hill Press.

Ingram, D. (1976). *Phonological disability in children*. American Elsevier Publishing.

Kamhi, A. (2006). Treatment decisions for children with speech-sound disorders. *Language, Speech, and Hearing Services in Schools*, *37*, 271–279.

Klein, E. S. (1996). Phonological/traditional approaches to articulation therapy: A retrospective group comparison. *Language, Speech, and Hearing Services in Schools*, *27*, 161–1461.

Lewis, B. A., Freebairn, L., Tag, J., Igo, R. P. Jr., Ciesla, A., Iyengar, S. K., Stein, C. M., & Taylor, H. G. (2019). Differential long-term outcomes for individuals with histories of preschool speech sound disorders. *American Journal of Speech-Language Pathology*, *28*, 1582–1596.

McCormack, J., Harrison, L. J., McLeod, S., & McAllister, L. (2011). A nationally representative study of the association between communication impairment at 4-5 years and children's life activities at 7–9 years. *Journal of Speech, Language, and Hearing Research*, *51*, 328–1348.

McDonald, E. T. (1964). *Articulation testing and treatment: A sensory motor approach*. Stanwix House.

McLeod, S., & Baker, E. (2017). *Children's speech: An evidence-based approach to assessment and intervention*. Pearson.

McLeod, S., & Baker, E. (2014). Speech-language pathologists' practices regarding assessment, analysis, target selection, intervention, and service delivery for children with speech sound disorders. *Clinical Linguistics and Phonetics*, *28*, 508–531.

Mota, H. B., Bagetti, T., Keske-Soares, M., & Pereira, L. F. (2005). Generalization based on implicational relationships in subjects treated with phonological therapy models. *Pro-Fono Revista de Atualizacao Cientifica Barucri (SP)*, *17*(1), 99–110.

Mota, H. B., Keske-Soares, M., Bagetti, T., Ceron, M. I., & Melo Filha, M. G. C. (2007). Comparative analyses of the effectiveness of three different phonological therapy models. *Pro-Fono Revista de Atualizacao Cientifica, Barucri (SP)*, *19*(1), 67–74.

Overby, M., Carrell, T., & Bernthal, J. (2007). Teachers' perceptions of students with speech sound disorders: A quantitative and qualitative analysis. *Language, Speech, and Hearing Services in Schools*, *38*, 327–341.

Overby, M., Trainin, G., Smit, Bosma, A., Bernthal J. E., & Nelson, R. (2012). Preliteracy speech sound production skill and later literacy outcomes: A study using the Templin archive. *Language, Speech, and Hearing Services in Schools*, *43*, 97–115.

Oxford Centre for Evidence-Based Medicine. (2011). *Levels of evidence*. https://www.cebm.net/2016/05/ocebm-levels-of-evidence/

Pagliarin, K. C., Mota, H. B., & Keske-Soares, M. (2009). Therapeutic efficacy analysis of three contrastive approach phonological models. *Pro-Fono Revista de Atualizacao Cientifica (SP)*, *21*(4), 297–302.

Powell, T. W., Elbert, M., & Dinnsen, D. A. (1991). Stimulability as a factor in the phonological generalization of misarticulating preschool children. *Journal of Speech and Hearing Research*, *14*, 1318–1328.

Powell, T. W., & Miccio, A. W. (1996). Stimulability: A useful clinical tool. *Journal of Communication Disorders*, *29*, 237–253.

Powers, M. H. (1971). Clinical educational procedures in functional disorders of articulation. In L. E. Travis (Ed.). *Handbook of speech pathology and audiology*. Prentice-Hall.

Prezas, R., & Hodson, B. W. (2010). The cycles phonological remediation approach. In A. L. Williams, S. McLeod, & R. J. McCauley (Eds.), *Interventions for speech sound disorders in children* (pp. 137–157). Brookes Publishing.

Rudolph, J. M., & Wendt, O. (2014). The efficacy of the cycles approach: A multiple baseline design. *Journal of Communication Disorders*, *47*, 1–16.

Rvachew, S. (1994). Speech perception training can facilitate sound production learning. *Journal of Speech, Language, and Hearing Research*, *37*(2), 347–357.

Rvachew, S., & Matthews, T. (2017). Demonstrating treatment efficacy using the single subject randomization design: A tutorial and demonstration. *Journal of Communication Disorders*, *67*, 1–13.

Rvachew, S., & Nowak, M. (2001). The effect of target selection strategy on phonological learning. *Journal of Speech, Language, and Hearing Research*, *44*, 610–623.

Saben, C. B., & Ingham, J. B. (1991). The effects of minimal pairs treatment on the speech sound production of two children with phonologic disorders. *Journal of Speech and Hearing Research*, *34*, 1023–1040.

Schmidt, R. A. (1991). *Motor learning & performance: From principles to practice*. Human Kinetics.

Shriberg, L. D., Tomblin, J. B., & McSweeny, J. L. (1999). Prevalence of speech delay in 6-year-old children and comorbidity with language impairment. *Journal of Speech, Language, and Hearing Research*, *42*, 1461–1481.

Storkel, H. L. (2018). The complexity approach to phonological treatment: How to select treatment targets. *Language, Speech, and Hearing Services in Schools*, *49*, 463–481.

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.

Sugden, E., Baker, E., Williams, A. L., Munro, N., & Trivette, C. M. (2020). Evaluation of parent- and speech-language pathologist–delivered multiple oppositions intervention for children with phonological impairment: A multiple-baseline design study. *American Journal of Speech-Language Pathology*, *29*(1), 111–126.

Topbas, S., & Unal, O. (2010). An alternating treatment comparison of minimal and maximal opposition sound selection in Turkish phonological disorders. *Clinical Linguistics and Phonetics*, *24*(8), 646–668.

Tyler, A., Edwards, M. L., & Saxman, J. H. (1987). Clinical application of two phonologically based treatment procedures. *Journal of Speech and Hearing Disorders*, *52*, 393–409.

Van Riper, C., & Irwin, J. V. (1959). *Voice and articulation*. Pitman Medical.

Weiner, F. (1981). Treatment of phonological disability using the method of meaningful minimal contrast: two case studies. *Journal of Speech and Hearing Disorders*, *46*, 97–103.

Williams, A. L. (2000a). Multiple oppositions: case studies of variables in phonological intervention. *American Journal of Speech-Language Pathology*, *9*, 289–299.

Williams, A. L. (2000b). Multiple oppositions: theoretical foundations for an alternative contrastive intervention approach. *American Journal of Speech-Language Pathology*, *9*, 282–288.

Williams, A. L. (2010). Multiple oppositions intervention. In A. L. Williams, S. McLeod, & R. J. McCauley (Eds.), *Interventions for speech sound disorders in children* (pp. 73–94). Brookes Publishing.

Williams, A. L. (2012). Intensity in phonological intervention: Is there a prescribed amount? *International Journal of Speech-Language Pathology*, *14*(5), 456–461.

Williams, A. L., McLeod, S., & McCauley, R. J. (2010). *Interventions for speech sound disorders in children*. Brookes Publishing.