Use of the Complexity Approach at a Reduced Intensity to Treat Speech-Sound Disorders

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ABSTRACT

Research has shown that the complexity approach is an effective treatment for typically developing children with moderate-to-severe speech-sound disorders when delivered in clinical settings. However, to date, no research has been conducted to help speech-language pathologists determine if this intervention would be as effective when used to treat students with mild language or cognitive delays in a school setting where three 1-hour weekly sessions are not feasible. This study was conducted to determine whether this intervention would be as successful when used to treat students on a typical school-based speech-language pathologist's caseload, if therapy intensity were reduced to three 20-minute sessions per week in a group of two students, provided that the therapy dosage remained at levels recommended by Warren et al. (2007).

Results of the study indicated that 20-minute therapy sessions may be insufficient to provide some students with attention issues with the number of trials needed for them to make adequate progress. In addition, shortening the session length without adjusting the number of sessions per phase of the intervention may not be appropriate, as two participants in this study did not appear to have sufficient time in each phase to adequately master the treatment target at both the imitative and spontaneous levels.

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Chapter 1

Introduction to the Study

Approximately 5% of early elementary-aged children are estimated to have a speech-sound disorder (Shriberg et al., 1999). Speech-sound disorders have been shown to impact children's academic performance negatively (Lewis et al., 2015) and contribute to the high caseloads of some school-based speech-language pathologists (SLPs). According to a survey conducted by the American Speech-Language-Hearing Association (American Speech-Language-Hearing Association [ASHA], 2022), the caseloads for school-based SLPs can exceed 60 students. When less efficient intervention approaches are used, students with speech-sound disorders remain on caseloads longer than necessary, contributing to larger caseload sizes for SLPs. Selecting the most efficient interventions to target these disorders may help mitigate the negative educational impacts of speech-sound disorders and enable SLPs to manage their caseloads more effectively (Storkel, 2018).

Statement of the Problem

Quick remediation of speech-sound disorders is essential for children. Research indicates that children's phonological systems become resistant to change by 8 ½ years of age (Shriberg et al., 1994). This means the longer it takes to remediate their speech-sound disorders, the more difficult it becomes to produce a change in their phonological systems.

In addition, research indicates that kindergarteners with severe speech-sound disorders are significantly more likely to experience academic difficulties. The reason may be that children's phonological knowledge, as gauged by their phonological awareness skills and the accuracy of their speech-sound production, is associated with the ability to decode words (Overby et al., 2012). Additional research by Lewis et al. (2015) indicates that students with speech-sound disorders are at risk for academic difficulties throughout childhood.

The risks of reading problems are not the only potential academic impact of speech-sound disorders. According to Allison et al. (2019), 10% of kindergarten and first-grade students miss one month or more of school during a single academic year. In addition, 13% miss 15 or more days of school. In post-pandemic years, the percentage is likely even higher. Students diagnosed with attention deficit/hyperactivity disorder and developmental delays are twice as likely to be chronically absent as their same-aged peers. Many of these students will also be diagnosed with a speech-sound disorder (Lewis et al., 2012). As a result, they will miss even more class time attending therapy, up to an additional 5.75 days per school year (Brandel, 2020). This necessitates making progress as quickly as possible (Storkel, 2018).

Although more than 40 different treatment approaches have been identified as effective for treating speech-sound disorders (Baker & McLeod, 2011), the primary approaches SLPs report using remain limited to a few interventions. In a survey by Sugden et al. (2018), many SLPs reported primarily using minimal pairs and auditory discrimination. Furlong et al. (2021) report that, currently, most SLPs surveyed use a combination of minimal pairs, traditional approaches, auditory discrimination, and cued articulation. Unfortunately, none of these interventions is associated with system-wide change across classes of sounds.

System-wide change refers to the change that occurs in treated and untreated sounds resulting from a particular intervention (Gierut, 2008b). System-wide change can occur both within and across classes of phonemes. This type of change reduces the number of phonemes that must be targeted directly in therapy, potentially leading to earlier discharge from speech therapy services.

The complexity approach is a linguistics-based intervention for children with moderate to severe speech-sound disorders that uses complex targets to initiate phonological learning and induce system-wide change (Morrisette, 2021). Complex targets are sounds or sequences of sounds that are later developing, including fricatives, affricates, liquids, and true consonant clusters with a small difference in sonority between the cluster elements (Storkel, 2018). Research indicates that using complex clusters with this approach is an effective and efficient method for remediating speech-sound disorders, due to its ability to effect change both within and across classes of sounds (Gierut, 2008b).

However, a survey conducted by Brumbaugh and Smit (2013) indicates that only 8% of SLPs use the complexity approach to treat speed-sound disorders. In addition, 54% of SLPs report selecting targets based on developmental norms rather than complexity principles, such as teaching nonstimulable and later-developing sounds (Sugden et al., 2018). Since the current recommendation from researchers regarding treatment intensity is three 1-hour sessions per week (Gierut, 2008b), some SLPs may be reluctant to use this approach because the level of intensity is not practical in school settings.

Purpose of the Study

According to Kaipa and Peterson (2016), research on optimal treatment intensity for speech-sound disorders is limited and complicated by differences in the characteristics of children with these disorders, such as the severity of the speech-sound disorder, learning capacity, and motivation for improvement. Additional research may help SLPs determine whether interventions, such as the complexity approach, are suitable for their students, considering time constraints and the diverse range of individual student characteristics within the school setting. Therefore, this study aimed to determine whether the complexity approach can be successfully implemented in school settings with a typical caseload, using less intensity than is currently recommended.

It can be difficult for students to miss classes for extended periods of time to attend therapy sessions. Therefore, shorter therapy sessions were implemented in this study. Rehfeld and Sulak's (2021) study found no significant difference between therapy delivered in two 30-minute sessions per week and four 15-minute sessions per week. Additionally, Williams (2012) suggests that 60 minutes per week is sufficient to produce changes in the phonological system. Research by Byers et al. (2021) suggests that shorter, more frequent sessions can also be effective for treating speech-sound disorders when motor-based approaches are used. Furthermore, additional research indicates that learning is more effective when practice is distributed across several sessions than when concentrated within fewer sessions (Janiszewski et al., 2003).

The evidence also suggests that the complexity approach can be successfully used to treat speech-sound disorders when delivered in small groups meeting for two 30-minute sessions per week (Taps, 2006). Given that the cited study reported a total therapy time of 60 minutes per week, it was hypothesized that the proposed three 20-minute sessions per week would also lead to generalization of untreated phonemes.

Dosage also plays a crucial role in the success of the complexity approach when administered in shorter, more frequent sessions. A minimum of 50 trials per 30-minute session is the current recommendation for treating speech-sound disorders (Williams, 2012). If a child received 60 minutes per week of therapy, this would equal about 33 trials per 20-minute session. This would exceed the 19 trials in the study by Rehfeld and Sulak (2021) and more closely approximate the dosage recommended by Williams. Therefore, a minimum of 33 trials per session was deemed appropriate.

Research Questions

This study sought to address the following research questions.

1. When using the complexity approach within the school-based setting with students with mild cognitive or language delays, using three 20-minute sessions per week for a maximum of 19 total sessions, would the participants be able to reach 90% accuracy, as recommended by Gierut (2008b), in the spontaneous production of the treatment targets across three consecutive therapy sessions?
2. When using the complexity approach within the school-based setting with students with mild cognitive or language delays, using three 20-minute sessions per week for a maximum of 19 total sessions and a dosage of at least 33 trials per session, would the intensity be sufficient for the participants to acquire a minimum of two untreated phonemes into their phonemic inventory?

It is hypothesized that the subjects will improve their production of the selected targets and increase the number of sounds in their phonemic inventories when therapy sessions are provided in shorter, more frequent sessions, provided the dosage is maintained at a minimum of 33 trials per session. Since it can be challenging for students to miss class for extended periods, shorter therapy sessions will be implemented in this study. Rehfeld and Sulak's (2021) study found no significant difference between therapy provided in two 30-minute sessions per week and therapy provided in four 15-minute sessions per week. Williams (2012) indicates that 60 minutes per week is sufficient to produce changes in the phonological system using the complexity approach. Research by Byers et al. (2021) suggests that shorter, more frequent sessions can also be used effectively to treat speech sound disorders when using motor-based approaches. Furthermore, additional research (Janiszewski et al., 2003) indicates that learning is more effective when practice is distributed across several sessions than when concentrated within fewer sessions.

Chapter II

Literature Review

Many SLPs working in public school systems have high caseloads, reaching up to 60 students (ASHA, 2022). Furlong et al. (2018) reported that 40% to 70% of these students receive speech therapy to address speech-sound disorders. To better manage their caseloads, SLPs need to use effective and efficient methods so students can be dismissed as quickly as possible (Storkel, 2018).

Speech-Sound Disorders

A speech-sound disorder occurs when a child experiences a substantial delay in the ability to produce their language's sounds compared to an adult model (Lewis et al., 2015). Speech-sound disorders are classified into two main categories: etiological and functional (Davis, 2005). Etiological disorders have known causes, such as neurological or motor deficits, developmental delays, or perceptual deficits (Bernthal & Bankson, 1998). Functional speech-sound disorders are those for which there is no known cause. Functional speech-sound disorders account for the majority of speech-sound disorders in children.

Many treatment interventions for functional speech-sound disorders are based on the theory that the deficits are either motor or linguistically based (Davis, 2005). Those who support the theory based on motor learning principles contend that speech-sound disorders result from possible perceptual deficits and a child's inability to produce the correct motor movements necessary to articulate certain speech sounds accurately

(Bernthal & Bankson, 1998). Conversely, those who argue for a linguistically oriented approach believe that the speech-sound errors produced by children with functional speech-sound disorders result from a poor understanding of their language's phonological rules (Davis, 2005).

Motor Learning Principles

Initially, speech-sound disorders were thought to result from two primary weaknesses (Bernthal & Bankson, 1998). The first was that children with speech-sound disorders were thought to have difficulty accurately perceiving differences in their own sound productions compared with those of adults. The second was that the children had delays in oral motor skills and needed instruction on the correct manner and placement for each sound they produced in error. Sound errors were categorized as sound substitutions, distortions, or omissions (Van Riper, 1963).

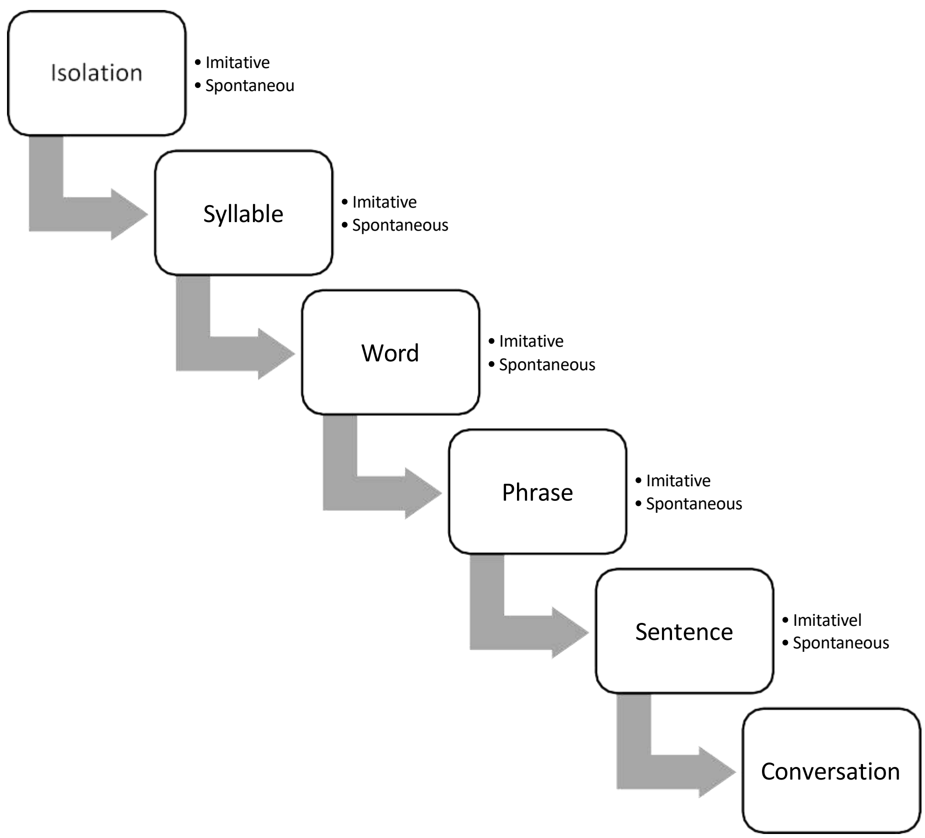
Traditional Approach

One of the primary interventions SLPs use is the traditional articulation approach, which is based on motor learning principles (Furlong et al., 2021). Developed by Van Riper (1963), the traditional approach is a compilation of various motor-based treatment techniques employed by early speech clinicians in the 1900s (Bernthal & Bankson, 1998). It is a drill-based approach that follows operant conditioning principles, progressing in complexity from production of the treatment target in isolation to syllables, phrases, sentences, and conversation (Preston & Leece, 2021). It is designed for school-age children with mild to moderate articulation disorders, phonological disorders, and apraxia of speech. It has also been used successfully with children with mild to moderate intellectual disabilities.

Treatment targets are selected from earlier-developing sounds and from those for which the child is stimulable (Van Riper, 1963). Sounds are treated one at a time by presenting a stimulus to the child to elicit a response. Therapy progression for this approach is described in Figure 1. The same progression is followed for each error sound.

Figure 1

Treatment Course for the Traditional Approach



Note. Adapted from (Preston & Leece, 2021).

Many studies support the use of the traditional approach for children with only a few sounds in error (Baker, 2021; Skelton & Richard, 2016; Sommers et al., 1962). However, other studies question its efficiency for some children. Evidence suggests that targeting sound classes using a linguistic approach is more efficient for children with moderate to severe speech-sound disorders (Baker, 2021; Preston & Leece, 2021).

Research also indicates that this approach is less effective for children with moderate to severe speech-sound disorders resulting from reduced phonological knowledge (Preston & Leece, 2021). This is because phonemes produced in error are targeted one at a time. Phonological interventions that target classes of sounds appear to be more appropriate as they result in faster progress (Preston & Leece, 2021).

Auditory Discrimination

Auditory discrimination, also known as speech perception training, is intended to be used in conjunction with the traditional intervention approach (Bernthal & Bankson, 1998). It has since been incorporated into other approaches, such as the minimal pairs approach (Rvachew, 1994) and the cycles approach (Hodson & Paden, 1983). The purpose of teaching auditory discrimination is to improve the child's perceptual skills so they can discriminate between accurate and inaccurate productions of error sounds (Rvachew & Brosseau-Lapre, 2021). It is hypothesized that this will improve children's ability to monitor their own productions.

When using speech perception interventions, the child is presented with auditory stimuli that contrast the child's incorrect production of a phoneme with its correct production within minimal pairs (Winitz & Bellerose, 1967). The child is asked to identify, from each word pair, which contains a presented sound. Initially, the sound contrasts presented differ maximally in terms of distinctive features. As a child improves his ability to discriminate, the differences between them are decreased (Rvachew, 1994).

The efficacy of speech perception training has been disputed for many years due to a lack of research investigating its effectiveness, with some studies contradicting one another (Rvachew, 1994). For example, Winitz and Bellerose (1967) found that speech-perception training did not improve children's production of /r/. However, Rvachew (1994) found that using a computer program to deliver the intervention was successful for some children in facilitating improved sound production when combined with another speech-sound intervention targeting production.

Cued Articulation

Cued articulation was developed to assist SLPs in explaining to children how sounds are produced using visual representations of each English consonant and vowel (Passy, 2010). Hand cues provide information about the placement of the articulators, voicing, and manner of production for each sound.

Derivational Theories

Linguistic-based approaches are based on derivational theories that posit sound errors result from a lack of understanding of the underlying phonological rules governing how sounds are produced and how they can be combined to form words (Bernthal & Bankson, 1998). Treatment, therefore, focuses on selecting treatment targets that will increase the child's phonological knowledge. Most linguistic intervention approaches developed use word pairs to contrast distinctive features, helping children learn linguistic contrasts between sounds and sound classes.

Minimal Pairs

The minimal pairs approach is one of the most familiar linguistics-based approaches (Sugden et al., 2018). The minimal pairs approach is designed for children ages three to six who exhibit phonological processes that result in a mild or moderate speech-sound disorder characterized by homonymy, where sound production errors make two or more different words sound alike (Baker, 2021). This approach consists of three steps. The first is familiarization. This involves the SLP stating the name of each picture and providing a brief description to ensure the child is familiar with the picture stimuli. The second step involves an auditory discrimination task in which word pairs are presented that contrast the correct sound with the error produced by the child. The third step comprises two parts. During the first part, the student produces the treatment words imitatively and then spontaneously once they achieve 90% accuracy over a minimum of 50 trials. During the second half, the child tells the SLP which picture to pick up when all treatment cards are placed face-up on a table. Praise is given when the child produces the target sound correctly, and a request for clarification is given if the child produces it incorrectly. When this step is complete, the child is directed to produce the target words in increasingly complex utterances, from phrases to the conversation level (Baker, 2021).

In a comparison of 49 studies, the minimal pairs approach was determined to be effective in remediating speech-sound disorders (Baker, 2021). However, since the minimal pairs approach focuses on contrasting pairs of sounds to treat individual sound classes, other phonological interventions that lead to both within and across-class generalization may be more appropriate for treating more severe disorders (Williams, 2012). In such cases, it may be more appropriate to use the minimal-pairs approach to supplement other interventions that lead to more widespread phonological change once the child's error patterns have decreased.

Optimality Theory

Although interventions based on phonological processes result in more efficient changes in therapy than the traditional approach, using a rule-based phonology to explain the different patterns across languages is inadequate (Dinnsen, 2008). Phonological processes do not account for the atypical error patterns observed in some children. This inadequacy led researchers to develop the optimality theory.

Optimality theory states that across all languages, there exists a set of common constraints among which are implicational relationships, rather than unbreakable rules, that are developmentally sequential and independent of one another (Dinnsen & O'Connor, 2001). The ranking of different constraints dictates sound combinations and structures for the words in each language (Dinnsen, 2008).

Constraints are divided into two categories- markedness constraints and faithfulness constraints. Markedness constraints influence how sound sequences may be produced across languages. Faithfulness constraints help maintain sound structure within words. These constraints are prioritized differently across languages and account for variation between them. When two or more competing constraints may affect a particular word's sound structure, the one most faithful to the prioritized ranking within a given language takes precedence (Dinnsen, 2008).

Some researchers have applied the optimality theory to speech-sound disorders to explain why children make various sound error patterns (Gierut, 2008a). Researchers hypothesize that markedness constraints, which forbid complex structures such as consonant clusters composed of two or three elements, are highly ranked in children's phonological systems. Therefore, targeting complex structures may lead to reprioritizing markedness constraints, causing widespread change in a child's phonological system.

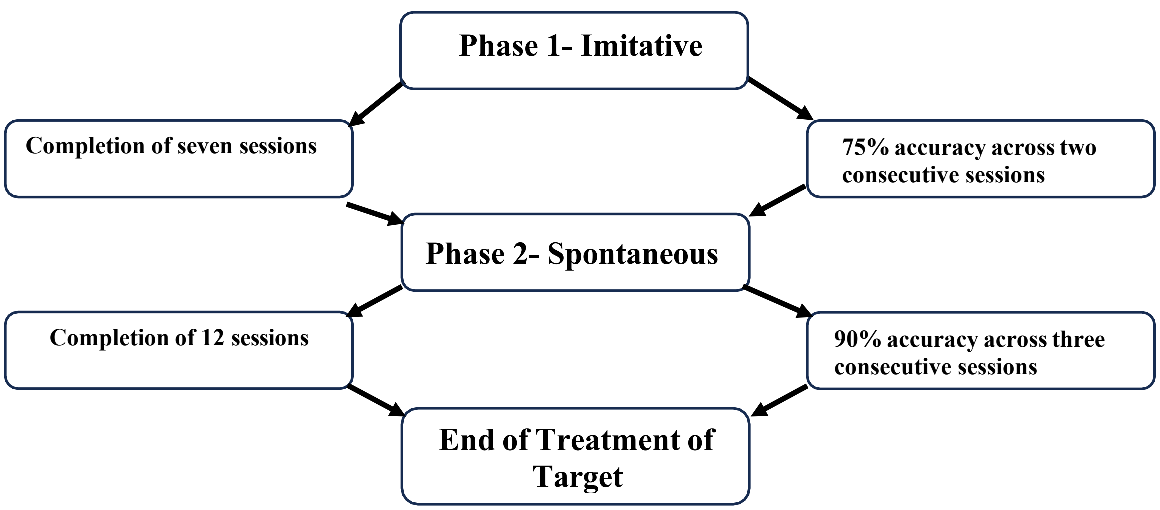
The Complexity Approach

The complexity approach, based on optimality theory, is an intervention designed to treat children with moderate-to-severe speech-sound disorders (Morrisette, 2021). The intervention uses complex targets to initiate phonological learning and induce system-wide change to untreated sounds. System-wide change refers to changes that occur in treated and untreated sounds within and across phoneme classes (Gierut, 2008b).

Typically, therapy is conducted in three 1-hour weekly sessions for each complex target across two phases (Gierut, 2008a). For the imitative phase, the treatment target is practiced at the word level until either seven sessions are completed or 75% mastery is achieved across two consecutive sessions. Then, the spontaneous phase continues at the word level for either 12 sessions or until 90% mastery is achieved across three consecutive sessions. The treatment course is outlined in Figure 2.

Figure 2

Treatment Course for the Complexity Approach



Note. Adapted from (Gierut, 2008a).

When possible, three-element clusters —consonant clusters composed of three consecutive consonants, such as /str/—are selected as treatment targets, since research indicates that three-element clusters are the most complex structure and the most likely to result in widespread generalization (Gierut & Champion, 2001). However, two-element clusters are selected if the child lacks the second or third elements of any three-element cluster in their phonemic inventory, as they are also effective in initiating system-wide change (Gierut, 1999). If the child has low frustration tolerance, later-developing complex singletons produced in error, for which the child is nonstimulable, are also appropriate targets.

The Complexity Approach: Principles and Guidelines

Research shows that complexity principles often guide treatment for communication disorders. For example, complexity principles are effective in treating expressive language delays that affect syntax. De Anda et al. (2020) examined whether targeting auxiliary “be” in questions, a more complex sentence structure, would improve the use of verb tense and agreement. The results indicated that the children increased their production of the treatment target and generalized to untreated, less complex structures and agreement forms. However, it is important to note that the various studies investigating the efficacy of the complexity approach have used participants that presented with cognition, oral motor skills, and hearing that were within normal limits (Gierut, 1999; Gierut & Champion, 2001; Gierut et al., 1987; Gierut et al., 1996; Gierut & O’Connor, 2002; Warren et al., 2007).

Complexity principles have also guided the treatment of speech-sound disorders in children. The complexity approach is based on the premise that treating sounds for which a child has the least phonological knowledge will result in widespread generalization to both treated and untreated phonemes (Gierut, 2008b) within and across sound classes (Gierut, 1998). In this approach, universal implicational laws are employed to identify more complex treatment targets (Gierut, 2007).

Universal Implicational Laws

Gierut (2007) defined implicational laws as the relationships among the phonological properties that define all languages and restrict the extent of possible grammars. Each law is based on the premise that the presence of more complex phonemes or sequences of phonemes implies the presence of less complex sounds and sequences in a child's phonological system. In the complexity approach, these laws serve as the basis for selecting treatment targets. Based on a review of the literature, Gierut identified 21 universal implicational laws, which are listed in Table 1.

Table 1

Implicational Laws

Hierarchical properties of sound systems	Ascertained implicational relationships
Phonetic Inventory	The presence of strident and/or lateral distinctions implies the phonetic presence of a liquid, which implies the presence of a fricative and/or affricate, which implies a voice distinction among cognate stops, which implies a nasal and glide. However, the reverse is not implied (Tyler & Figurski, 1994).
Phonemic inventory	Consonants imply vowels but not vice versa (Robb et al., 1999). Liquids imply the presence of nasals but not vice versa (Gierut et al., 1994) Velars imply the presence of coronals but not vice versa (Stoel-Gammon, 1996) Affricates imply fricatives with vowels but not vice versa (Dinnsen et al., 1992). Fricatives imply stops with vowels but not vice versa (Dinnsen & Elbert, 1984).

	Voiced obstruents imply voiceless obstruents, but not vice versa (McReynolds & Jetzke, 1986).
Distributional properties	Fricatives in the initial position imply fricatives in the final position with vowels, but not vice versa (Ferguson, 1977). Stops in the final position imply stops in initial position with vowels but not vice versa (Dinnsen, 1996). Word-initial /r/ implies post-vocalic /r/ vowels but not vice versa (Smit, 1993).
Syllable structure	Clusters imply singletons and vowels but not vice versa (Gierut & Champion, 2001). Clusters imply affricates and vowels, but not vice versa (Gierut & O'Connor, 2002). Clusters with a small sonority difference imply clusters with a greater difference in vowels, but not vice versa (Gierut, 1999). Fricative+Liquid clusters imply Stop+Liquid clusters with vowels but not vice versa (Elbert et al., 1984). Liquid onset clusters imply a liquid in coda position, but not vice versa (Baertsch, 2002).
Phonological processes	Stopping implies liquid gliding and vowels, but not vice versa (Dinnsen & O'Connor, 2001).

	Manner assimilation implies liquid gliding with vowels, but not vice versa (Dinnsen & O'Connor, 2001).
	Spirantization implies place assimilation of vowels but not vice versa (Dinnsen & O'Connor, 2001).
	Progressive place assimilation implies regressive place assimilation with vowels, but not vice versa (Stoel-Gammon, 1996).
	Velar fronting word-finally implies velar fronting word-initially with vowels, but not vice versa (Morrisette et al., 2003).
	The absence of a voice contrast in the final position implies the absence of a voice contrast in the initial position with vowels, but not vice versa (Dinnsen et al., 2001).
	Errors of weak syllable deletion in syllables beginning with an obstruent imply like errors in syllables beginning with sonorant vowels but not vice versa (Kehoe & Stoel-Gammon, 1997).

Note. Adapted from Gierut, 2007.

Numerous studies have investigated the validity of the universal implicational laws identified by Gierut (2007). For instance, Eckman (1991) conducted a study with eleven English language learners whose primary languages did not allow two-element or three-element clusters. The researchers interviewed each participant individually to collect samples of connected speech. The researchers also had the participants complete various tasks designed to elicit spontaneous productions of two and three-element consonant clusters. All speech samples were analyzed for the presence of two specific implicational laws, the fricative-stop principle and the resolvability principle, both of which affect the acquisition of consonant clusters. The fricative-stop principle states that if a language allows a stop + stop consonant cluster, it must also allow a fricative + stop consonant cluster. The resolvability principle states that if a language allows a consonant cluster composed of a certain number of phonemes, that language must also allow consonant clusters composed of fewer than that number. The study's results provided compelling evidence that the two implicational laws impact the production of consonant clusters (Eckman, 1991).

Gierut and O'Connor (2002) conducted a study to test the following hypotheses as they relate to relationships between clusters and affricates and consonant + liquid clusters and comprehension of liquid contrasts: the presence of X implies Y, where X is more marked and complex, and Y is less marked and complex, but the reverse is not true. They include X is not present, then Y is not present, X is not present, but Y is, both X and Y are present, and X is present but not Y. Results of the study indicated that 94% of the participants presented with phonological systems that demonstrated markedness relationships between clusters and affricates, providing further evidence of the existence of implicational relationships. Similarly, 95% of participants demonstrated evidence of the same relationships between consonant + liquid clusters and liquid distinction in their phonological systems.

However, Watts and Rose (2020) conducted a post hoc longitudinal study of four children who spoke languages other than English. They found only seven of the implicational laws held across all the represented languages. Their results provide evidence that some of the implicational laws may be specific to English. However, those relationships remain valuable for treating English-speaking children with speech-sound disorders using complexity principles.

Phonological Knowledge

Closely related to implicational laws is a child's productive phonological knowledge. Productive phonological knowledge is a child's implicit and explicit understanding of their language's sound system (Gierut et al., 1987). Productive phonological knowledge can be determined by evaluating the presence of minimal pairs, the accuracy of the production of phonemes, and the presence of phonemes representing all sound classes across all word positions (Gierut et al., 1987). Phonemes for which a child has the least phonological knowledge are labeled inventory constraints (Morrisette, 2021). The selection of treatment targets for which a child has the least phonological knowledge and is considered more complex has been hypothesized to lead to greater system-wide change.

Gierut et al. (1987) conducted three experiments to examine the role of productive phonological knowledge in triggering system-wide generalization of learning in typically developing children. The results of the experiments indicated that participants treated using targets for which they had the most phonological knowledge generalized only to the treated sounds. However, the children who received therapy using targets for which they demonstrated the least phonological knowledge experienced generalization to both treated and untreated phonemes. In other words, using more complex targets in treatment resulted in greater generalization of the treatment effects.

While the results of several studies have shown such widespread generalization, how children generalize their learning can vary considerably (Gierut et al., 1987).

Consequently, Williams (1991) conducted a study to investigate this phenomenon. She used a single-subject, multiple-baseline design to examine whether children with similar articulation profiles exhibited similar learning patterns. She found that her data appeared to conflict with that of Gierut et al. (1987). However, Williams used /st/ as one of her treatment targets. This consonant sequence is considered an adjunct to a simple onset rather than a true cluster (Gierut, 1999) because it violates the sonority sequencing principle, which states that within a syllable, sonority rises with the onset and falls with the coda (Clements, 1990, as cited in Gierut, 1999). Selecting this treatment target may have affected the results of Williams's study and contributed to the differences between her results and those of Gierut et al. (1987). This is because using adjuncts as treatment targets has the potential to create gaps in children's learning and, at times, may lead to overgeneralization.

In a novel approach, Maggu et al. (2019) investigated the use of simple versus complex structures using a behavioral and neurophysiological framework. They used a pseudoword picture task with undergraduate Cantonese speakers. The pseudowords contained Hindi dental and retroflexed contrastive sounds, which are more marked than the voiceless alveolar plosives in Cantonese and more difficult for Cantonese speakers to discriminate. They compared the amplitude and latency of mismatch negativity, which measures a person's capacity to distinguish between sound contrasts before and after the intervention. The results of both behavioral and electrophysiological evaluations indicated greater improvements in discrimination of complex and simple sound contrasts among participants treated with complex stimuli (Maggu et al., 2019).

Early- Versus Late-Developing Sounds

An aspect of productive phonological knowledge is the age of acquisition for phoneme classes. According to universal implicational laws, earlier developing sounds are less marked and less complex (Gierut, 2007). Traditionally, experts have recommended that treatment targets be selected according to developmental norms, in which earlier developing and, hence, less complex sounds that are in error should be treated first (Gierut et al., 1996). However, researchers have questioned this recommendation after reviewing research regarding complexity principles.

Gierut et al. (1996) conducted two multiple-baseline studies to determine whether targeting earlier-developing or later-developing sounds results in the greatest change in a typically developing child's sound system. The first study was a within-subject design in which earlier-developing sounds were alternated with later-developing sounds during treatment. The second study was a within-subject study, in which one group was treated with earlier-developing sounds and the other with later-developing sounds. Both studies demonstrated that targeting earlier-developing sounds yielded only within-class generalization, whereas targeting later-developing sounds led to across-class generalization (Gierut et al., 1996). Gierut et al.'s studies provide further evidence of the efficacy of using more complex sounds as treatment targets.

Syllable Structure

The syllable is one of the basic foundational structures of phonology (Gierut, 1999). It is composed of the onset, the nucleus, and the coda, whose structure is thought to be guided by the sonority sequencing principle (Clements, 1990, as cited in Gierut, 1999). This principle states that within a syllable, sonority rises with the onset and falls with the coda. Syllable structure, specifically of a complex onset, can be difficult for some children to understand (Gierut, 1999).

Because complex onsets or clusters require greater phonological knowledge to produce, researchers conclude that they are appropriate treatment targets for the complexity approach (Gierut, 1999). In one study, Gierut found that using marked complex clusters as treatment targets resulted in both within- and across-class phoneme generalization. Using unmarked clusters resulted in limited within-class generalization.

Gierut (1999) then extended her study by investigating how /s/ + stop clusters affect phonological learning since they violate the sonority sequencing principle. The results of the study indicated that using /s/ + stop clusters as treatment targets interferes with phonological learning and can result in overgeneralization and gaps in the sonority sequence of the children's sound systems. Gierut stated that the results indicated that /s/ is an adjunct to the second element. This is logical as /s/ + stop clusters violate the sonority sequencing principle. Subsequent studies by Gierut and Champion (2001) and Barlow (2005) support the proposition that treating speech-sound disorders by targeting appropriate consonant clusters such as /str/, /spl/, /skw/, /skr/, and /spr/, which combine an adjunct with an actual consonant cluster, is effective.

Stimulability

Another aspect of a child's productive phonological knowledge is stimulability, which indicates a child's ability to correct an error-sound with minimal prompts (Sommers et al., 1967). Although early research recommended targeting error sounds for which a child is stimulable, more recent research indicates that this may not be the most effective approach for many children.

A prospective cohort study conducted by To et al. (2012) examined factors affecting the time it takes for children to normalize their sound systems. They found that children who were nonstimulable for error sounds and were less intelligible, indicating their productive phonological knowledge was on the lower end of the continuum, took longer to normalize their sound system. Conversely, those with good stimulability scores normalized their sound systems in a shorter time, often without intervention.

Sommers et al. (1967) conducted a study investigating how error inconsistency and stimulability affected children's improvement in speech production with and without therapy. Their study indicated that children with poor stimulability scores received more benefits from therapy. This outcome suggests that targeting sounds for which a child is less stimulable may yield greater gains.

A study that looked specifically at whether children's stimulability skills before treatment were correlated to greater generalization after therapy was conducted by Powell et al. (1991). The results of their study indicated that children taught a sound for which they were stimulable only generalized that sound. Conversely, those taught a nonstimulable sound generalized their learning to other error sounds for which they were stimulable. In other words, when taught sounds for which they demonstrated the least productive phonological knowledge, they generalized to other sounds for which they had more knowledge.

Target Selection

When using the complexity approach, the target selection process begins by determining a child's phonemic inventory, as this independent analysis indicates whether a child understands sonority relationships (Gierut, 1999). A phonemic inventory analysis assesses the presence of functional phoneme contrasts, thereby providing a picture of a child's phonological knowledge (Combiths et al., 2019). A phoneme is considered a part of a child's phonemic inventory if it occurs in at least two different minimal pair sets. Once the child's phonemic inventory is assessed, appropriate treatment targets can be selected by determining which phonemes are excluded from the child's inventory.

Treatment Intensity

One barrier practitioners often encounter when implementing new or unfamiliar treatment interventions is the difficulty they face in translating research findings into practical applications for their caseloads (Morris et al., 2019). Often, research reported in professional journals is conducted in idealistic circumstances (Kazdin, 2011). For example, current research recommends that speech-language pathologists using the complexity approach provide treatment to children in individual rather than group sessions for three or more sessions per week for up to 60 minutes per session (Gierut, 2008b). However, this level of intensity is impractical for speech-language pathologists working in the school setting.

There are two primary reasons this level of intensity is not practical for a school setting. First, large caseload sizes necessitate therapy to be provided in groups rather than in individual sessions to accommodate all students (Brandel & Frome Loeb, 2011). Second, this level of intensity would require a student to miss significant class time, which may negatively impact academic performance. To address both concerns, treatment delivered within school settings is typically provided in groups of two to three students (Sugden et al., 2018), for one to two sessions per week, each lasting between 20 and 30 minutes (Brandel, 2020). This differs significantly from what is recommended for the complexity approach.

While intensity is a critical aspect of therapy, there is often a lack of guidance regarding the appropriate intensity levels for different intervention approaches (Kaipa & Peterson, 2016; Warren et al., 2007). This is unfortunate, as intensity levels that are too high may waste time and resources. Conversely, when the intensity is too low, it may slow progress (Alighieri et al., 2021). Therefore, it is important to utilize available research to determine appropriate levels for the various aspects of intensity.

Warren et al. (2007) argue that intensity is a crucial variable in optimizing the treatment of various communication disorders. To help SLPs with this process, they proposed five factors of intensity to consider when planning treatment. These include the dosage or number of teaching opportunities within a given session, combined with the form those opportunities take, the frequency with which sessions are provided within a given time frame, the length of each session, and the total time needed to remediate the disorder. Multiplying the dose by the dose frequency by the total intervention duration yields the cumulative treatment intensity. By considering each of these factors, SLPs can evaluate the impact each plays on progress toward improved sound production (Warren et al., 2007).

Dose. Dose is the number of teaching opportunities provided within a given session (Warren et al., 2007). Comparisons of studies reporting on the dosage provided to participants provide evidence that a higher dosage is associated with greater gains in speech production accuracy (Williams, 2012). Based on these comparisons, Williams recommended a minimum of 50 trials per 30-minute session for children with mild to moderate speech-sound disorders and 70 trials per 30-minute session for children with severe speech-sound disorders. The authors reported no information regarding the appropriate dosage for those with concomitant language disorders or cognitive delays.

Evidence suggests that these recommended levels may not be consistently provided during therapy sessions. Hegarty et al. (2018) surveyed SLPs in the United Kingdom regarding their treatment of children with speech-sound disorders. The survey results indicated that the average number of trials per session for children on their caseload ranged from 10 to 30. In a literature review, Sugden et al. (2018) found that some speech-language pathologists in the United States reported providing therapy to remediate speech-sound disorders at intensities below those recommended by research, with practice opportunities as low as 23 per session.

A study by Farquharson et al. (2022) may provide insight into the reasons for lower dosage levels. In their study, they employed the experience sampling method, in which data are collected randomly during participants' days in real-time, to determine the dosage levels provided to children with speech-sound disorders in school settings. They found that group size was negatively related to the dosage provided during sessions. In other words, the larger the group, the lower the dosage per member. In addition, students with comorbidities received lower doses, presumably because more goals needed to be targeted during treatment sessions.

Dose form. Dose form refers to the activities or tasks used to present the dose (Warren et al., 2007). These tasks and activities may range from more naturalistic to more structured. While a naturalistic dose form is an appropriate option for therapy, Byers et al. (2021) found that most SLPs treating speech-sound disorders, including those conducting research and those in clinical settings, prefer clinician-directed drill activities. This may be due to evidence suggesting that higher doses are needed during therapy sessions to produce significant change. Drill activities provide these opportunities more efficiently than child-directed activities (Warren et al., 2007). Additionally, clinician-directed activities enable clinicians to adjust practice parameters more easily, thereby maintaining an optimal level of difficulty throughout sessions, which has been shown to facilitate faster remediation of speech-sound disorders (Matthews et al., 2021).

Session length. While session length is not a factor of intensity proposed by Warren et al. (2007), it is one of the more documented aspects of treatment intensity, with the researchers recommending various session lengths for different interventions. For example, according to Allen (2013), 30-45 minutes per session is appropriate for the multiple oppositions approach. As previously noted, Gierut (1990) recommends 60-minute sessions when using the complexity approach.

Clinicians use a range of session lengths when providing therapy to the children on their caseloads. The results of a survey conducted by Hegarty et al. (2018) indicated that SLPs in the United Kingdom provide sessions ranging from 21 to 50 minutes each when treating speech-sound disorders. Baker (2021) reported that session length for the minimal pairs approach can range from 30 minutes to 4 ½ hours. According to Brandel and Frome Loeb (2011), therapy sessions in schools in the United States typically last 21 to 30 minutes to address various communication needs. In contrast, Baker and McLeod (2011) reported that sessions last between 30 and 60 minutes when treating speech-sound disorders.

Research studies indicate that session length does not significantly affect treatment outcomes, provided the cumulative dosage intensity remains constant. Rehfeld and Sulak (2021) and Byers et al. (2021) conducted studies comparing therapy for speech-sound disorders delivered in longer, less frequent sessions per week versus shorter, more frequent sessions. Similar dosages were provided to both groups in each study. Both reported there were no significant differences in progress made between the children in the two groups.

Dose frequency. Dose frequency refers to how often treatment is provided within a given time frame (Warren et al., 2007). This includes daily, weekly, or monthly sessions, which vary significantly among SLPs. According to Hegarty et al. (2018), SLPs in the United Kingdom frequently provide therapy sessions to treat speech-sound disorders once per week. In the United States, Brumbaugh and Smit (2013) reported that the SLPs they surveyed provided sessions one to two times per week when treating speech-sound disorders, while Baker and McLeod (2011) reported that the SLPs they surveyed provided therapy two to three times per week.

Many studies indicate that higher dose frequency leads to greater gains. Farquharson et al. (2022) conducted a study with kindergarten through 2nd-grade children to investigate the impact of session length and frequency on student progress. They found that children who received therapy with more sessions per week made the greatest gains in their sound production.

The results of their study are consistent with other research. For example, Allen (2013) found that three weekly sessions produced greater gains when using the multiple oppositions approach. Kaipa and Peterson (2016) and Williams (2012) also stated that the results of their studies indicate that more concentrated sessions per week may produce better therapy outcomes when treating speech-sound disorders.

One study that contradicts the proposition that greater dosage frequency results in better outcomes was conducted by Cummings et al. (2021). In their study, the researchers compared the results between two groups: one that received therapy in two 50-minute sessions per week and another that received therapy in four 50-minute sessions per week. Progress regarding phonological generalization was measured by calculating the percentage of consonants correct. The study found no statistically significant difference between the two groups. The reason for the difference in results between this study and those demonstrating greater gains with increased dose frequency is difficult to determine, but it may be related to the other factors of intensity.

Total intervention duration. Total intervention duration refers to the overall time an intervention is provided (Warren et al., 2007). Hegarty et al. (2018) found that SLPs in the United Kingdom provide between five and 30 sessions before discontinuing therapy for speech-sound disorders, with most ranging from nine to 12 sessions. In the United States, surveys of SLPs indicate intervention duration for speech-sound disorders may last from seven to 36 months, with an average of 12 months (Baker & McLeod, 2011).

Providing therapy for a sufficient length of time is crucial to progress. In 2012, a study by Williams found that when the overall treatment duration for speech-sound disorders was fewer than 30 sessions, the effectiveness of therapy was limited for children with mild to moderate speech-sound disorders. The children with severe speech-sound disorders needed at least 40 sessions to make adequate progress.

Cummings et al. (2021) conducted a single-subject, multiple-baseline study to examine the impact of providing therapy for children with speech-sound disorders across different intervention durations, which supported the findings of Williams (2012). One group received 11 50-minute treatment sessions, and the other received 19 50-minute treatment sessions. The results indicated that the group who participated in 19 treatment sessions attained six times the gains of those who participated in 11 sessions.

Cumulative intervention intensity. Cumulative total intervention intensity results from multiplying the dose by the frequency by the total intervention duration (Warren et al., 2007). This measure helps compare treatment groups when investigating the impact of intensity on treatment outcomes. By calculating cumulative intervention intensity, researchers can determine the impact of factors beyond the independent variables examined in the study. It is also valuable to help determine if clinicians provide sufficient overall intensity when various aspects of intensity are being adjusted in response to workload demands. The survey results collected by Hegarty et al. (2018) show that school-based SLPs in the United Kingdom vary significantly in the cumulative intervention intensity provided to children on their caseloads, ranging from 50 to 900 trials. In the United States, Baker and Williams (2011) report that only 7.5% of the studies they reviewed provide sufficient information to determine cumulative total intensity. Based on the studies that provided sufficient information, the total intensity ranged from 1, 596 to 2, 136 trials. However, whether these studies were conducted in university clinics or school settings was not reported.

In 2019, Swartz et al. reviewed 477 articles to examine the cumulative intervention intensity used in research on therapy incorporating biofeedback to treat speech-sound disorders. Only 29 of the reviewed articles provided sufficient detail to calculate the cumulative intervention intensity. The results demonstrated a positive correlation between higher cumulative intensity and better treatment outcomes. However, the researchers stated that it is difficult to draw firm conclusions from their analysis because the studies they reviewed measured progress in diverse ways.

Factors affecting intensity recommendations. SLPs consistently indicate in survey studies that they base intensity recommendations on patient needs (Brandel, 2020; Brandel & Frome Loeb, 2011). However, data indicate that caseload size and years of experience are the primary factors in decisions made regarding intensity, as evidenced by the same frequency and session lengths being prescribed for most students regardless of severity (Brandel, 2020; Brandel & Frome Loeb, 2011; Brumbaugh & Smit, 2013; To et al., 2022). For instance, Brandel and Frome (2011) found that as the size of an SLP's preschool caseload increased, the recommended intensity decreased, even though these children were diagnosed with severe communication disabilities. In addition, SLPs who had practiced speech therapy longer were more likely to recommend greater intensity for children with moderate to severe disabilities. Consequently, SLPs should be aware of the appropriate criteria to use when making intensity recommendations, as well as other factors that may influence their decisions.

Research on determining appropriate criteria for intensity levels of dose, dose form, session length, and frequency is sparse (Kaipa & Peterson, 2016). Some intervention approaches, such as the complexity approach (Gierut, 1990) and the multiple oppositions approach (Williams, 2000), recommend levels for certain aspects of intensity. However, not all intensity aspects are addressed, and several interventions have no intensity recommendations. This may be one reason surveys of intensity levels provided by SLPs indicate little variation in recommendations across children. Unfortunately, providing treatment intensity at inappropriate levels can have adverse effects on children and clinicians (Alighieri et al., 2021).

The intensity SLPs provide to their clients highlights the gap between research and practice in communication disorders (Sugden et al., 2018). Ideally, all SLPs would use existing recommendations when making intensity recommendations. However, the conditions SLPs face in their work settings may be a contributing factor to this gap. Implementing these recommendations is challenging when caseload sizes necessitate therapists providing services to students in larger groups. However, Baker and Williams (2011) suggest that workload considerations for SLPs are relevant when determining between optimal intensities and those that are feasible in work settings.

Chapter III

Methodology

The complexity approach to phonological remediation is promising in its capacity to help SLPs effect system-wide change in a child's phonological system (Gierut, 2008b). However, the intensity of three 1-hour sessions per week, currently recommended by research on implementing this approach, is prohibitive in the school environment. Research by Taps (2006) suggests that 60 minutes per week may be sufficient for the complexity approach to be successful. However, research on optimal intensity for this and other methods is limited (Kaipa & Peterson, 2016).

The purpose of this study was to determine whether 60 minutes per week, divided into three 20-minute sessions per week, would be sufficient to implement the complexity approach successfully in a small group setting within the school environment while minimizing the impact of missed class time for therapy sessions. A single-subject, multiple-baseline design was used for the study, as it is more appropriate for such a small sample size. In this investigation, the complexity approach, implemented with three 20-minute sessions per week, served as the independent variable. The dependent variable was the addition of at least two phonemes in each child's phonemic inventory and the accuracy of the production of the selected treatment targets.

Participants

The proposed study included three participants recruited from a public school district in West Central Georgia. Before initiating participant recruitment, approval was obtained from the Valdosta State University Institutional Review Board and the Muscogee County School District Institutional Review Board. These documents are available for review in Appendices A and B. The participants selected included pre-kindergarten and kindergarten students whose teachers or parents expressed concerns regarding their intelligibility. This age group was the focus of the study, as research indicates that children between the ages of four and six are within an important period of phonological learning and development (Shriberg et al., 1994).

Criteria for inclusion in the study included the following: written consent from both the parent(s) or guardian(s) and the participants, the presence of a moderate to severe phonological disorder, as indicated by standard scores that were one standard deviation below the mean or greater on a formal articulation assessment, the absence of a minimum of six sounds from their phonemic inventories (Gierut, 2008b), normal hearing, English as the first language, and the absence of any oral motor deficits. The consent forms used to obtain consent from the parents and participants are located in Appendices C and D. The selected inclusion criteria were used to ensure that only students with moderate to severe articulation disorders were included and to strengthen the validity of the collected data. Students with mild cognitive and expressive language deficits were included in the study, as typical caseloads in school settings often include students with these characteristics.

Materials

The Goldman-Fristoe Test of Articulation-3 (GFTA-3) (Goldman & Fristoe, 2015) was used to assess each student's articulation skills and help determine whether each child met the participation criteria. Each child's phonemic inventory was assessed using the Phonemic Inventory Assessment located in Appendix E and the Phonemic Inventory Score Sheet in Appendix F. This assessment provided a minimum of 5 opportunities to contrast each English consonant in different sets of minimal pairs. This provided multiple opportunities for each child to produce at least two contrasts between two sets of words, as recommended by Barlow and Gierut (2002). The In-depth Stimulability Task, adapted from Glaspey and Stoel-Gammon (2005), was used to assess the stimulability of error sounds across various word positions (see Appendix G). An Evistr Digital Voice Recorder was used to record audio during the assessment of each child's phonemic inventory. An iPhone 13 was used to record audio as a backup in case of technological difficulties.

The investigator used treatment picture cards depicting the complex targets selected for each student to elicit productions. Incentives and games were used to maintain attention and motivation during treatment. Incentive items included, but were not limited to, a mini basketball and hoop, bubble-blowing supplies, a balloon, and the games of Jumping Monkeys and Hopping Frogs.

Procedures

The study started with providing training to the SLP who was assisting with determining inter-rater reliability. The investigator received training before the commencement of the study. Potential participants were evaluated to determine their eligibility to participate in the study and to assess their baseline levels. Once eligibility was determined, the treatment was implemented. After this, final assessments were administered.

Therapist Training

The investigator and one other SLP were involved in the study. The investigator assessed the participants before and during the study and administered the intervention. The other SLP collected data periodically by reviewing audio recordings of the phonemic inventory assessments and two therapy sessions per phase, to assess inter-rater reliability. Before implementing the intervention, both SLPs involved in the study completed two online modules, *Powerful Phonological Assessment and Analysis* (Richard, 2014b) and *Phonological Treatment: Targeting Complex Sounds* (Richard, 2014a), created by Jennifer Taps Richard, an SLP specializing in the complexity approach. As the coordinator of the Phonology and Articulation Resource Center (PARC), she supports and trains SLPs in the use of research-based interventions for speech-sound disorders (Richard, 2014b). She has also been an ASHA Certified Professional Development Provider since 2010 (Richard, n. d.-b). She has provided professional development nationwide at state and national conferences (Richard, n. d.-a). In 2015, she received the Certificate of Recognition for Outstanding Contributions in Preschool-Grade 12 Education Settings from ASHA. She has also published articles in peer-reviewed journals, including Perspectives on School-Based Issues (Richard, n. d.-b).

The SLPs' training consisted of participating in two online modules, *Powerful Phonological Assessment and Analysis* (Richard, 2014b) and *Phonological Treatment: Targeting Complex Sounds* (Richard, 2014a). Both courses are based on peer-reviewed research on the complexity approach, particularly Gierut's work. Both courses closely follow Gierut’s (2008a) recommendations regarding the assessment and implementation of the complexity approach. Both courses have also been approved by ASHA for continuing education credits. This training helped ensure that the SLPs providing assessment, treatment, and collecting data would do so consistently. This training also helped improve inter-rater reliability during data collection.

Assessment of Articulation

Assessment and treatment took place in the school's speech therapy room, where the children typically attended. The GFTA-3 (Goldman & Fristoe, 2015) was used to assess all students' articulation skills and determine the severity of the disorder. Scores below 77 indicate moderate or greater disability.

Assessment of Phonemic Inventory

In addition, each student's phonemic inventory was assessed before the initiation of treatment, between the imitation and spontaneous phases of treatment, immediately after treatment ended, and again two weeks after treatment ended. During this assessment, each participant was asked to name each picture. If he could not spontaneously name a picture, he was prompted to name the object through delayed imitation. The phonemic transcription of his response was recorded on the Phonemic Inventory Score Sheet in Appendix F. After administering the assessment, the transcription was analyzed to determine how many minimal pair contrasts for each consonant were produced.

The investigator conducted the phonemic inventory assessment and recorded her results on the Phonemic Inventory Score Sheet. Each child's productions were audio-recorded during this assessment. The second SLP used the audio recording of the test administration to document her observations on a second form. Forms completed by both SLPs were compared to determine inter-rater reliability and ensure the accuracy of the child's phonemic inventory. If a consensus could not be reached regarding differences in the results, the participant's production in question was not used in the analysis. The assessment results were used to determine an appropriate treatment target for each participant and served as the baseline for each child's phonemic inventory before the intervention.

In addition to evaluating each child's phonemic inventory, his stimulability for each sound missing from the phonemic inventory was assessed. Powell et al. (1991) found that using nonstimulable sounds as treatment targets resulted in the generalization of untreated sounds. The In-Depth Stimulability Task (Richard, 2020), adapted from Glaspey and Stoel-Gammon (2005), was used to assess each child's stimulability for each missing sound. This assessment is in Appendix E. The assessment was used to evaluate each sound in isolation and syllables in different word positions with various vowels.

When possible, a three-element cluster was selected as a treatment target, as they are the most complex structure and the most likely to result in widespread generalization (Gierut & Champion, 2001). However, two-element clusters were selected when a participant did not have the second or third elements of any three-element cluster in their phonemic inventory. The two-element cluster selected was based on which one contained the most non-stimulable sounds for the child, since treating nonstimulable sounds has been shown to result in greater generalization to untreated sounds (Powell et al., 1991). If no two-element cluster was considered an appropriate target, a later-developing, nonstimulable sound was selected.

Baseline data on the production of the selected complex target were collected from all participants over a three-day period. Participants had to produce the complex target with 0% accuracy over at least three consecutive data collection points to indicate that the baseline was stable and the selected target was appropriate. It was crucial that the complex target was not produced correctly at baseline, because one key premise of the complexity approach is that treating targets for which the child has the least phonological knowledge yields greater gains (Morrisette, 2021). Another complex treatment target was selected if the participant could produce it independently with more than 0% accuracy. Then, baseline data were collected again for three days. Once a stable baseline had been obtained, the intervention began for the first participant.

Treatment Schedule

A multiple baseline design across subjects was used in this study. This research design was selected because it best suits a small number of participants and does not require withdrawing the intervention to demonstrate treatment effects. Additionally, according to Kazdin (2011), the multiple-baseline research design across participants is appropriate when examining changes in one behavior among different participants when the intervention is introduced sequentially across participants.

Treatment followed the schedule recommended by Gierut (Gierut, 2008b). In Phase 1, the participant was taught to produce the selected complex target imitatively. This treatment phase lasted until the participant either achieved 75% accuracy in imitating the target across two consecutive sessions or completed seven sessions. The SLP providing the intervention collected data at every session on the production of the target. In contrast, a second SLP collected data during two sessions during Phase 1 using audio recordings. Short reinforcing activities were used to maintain motivation and interest in treatment.

Phase 2 consisted of the participant producing the target spontaneously until either 90% accuracy was achieved across three consecutive sessions or the child completed 12 sessions. Phase 2 was discontinued after 12 sessions, regardless of the participants' accuracy level. Short, reinforcing activities were continued to maintain motivation during therapy sessions. The SLP providing the intervention continued to collect data on the target production in every session, with a second SLP also collecting data in at least two recorded sessions during Phase 2.

Each participant attended therapy in a group of no more than two students. Sessions were provided three times per week, lasting 20 minutes each. The incentives included the following:

1. Students were allowed one basketball throw toward a basketball hoop per ten trials.
2. Twenty seconds of bubble blowing were allowed following ten trials.
3. Twenty seconds of balloon play was allowed following ten trials.
4. One catapult of a monkey in the game Jumping Monkeys was allowed per ten trials.
5. Twenty seconds of hopping frogs was allowed following ten trials.

The SLP varied activities across sessions to maintain interest and motivation.

Chapter IV

Results

The purpose of this study was to examine whether the complexity approach could be successfully implemented in the school environment with less intensity than recommended in the literature. The complexity approach was administered to treat three children ranging in ages from 4 years 7 months to 5 years 3 months for moderate to severe speech-sound disorders across 19 therapy sessions. The goal during the intervention was to provide at least 33 trials per session.

Before the intervention, each participant was evaluated to determine eligibility to participate in the study, assess current performance levels, and select appropriate treatment goals. The GFTA-3 (Goldman & Fristoe, 2015) was the formal assessment used to determine the presence of a speech-sound disorder. The In-Depth Stimulability Task (Richard, 2020), adapted from Glaspey and Stoel-Gammon (2005), was used to assess each child's stimulability for each missing sound from the participant's phonemic inventory. The results of both are presented in Table 2.

Additionally, a phonemic inventory assessment was administered to determine which phonemes were missing from each child's phonemic inventory. Testing of each child's phonemic inventory was also administered after the completion of Phase 1, Phase 2, and two weeks post-intervention. Each phonemic inventory assessment was audio-recorded. A second SLP transcribed the students' responses from the recording. The transcriptions of both SLPs were compared for accuracy. Both SLPs had to verify their inclusion before a phoneme was considered added to the phonemic inventory. The results are presented in Table 3.

Table 2

Articulation and Stimulability Evaluation Results

Participant	GFTA-3 Results	In-Depth Stimulability Task Results
Participant A	Standard Score of 66	Non-stimulable for /r, l, θ, ð, ʒ/
Participant B	Standard Score of 40	Non-stimulable for /k, g, **ŋ**, l, r, θ, ð, dʒ, ʒ/
Participant C	Standard Score of 60	Non-stimulable for /θ, ð, z, ʒ/

Table 3

Results of Phonemic Inventory Assessments

	Phonemes excluded from the child's inventory before the intervention	Phonemes excluded from the child's inventory after the intervention	Phonemes added to the child's inventory immediately post-intervention	Phonemes added to the child’s inventory 2 weeks post-intervention
Participant A	/r, θ, ð, l, z, ʒ/	/r, θ, ð, l, z, ʒ/	none	none
Participant B	/k, g, ŋ, θ, ð, z, tʃ, dʒ, r, j, ʒ/	/k, g, ŋ, θ, ð, z, tʃ, dʒ, r, l, ʃ, ʒ/	none- lost /ʃ/	none- lost /ʃ/
Participant C	/θ, ð, z, ʃ, ʒ, tʃ, ŋ, l, r/	/θ, ð, z, ʒ, tʃ, ŋ, dʒ, l, r/	/ʃ/	/ʃ, tʃ/

Participant A

Participant A was a 4-year, 7-month-old female at the beginning of her participation in the study. The participant had not received speech therapy before her participation in the study to address her speech-sound disorder. She obtained a standard score of 66 on the GFTA-3 (Goldman & Fristoe, 2015). The results of the In-Depth

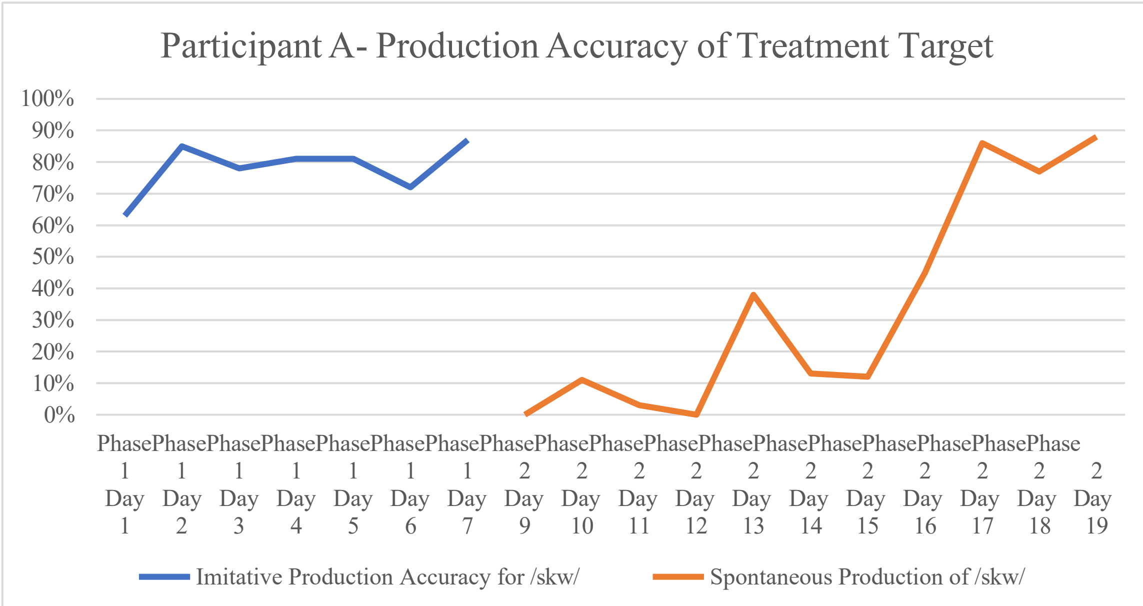
Stimulability Task indicated she was not stimulable for the following error sounds: /θ, ð, l, r, ʒ/. According to the results of the initial phonemic inventory assessment, the child excluded the following phonemes from her inventory: /r, θ, ð, l, z, ʒ/. Based on the evaluation results, the /skw/ cluster was selected as an appropriate treatment target. Participant A's baseline data for the treatment target before the intervention was 0%, indicating that this treatment target was appropriate.

The protocol developed by Gierut (2008a) allows up to seven therapy sessions during Phase 1. Participant A did not reach the criteria of two consecutive sessions with an accuracy of 75% or greater. Therefore, she participated in all seven sessions allowed for this phase. During the last session of Phase 1, Participant A achieved 87% accuracy in imitating the treatment target. However, she typically segmented rather than blended the phonemes to produce the target cluster. Participant A's phonemic inventory was reassessed after the completion of Phase 1. The results of this assessment indicated that no phonemes had been added to her inventory. Data collected during therapy sessions in Phases 1 and 2 are shown in Figure 3.

Following the end of Phase 1, the participant completed all 12 sessions of Phase 2. At the completion of Phase 2, Participant A was able to spontaneously produce the treatment target with 88% accuracy, falling short of the set criterion of 90% accuracy across three consecutive sessions. Throughout Phase 2, she continued to segment the target cluster rather than blend it smoothly. Her phonemic inventory was reassessed immediately after Phase 2 and again 2 weeks post-intervention. Both assessments indicated she had added no phonemes to her inventory.

Figure 3

Production Accuracy of Treatment Target for Participant A



Participant B

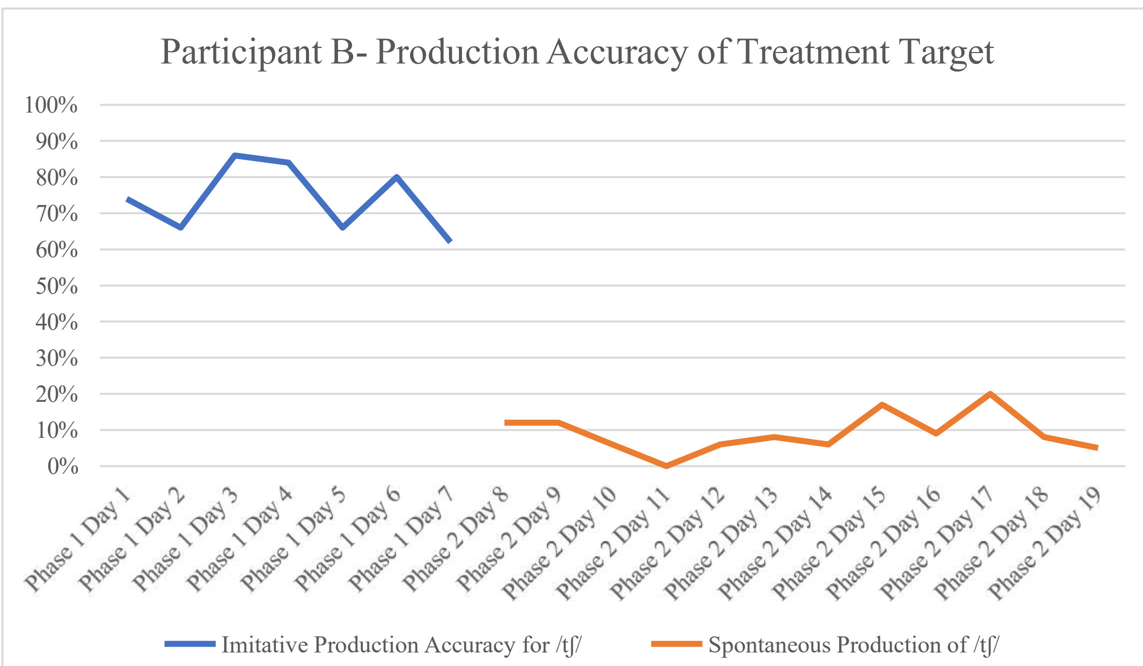
Participant B was a 4-year, 10-month-old male at the beginning of the study. He had not received previous speech therapy for his speech-sound disorder. Participant B obtained a standard score of 40 on the GFTA-3 (Goldman & Fristoe, 2015). Based on the results of the In-depth Stimulability Task, he was not stimulable for the following error sounds: /k, g, ŋ, θ, ð, z, tʃ, dʒ, r/. The results of the initial phonemic inventory assessment indicated that the child excluded the following phonemes from his inventory: /k, g, ŋ, θ, ð, z, tʃ, dʒ, r, j, ʒ/. After reviewing the evaluation results, /fl/ was selected initially as a treatment target. However, due to the participant's frustration level and difficulty producing the blend during initial therapy sessions, the treatment target was changed to /tʃ/. Participant B's baseline data for the treatment target before the intervention was 0%, indicating /tʃ/ was an appropriate treatment target.

Upon completion of Phase 1, Participant B was able to produce the treatment target with 80% accuracy imitatively. He, like Participant A, segmented the target from the rest of the word rather than blending it. Participant B's phonemic inventory was reassessed after the completion of Phase 1. No phonemes were added.

Following the completion of Phase 1, Phase 2 was completed in 12 sessions. The students' production accuracy varied significantly throughout the phase. During the last session of Phase 2, the participant spontaneously produced the treatment target with 5% accuracy. During this phase, he continued to segment the treatment target from the rest of the word. Data for sessions collected during Phases 1 and 2 are in Figure 4.

Figure 4

Production Accuracy of Treatment Target for Participant B



Participant B's phonemic inventory was reassessed after Phase 2 and 2 weeks after the intervention. Immediately after the intervention, Participant B's phonemic inventory assessment indicated the loss of /ʃ/. The assessment conducted 2 weeks later yielded the same results. Rather than having added any phonemes, the student then excluded /ʃ/ from his inventory.

Participant C

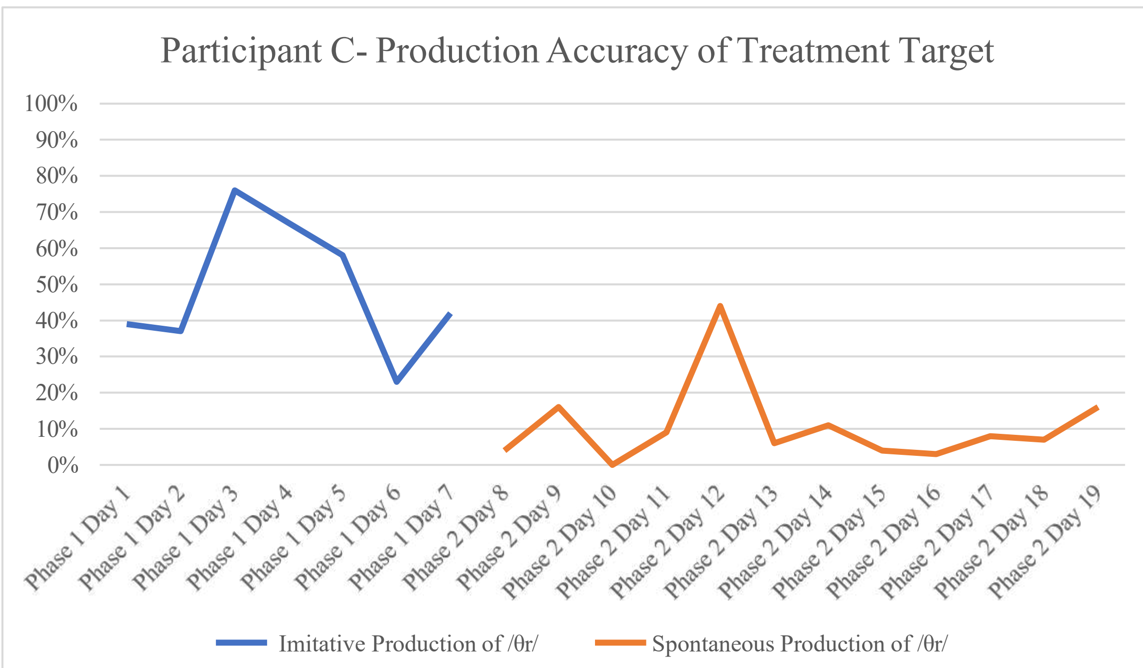
Participant C was a 5-year-3-month-old male at the beginning of the study. The participant had received previous speech therapy for his speech-sound disorder through his previous school. He obtained a standard score of 60 on the GFTA-3 (Goldman & Fristoe, 2015). Test results indicated he was not stimulable for the following error sounds: /θ, ð, z, ʒ/. The results of the initial phonemic inventory assessment showed that the child excluded the following phonemes from his inventory: /θ, ð, z, ʃ, ʒ, tʃ, ŋ/. Based on the evaluation results, the /skw/ cluster was selected as a potential treatment target. However, the student demonstrated stimulability for this cluster while the baseline data was being collected. Therefore, the /θr/ cluster was selected as an alternative treatment target. Participant C's baseline data for this treatment target, prior to the intervention, was 0%, indicating that the target was appropriate for therapy.

The participant produced the cluster once with 76% accuracy but was unable to meet the criteria across two consecutive therapy sessions and therefore had to participate in all seven therapy sessions of Phase 1. Production accuracy varied significantly from session to session, as seen in Participant B. During the final session of Phase 1, Participant C imitated the treatment target with 47% accuracy. The results of the phonemic inventory assessment administered at the end of Phase 1 indicated that the student added /ð/ to his inventory but then excluded /dʒ/, which was included in the initial phonemic inventory assessment.

After Phase 1, the student completed all 12 sessions for Phase 2. During the final session of Phase 2, he produced the treatment target with 16% accuracy. Data for sessions collected during Phases 1 and 2 are in Figure 5. Immediately after the intervention was completed, the results of the final phonemic inventory assessment indicated Participant C added /ʃ/ to his inventory, but once again excluded /ð/. The assessment conducted 2 weeks later indicated that, in comparison to his initial phonemic inventory, he had added the following phonemes: /ʃ, tʃ/.

Figure 5

Production Accuracy of Treatment Target for Participant C

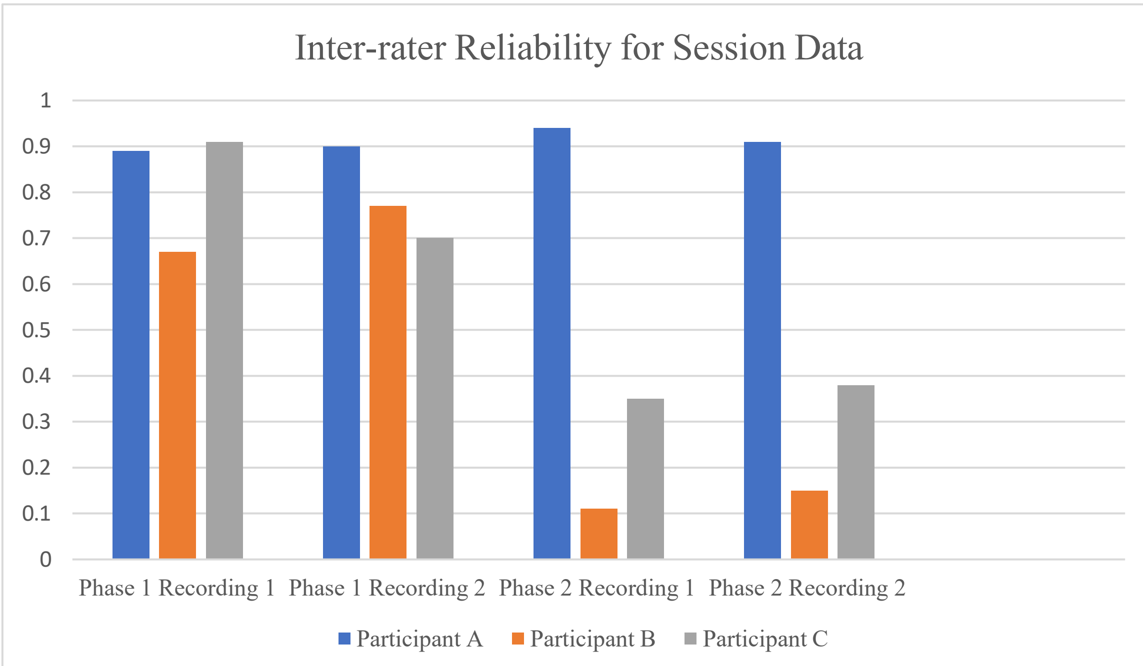


Inter-rater Reliability

Two sessions from each phase were recorded for each participant. A second SLP, who received training in the assessment and treatment of speech-sound disorders using the complexity approach, listened to the recordings and collected data for each participant during these sessions. Inter-rater reliability was calculated using Cohen's Kappa. The results of the calculations are presented in Figure 6.

Figure 6

Inter-rater Reliability Ratings for Recorded Session Data



Overall inter-rater reliability for the data collected during recorded sessions ranged from slight agreement (15%) to high agreement (94%). Differences in agreement may be attributable to several factors. First, high background noise levels were present in some recordings. In some cases, the noise originated from classes adjacent to the therapy room or from the hallway. In other cases, it came from the second child during the therapy session. Additionally, Participants B and C had significant difficulty remaining seated and focused during therapy. They repeatedly walked around the room, fidgeted with objects, and spoke off-topic during sessions, which adversely affected the second SLP's ability to assess the accuracy of trial productions from recordings. These two participants were significantly distracted by being recorded, and they often touched or pushed the recording device across the table. One would alternately whisper and yell into the recorder, distorting the sound quality. The SLP listening to the recordings indicated it was also difficult to differentiate between fricatives for one participant without being able to see the child's mouth during production, as he often substituted s/θ.

Chapter V

Discussion

Effectively and efficiently treating students with speech-sound disorders is vital in the school setting. Academic difficulties may be exacerbated due to class time missed to attend therapy sessions (Brandel, 2020). Phonological disorders have the potential to impact literacy skills negatively (Overby et al., 2012). Moreover, it is likely that the longer a phonological order persists, the more resistant it becomes to change (Shriberg et al., 1994). However, selecting the appropriate intervention for students can be challenging for SLPs, as there are over 40 interventions from which to choose (Baker & McLeod, 2011).

The purpose of the current study was to investigate whether the complexity approach, which has been shown to be both effective and efficient in clinical settings, would also be effective in the school setting when session length was reduced, and the trial dosages recommended by Warren et al. (2007) were followed. As three 1-hour sessions per week are not feasible in most school settings due to caseload sizes and the time students would miss class, this study was designed to determine whether the approach could be implemented in three 20-minute sessions per week. Rather than only selecting participants with typical cognition and language skills, as did Gierut in her studies, students with mild language disorders, or those with mild cognitive deficits were included as participants. The same protocol recommended by Gierut (2008b) was followed in all other aspects.

Two hypotheses were postulated regarding the potential results of the intervention. First, it was hypothesized that participants would improve their accuracy in producing the treatment targets to 90% spontaneously, provided a treatment dosage of at least 33 trials per session could be maintained. Second, it was hypothesized that each participant would increase the number of phonemes in their phonemic inventory by at least two, provided the dosage consisted of at least 33 trials per session. However, Participant B achieved an average accuracy of only 9% spontaneously throughout Phase 2, while Participant C achieved an average accuracy of 11% during this phase. However, while all participants improved their ability to produce their treatment targets, no one achieved 90% accuracy across three consecutive sessions during Phase 2. Only Participant C added two phonemes to his phonemic inventory.

Several variables noted during the study may have impacted the effectiveness of this intervention, as it was administered to two of the three participants. First, while Participant A was able to produce her target cluster with 88% accuracy by the end of Phase 2, she had difficulty producing the blend without segmenting each sound in the cluster. Participant B, the only participant who met the 75% accuracy criteria for Phase 1, also continued to segment the target sound from the rest of the word.

During Phase 2, Participant C was able to produce his treatment target at the end of Phase 1 with only 47% accuracy, imitatively, and at the end of Phase 2 with 5% accuracy, spontaneously. Despite his low accuracy during Phase 2, Participant C — the only participant who did not need to segment the treatment target — was also the only student to add any phonemes to his inventory.

It is possible that two of the participants required additional sessions at each level to eliminate the segmentation of the treatment targets and solidify their productions to the recommended criteria before concluding each phase. Without high correct production accuracy, it could be argued that participants had an insufficient opportunity to learn the underlying phonological rules governing the correct production of their treatment targets, which would lead to the addition of phonemes to their phonemic inventories.

An interesting fact about the two participants who did not add any phonemes to their inventories was that both exhibited lower levels of *grit*. Grit, defined as the ability to persevere through difficult circumstances and obstacles to achieve a goal (American Psychological Association, 2018), has been identified as a potential predictor of success. It includes the willingness to keep trying despite encountering difficulties and frustration (Duckworth et al., 2007).

Observation revealed that Participants A and B exhibited lower levels of grit than Participant C. Specifically, Participant B struggled to persevere on challenging tasks, frequently complaining and engaging in avoidance behaviors. Participant A often would not attempt a given word without a verbal model. However, Participant C was more resilient and willing to attempt difficult tasks. He did not typically become frustrated and was more easily redirected to tasks. Again, he was the only participant to add any phonemes to his inventory.

Another factor that may have contributed to the poor results of the intervention for one of the participants was that participant's attention levels. While Participant B had no official diagnoses at the time of his participation in the study, he had significant difficulty with impulsivity and remaining focused and on-task during therapy sessions.

He often demonstrated out-of-seat behaviors and needed frequent redirection and positive reinforcement to participate during sessions.

Nigg and Casey (2005) report that difficulties with attention may be associated with weaknesses in working memory. Some such individuals have challenges with monitoring and mentally manipulating new information. Due to differences in specific areas of the brain, these individuals also appear to have more difficulty controlling their thoughts and behaviors. These challenges may lead these individuals to avoid tasks perceived as difficult. As a result, efficiently processing and learning new information may be more difficult for some students with attention issues.

Nigg (2009) indicated that individuals with weaknesses in attention and impulsivity may require frequent rewards to enhance alertness and focus on the task. Additionally, these children will likely require specialized support to facilitate the learning process (Martinussen et al., 2005). As a result, shorter sessions, such as those in this study, may be contraindicated for some children with attention difficulties. More frequent positive reinforcement and the need for additional cues to scaffold working memory deficits may negatively impact the ability to provide sufficient trials for the remediation of their speech-sound disorder during shorter sessions.

Data indicated that difficulties with attention and focus negatively impacted the administration of the recommended therapy dosage during treatment sessions in this study. While the number of trials ranged from 35 to 45 in most sessions, during three sessions, Participant C produced fewer than 33 trials due to off-task behaviors. Participant B produced only 18 trials during one session and 16 during another. Given research indicating that greater progress is associated with higher dosages (Warren et al., 2007), this could be one reason Participant B did not respond as well to the intervention. However, this did not appear to impact Participant C.

Another barrier may have been the stimulus cards used during therapy. Unfortunately, words containing more complex clusters are often challenging to depict in pictures and are unfamiliar to younger children. Therefore, Participants A and C were not only learning new target sounds or blends, but also new vocabulary words. Subject A appeared to struggle with labeling the pictures. However, when presented with a reward for making spontaneous attempts, she became more willing to try to label most pictures several sessions into Phase 2. On the other hand, Participant B's treatment target is present in the names of numerous words that would be easier to depict in pictures. While Participant C appeared to learn the new vocabulary more quickly, the unfamiliar vocabulary may have contributed to his difficulty in progressing during the spontaneous phase.

Data collected during the intervention indicate that it was less successful than anticipated in helping two participants add phonemes to their phonemic inventories. Although the aim was to provide at least 33 trials per therapy session, this is not always possible due to factors such as attentional difficulties, age, and maturity. Additionally, individuals with cognitive deficits may need more trials to achieve significant change (Warren et al., 2007). Insufficient dosage resulting from these factors may negatively affect the effectiveness of the complexity approach when delivered at reduced intensity.

Limitations

Several factors limit the ability to generalize the results of this study. The small sample size of three participants limits the generalizability of the results to a broader range of children. In addition, participants' varying personal characteristics, such as difficulty maintaining attention and focus, low perseverance, and language delay, make it difficult to determine which factors contributed to the intervention's poor results for two of the participants. They also make it difficult to determine whether the complexity approach provided in this format would be successful with children who have average cognition, language skills, and attention levels. Finally, Participant C received speech therapy before initiation of this intervention. This fact makes it difficult to determine whether the child's addition of two phonemes was due to the intervention administered during this study or to an undetected impact from previous therapy.

Recommendations for Future Research

While research studies in clinical settings provide valuable insights for clinicians, their stringent protocols and participation criteria often prompt school-based practitioners to question whether the same interventions would be effective with their heterogeneous caseloads. Few SLPs who work in a school setting work with students who all have average cognition and language skills. These SLPs also face considerable time constraints due to caseload sizes and the need to keep students in the classroom as much as possible. Further research is necessary in school settings to determine whether interventions that are successful in clinical settings would also be effective in more real-world settings.

Future research should investigate the use of the complexity approach with a larger sample to enhance the generalizability of the findings. Starting with participants with average cognitive, language, and attention skills would help determine whether the complexity approach can be successfully adapted to a school environment. If results indicate the intervention can be successfully implemented in schools, additional studies should branch out to include participants with other characteristics, such as mild and moderate delays in cognition, language delays, and attention concerns, one characteristic at a time, to determine if the complexity approach would be appropriate to use with these populations.

Based on the results of this study, it may also be beneficial to investigate whether increasing session length to 30 minutes for individuals with attention issues is warranted. Additionally, research should be conducted to determine whether extending the number of sessions required to complete the imitative and spontaneous phases is necessary in some cases for effective and efficient remediation. For example, a study could investigate whether extending Phase 1 until 75% accuracy is reached across two consecutive sessions and Phase 2 until 90% accuracy is reached across three consecutive sessions would be advantageous, rather than restricting the number of sessions per phase. Finally, studies examining the effects of personal attributes, such as grit, on the use of the complexity approach would help SLPs make evidence-based intervention decisions for individual students.

Conclusion

Although the results of this study did not turn out as anticipated, the information obtained remains valuable. It adds to the body of information SLPs can use to help determine which interventions are appropriate for different students. A review of Gierut's research on the complexity approach shows that it has been conducted on typically developing children. The results of this study suggest that this approach may not be suitable for some children with specific characteristics, such as poor attention or lack of perseverance. It also shows the need for more research on the complexity approach using participants with attention difficulties, cognitive deficits, and language disorders, as these students make up a substantial portion of the average school-based SLP's caseload. The more research is conducted in this area in more realistic settings, the easier it will be for SLPs across various settings to make evidence-based decisions regarding intervention selection.

References

Alighieri, C., Van Lierde, K., De Caesemaeker, A.-S., Demuynck, K., Bruneel, L., D'haeseleer, E., & Bettens, K. (2021). Is high-intensity speech intervention better? A comparison of high-intensity intervention versus low-intensity intervention in children with a cleft palate. *Journal of Speech, Language, and Hearing Research*, *64*(9), 3398–3415. https://doi.org/10.1044/2021_jslhr-21-00189

Allen, M. M. (2013). Intervention efficacy and intensity for children with speech sound disorder. *Journal of Speech, Language, and Hearing Research*, *56*(3), 865–877. https://doi.org/10.1044/1092-4388(2012/11-0076)

Allison, M. A., Attisha, E., Lerner, M., De Pinto, C., Beers, N., Gibson, E. J., Gorski, P., Kjolhede, C., O'Leary, S. C., Schumacher, H., & Weiss-Harrison, A. (2019). The link between school attendance and good health. *Pediatrics*, *143*(2). https://doi.org/10.1542/peds.2018-3648

American Psychological Association. (2018). *APA dictionary of psychology*. American Psychological Association. https://dictionary.apa.org/grit

American Speech-Language-Hearing Association. (2022, August 17). *2022 Schools Survey*. www.asha.org. https://www.asha.org/siteassets/surveys/2022-schools-survey-slp-caseload.pdf

Baertsch, K. (2002). *An optimality theoretic approach to syllable structure: The split margin hierarchy* (Unpublished doctoral dissertation). Indiana University.

Baker, E. (2021). Minimal pairs intervention. In A. L. Williams & R. J. McCauley (Eds.), *Interventions for Speech-sound Disorders in Children* (pp. 33–60). 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*(2), 102–139. https://doi.org/10.1044/0161-1461(2010/09-0075)

Baker, E., & Williams, A. L. (2011). *Intervention intensity for speech-sound disorders: How much and for how long?* (Presented at the American Speech-Language-Hearing Association Convention, San Diego, CA.)

Barlow, J. A. (2005). Phonological change and the representation of consonant clusters in Spanish: A case study. *Clinical Linguistics & Phonetics*, *19*(8), 659–679. https://doi.org/10.1080/02699200412331279794

Barlow, J. A., & Gierut, J. A. (2002). Minimal pair approaches to phonological remediation. *Seminars in Speech and Language*, *23*(1), 057–068. https://doi.org/10.1055/s-2002-24969

Bernthal, J. E., & Bankson, N. W. (1998). Factors related to phonological disorders. In N. W. Bankson & J. E. Bernthal (Eds.), *Articulation and Phonological Disorders* (4th ed., pp. 172–232). Allyn and Bacon.

Brandel, J. (2020). Speech-language pathology services in the schools: A follow-up 9 years later. *Language, Speech, and Hearing Services in Schools*, *51*(4), 1037–1048. https://doi.org/10.1044/2020_lshss-19-00108

Brandel, J., & Frome Loeb, D. (2011). Program intensity and service delivery models in the schools: SLP survey results. *Language, Speech, and Hearing Services in Schools*, *42*(4), 461–490. https://doi.org/10.1044/0161-1461(2011/10-0019

Brumbaugh, K., & Smit, A. (2013). Treating children ages 3–6 who have speech-sound disorder: A survey. *Language, Speech, and Hearing Services in Schools*, *44*(3), 306–319. https://doi.org/10.1044/0161-1461(2013/12-0029)

Byers, B. A., Bellon-Harn, M. L., Allen, M., Saar, K., Manchaiah, V., & Rodrigo, H. (2021). A comparison of intervention intensity and service delivery models with school-age children with speech-sound disorders in a school setting. *Language, Speech, and Hearing Services in Schools*, *52*(2), 529–541. https://doi.org/10.1044/2020_lshss-20-00057

Combiths, P. N., Barlow, J. A., & Sanchez, E. (2019). Quantifying phonological knowledge in children with phonological disorder. *Clinical Linguistics & Phonetics*, *33*(10-11), 885–898. https://doi.org/10.1080/02699206.2019.1584247

Cummings, A., Giesbrecht, K., & Hallgrimson, J. (2021). Intervention dose frequency: Phonological generalization is similar regardless of schedule. *Child Language Teaching and Therapy*, *37*(1), 99–115. https://doi.org/10.1177/0265659020960766

Davis, B. L. (2005). Clinical diagnosis of developmental speech disorders. In A. G. Kamhi & K. E. Pollock (Eds.), *Phonological disorders in children* (pp. 3–21). Paul H. Brookes Publishing Co., Inc.

De Anda, S., Blossom, M., & Abel, A. D. (2020). Cross-morpheme generalization using a complexity approach in school-age children. *Journal of Speech, Language, and Hearing Research*, *63*(10), 3501–3524. https://doi.org/10.1044/2020_jslhr-19-00173

Dinnsen, D. A. (1996). Context-sensitive underspecification and the acquisition of phonemic contrasts. *Journal of Child Language*, *23*(1), 57–79. https://doi.org/10.1017/s0305000900010096

Dinnsen, D. A. (2008). Fundamentals of optimality theory. In D. A. Dinnsen & J. A. Gierut (Eds.), *Optimality Theory, Phonological Acquisition and Disorders* (pp. 3–36). Equinox Publishing (UK).

Dinnsen, D. A., Chin, S. B., & Elbert, M. (1992). On the lawfulness of change in phonetic inventories. *Lingua*, *86*(2-3), 207–222. https://doi.org/10.1016/0024-3841(92)90036-i

Dinnsen, D. A., & Elbert, M. (1984). On the relationship between phonology and learning. In D. A. Dinnsen & M. Elbert (Eds.), *Phonological theory and the misarticulating child* (pp. 59–68). American Speech-Language-Hearing Association.

Dinnsen, D. A., & O'Connor, K. M. (2001). Implicationally related error patterns and the selection of treatment targets. *Language, Speech, and Hearing Services in Schools*, *32*(4), 257–270. https://doi.org/10.1044/0161-1461(2001/023)

Dinnsen, D. A., O'Connor, K. M., & Gierut, J. A. (2001). The puzzle-puddle-pickle problem and the Duke-of-York gambit in acquisition. *Journal of Linguistics*, *37*(3), 503–525. https://doi.org/10.1017/s0022226701001062

Duckworth, A. L., Peterson, C., Matthews, M. D., & Kelly, D. R. (2007). Grit: Perseverance and passion for long-term goals. *Journal of Personality and Social Psychology*, *92*(6), 1087–1101. https://doi.org/10.1037/0022-3514.92.6.1087

Eckman, F. R. (1991). The structural conformity hypothesis and the acquisition of consonant clusters in the interlanguage of ESL learners. *Studies in Second Language Acquisition*, *13*(1), 23–41. https://doi.org/10.1017/s0272263100009700

Elbert, M., Dinnsen, D. A., & Powell, T. W. (1984). On the prediction of phonologic generalization learning patterns. *Journal of Speech and Hearing Disorders*, *49*(3), 309–317. https://doi.org/10.1044/jshd.4903.309

Farquharson, K., McIlraith, A., Tambyraja, S., & Constantino, C. (2022). Using the experience sampling method to examine the details of dosage in school-based speech-sound therapy. *Language, Speech, and Hearing Services in Schools*, *53*(3), 698–712. https://doi.org/10.1044/2021_lshss-21-00130

Ferguson, C. A. (1977). New directions in phonological theory: Language acquisition and universals research (R. W. Cole, Ed.). *Current issues in linguistic theory*, 247–299.

Furlong, L. M., Morris, M. E., Serry, T. A., & Erickson, S. (2021). Treating childhood sound disorders: Current approaches to management by Australian speech-language pathologists. *Language, Speech, and Hearing Services in Schools*, *52*(2), 581–596. https://doi.org/10.1044/2020_LSHSS-20-00092

Furlong, L., Serry, T., Erickson, S., & Morris, M. E. (2018). Processes and challenges in clinical decision-making for children with speech-sound disorders. *International Journal of Language & Communication Disorders*, *53*(6), 1124–1138. https://doi.org/10.1111/1460-6984.12426

Gierut, J. A. (1990). Differential learning of phonological oppositions. *Journal of Speech, Language, and Hearing Research*, *33*(3), 540–549 https://doi.org/10.1044/jshr.3303.540

Gierut, J. A. (1998). Treatment efficacy: Functional phonological disorders in children. *Journal of Speech, Language, and Hearing Research*, *41*(1), S85–S100.

Gierut, J. A. (1999). Syllable onsets: Clusters and adjuncts in acquisition. *Journal of*

Speech, Language, and Hearing Research, *42*(3), 708–726. https://doi.org/10.1044/jslhr.4203.708

Gierut, J. A. (2007). Phonological complexity and language learnability. *American Journal of Speech-Language Pathology*, *16*(1), 6–17. https://doi.org/10.1044/1058-0360(2007/003)

Gierut, J. A. (2008a). Fundamentals of experimental design and treatment. In D. A. Dinnsen & J. A. Gierut (Eds.), *Optimality theory, phonological acquisition and disorders* (pp. 93–118). Equinox.

Gierut, J. A. (2008b). Phonological disorders and the developmental phonology archive. In D. A. Dinnesen & J. A. Gierut (Eds.), *Optimality Theory, Phonological Acquisition and Disorders* (pp. 37–92). Equinox.

Gierut, J. A., & Champion, A. (2001). Syllable onsets II: Three-element clusters in phonological treatment. *Journal of Speech, Language, and Hearing Research*, *44*(4), 886–904. https://doi.org/10.1044/1092-4388(2001/071)

Gierut, J. A., Elbert, M., & Dinnsen, D. A. (1987). A functional analysis of phonological knowledge and generalization learning in misarticulating children. *Journal of Speech and Hearing Research*, *30*, 462–479.

Gierut, J. A., Simmerman, C. L., & Neumann, H. J. (1994). Phonemic structures of delayed phonological systems. *Journal of Child Language*, *21*, 291–316.

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*(3), 215–230. https://doi.org/10.1044/0161-1461.2703.215

Gierut, J. A., & O'Connor, K. M. (2002). Precursors to onset clusters in acquisition.

Journal of Child Language, *29*(3), 495–517. https://doi.org/10.1017/s0305000902005238

Glaspey, A. M., & Stoel-Gammon, C. (2005). Dynamic assessment in phonological disorders: The scaffolding scale of stimulability. *Topics in Language Disorders*, *25*(3), 220–230. https://doi.org/10.1097/00011363-200507000-00005

Goldman, R., & Fristoe, M. (2015). *Goldman-Fristoe 3 Test of Articulation*. Bloomington, Minnesota: PsychCorp, an imprint of Pearson Clinical Assessment.

Hegarty, N., Titterington, J., McLeod, S., & Taggart, L. (2018). Intervention for children with phonological impairment: Knowledge, practices and intervention intensity in the UK. *International Journal of Language & Communication Disorders*, *53*(5), 995–1006. https://doi.org/10.1111/1460-6984.12416

Hodson, B. W., & Paden, E. (1983). *Targeting Intelligible Speech: A Phonological Approach to Remediation*. College-Hill Press.

Janiszewski, C., Noel, H., & Sawyer, A. G. (2003). A meta-analysis of the spacing effect in verbal learning: Implications for research on advertising repetition and consumer memory. *Journal of Consumer Research*, *30*(1), 138–149. https://doi.org/10.1086/374692

Kaipa, R., & Peterson, A. (2016). A systematic review of treatment intensity in speech disorders. *International Journal of Speech-Language Pathology*, *18*(6), 507–520. https://doi.org/10.3109/17549507.2015.1126640

Kazdin, A. E. (2011). *Single-Case Research Design* (2nd ed.). Oxford University Press, Inc.

Kehoe, M., & Stoel-Gammon, C. (1997). The acquisition of prosodic structure: An investigation of current accounts of children's prosodic development. *Language*, *73*(1), 113. https://doi.org/10.2307/416597

Lewis, B. A., Freebairn, L., Tag, J., Ciesla, A. A., Iyengar, S. K., Stein, C. M., & Taylor, H. (2015). Adolescent outcomes of children with early speech-sound disorders with and without language impairment. *American Journal of Speech-Language Pathology*, *24*(2), 150–163. https://doi.org/10.1044/2014_ajslp-14-0075

Lewis, B. A., Short, E. J., Iyengar, S. K., Taylor, H., Freebairn, L., Tag, J., Avrich, A. A., & Stein, C. M. (2012). Speech-sound disorders and attention-deficit/hyperactivity disorder symptoms. *Topics in Language Disorders*, *32*(3), 247–263. https://doi.org/10.1097/tld.0b013e318261f086

Maggu, A. R., Kager, R., Xu, S., & Wong, P. M. (2019). Complexity drives speech-sound development: Evidence from artificial language training. *Journal of Experimental Psychology: Human Perception and Performance*, *45*(5), 628–644. https://doi.org/10.1037/xhp0000633

Martinussen, R., Hayden, J., Hogg-Johnson, S., & Tannock, R. (2005). A meta-analysis of working memory impairments in children with attention-deficit/hyperactivity disorder. *Journal of the American Academy of Child & Adolescent Psychiatry*, *44*(4), 377–384. https://doi.org/10.1097/01.chi.0000153228.72591.73

Matthews, T., Barbeau-Morrison, A., & Rvachew, S. (2021). Application of the challenge point framework during treatment of speech-sound disorders. *Journal of Speech, Language, and Hearing Research*, *64*(10), 3769–3785. https://doi.org/10.1044/2021_jslhr-20-00437

McReynolds, L. V., & Jetzke, E. (1986). Articulation generalization of voiced-voiceless sounds in hearing-impaired children. *Journal of Speech and Hearing Disorders*, *51*(4), 348–355. https://doi.org/10.1044/jshd.5104.348

Morris, M. A., Oshita, J. Y., & Stransky, M. (2019). Advancing the delivery of communication sciences and disorders services through research: The promise of health services research. *Perspectives of the ASHA Special Interest Groups*, *4*(1), 16–26. https://doi.org/10.1044/2018_pers-st-2018-0002

Morrisette, M. (2021). Complexity approach. In A. L. Williams, S. McLeod, & R. McCauley (Eds.), *Interventions for Speech-sound Disorders in Children* (2nd ed., pp. 91–107). Brooks Publishing.

Morrisette, M. L., Dinnsen, D. A., & Gierut, J. A. (2003). Markedness and context effects in the acquisition of place features. *Canadian Journal of Linguistics/Revue canadienne de linguistique*, *48*(3-4), 329–355. https://doi.org/10.1017/s0008413100000694

Nigg, J. T. (2009). Cognitive impairments found with attention-deficit/hyperactivity disorder. *Psychiatric Times*, *28*(6), 56–64.

Nigg, J. T., & Casey, B. J. (2005). An integrative theory of attention-deficit/ hyperactivity disorder based on the cognitive and affective neurosciences. *Development and Psychopathology*, *17*(03). https://doi.org/10.1017/s0954579405050376

Overby, M. S., Trainin, G., Smit, 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*(1), 97–115. https://doi.org/10.1044/0161-1461(2011/10-0064)

Passy, J. (2010). *Cued articulation: Consonants and vowels* (Revised ed.). ACER Press.

Powell, T. W., Elbert, M., & Dinnsen, D. A. (1991). Stimulability as a factor in the phonological generalization of misarticulating preschool children. *Journal of Speech, Language, and Hearing Research*, *34*(6), 1318–1328. https://doi.org/10.1044/jshr.3406.1318

Preston, J. L., & Leece, M. C. (2021). Articulation interventions. In A. L. Williams, S. McLeod, & R. J. McCauley (Eds.), *Interventions for Speech-sound Disorders in Children* (2nd ed., pp. 419–445). Brookes Publishing.

Rehfeld, D. M., & Sulak, T. N. (2021). Service delivery schedule effects on speech-sound production outcomes. *Language, Speech, and Hearing Services in Schools*, *52*(2), 728–737. https://doi.org/10.1044/2021_lshss-20-00068

Richard, J. T. (n. d.-a). *About us*. SLPath. https://slpath.com/about.html

Richard, J. T. (n. d.-b). *Jennifer Taps Richard's curriculum vitae*. https://slpath.com/docs/cv.pdf

Richard, J. T. (2014a). *Phonological treatment: Targeting complex sounds* [Webinar]. SLPath. https://slpath.com/phonologicaltreatment.php

Richard, J. T. (2014b). *Powerful phonological assessment and analysis* [Webinar]. SLPath. https://slpath.com/phonologicalassessment.php

Richard, J. T. (2020). *In-depth stimulability task*. SLPath. https://slpath.com/stimulabilitytask.html

Robb, M. P., Bleile, K. M., & Yee, S. S. (1999). A phonetic analysis of vowel errors during the course of treatment. *Clinical Linguistics & Phonetics*, *13*(4), 309–321. https://doi.org/10.1080/026992099299103

Rvachew, S. (1994). Speech perception training can facilitate sound production learning. *Journal of Speech, Language, and Hearing Research*, *37*(2), 347–357. https://doi.org/10.1044/jshr.3702.347

Rvachew, S., & Brosseau-Lapre, F. (2021). Speech perception intervention. In A. L. Williams, S. McLeod, & R. J. McCauley (Eds.), *Interventions for Speech-sound Disorders in Children* (2nd ed., pp. 201–224). Brookes Publishing.

Shriberg, L. D., Gruber, F. A., & Kwiatkowski, J. (1994). Developmental phonological disorders III: Long-term speech-sound normalization. *Journal of Speech, Language, and Hearing Research*, *37*(5), 1151–1177. https://doi.org/10.1044/jshr.3705.1151

Shriberg, L. D., Tomblin, J., & 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*(6), 1461–1481. https://doi.org/10.1044/jslhr.4206.1461

Skelton, S. L., & Richard, J. T. (2016). Application of a motor learning treatment for speech-sound disorders in small groups. *Perceptual and Motor Skills*, *122*(3), 840–854. https://doi.org/10.1177/0031512516647693

Smit, A. B. (1993). Phonologic error distributions in the Iowa-Nebraska articulation norms project. *Journal of Speech, Language, and Hearing Research*, *36*(3), 533–547. https://doi.org/10.1044/jshr.3603.533

Sommers, R. K., Copetas, F. G., Bowser, D. C., Fichter, G. R., Furlong, A. K., Rhodes, F. E., & Saunders, Z. G. (1962). Effects of various durations of speech improvement upon articulation and reading. *Journal of Speech and Hearing Disorders*, *27*(1), 54–61. https://doi.org/10.1044/jshd.2701.54

Sommers, R. K., Leiss, R. H., Delp, M., Gerber, A. J., Fundrella, D., Smith, R. M. II, Revucky, M. V., Ellis, D., & Haley, V. A. (1967). Factors related to the effectiveness of articulation therapy for kindergarten, first, and second grade children. *Journal of Speech and Hearing Research*, *10*(3), 428–437. https://doi.org/10.1044/jshr.1003.428

Stoel-Gammon, C. (1996). On the acquisition of velars in English. In B. Bernhardt, J. Gilbert, & D. Ingram (Eds.), *Proceedings of the UBC international conference on phonological acquisition* (pp. 201–214). Cascadilla Press.

Storkel, H. L. (2018). The complexity approach to phonological treatment: How to select treatment targets. *Language, Speech, and Hearing Services in Schools*, *49*(3), 463–481. https://doi.org/10.1044/2017_lshss-17-0082

Sugden, E., Baker, E., Munro, N., Williams, A., & Trivette, C. M. (2018). Service delivery and intervention intensity for phonology-based speech-sound disorders. *International Journal of Language & Communication Disorders*, *53*(4), 718–734. https://doi.org/10.1111/1460-6984.12399

Swartz, M. T., Lopez, M., & Hitchcock, E. R. (2019). Speech-sound disorder and visual biofeedback intervention: A preliminary investigation of treatment intensity. *Seminars in Speech and Language*, *40*(02), 124–137. https://doi.org/10.1055/s-0039-1677763

Taps, J. (2006). An innovative educational approach for addressing articulation differences. *Perspectives on School-Based Issues*, *7*(4), 7–11.

https://doi.org/10.1044/sbi7.4.7

To, C., Law, T., & Cheung, P. P. (2012). Treatment intensity in everyday clinical management of speech-sound disorders in Hong Kong. *International Journal of Speech-Language Pathology*, *14*(5), 462–466. https://doi.org/10.3109/17549507.2012.688867

To, C., McLeod, S., Sam, K., & Law, T. (2022). Predicting which children will normalize without intervention for speech-sound disorders. *Journal of Speech, Language, and Hearing Research*, *65*(5), 1724–1741. https://doi.org/10.1044/2022_jslhr-21-00444

Tyler, A. A., & Figurski, G. (1994). Phonetic inventory changes after treating distinctions along an implicational hierarchy. *Clinical Linguistics & Phonetics*, *8*(2), 91–107. https://doi.org/10.3109/02699209408985299

Van Riper, C. (1963). *Speech correction: Principles and Methods* (4th ed.). Prentice-Hall.

Warren, S. F., Fey, M. E., & Yoder, P. J. (2007). Differential treatment intensity research: A missing link to creating optimally effective communication interventions. *Mental Retardation and Developmental Disabilities Research Reviews*, *13*(1), 70–77. https://doi.org/10.1002/mrdd.20139

Watts, E., & Rose, Y. (2020). Markedness and implicational relationships in phonological development: A cross-linguistic investigation. *International Journal of Speech-Language Pathology*, *22*(6), 669–682. https://doi.org/10.1080/17549507.2020.1842906

Williams, A. (1991). Generalization patterns associated with training least phonological knowledge. *Journal of Speech, Language, and Hearing Research*, *34*(4), 722–733. https://doi.org/10.1044/jshr.3404.733

Williams, A. (2000). Multiple oppositions: Case studies of variables in phonological intervention. *American Journal of Speech-Language Pathology*, *9*(4), 289–299. https://doi.org/10.1044/1058-0360.0904.289

Williams, A. (2012). Intensity in phonological intervention: Is there a prescribed amount? *International Journal of Speech-Language Pathology*, *14*(5), 456–461. https://doi.org/10.3109/17549507.2012.688866

Winitz, H., & Bellerose, B. (1967). Relation between sound discrimination and sound learning. *Journal of Communication Disorders*, *1*(3), 215–235. https://doi.org/10.1016/0021-9924(68)90033-6

Appendix A:

Valdosta State University IRB Approval Report

VALDOSTA STATE UNIVERSITY

Institutional Review Board (IRB) for the Protection of Human Research Participants

EXPEDITED PROTOCOL APPROVAL REPORT

Protocol Number: 04548-2024

Responsible Researcher: Diana Clemmons

Supervising Faculty: Dr. Mary Gorham-Rowan

Dissertation Research Member: Dr. Matthew Carter

Project Title: *Use of the Complexity Approach to Treat Speech Sound Disorders with Reduced Intensity.*

Level of Risk: ☒ Minimal ☐ More than Minimal

Type of Review: ☒ Expedited ☐ Convened (Full Board)

Approval Category: 6 & 7

Approval Date: 11.18.2024

Expiration Date: 11.18.2027

Consent Requirements:

- ☐ Adult Participants – Written informed consent with documentation (signature)
- ☐ Adult Participants – Written informed consent with waiver of documentation (signature)
- ☐ Adult Participants – Verbal informed consent (research statement) – interview
- ☐ Adult Participants – Research consent statement – online survey
- ☐ Adult Participants – Waiver of informed consent
- ☒ **Minor Participants – Written parent/guardian permission with documentation (signature)**
- ☐ Minor Participants – Written parent/guardian permission with waiver of documentation (signature)
- ☐ Minor Participants – Verbal parent/guardian permission
- ☐ Minor Participants – Waiver of parent/guardian permission
- ☐ Minor Participants – Written assent with documentation (signature)
- ☒ **Minor Participants – Written assent with waiver of documentation (no signature)**
- ☐ Minor Participants – Verbal assent
- ☐ Minor Participants – Waiver of assent
- ☐ Waiver of some elements of consent/permission/assent

Comments: *IRB approval must be received before amending or altering the scope of the project, the research protocol, or implementing changes to the approved consent process/forms.*

Approval: *This research protocol is **approved** as presented. The approved consent form, bearing the IRB approval stamp and protocol expiration date is attached.*

Elizabeth Ann Olphie 11.18.2024

Elizabeth Ann Olphie, IRB Administrator Date

Form Revised: 07.09.2024 - tw

Additional Information:

If your protocol received expedited approval, it was reviewed by a two-member team, or, in extraordinary circumstances, the IRB Administrator, the Chair, or the Vice-Chair of the IRB. Although the expediters may approve protocols, they are required by federal regulation to report expedited approvals at the next IRB meeting. At that time, other IRB members may express concerns and request minor modifications to the protocol. In rare instances, the IRB may request that research activities involving participants be halted until such amendments are implemented. If this situation occurs, you will receive an explanatory letter from the IRB.

Protocol approvals are valid for three years unless otherwise noted.

In rare instances, when a protocol is determined to place participants at more than minimal risk, the IRB may shorten the approval period so that protocols are reviewed more frequently, allowing the IRB to reassess the potential risks and benefits to participants. The expiration date of your protocol approval is noted on the approval form.

Contact the IRB administrator at tmwright@valdosta.edu for guidance on obtaining continuation approval. If continuation approval is not received before the expiration date all research activities involving participants (including interaction, intervention, data collection, and data analysis) must stop until approval is reinstated.

You must report to the IRB any unanticipated problems or adverse events that become apparent during the course or as a result of the research and the actions taken.

Please refer to the IRB website (https://www.valdosta.edu/academics/graduate-school/research/office-of-sponsored-programs-research-administration/institutional-review-board-irb-for-the-protection-of-human-research-participants.php) for additional information about Valdosta State University's human protection program and your responsibilities as a researcher.

Appendix B:

Letter of Approval from School District

Muscogee County School District
Columbus, Georgia

Research, Accountability
and Assessment
●
Patrick C. Knopf
Senior Director

October 9, 2024

Diana Clemmons has requested permission to conduct a research project entitled *Use of the Complexity Approach to Treat Speech Sound Disorders with Reduced Intensity*. Her request has been approved as currently written. Any changes to this study will require a resubmission to the district's IRB for final approval. All study activities must be conducted outside of school hours, be completely voluntary and may only use deidentified information. A final copy must be filed with our office upon completion.

Patrick Knopf
Senior Director, Research Accountability and Assessment

2960 Macon Road ● Columbus, Georgia 31906
Phone (706)748-2020 ● FAX (706) 748-2029

Appendix C:

Parental Consent Permission Form

Parental Consent for Participation in a Research Study Investigating the Use of the Complexity
Approach with Reduced Intensity

VALDOSTA STATE UNIVERSITY
Parent/Guardian Permission for Child's/Ward's Participation in Research

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You are being asked to allow your child (or ward) to participate in a research study entitled "Use of the Complexity Approach to Treat Speech-sound Disorders with Decreased Intensity." Diana Clemmons, a Communication Science Disorders Department student at Valdosta State University, is conducting this research study. This research aims to determine if the Complexity Approach, an evidence-based practice used to treat speech-sound disorders, is effective when used in three 20-minute sessions per week. Your child's participation in this study is entirely voluntary. From this point on in this form, the term "child" is used for either a child or a ward.

As described in more detail below, we will ask your child to participate in assessment and treatment using the Complexity Approach. Your child's participation in the study will last for no more than 19 treatment sessions, each lasting 20 minutes, and four evaluation sessions that will be used to determine your child's progress. The initial evaluation should last approximately 40 minutes. Each subsequent evaluation session should last 20-30 minutes. Someone in your position might be interested in allowing your child to participate because it may increase the rate at which your child improves their speech disorder. There are no anticipated risks as this treatment intervention has been shown to be effective. However, it is possible that since this treatment will be provided for shorter treatment sessions, their rate of progress may be slower. Because of this and the possibility of other unforeseen risks, you may not wish to allow your child to participate. It is important for you to know that you or your child may discontinue participation at any time during this study.

This form includes detailed information to help you decide whether to participate in this research project. Please read it carefully and ask questions that you have before you agree to participate. Please be sure to keep a copy of this form for your records.

Procedures:

Your child's participation will involve assessment and treatment, which will take place over approximately 11 weeks. Therapy sessions will be provided for three 20-minute sessions per week. Portions of the assessments and therapy sessions will be audio-recorded to ensure the accuracy of the data collected during the sessions. A second speech-language pathologist will assist with reviewing the recordings to ensure the accuracy of the data collected but will not be provided any identifying information about the participants.

If you agree for your child to participate, your child's articulation skills will be formally and informally assessed. The Goldman-Fristoe Test of Articulation 3 will be used to determine the severity level of your child's articulation disorder and identify specific sounds they have difficulty saying. Your child's phonemic inventory will also be assessed. Their phonemic inventory is all the sounds they use to create differences between words that are the same for all other sounds. For example, if a child consistently uses "h" and "m" to create two different words that have the same ending, like "hat" versus "mat," "h" and "m" are considered part of their phonemic inventory. In addition, their ability to correct their pronunciation for a sound they produced in error on the test with only a few prompts will be assessed. This information, combined with the results of the phonemic inventory assessment, will be used to determine which sounds or sound combinations (consonant clusters) will be treated in therapy.

Your child's phonemic inventory will also be assessed between Phase 1 and Phase 2 of treatment, immediately after Phase 2, and again 2 weeks following the end of Phase 2. These assessments will be used to determine your child's growth and progress during the intervention.

Your child's productions will be audio-recorded during each assessment. Mrs. Clemmons will conduct the phonemic inventory assessment and record her results. A second SLP, Ms. Owens, will review the recording of the assessment administration and document her observations on a second form. She will not be provided with any identifying information about your child. Forms completed by both SLPs will be compared to ensure the accuracy of the child's phonemic inventory. The initial assessment results will be used to determine an appropriate treatment target and serve as the baseline for each child's phonemic inventory before the intervention is implemented. Results of the phonemic inventory assessments administered after Phase 1 and Phase 2 will be used to determine the addition of sounds that were not directly treated in therapy to your child's phonemic inventory.

Treatment using the Complexity Approach will take place in two phases. In Phase 1, your child will be taught to imitatively produce the selected treatment target. This treatment phase will last until they either achieve 75% accuracy in producing the target imitatively across two consecutive sessions or have participated in seven sessions. At the end of Phase 1, your child's phonemic inventory will be reassessed.

Phase 2 will consist of the participant producing the target spontaneously until either 90% accuracy is reached across three consecutive sessions, or your child has participated in 12 sessions. Phase 2 will be discontinued after 12 sessions, regardless of your child's accuracy level in producing the treatment target.

Two sessions will be audio-recorded during each phase of the intervention. Mrs. Clemmons will continue to collect data regarding the production of the target during every session, while a second SLP, Kim Owens, will take data using the recordings of two sessions each from Phase 1 and Phase 2. At the end of each phase, each child's phonemic inventory will be reassessed, with Ms. Owens using the audio recordings to take data that will be used to verify the accuracy of the data Mrs. Clemmons collects.

Two weeks after Phase 2 is complete, each student's phonemic inventory will be reassessed once more to determine if any further change has occurred.

You or your child may discontinue participation at any time during this study, regardless of the reason.
All direct interaction with your child will occur at North Columbus Elementary School during their regularly scheduled therapy sessions.

This study involves research. There are no alternatives to the experimental procedures in this study. The only alternative is for you to choose not to allow your child to participate.

Risks or Discomfort:
This is a minimal-risk research study. That means the risks of participating are no more likely or serious than those you encounter in everyday activities. Although there are no known risks to your child associated with the research procedures, it is not always possible to identify all potential risks of participating in a research study. However, the University has taken reasonable safeguards to minimize potential but unknown risks.

Although there are no known risks associated with these research procedures, it is not always possible to identify all potential risks of participating in a research study. However, the University has taken reasonable safeguards to minimize potential but unknown risks. By agreeing to participate in this research project, you are not waiving any rights that you or your child may have against Valdosta State University for injury resulting from negligence of the University or its researchers.

Potential Benefits:
Research has shown that using the Complexity Approach when treating speech-sound disorders typically results in quicker remediation of children's disorders. This means less academic time is missed due to a decrease in the amount of therapy time needed. As a participant in this study, your child may receive this potential benefit.

Costs and Compensation:
There are no costs to you, and there is no compensation (no money, gifts, or services) for your participation in this research project.

Assurance of Confidentiality:
Valdosta State University and the researcher will keep your child's information confidential to the extent allowed by law. Members of the Institutional Review Board (IRB), a university committee charged with reviewing research to ensure the rights and welfare of research participants, may be given access to your child's confidential information.

No identifying information will be included in the data analysis or the dissertation. Each participant will be assigned a letter to refer to them in all documentation. All assessments administered to the study participants will be kept in a locked cabinet in the speech therapy room at each student's school. Once all assessments have been administered,

scans of the documents will be saved to a flash drive that will be secured under lock and key.
Audio recordings of the phonemic inventory assessments and the therapy session will be saved to a second flash drive, which will be shared only with the second SLP assisting with data collection. This SLP will keep the flash drive under lock and key when it is not being used for analysis. All analyses will be conducted during personal time. Each time she has completed her review of the data for an assessment or a recorded therapy session, the flash drive will be returned to Mrs. Clemmons, the investigating SLP.
Digital copies of the assessments will be used in data analysis after the intervention is completed. Hard copies of the documents will be filed in the student's permanent records for special education. Data collected during the therapy sessions will be stored in an online HIPPA-compliant platform approved by the school district the children attend.
Once the dissertation process is complete, all documentation, audio recordings, and data analysis not required to be kept in each student's special education file will be destroyed.

Data from this study will be reported in combination with data obtained from other participants. None of the participants will be identified in this study by name or birth date.

Voluntary Participation:
Your decision to allow your child to participate in this research project is entirely voluntary. If you agree now to allow your child to participate and you change your mind later, you are free to withdraw your child from the study. By not allowing your child to participate in this study or by withdrawing them from the study before the research is complete, you are not giving up any rights that you or your child have or any services to which you or your child are otherwise entitled. If you decide to withdraw your child from the study after data collection is complete, your child's information will not be included in the research results. However, data will be maintained as part of your child's speech therapy notes.

Information Contacts:
Questions regarding the purpose or procedures of the research should be directed to Diana Clemmons at dlclemmons@valdosta.edu. This study has been approved by the Valdosta State University Institutional Review Board (IRB) for protecting Human Research Participants. The Valdosta State University IRB, a university committee established by Federal law, protects the rights and welfare of research participants. If you have concerns or questions about your rights as a research participant, you may contact the IRB Administrator at 229-253-2947 or irb@valdosta.edu.

Agreement to Participate:
The research project and my child’s (or ward’s) role in it have been explained to me, and my questions have been answered to my satisfaction. I grant permission for my child to participate in this study. By signing this form, I indicate that I am the custodial parent or legal guardian of the child. I have received a copy of this permission form.

I would like to receive a copy of this document. ____Yes _____No

Mailing Address: ______________________________

E-mail Address: ____________________________

____
Printed Name of Child/Ward

____
Printed Name of Parent/Guardian

____
Signature of Parent/Guardian *Date*

____
Signature of Person Obtaining Consent *Date*

This research project has been approved by the Valdosta State University Institutional Review Board for the Protection of Human Research Participants through the date noted below:

VALDOSTA STATE UNIVERSITY
APPROVAL DATE
11.18.2024
IRB #
04548-2024
EXPIRATION DATE
11.18.2027
INSTITUTIONAL REVIEW BOARD

Appendix D:

Participant Consent for Participation

Participant Consent for Participation in a Research Study Investigating the Use of the Complexity Approach with Reduced Intensity

Hi. My name is Diana Clemmons. I'm a student at Valdosta State University. Right now, I'm doing a research study about how to treat speech-sound disorders. I would like to ask you to help me by being in a study, but before I do, I want to explain what will happen if you decide to help me.

I will ask you to practice your speech sounds and participate in some testing to see how much your speech improves. The study will take approximately 11 weeks and will take place when you are usually scheduled to come to speech. I will be recording you at times to make sure that I accurately record your responses. Another speech-language pathologist who works for the school system will listen to these recordings to help me see if my data is accurate. This person will not know your name or who you are. Therapy will be with me and will be the same as usual. The only differences will be some added tests and you sometimes being recorded. By being in the study, you will help me understand if the treatment I will be using with you works for students in schools when they have shorter sessions more often during the week. This treatment may also help you improve your speech faster.

When I tell other people about my study, I will not use your name, and no one will be able to tell who I'm talking about.

Your parents have said that it is okay for you to be in my study. However, if you don't want to be in the study, you don't have to be. What you decide won't make any difference. You will still get to come to speech. I won't be upset, and no one else will be upset if you don't want to be in the study. If you want to be in the study now but change your mind later, that's okay. You can stop at any time. If there is anything you don't understand, you should tell me so I can explain it to you.

You can ask me questions about the study. If you have a question later that you don't think of now, you can call me or ask your parents to call me or send me an email.

Do you have any questions for me now?

Would you like to be part of my study and help me and others learn how best to help children like you improve their speech as quickly as possible?

NOTES TO RESEARCHER: The child (under age 18) must answer "**Yes**" or "**No**." Only a definite "**Yes**" may be taken as assent to participate.

Name of Student: ______________________________ **Parental Permission on File:** ☐ Yes ☐ No ***(If "No," do not proceed with assent or research procedures.)***

Student's Voluntary Response to Participation: ☐ Yes ☐ No

Signature of Researcher: ______________________________ **Date:** -___________________

Appendix E:

Phonemic Inventory Assessment


*Phonemic
Inventory
Assessment


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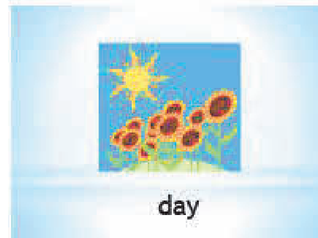
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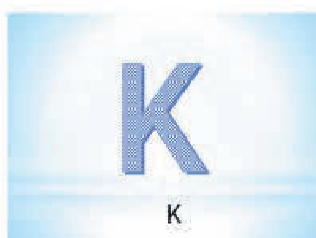
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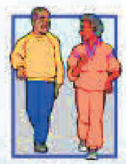

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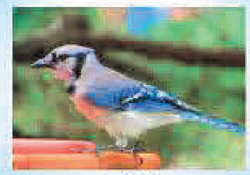

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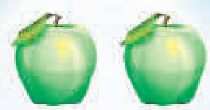

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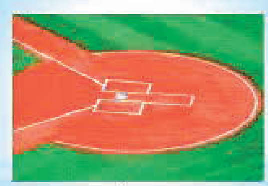

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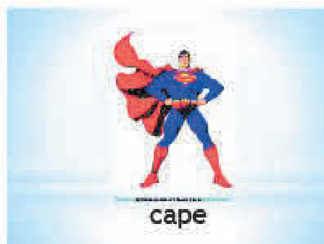
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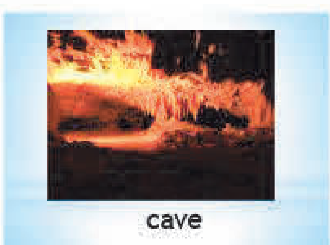
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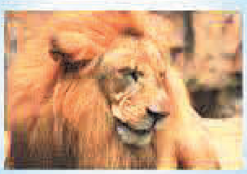
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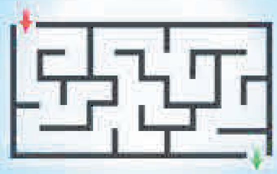
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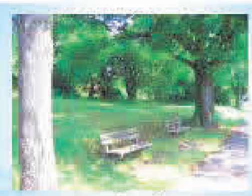
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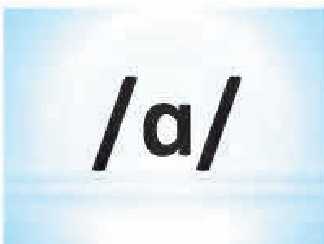
bathing


baking

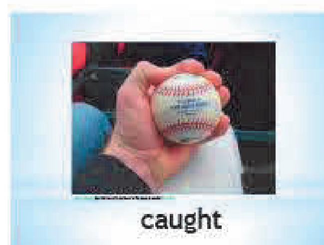

/a/


car


far


cough

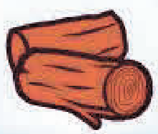

cob


caught

bought

wrong

rock



log

lock

fog

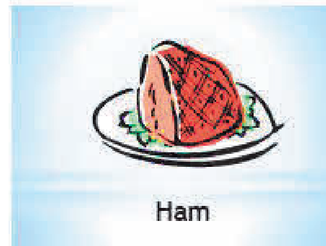
dog

dot

hot


pot

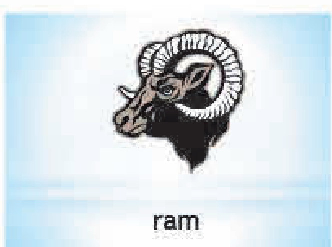

/æ/


Ham


Have


Hat


jam

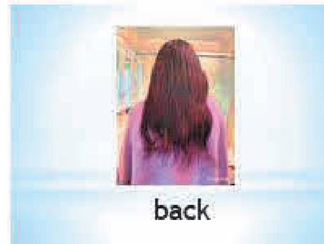

ram


rat


bat


THE
BAD
BATCH
batch


bath


back


badge


rag


ran


cap

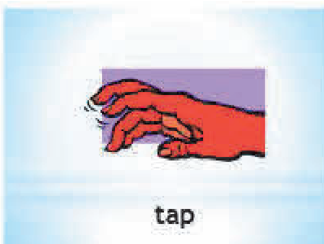

cash

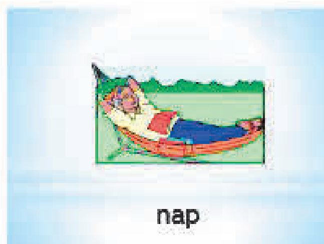

cab


can


that

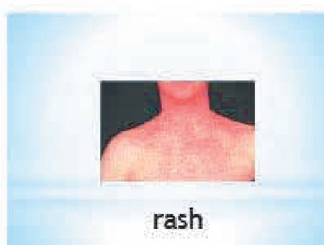

cat


tap


nap


ZAP!
zap


mash


rash


/i/


heat


meat

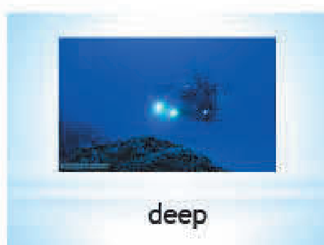

seat


feet


wheat


weed


read


deep


jeep


peep


sheep


king


key


the
the


keys


ring


wing


wheat


weak


Things to do
thing


think


thief

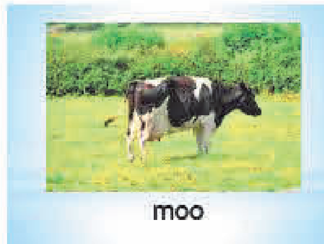

/u/


zoo


U
U


shoe


BOO
to you!
boo



/au/

/ɛ/

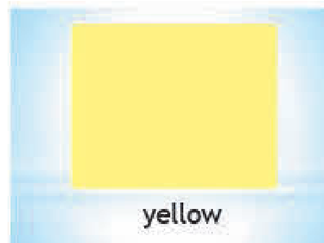

where


chest


vest

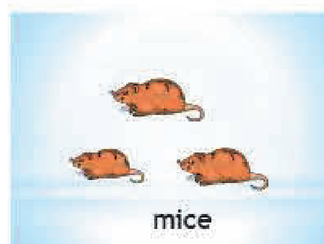

guess


yes


yellow


jello


/ai/

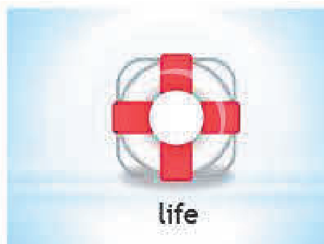

mice

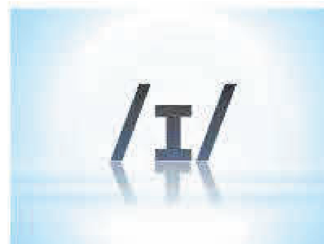

dice


nice


knife


wife


life

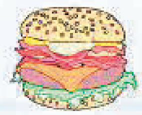

/ɪ/


chick


kick

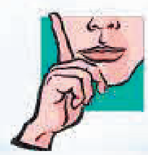

lick


sick


thick

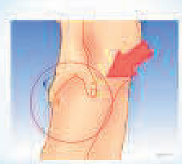

pick

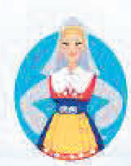

thin


chin


dip


chip


shin


hip

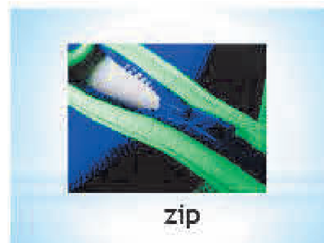

lip


fit


hit


rip

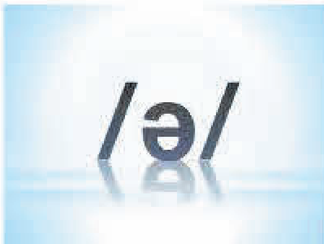

ship


zip


/oi/

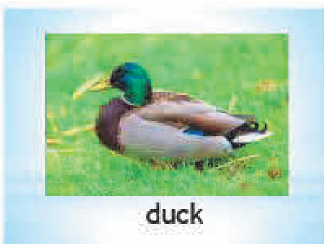

joy


boy


/ə/


thump


jump

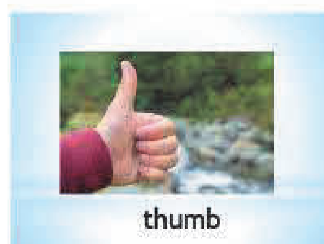

duck


10kg
ton


tongue


judge


jug


thumb


gum

Appendix F:

Phonemic Inventory Score Sheet

Phonemic Inventory Score Sheet

Name: Date:

Phonemic Inventory Assessment

e		e		a		ae		i		u		I		oi
day		shade		car		ham		heat		zoo		chick		joy
days		shave		far		have		meat		U		kick		boy
lay		bathing		cough		hat		seat		boo		lick		
way		baking		cobb		jam		feet		two		sick		
hay				caught		ram		wheat		moo		thick		
K				bought		rat		weed				pick		
KKs				wrong		bat		read				thin		**uh**
yeah				rock		batch		deep				chin		thump
they				log		bath		jeep				dip		jump
jay				lock		back		peep		**au**		chip		yuck
name				fog		badge		sheep		wow		shin		tongue
same				dog		rag		king		vow		hip		ton
game				dot		ran		key		chow		lip		judge
bake				hot		cap		the		thou		fit		jug
rake				pot		cash		keys				hit		thumb
base						cab		ring				rip		gum
bait						can		wing		**eh**		ship		
cake						that		weak		there		zip		
cage						cat		thing		where				
cane						tap		think		chest		**ʒ**		
cape						nap		thief		vest		Asia		
case						zap		mash		guess		Basia		
cave								rash		yes		Beige		
lake										yellow		Deige		
late										jello		dijon		
take												pijon		
tape										**ai**		taj		
make										mice		saj		
mane										dice		rouge		
maze										nice		pouge		
rain										knife				
race										wife				
shake										life				

Appendix G:

In-Depth Stimulability Task

In-Depth Stimulability Task

Sound	Isolation	#__i	i__i	i__#	#__a	a__a	a__#	#__u	u__u	u__#	Total	%	Stimulable?
p											/10		Yes No
b											/10		Yes No
t											/10		Yes No
d											/10		Yes No
k											/10		Yes No
g											/10		Yes No
f											/10		Yes No
v											/10		Yes No
θ											/10		Yes No
ð											/10		Yes No
s											/10		Yes No
z											/10		Yes No
ʃ											/10		Yes No
ʒ											/7		Yes No
ʧ											/10		Yes No
ʤ											/10		Yes No
m											/10		Yes No
n											/10		Yes No
ŋ											/7		Yes No
w											/7		Yes No
j											/7		Yes No
h											/7		Yes No
l											/10		Yes No
r											/10		Yes No

Adapted from Glaspey, A. & Stoel-Gammon, C. (2005). Dynamic assessment in phonological disorders: The scaffolding scale of stimulability. *Topics in Language Disorders, 25,* 220-230.

*Please note that research suggests that a sound produced with 30% or greater accuracy is considered stimulable.

**Gray boxes indicate impermissible contexts – see #3 on page 2 for more information