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## Picture Cued and Speech Production Cued Approaches for Speech Sound Learning

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PICTURE CUED AND SPEECH PRODUCTION CUED APPROACHES FOR SPEECH  
SOUND LEARNING

A Thesis

Submitted to the Graduate Faculty of the  
Louisiana State University and  
Agricultural and Mechanical College  
in partial fulfillment of the  
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in

The Department of Communication Sciences and Disorders

by  
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## ABSTRACT

This study examined the use of speech production cued cards, MorphoPhonic faces (MPF), and plain picture (PP) cards when seeking to remediate speech sound errors, specifically sounds /ɪ/ and /s/ in the word initial position. Fourteen children were provided articulation therapy at their public school using both stimulus types across four weeks. Each week, the total number of correct productions of target phoneme /s/ and /ɪ/ were recorded and averaged. These results were used to graphically showcase trends in their performance with both stimulus types. The results demonstrated that MPF cards were advantageous for remediation of /ɪ/ production at a significant level, while /s/ approached but did not attain significance. Three pre- and post-treatment assessments were administered to determine if treatment aided in children's decoding skills, sight word knowledge, and spectral acoustic patterns. Acoustic trajectories demonstrated increased intensity during production of /s/ and decreased F2 values during /ɪ/ production, however, these changes were not statistically significant. This study sought to explore if the use of MPF cards were advantageous compared to traditional plain picture articulation cards. The findings were mixed, and further studies need to be conducted to support the findings of this study.

## CHAPTER 1. LITERATURE REVIEW

There is a strong relationship between speech sound disorders (SSD) and reading disabilities. Children with SSD at preschool are more likely to have difficulty learning to read, and if a comorbid language disorder is present, the reading deficits may persist into adulthood (Conti-Ramsden, Botting, & Faragher, 2001; Lewis & Freebairn, 1992). Speech sound disorders manifest early as difficulty with phonemic awareness (Raitano, Pennington, Tunick, Boada, & Shriberg, 2004) and are predictive of continuing difficulty with both decoding and reading fluency (Durand, Loe, Yeatman, & Feldman, 2013). However, the relationship between speech sound disorders and reading deficits is complex, with only a moderate correlation between SSD and reading difficulties, which has initiated research to explore subtypes of SSD.

Discovery of subtypes may lead to greater ability to predict, assess and treat SSD subtypes that negatively impact reading. It has been shown that typical speech-language intervention has no effect on literacy (Gillon & Dodd, 1995; Justice, 2006). However, phonological awareness training has been shown to benefit early reading and speech production (Denne, Langdown, Pring & Roy, 2005), suggesting that literacy instruction can benefit speech as well. This study will examine changes in speech sound production for children with dyslexia when presented speech production cues (i.e., printed letters representing articulators within a face), thus linking speech sounds directly to reading. Our first prediction is that these speech production cues will improve speech production. Our second prediction is that the presentation of articulation stimuli in groups of either short vowel words (CVC or CVCC spelling patterns) or long vowel words (CVVC or CVCe spelling patterns) will result in improvements in decoding these patterns. The third prediction is that sight word recognition of words in which the spelling and meaning are superimposed in the pictures will result in sight word learning for target words.



The fourth and final prediction is that changes in production perceived by a listener will generate positive acoustic change shown in spectrographic analysis.

### **Speech Sound Disorders and Reading**

Three decades of research have consistently shown a relationship between SSD and reading difficulties. One body of literature showed that those with reading disabilities are likely to have a history of or current SSD. Bird, Bishop, and Freeman (1995) compared children with SSD with and without comorbid language disorders to typically developing peers. Both groups of SSD children performed below controls on phonological awareness, as well as reading and writing non-words and real words. The children with more severe SSD at school entry were of particular risk. The researchers suggested articulation and reading problems may both arise from poor ability to analyze syllables into smaller phonological units. Lewis and Freebairn (1992) used a cross-sectional design to examine individuals with a history of preschool SSD at preschool, grade school, adolescence and adulthood. At all age levels, those with a history of SSD performed more poorly than peers on measures of phonology, reading and spelling. Those with a history of comorbid language disorders performed more poorly than SSD alone. More recently, Gallagher, Frith and Snowling (2003) found that of children with a family history of dyslexia, 57% showed reading problems in first grade as well as significantly slower speech and language development. The severity of the speech and language delay predicted individual differences in reading development. Other studies report similar findings linking SSD to reading disabilities (Bishop & Adams, 1990; Catts, 1993; Larrivee & Catts, 1999).

Longitudinal studies have shown that children with SSD are at-risk for reading disabilities. Scarborough (1990) found that both delays in syntactic and speech sound development at 30 months were prevalent in children with later reading disabilities. However,

receptive (speech discrimination) skills were not impaired, consistent with the findings of Mann and Dittunno (1990) and arguing against the proposal that both are caused by an incomplete or distorted perception of language input. Stothard, Snowling, Bishop, Chipchase, and Kaplan (1998) followed up at adolescence on children who had speech and language delays at kindergarten. Those whose speech and language problems had resolved were similar to peers on vocabulary and language comprehension but performed significantly worse on phonological processing (non-word reading, spoonerisms) and word reading and spelling. Those with persistent speech and language problems performed poorly on all measures of oral and written language.

Overby et al. (2012) found that 25% of children with SSD only in kindergarten showed poor reading in first-second grade, even though vocabulary skills were average. Of those with comorbid language impairment, 66% showed reading problems. Leitaio and Fletcher (2004) measured phonological processing and literacy skills of children with SSD from age 5-6 to 12-13. During the first three years of school, children with SSD showed developmental and non-developmental speech errors, weaker phonological awareness, and delayed development of reading accuracy and spelling. By the end of primary school, they continued to show difficulty with reading and spelling, particularly those with non-developmental speech errors. The researchers suggested that weak phonological representations underlie both SSD and reading deficits.

### **Dyslexia, SSD, and Phonological Awareness**

Dyslexia is a specific learning disability, with a prevalence ranging from 5-10 percent making it the most common subtype of learning disabilities. The reading deficit is neurobiological in origin and inconsistent with other cognitive abilities, resulting in persistent

difficulties despite adequate cognitive abilities and the provision of effective instruction. Dyslexia affects accurate and/or fluent word recognition, spelling and decoding abilities. Over time, poor reading may lead to secondary consequences including difficulty with reading comprehension, poor vocabulary growth and limitations in the acquisition of background knowledge, further exacerbating the core problem. The core difficulties are believed to result from a deficit in the phonological component of language with a phonological awareness deficit considered the hallmark difficulty (Lyon, Shaywitz & Shaywitz, 2003).

Several studies have shown that children with SSD are at-risk for poor phonological awareness abilities at school age. Rvachew, Chiang, and Evans (2007) looked at types of speech sound errors and phonological awareness skills at prekindergarten and kindergarten. No specific pattern of errors predicted phonological awareness abilities at the end of kindergarten, although those who achieved age-appropriate articulation skills also achieved age-appropriate phonological awareness abilities. Raitano, Pennington, Tunick, Boada, and Shriberg (2004) showed that both children with SSD only and SSD with language impairment performed poorly on phonological awareness tasks compared to typically developing peers. In contrast with Rvachew et al. (2007), even those whose speech had normalized had poorer performance in phonological awareness.

Studies consistently show a relationship between SSD and poor phonemic awareness, but a paradox is shown in that not all children with SSD have phonological awareness deficits, and not all children showing phonological awareness deficits have a history of SSD. This has led researchers to look for subtypes of SSD. Rvachew and Grawburg (2006) conducted an analysis to determine variables that may contribute to poor phonological awareness skills in SSD,

including speech perception, articulation and receptive vocabulary. Results showed that poor speech perception and/or poor receptive vocabulary were most predictive of phonemic awareness skills, and phonemic awareness skills were the best predictor of early literacy skills. Articulation did not have a direct impact on phonemic awareness. Rvachew (2007) followed up, identifying children in prekindergarten who had SSD and poor phonological processing (PP) skills (i.e., speech perception and phonological awareness for rime and onset), SSD and good phonological processing, and children with typical speech. At the end of first grade, the original tests were re-administered as well as measures of sight words and non-word decoding. Only the SSD-low PP group had lower non-word decoding skills, while both SSD groups continued to display articulation delays.

Preston and Edwards (2010) used a picture-naming task to test for typical sound changes, atypical sound changes and distortions of speech. Receptive vocabulary also was measured. These were used to predict performance on phonological awareness tasks. Results indicated that lower vocabulary scores and atypical sound errors predicted phonological awareness abilities. Others have shown that for both children with and without SSD, vocabulary is the best predictor of phonological awareness skills (Bishop & Adams, 1990; Elbro et al., 1998; Metsala, 1999; Rvachew, 2006; Rvachew & Grawburg, 2006; Rvachew, Nowak, & Cloutier, 2004). This finding is important because vocabulary is the source of the development of phonological representations, which has led many researchers to identify poor phonological representations as the underlying cause of both SSDs and phonological awareness deficits, and consequently dyslexia (Elbro, Borstrom, & Peterson, 1998; Larrivee & Catts, 1999; Perfetti & Hart, 2002; Rvachew, 2007; Rvachew & Grawburg, 2006; Sutherland & Gillon, 2005; Swan & Goswami, 1997).

## **Phonological Representations**

Speech sounds can be described according to phonetic features, such as voicing, placement, or manner of production. Morais (1991) proposes that features that are similar (e.g., unvoiced stops) enable children to organize speech input into phonological representations that can be cognitively constructed, stored and retrieved. At the same time, differences in features must be perceived to differentiate the sounds of the language. The child's system must function as an efficient pattern finder, capable of segmenting the speech signal into features, discriminating speech sounds from each other, and organizing them into phonological categories by both similarities and differences.

Phonological categories are language specific and in adult language they differentiate all of the words of the language. For example, the /d/ and /t/ phonemes are distinctive categories because there are pairs of words that differ by only one feature (dug/tug; die/tie; down/town), in this case the voicing contrast of these phonemes. This system of distinctive features needs to be constructed by every child, emerging developmentally with both increasing age and new vocabulary words that provide the input for data comparison and sorting. As vocabulary increases, children gain a broader range of data from which to abstract sound contrasts, patterns, and sound combinations or sequences that form words (Metsala, 1999). These are referred to as phonological representations. Metsala (1999) suggested that children with larger vocabularies have more adult-like phonological representations in their features and organization because they have stored similar-sounding words differentially. This is a gradual process that for most children is nearly adult-like by kindergarten (Kilminster & Laird, 1978). During the period of acquisition, the phonological representations undergo continuous changes that result in sound substitutions and deviations from the adult ideal (e.g., "tat" for "cat" or "wawa" for "water").

These predictable patterns, known as phonological processes, can be observed in both children with typical and atypical speech sound development (Edwards, 1992; Edwards & Shriberg, 1983). Problems arise when speech sounds persist beyond the age of normalcy or are atypical in nature (Bernthal, Bankson, & Flipsen, 1988; Preston et al., 2013).

Sutherland and Gillon (2007) proposed that children who either have poorly formed phonological representations or difficulty accessing good-quality representations of words would perform poorly on phonological awareness tasks and as a result, experience difficulty learning to read. In tasks requiring processing of phonological information, children with SSD performed poorly on those requiring them to judge correct and incorrect word productions, recognize newly learned non-words, and perform phonological awareness tasks. They concluded poorly specified phonological representations can have a negative impact on listening, speaking, articulation, phonological awareness, and decoding.

For children with SSD, many researchers propose that a combination of genetic and environmental factors may contribute to poorly formed phonological representations resulting in both SSD and reading disabilities. This is supported by the finding that poor phonemic awareness is associated with more atypical speech sound errors and lower receptive vocabulary (Preston & Edwards, 2010). Furthermore, reading disabilities also are characterized by poor vocabulary development. This effect may be indirect in that vocabulary contributes to young children's phonological awareness, which in turn contributes to their word recognition (Goswami, 2001; Nagy, 2005). Those with poor word recognition read less and understand less of what they read, resulting in fewer vocabulary words learned from reading than their peers (Beck, McKeown, & Kucan, 2002).

## **Interventions for Phonological Awareness and Articulation**

A few researchers have explored the outcome of treatment targeting either articulation or phonological awareness on outcomes in both domains. Hesketh, Adams, Nightingale and Hall (2000) provided either articulation-based or metaphonologically-based (i.e., phonological awareness) therapy for 10 sessions to 61 children aged 3;1 to 5;0 with speech sound disorders. Results showed both groups showed significant improvement in both domains with no group differences. Follow-up three months later showed no group differences, although there was a trend for the metaphonological group to make more long-term changes in one measure of phonological awareness.

Denne, Langdown, Pring, and Roy, P. (2005) randomly assigned 20 children to control and treatment groups who received 20 hours of small group therapy in phonological awareness. The treatment group made significant gains in phonological awareness, but smaller and nonsignificant changes in speech production. They cautioned that children may need a therapy approach that targeted speech production more directly.

Most phonological awareness treatments as well as articulation therapy do not incorporate visual symbols. Phonological awareness training typically includes activities such as rhyming, listening for sounds in word positions, and segmenting sounds in words. However, the National Reading Panel's review of research revealed that the most effective training in phonological awareness for at-risk children occurred when letters were used to teach these concepts (Ehri et al., 2001). Further, studies on infant speech perception show that visual speech productions by the speaker enhances phoneme discrimination as well as determining phoneme boundaries in speech (Teinonen, Aslin, Alku, & Csibra, 2008), suggesting that from early stages children rely on the visual cues of speech for information about phonemes. Castiglioni-Spalten

and Ehri (2003) found that kindergarten children learned to segment and recognize words better when they were taught to monitor articulatory gestures. Attention to the mouth of the therapist modeling speech sound productions is a basic cuing system used in a wide range of articulation therapies. However, even with articulatory gestures, speech sound productions are fleeting and difficult for children with SSD to perceive and manipulate auditorily. This has led some researcher to explore using an iconic visual symbol to provide a stable and lasting representation of a phoneme. The concrete visual representation provides the child with a stable means to view and reflect on the phoneme.

### **Concrete Visual Representations**

Pieretti, Kaul, and Zarchy (2014) compared a multimodal program termed FONEMZ with traditional articulation therapy. Originally developed for the deaf and hard of hearing, FONEMZ targets articulation by emphasizing phonemic awareness using a different color and shape to represent each phoneme in English. Some of the symbols partially resemble their corresponding letters, some resemble the shape of the mouth during the production of the sound, and some resemble the International Phonetic Alphabet (IPA) symbol for the sound. The disassociation between alphabetical letters and FONEMZ symbols was done purposefully to eliminate confusion between the concept of a letter name and letter sound. There is a distinct FONEMZ symbol for each phoneme, a one-to-one relationship that is purportedly easier to grasp than English spelling which uses 250 different letters or letter combinations to symbolize 40 phonemes. The visual symbol of FONEMZ theoretically provides a visual and concrete representation to anchor the sound in memory.

Two four-year-old children with severely unintelligible speech characterized by multiple sound substitutions, distortions and omissions were selected for treatment. Both had poor



phonological awareness skills. A multiple baseline treatment design across 20 biweekly sessions was used to target three phonemes, with one phoneme receiving language therapy only (control), one receiving FONEMZ after a baseline of language therapy only, and one receiving traditional articulation after baseline. Results showed that greater gains in articulation were made for the phoneme treated using the FONEMZ approach, and that changes were also shown for phonological awareness and early literacy skills. They concluded that the visual component of the FONEMZ symbol increased the accuracy of phoneme production and also resulted in improvements in phoneme awareness and letter recognition.

A close association between the visual cues of speech and letters is found in an approach termed Phonic Faces (Norris, 2001). The faces are drawn to represent kids (i.e., consonants), babies (i.e., short vowels) and adults (i.e., long vowels) producing phonemes symbolized by letter shapes. The letter is embedded into the face to cue phoneme production, using the shape and position of the letter to represent oral production cues associated with that phoneme. An analogy is made between straight line on the letter “p” and the concept of stopping the airflow, and the curve on letter “p” to represent the top lip used to produce the plosive /p/ sound, as shown in Figure 1.1.

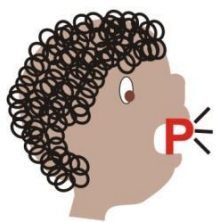


Figure 1.1. Phonic Face (Norris, 2001) represent the production of the /p/ sound as the letter “p” as stopping and then using the top lip to release the airflow.

Phonic Faces (2001) has been used with a varying population to teach phonological awareness principles. Terrell (2007) used Phonic Faces to teach toddlers (ages 20-24 months)

phonological awareness skills. Sixteen toddlers in daycare programs were tested using letter awareness tasks (finding letters, identifying letters, discriminating letters) and phoneme awareness tasks (sound/letter correspondence, identifying sounds, discriminating sounds, producing sounds). The toddlers were read alphabet books (i.e., each page containing a letter and 3-4 pictured objects that began with the phoneme, as in “b” depicted with “ball,” “bed,” and “boy”) with some letters embedded in Phonic Faces and some not. Results showed that toddlers made significantly greater gains for letters embedded in Phonic Faces ( $p < .007$ ) in both sound awareness and letter awareness, specifically in finding any letters on Phonic Faces cards, finding specific letters on Phonic Faces cards, and producing sounds from Phonic Faces cards. These findings demonstrate that Phonic Faces were effective in increasing phonological awareness skills. McInnis (2008) found similar results for toddlers taught using sight words containing Phonic Faces (i.e., MorphoPhonic Faces) as the initial sound accompanied by pictures depicting the meaning drawn into the remaining letters. The toddlers not only learned more words in this condition but also showed evidence of abstracting and using the alphabetic principle. That is, the cues provided by the analogy between the letter and the sound production resulted in the toddlers associating the phoneme represented by the letter with new, untaught words.

A study by Powell, Hartman, Hoffman, and Norris, (2007) showed that more MorphoPhonic Faces (MPF) words were learned daily by poor readers compared to plain words, and greater gains were made in phonemic awareness. Similar results were found by Williams (2013) for 1st graders with poor reading skills. While the number of words learned daily did not differ between MPF and plain words, better short and long-term retention occurred for words learned using MPF. Greater improvement in measures of phonemic awareness, letter-sounds, and decoding also showed the predicted increases in alphabet skills. Qualitative analyses

revealed that words from all grammatical classes were learned but while some words were learned by all, there was a continuum of increasingly more difficult words to picture that resulted in the most abstract words (i.e., of, could) that were learned by none of the subjects. Brown (2014) compared word learning for kindergarten children under conditions of MPF and plain print words. Word learning was minimal under both conditions with no significant differences for word type. However, alphabet skills did improve significantly.

Brazier-Carter (2008) recruited four Head Start teachers from an urban population to read either Phonic Faces alphabet storybooks or emergent reading books to their class for 15-20 minute sessions daily for 6 weeks. The same storybook was read five times per week. The alphabet storybooks centered on one specific phoneme, which was pictured using the Phonic Face character producing the sound as a natural part of the story (Peter makes the /p/ sound as popcorn is heard and seen popping). Instances of the letter/sound also occur throughout the text so that children can be encouraged to listen for the sound, sound in word position, rhyming words, and other phonological awareness abilities (i.e., “Peter popped popcorn - /p/ /p/ /p/”). Teachers were trained to exploit these opportunities for letter and phoneme awareness throughout the reading of the book. In the emergent reading book condition, books were chosen from the Wright Group Sunshine series (Wright Group, 1990-1998). These books have high repetition of words and sentences, and control group teachers were taught to reference the letters and sounds in these repeated words throughout the book reading. One week prior to the storybook reading intervention, the Head Start teachers participated in four 30-minute trainings that focused on one topic per session, including: phonemic awareness (initial sound, rhyme, and sound segmenting), print referencing (letter name, letter sound, book conventions), vocabulary

(definitions, picture explanations, personal experiences), and narrative (retelling, questions, paraphrasing/explaining).

The results of Brazier-Carter (2008) showed that teachers using the Phonic Faces books made significantly more references to phonemic awareness and print referencing than the emergent reading book group. They also made significantly more references to meaning (vocabulary and story elaboration) than with the emergent reading books. These results show that using Phonic Faces cues improved teachers' consistency for referencing and teaching pre-reading skills, such as phonemic awareness and print awareness, but not at the expense of meaning. Furthermore, when the Phonic Faces books were used, the students made significantly greater gains in vocabulary, print concepts, and phonemics awareness.

Kaufman, Norris, and Hoffman (2007) used the word variation of Phonic Faces, termed MorphoPhonic Faces (MPF) (see Figure 1.2), to treat a nonverbal four-year-old who had been recommended for AAC. The MPF were used to prompt the productions of the content words in a *Little Critter* storybook as well as play. Using the MPF prompts, verbal responses were elicited during the first session, with a steady increase in imitated and spontaneous productions across time. Following 20 sessions, the subject's spontaneous MLU increased with 2-5 word productions and a wide range of phonemes produced or approximated.



Figure 1.2. MorphoPhonic Face providing phoneme, meaning, and orthographic word cues

Nettleson and Hoffman (2006) randomly assigned eight preschoolers with moderate phonological disorders to either a Phonic Faces storybook or Animated Literacy storybook condition. Animated literacy features characters whose names begin with the target letter-sound such as Polly Panda (see Figure 1.3.). The stories present multiple words throughout beginning with that letter-sound. The results showed that Phonic Faces resulted in faster acquisition of all target measures with significantly greater gains in letter-sound relationships, letter naming and speech sound accuracy during daily probes and storybook readings. The direct speech production cues provided by the faces prompted subjects to use those features in their speech productions. The practice provided by the alliteration of the Animated Literacy characters provided practice, but no cues to distinguish correct from incorrect speech production attempts.



Figure 1.3. Alliteration cues provided by Animated Literacy

The concept of correct versus incorrect speech production is typically a subjective judgment with differences between listeners. Munson, Johnson, and Edwards (2012) found that the ratings of experienced speech-language pathologists and inexperienced listeners differed for productions of / s / and / θ\_/. Experienced raters had higher intra-rater reliability, showed less bias toward a more frequent sound, and their judgments were more closely related to the acoustic characteristics of the children's speech. This suggests an acoustic analysis can add an objective measurement of change in treatment studies.

## Acoustic Characteristics of R and S

The production of /ɹ/ has historically been described as a phoneme that carries a one-to-many ratio in terms of variations of production. It can be produced with a retroflexed or bunched lingual configuration as it articulates with the palatal vault (Espy-Wilson, Boyce, Jackson, Narayanan, Alwan, A., 2000). Furthermore, because of r's predilection to be influenced by surrounding vowels, variation can occur dependent on its position (i.e., prevocalic, postvocalic, or syllabic). Acoustically, /ɹ/ is characterized by a stable acoustic pattern of F3 that decreases to match or meet the value of F2 (Stevens, 1999; Espy-Wilson et al., 2000). Dalston (1975) found that correct production of word initial /ɹ/ with a mean F3 of 2500 Hz in both children and adults could help delineate /ɹ/ from "w", a common substitution pattern. To best define the acoustic properties of /ɹ/, Espy-Wilson et al. (2000) set forth the properties of ɹ-ness as low F3 and smaller F3-F2). This suggests that F3-F2 and F3 can be compared to the norm established by Dalston (1975) as a more objective measure of the correct production of /ɹ/.

When determining the acoustic characteristics of the /s/ phoneme, the current literature on the accurate production of /s/ is varied. Flipsen, Shriberg, Weismer, Karlsson and McSweeney (1999) studied the speech acoustic patterns of 26 adolescent children to generate reference data to better guide speech disorders research. One finding from this study was that /s/ can be characterized by extraction of midpoint value. Historically, research extracting values from /s/ production have used a version of Fourier transform (e.g., FTT and DFT) or linear predicative coding to examine the frequency and intensity trajectory of /s/. An alternative that uses a single value (i.e., center of gravity), as opposed to a trajectory, to acoustically describe /s/ was found by Abdelatty, Ali, and Muelle (1998). Using acoustic analysis, Holliday, Reidy, Beckman, and Edwards (2015) found that /s/ and /θ/ will overlap in children's production due

to covert contrast; a phenomenon where a child is able to accurately perceive a sound, yet their production will be judged as incorrect. This suggests that an external cue such as contrasting the speech production cues provided by the /s/ and /θ/ Phonic Faces may assist the child in establishing a phonetic category for distinction between similar sounding fricatives (i.e. /θ/ and /s/).

### **Acoustic Analysis**

**Acoustic Analysis of /ɹ/. For phoneme /ɹ/, boundaries were established using the criteria set forth by Peterson and Lehiste (1960) and (Chaney, 1988) analyzing the spectrogram for the directional shift in F2. Once the onset and offset were bound, using time as an axis, the spectrum was marked at the center of the formant band and the second and third formant frequency were extracted from this midpoint. F3 was analyzed and compared to pre- and post-treatment for positive acoustic change. We would expect for subjects to show a lower F3, to indicate increased rhoticity and perceptual accuracy. F3-F2 values were taken pre- and post-treatment, in addition to a comparing post-treatment F3 to the norm (F3=2500Hz) set forth by Dalston (1975).**

**Acoustic analysis of /s/. Current literature on optimal acoustic characteristics of English fricatives is ongoing. The most common measures for identification remain higher spectral mean, defined peaks, and larger overall amplitude compared to voiced fricatives (Maniwa et al., 2008). For this study, phoneme /s/ was analyzed using the Pratt program. Phoneme boundaries were established on the basis of the presence of turbulent aperiodic frequencies. After each phoneme was bound, center of gravity was extracted by creating a spectral slice and intensity was automatically generated.**

## Summary

The studies exploring use of drawings that provide a visual iconic representation of phonemic production features suggest they may provide a useful cue that enables children to formulate more accurate speech sound productions. They also suggest that using letter and word-based cues for articulation may simultaneously prompt word recognition and word pattern learning, thus addressing literacy as part of the treatment outcomes of therapy for speech sound disorders.

### **The questions of this study therefore are:**

1. Will subjects produce more correct productions of isolated words beginning with a target phoneme (/ s / or / ɪ /) when the words are elicited using pictures that incorporate speech production cues?
2. Will subjects recognize more of the written sight words for words practiced using MorphoPhonic Faces pictures than plain print pictures?
3. Will subjects show better ability to decode nonsense words with patterns that were practiced in the treatment lessons?
4. Will subjects who demonstrate improved productions according to listener perception also show changes in acoustic formant trajectories for / ɪ / and intensity for / s / phonemes?



## CHAPTER 2. METHODS

This study compared gains in the number of correct productions of target phonemes (i.e., either / ɪ / or / s /) under elicitation conditions of either plain clip art pictures or pictures that provide speech production cues (i.e., MorphoPhonic Faces). Productions were elicited in imitated and spontaneous daily probes across four treatment weeks (i.e., 5 to 11 sessions depending on Individualized Education Program requirements and absences). In addition, pre-treatment and post-treatment performance on decoding and sight word recognition were compared. Students receiving treatment for speech sound disorders were instructed using both plain and MPF pictures in an alternating treatment design. Participants received treatment two to three times weekly in 8-minute sessions within a school.

### Participants

**Graduate Students.** The students implementing the intervention were nine masters level graduate students. Each graduate student implemented two short (approximately eight minute) intervention sessions weekly with the same child. Since children were seen two to four times weekly, two different students may have seen the children each week (i.e., one on Tuesday/Thursday and one on Monday/Wednesday). A PhD researcher trained the students in the treatment procedures and served as a fidelity checker along with the course supervisor for the practicum. She also modeled the procedures as needed and alerted the course supervisor when students were having difficulty with implementation, in which case the graduate student clinician was given additional training.

**Participants with Speech Sound Disorders.** The participants were 14 elementary students in an urban school, ranked among the lowest achieving elementary schools in the state. The school was predominantly African American (61.6%). All of the students received free or reduced lunch. The participants ranged in age from 6;2 to 12;4 years (mean 8;7, including 11 males and 3 females. To

be included in the study, students must have no known significant visual or hearing loss according to school records. Students were tested prior to the beginning of intervention for sight words recognized and word decoding. Results show the groups were comparable in reading skill levels. The characteristics of subjects are profiled in Table 2.1.

Table 2.1 Profile of Demographic Characteristics, Decoding, and Sight Word Test at Pretest.

Group	Mean Age	Gender		Race		Mean Pretest Score	
		Male	Female	A A	C	Decoding	Sight Words
/ɪ / phoneme	9;1	4	3	2	5	16.4/40	19.8/64
/s / phoneme	8;4	7	0	3	4	13.0/40	18.4/60

### Test Instruments

**Abbreviated Phonics Inventory.** The abbreviated phonics inventory is comprised of five items adapted from an informal phonics Inventory. The items assessed the phonic patterns present in the stimulus words used in this study. The first two items asked the participants to 1) name the vowels, and 2) name the short vowel heard in five named real words (*strip, bunk, trap, block, and bread*). The last three items required participants to read ten nonsense words for each of the word patterns, including test item 3) short vowels in CVC constructions; 4) long vowels in double vowel CVVC patterns; and 5) long vowels in CVCe patterns.

**Sight Word List.** For each phoneme (/ɪ / and /s /) a sight word list was created comprised of 24 MPF words and 24 PP words used during intervention. The words included CVC, CVVC, CVCe patterns. In addition, 13 additional words containing the practiced patterns but not exposed to in intervention were included in the sight word list. Students were given 3 seconds to recognize the words.

**Contextualized Speech Elicitation and Acoustic Analysis Task.** Four story pictures for each phoneme (initial / s / and / ɪ /) were created by the researcher to elicit productions of the target sound (/s/ or /ɪ/) in sentences to be used for acoustic analysis of phoneme production. Six subjects were asked to look at a color picture while the researcher read aloud a 20-25-word story script that corresponded with the picture. The child was immediately asked to retell the story that was audio recorded. Each script contained 12 words beginning with the target phoneme, resulting in potentially 48 words the child could produce in retellings (e.g., “A small sad girl named Sam sat in the sun. Some soap was spilled on her seat. Sam started to sob”). See Appendix A for the pictures and scripts.

The acoustic analysis was conducted using the PRATT program to create text grids and subsequent acoustic boundaries for initial / s / and / ɪ / in words. Measurements taken were a) center frequencies of the second and third formants for phoneme / ɪ / and b) center of gravity and intensity for phoneme / s /. Literature has indicated difficulties in extracting frequencies from audio recordings with adequate acoustic power and spectral bandwidth to accurately delineate resonant frequencies (Hoffman et al., 1983; Huggins, 1980) but these recordings provided a rough measure of acoustic change. For the purposes of this study, F3, F3-F2 and F3 for / ɪ / will be compared to the norms established by Dalston (1975).

### CHAPTER 3. MATERIALS

**Plain Picture Stimuli Cards (PP):** Plain Picture stimuli were comprised of 24 / s / words including 12 short vowel CVC picture word cards and 12 long vowel CVVC or CVCe pattern words cards for each phoneme. The pictures were accompanied by the printed word in 45-point font. The words displayed in a single set as seen in Figure 1. All words in a set adhered to either the short or long vowel pattern.

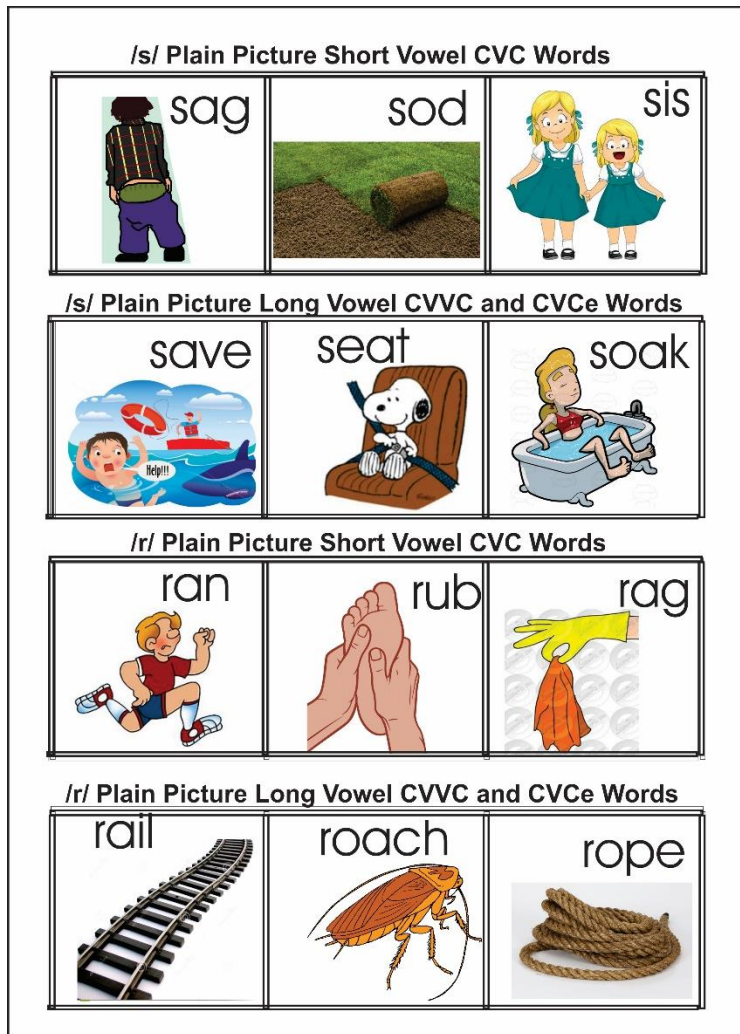


Figure 2.1. Stimuli with plain pictures accompanied by printed words.

**MorphoPhonic Faces Stimuli Cards (MPF):** MorphoPhonic Faces stimuli cards were comprised of 24 / s / words and 24 / r / words, including 12 short vowel CVC picture word cards and 12 long

vowel CVVC or CVCe pattern words cards for each phoneme. The pictures were accompanied by the printed word in 45-point font. The words displayed in a single set (see Figure 2) all adhered to either the short or long vowel pattern. The pictures provide a speech production cue in the face of the character for the onset phoneme/letter. In addition, the orthographic spelling of the rime was drawn to visually overlap with the word meaning by superimposing meaning cues with the letters.

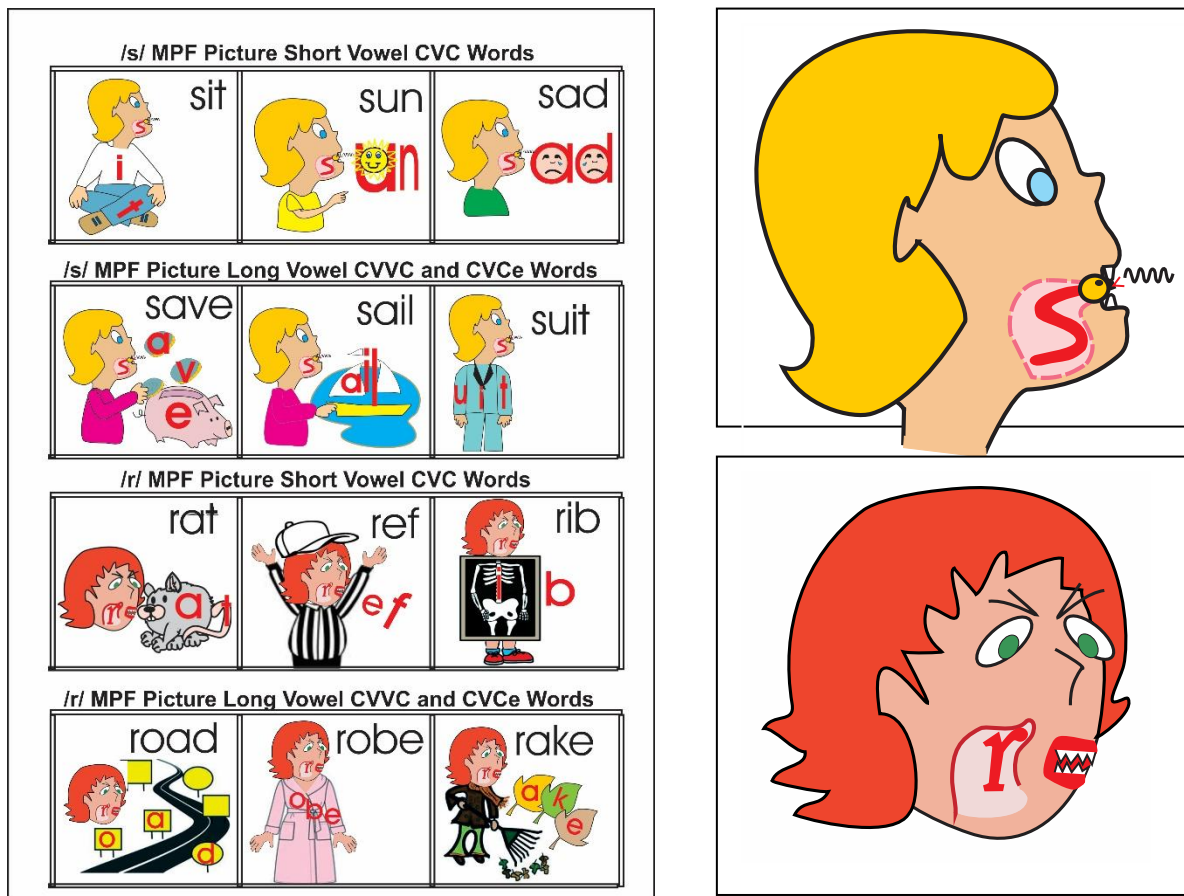


Figure 2.2. Stimuli with MorphoPhonic Face. A cue for onset phoneme speech production and overlapping letter and pictures cues for word spelling and meaning.

### Alternating Treatment Design

A single subject alternating treatment design was implemented. Participants received both plain pictures and MPF pictures during each treatment session. Both types of pictures

followed the same short or long vowel syllable pattern. Four different sets for each phoneme (/r/ and /s/) were generated, each with 12 cards (6 plain picture and 6 MPF) (see Figure 2.3). Two of the word lists were comprised of short vowel CVC words, and two with long vowel CVVC or CVCe words. With few exceptions the words were pronounced with the CVC pattern; however, many of the spellings had more letters because of English Orthography (i.e., “rich” and “rock” have three phonemes but four letters etc.). One set was practiced during an 8-minute session. A different set was practiced each week, with multiple exposures to all words during a session. The cards were shuffled at the beginning and between each exposure so that the presentation of the PP and MPF words occurred randomly. The clinician used elicitation and feedback strategies to shape correct responses to all words.

<b>/r/ Word Lists</b>				<b>/s/ Word Lists</b>			
<b>WEEK 1</b>	<b>WEEK 2</b>	<b>WEEK 3</b>	<b>WEEK 4</b>	<b>WEEK 1</b>	<b>WEEK 2</b>	<b>WEEK 3</b>	<b>WEEK 4</b>
<b>MPF R1</b>	<b>MPF R2</b>	<b>MPF R3</b>	<b>MPF R4</b>	<b>MPF S1</b>	<b>MPF S2</b>	<b>MPF S3</b>	<b>MPF S4</b>
ram	rap	race	rake	sack	sick	Say	safe
rat	red	rain	right	sad	six	sail	same
rich	ref	read	robe	sap	sit	save	seed
rock	rib	reach	rose	sell	sip	see	seal
rug	ring	ride	road	sob	sock	soap	size
run	rip	role	rule	sun	sub	suit	sore
<b>PP R1</b>	<b>PP R2</b>	<b>PP R3</b>	<b>PP R4</b>	<b>PP S1</b>	<b>PP S2</b>	<b>PP S3</b>	<b>PP S4</b>
raft	rag	rail	reap	sag	sax	sage	sane
ran	rash	reef	rise	sat	cell	save	seal
rang	wreck	rice	write	set	sink	sea	sew
rob	rim	ripe	roach	sing	son	seek	side
rod	rot	root	roll	sis	suck	seat	soak
rub	ruff	rude	rope	sod	sum	soar	soup

Figure 2.3. Weekly word lists for /r/ and /s/ Words

At the end of the session, the cards were reshuffled, and the participant produced each word without prompts or feedback. The child was immediately prompted to imitate any words that were not produced correctly. The clinician working with the child used a scoring sheet to tally number of correct and incorrect responses for both spontaneous and imitated productions (see Figure 4).

The number of correct responses elicited by each type of picture (PP vs MPF) were used to assess whether either picture type demonstrated an advantage.

<b>S 1</b>		<b>Daily Final Probe of Practiced Words</b>			
		<b>Week 1 /s/ CVC</b>			
Child's Code _____		Date _____		Clinician _____	
Score <b>1</b> (correct production of initial /r/ sound) or <b>0</b> (incorrect production ( <u>Sp</u> =spontaneous; <u>Im</u> =imitation))					
<b>Words produced in isolation</b>					
📌 MPF S1 Pre	PP S1 Pre		MPF S1 Post	PP S1 Post	
<u>Sp</u> <u>Im</u>	<u>Sp</u> <u>Im</u>		<u>Sp</u> <u>Im</u>	<u>Sp</u> <u>Im</u>	
___ sack	___ sag		___ sack	___ sag	
___ sad	___ sat		___ sad	___ sat	
___ sap	___ set		___ sap	___ set	
___ sell	___ sing		___ sell	___ sing	
___ sob	___ sis		___ sob	___ sis	
___ sun	___ sod		___ sun	___ sod	
___ TOTAL	___ <u>TOTAL</u>		___ TOTAL	___ <u>TOTAL</u>	

Figure 2.4. Daily Final Probe for Practiced Words

## **Feedback/Prompt Hierarchy**

To elicit correct sound productions, Feedback/Prompt Hierarchy profiled in Table 2.2) will be used for sounds in isolation as well as sounds in words, phrases and sentences. The first level is a spontaneous or self-corrected production, indicating the child is ready to try the word in a phrase. The next four prompts are used when the sound is stimulable but the child does not have a good representation of the correct production or has habituated an incorrect production. These include Level II, giving feedback to make the child aware of his attempted production and modeling and requesting a correction [child: θæt/sat. Adult: You said θæt; Remember your / s / sound and say /sæt/.

Level III is similar, however it provides a visual reminder of the difference that the child can look at and think about before responding, giving time to plan a different motor response that is within the child's repertoire. Level IV provides speech production cues (i.e., "Remember to keep your teeth together," "Pull your tongue back a bit") that remind the child how to produce the target sound. Level V uses a tool like a mirror, tongue depressor or lollipop to remind the child how to place the articulators and to view their incorrect attempt. Level VI is to use an elicitation technique when the target is not yet stimulable using the above feedback and prompts, such as shaping the "s" from a "t" by holding the "t" for the last repetition (i.e., t...t...t... tssss).

Suggested elicitation techniques are found in Appendix B.

For Level III, Contrast with Picture, clinicians were given Phonic Faces (Norris, 2001) of the / s /, / θ /, / ɪ / and /w/ letter-phonemes. The use of the contrasts to enable participants to compare their production to the target productions was modeled.



Table 2.2 Levels of Feedback/Prompt Complexity for Speech Production Errors.

<b>Level</b>	<b>Strategy</b>	<b>Feedback</b>	<b>Prompt</b>
I	No Prompt Needed	Nice, correct, perfect...	Say the word in a phrase or sentence (with a model or spontaneously)
II	Contrast	No, you said X	Say Y (model)
III	Contrast with Picture	No, you said X (show error production picture)	Say Y (show correct picture)
IV	Placement Cue	Listen, /X/ /Y/ They are different	Put your tongue/lips/teeth (higher, lower, back, together)
V	Placement Cue with Tool	No, your (state problem)	Use mirror, tongue depressor, etc.
VI	Elicitation Technique	[target not yet stimuable]	Use strategy from Appendix B

## CHAPTER 4. PROCEDURE

**Consent Forms.** The proposed study, including the consent form, underwent IRB review and received approval prior to the initiation of the study. The school speech-language pathologist conducted an initial screening to identify elementary students who met the criteria of a misarticulation of either the / ɪ / or / s / phoneme comprised of a substituted phoneme or a distortion. The school distributed the consent form to eligible students. Those students whose parents returned a consent form met with the primary investigator to discuss the study and sign a Child Assent form. A time then was arranged for students with consent and assent to complete the pretest battery.

**Pretest – Posttest.** The school was consulted regarding times when the pretest battery could be administered to students. A quiet room in the school was used to conduct the assessments. Most students were able to complete the battery on a single session, but a second session was scheduled if needed. At the end of the study, the same procedure was followed for collection of posttest data.

**Training.** Training was conducted to clinicians implementing the treatment to assure fidelity in implementation of the treatment as well as improving interrater judgment of either correct or incorrect production of the target phonemes. Clinicians were provided written instructions and shown a video of the implementation. Questions were answered and instructions reviewed. The PhD researcher was present for the first two weeks of the study, modeling the procedure for clinicians with their subjects, and then observing the clinician and providing corrective feedback. The researcher made additional observations during the final two weeks. During all weeks, the treatment implementation was observed by a certified SLP who was supervising the clinicians, attending training sessions, and working closely with the researchers.

**Presentation of the Cards.** Each week a different set of cards were used to elicit sound productions as shown in Figure 3. The sets have 6 MPF pictures and 6 PP which were presented in random order. If time allows, shuffle again before a second presentation of the cards are practiced. This should continue until the post-session probe, at which time the cards are shuffled once again before the probe begins.

### **MPF Card Procedure**

The following presentation was used to elicit words for both the / s / and / ɹ / phonemes on the MPF cards.

**Sound in Isolation / s /.** Participants were presented with an MPF card from the weekly card set. The examiner pointed to the Phonic Face at the beginning of the word. Clinician stated, “This is Ester. Look at the letter “s” in her mouth. It is shaped like a tongue that is curled like a snake’s body. See how the head of the snake is right behind her teeth? The sound the snake says, /s:/, is going straight out of her mouth – see the wavy line of air? Listen when I say her sound /s:/. My tongue is right behind my teeth but not touching so the air can go out and make the sound like a snake. So when you make the / s / sound you need to keep the “s” or the snake’s head up high in your mouth, behind your teeth, and only let the air out, not your tongue. Let me hear you try it.” If the child’s production was correct 5 times out of 8, clinician moved on to the first word of the week 1 card set. If not, the sound was shaped after each attempt using the Feedback/Prompt Hierarchy and then move on to the elicit the words using Sound in Word procedures.

**Sound in Isolation / ɹ /.** Participants were presented with a MPF card from that week’s card set. The examiner pointed to the Phonic Face at the beginning of the word. The clinician would say, “This is Arlene. Look at the letter “r” in her mouth. It is shaped like a tongue that is up in the back of the mouth, touching the back top teeth (say “eeee” to find that spot). But then you will

see the tip of the tongue go up toward the top of her mouth but not touch anything and her lips point to show her teeth, making a growling sound /ə/. This is like the /ʃ/ sound (say /ʃ/) to find the spot. Feel your lips when you say /ʃ/; they are pointed, and your teeth show. But Arlene is mean, so she isn't quite like /ʃ/, she has her voice on so she can growl /ə/. So, when you make the /ɪ/ sound you need to hold the back of your tongue where you make the /i/ sound and the tip of your tongue up and show your teeth like you are growling." The name of the PF, *Arlene*, was also used to prompt a correct production because the transition from /ɪ/ to /l/ within the name moved the tongue into the correct position for /ɪ/ for many of the children.

If the child's production is correct 5 times out of 8, move on to the first word of that week's card set. If not, shape the sound after each attempt using the Feedback/Prompt Hierarchy and then move on to the elicit the words using Sound in Word procedures. Suggested strategies: The word "ear" may help the child find the correct /ɪ/ position. "Say the /i/ sound. Now keep touching your tongue on your teeth in back but move just your tongue tip up and point your lips (show the three features on Arlene). If the child has difficulty with tongue tip placement, the words "sure" may help. "Say eee. Now say the silly word esh." This should place the tongue and lips in the correct position for /ɪ/. "Now say it again but turn on your mean voice, 'esh.' Now hold your mouth in that position and say "sure." Now hold your mouth in that position and just say /ə/).

**Sound in Word for MPF Words.** The first MPF card of the set was presented (i.e., 6 MPF words and 6 PP words in each set), beginning with the first set of CVC short vowel words. The clinician would use the following prompt:

"All of these words have three sounds, a beginning, middle and ending sound. All of the words begin with the /s/ sound." The child was then asked to point to the first picture, "sit" (see first picture in Figure 2.2), specifically to Ester. "This is Ester. She makes the /s/ sound. The rest of the letters in the word are hiding in the picture. The vowels are short vowels. Together, they say

the name of the word. Ester says / s / and the letters “i” (point to “i” on shirt) says /i/ and “t” (point it “t” on jeans) says /t/. Together, the letters say / sɪt /. Now you look at Ester’s mouth and keep the head of the snake behind your teeth and say the word.”

If an error in production occurred clinician would say,

“Remember, the sound the snake makes /s:/ is going straight out of her mouth – see the wavy line of air? Listen when I say her words, / s:æk/, /s:sæd/, /s: ab/. My tongue is right behind my teeth but not touching so the air can go out and make the sound like a snake. You need to keep the “s” or the snake’s head up high in your mouth, behind your teeth, and only let the air out, not your tongue.”

The child would be asked to try the word again. Several attempts were made to elicit the correct production, or obtain three consecutive correct productions, following, the child was to move on to the next word. “Great, that was Ester’s sound. Let’s try the next word” or “Pretty close. Let’s try the next word.” This was continued through the set of cards, using the above procedure only for the 6 MPF words.

**Sound in Phrases and Sentences.** If the child readily produced the sound in the word correctly with minimal prompts (Levels I or II), the word was recast in a 2-3-word phrase and the child was asked to repeat the phrase (“Sit down.” or “Ester sits down.”) If other / s / sounds in the phrase were produced incorrectly (Ester, sits), corrective feedback was provided, and the child was asked to try again. If the child readily produced the sound in phrases, the child was to create a sentence using the target pictured word. Feedback was provided when appropriate.

### **Plain Picture Procedure**

**Sound in Isolation / s /.** Sounds on PP cards will be treated like traditional articulation therapy cards. The first PP card of the set were presented (i.e., 6 PP words and 6 MPF words in each set), beginning with the first set of CVC short vowel words. Clinician would say, “This word begins

with the /s: / sound. Watch how I make the sound.” Participants were given a model of the target sound. The clinician would use the following prompt:

“My tongue is right behind my teeth but not touching so the air can go out and make the sound like a snake. So when you make the / s / sound you need to keep your tongue up high in your mouth, behind your teeth but not touching, and only let the air out, not your tongue. Let me hear you try it.”

If the child’s production was correct 5 times out of 8, they progressed on to the first word of the week 1 card set. If not, the sound was shaped after each attempt using the Feedback/Prompt Hierarchy and child was to move on and begin to elicit the words using Sound in Word procedures.

**Sound in Word.** The child was presented with the first of 12 word cards that began with the short vowel sound (complexity Stage A). The clinician would say, “All of these words begin with the /s/ sound.” This was done while pointing to the picture. Production was modeled by stating the word with an exaggerated / s / production.

“My tongue is right behind my teeth but not touching so the air can go out and make the sound like a snake. You need to keep your tongue up high in your mouth, behind your teeth, and only let the air out, not your tongue.”

The child was asked to produce the first word, *sit*. If an error in production occurred, the sound was shaped using the Feedback/Prompt Hierarchy. When the child produced the word three consecutive times, they moved on to the next word. “Great that was a good / s: / sound. Let’s try the next word.” When the third word in the row was produced correctly, the child was asked if they could say the preceding three word-cards without help. Feedback was provided as needed.

**Sound in Phrases and Sentences.** If the child readily produced the sound in the word correctly with minimal prompts (Levels I or II), the word was recast in a 2-3-word phrase and the child was asked to repeat the phrase (i.e. “Sit down” “Ester sits down.”) If other / s / sounds in the phrase were

produced incorrectly (Ester, sits), corrective feedback was provided and the child was asked to try again. If the child readily produced the sound in phrases, the child was to create a sentence using the target pictured word and provide feedback as appropriate.

**Probe.** A probe was administered at the end of each session during the final minute. At the end of each word set (or as far as the child progressed during the session) the subject was asked to say each word with the correct target sound. If an incorrect production occurred, the child was asked to imitate the work and a correct production was modeled. The clinician then calculated the percent target phonemes correct. This summation of data was collected for each session.

### **Data Analysis Procedure**

**Speech Perception Reliability.** An inter-rater reliability training was completed prior to the initiation of the study. Graduate clinicians were asked to listen to audio recordings of 70 productions of phonemes / s / and / ɪ / in the initial position of words from students who attended Key Academy. Repetitions of each recording were allowed once and each graduate clinician was asked to rate the production as correct or incorrect. Inter-rater reliability for / s / was .84 and .92 for / ɪ /. This demonstrated high interrater reliability under quiet conditions that were free from distractions. Note that these conditions were not characteristic of judgements made in the school setting where the study was conducted.

**Test Score Reliability.** The test administrator scored the pre- and post-assessments and weekly score sheets. Test sheets were scanned and digitally copied to a secure drive. Raw scores were added from the protocol scoring pages and each list was checked twice by a graduate researcher. Entry of scores into excel data files was completed by the graduate researcher and PhD committee member.

**Fidelity.** The intervention sessions for the 14 participants were staggered throughout the week (Monday through Thursday). Depending on the number of times a child was seen weekly in accord with their Individualized Education Program (IEP), the same clinician provided intervention to the same participant twice weekly but an additional clinician might see the child a third or fourth day. At least  $\frac{1}{4}$  of the sessions were observed by either the PhD researcher or the MA supervisor, both holding clinical certification from the American Language-Speech-Hearing Association (ASHA). While observing, if needed, the fidelity checkers would model the appropriate teaching technique and provide corrective feedback as needed. No video or written records of interventions were obtained because of logistics. Multiple sessions occurred simultaneously throughout the school building with each session lasting only 8 minutes. However, each clinician-child dyad was observed for part of a session each week by one or both fidelity checkers.

### **Analyzing Question Outcomes**

Question 1. Visual inspection of graphs of daily probes for the MPF and PP responses for each subject were used to determine patterns of correct and incorrect responses across time. The mean number of correct responses for each condition ( $r$  MPF,  $r$  PP,  $s$  MPF,  $s$  PP) averaged across the seven subjects for / s / and / ɪ /, respectively, were tested for significant differences.

Question 2. The mean gain scores for sight words to which subjects were exposed but not directly taught during treatment using MPF pictures that overlapped picture and print were compared to the PP words where the printed word was presented separately from the picture. A 2x2 Two-Factor (pre-post x group; MPF, PP) ANOVA was used to test for condition differences.



Question 3. The mean gain scores for phonic patterns to which subjects were exposed during treatment using MPF pictures (that overlapped picture and print) were compared to the PP words (where the printed word was presented separately from the picture.) A 2x2 Two-Factor (time x group; MPF, PP) ANOVA with repeated measures on one factor was conducted to test for condition differences.

Question 4. A spectrographic analysis was examined for indications of change reflecting more adult-like productions of speech, including lower 2<sup>nd</sup> formant frequency and a lower 3<sup>rd</sup> formant frequency for / ɪ / productions, and an increase in intensity and spectral centroid for / s / productions. t-tests were used to compare these values pre- and post-treatment.

## CHAPTER 5. RESULTS

Fourteen students received an alternating treatments for either a / s / or / ɪ / speech sound production. There were 7 subjects for each speech sound (i.e., / s / or / ɪ /). Six of the stimulus training cards were presented as plain pictures and 6 were presented as MorphoPhonic pictures that provided speech sound cues. At the end of the session, a probe was conducted where the spontaneous productions elicited for the 12 pictures were judged for correctness of production.

### Question 1

The first question asked whether a greater number of correct spontaneous productions would result when the picture presented a speech production cue (i.e., MPF). If the MPF condition was more effective for an individual child, we would expect to see MPF words produced at increasingly higher rates of correct production compared to the PP words across sessions.

**Results for / ɪ /.** The seven children receiving treatment for / ɪ / averaged ten sessions (range 7-12 sessions;  $\bar{x} = 10.28$ ,  $SD = 1.7$ ). Figures 4.1 through 4.7. profile probe results across 11 sessions. Examination of Figure 4.1 shows that correct responses never rose above 2 out of 6 for the plain picture condition (reached twice), while the MPF condition achieved 2 correct three times, 3 correct once and 4 correct once. The last four sessions showed correct responses were rising for MPF while the child achieved 0 for the plain print words for the final six sessions. Figure 4.2. shows that subject r2 made steady progress under both picture conditions, but that greater accuracy was shown for the MPF pictures for all but two sessions.

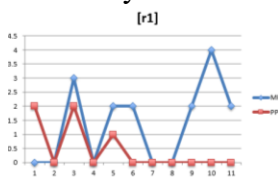


Figure 4.1. Profile of subject r1

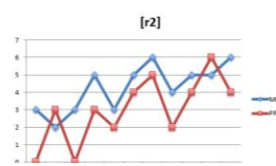


Figure 4.2. Profile of subject r2

Figure 4.3. shows that Subject 3 produced more correct responses (i.e., 5 out of 6) to the MPF picture for 3 of seven sessions attended while the plain pictures elicited one more correct response on the final probe. Figure 4.4. showed a higher level of correct responses for 6 of the sessions for MPF while 5 of the sessions favored the plain pictures.

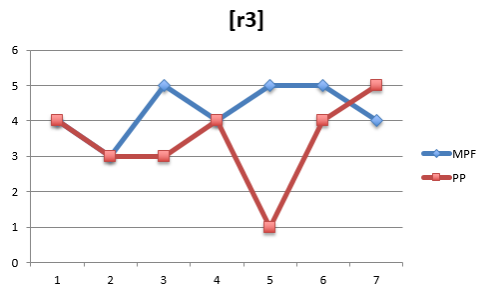


Figure 4.3. Profile of subject r3

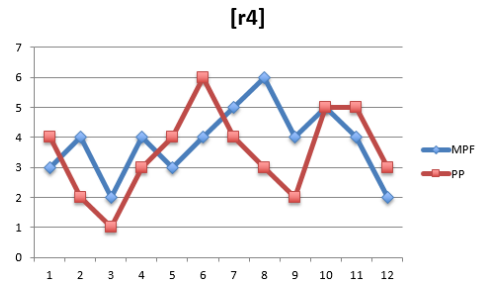


Figure 4.4. Profile of subject r4

Figure 4.5. shows an initial advantage for the MPF pictures, achieving 6 out of 6 at session 4 but then decreasing while plain print held an advantage for three sessions. Both final sessions favored MPF. Figure 4.6. showed similar variability that started with 6 of 6 correct for both

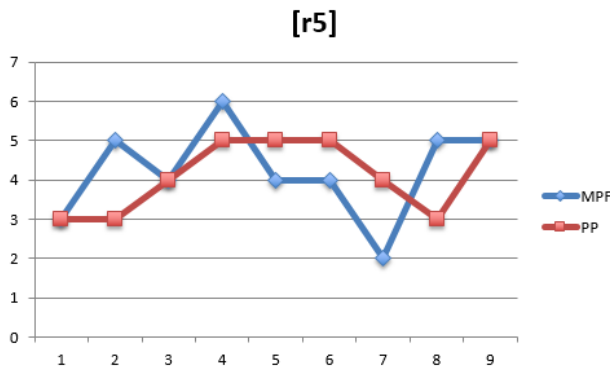


Figure 4.5. Profile subject r5

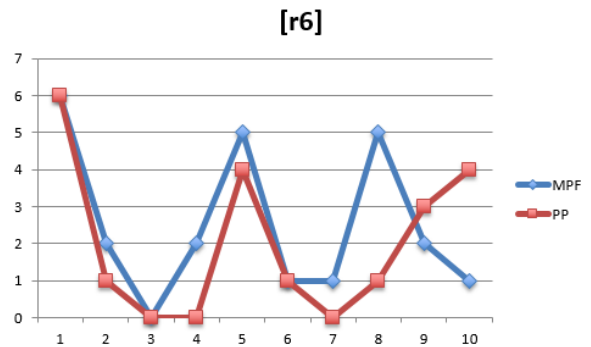


Figure 4.6. Profile of subject r6

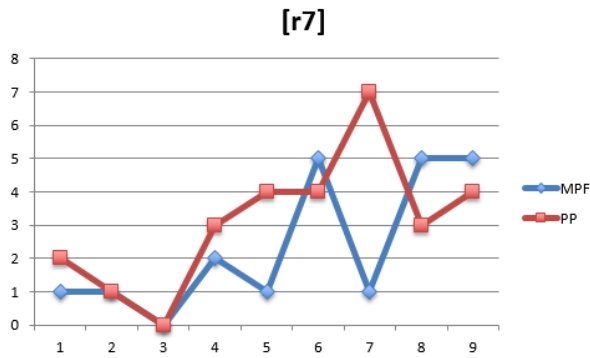


Figure 4.7. Profile of subject r7

picture types and then dropped to 0 and then back up to 5. This patterns occurred twice within the ten sessions. Within this variability, the MPF had a greater number of correct responses (5) or ties (3) for 8 out of 10 sessions.

Figure 4.7 showed that Subject r7 showed a fairly steady increase in correct responses for both conditions except for a drop in session 7 for MPF. MPF elicited more correct responses for the final two sessions. None of these patterns followed the predicted steady increase in correct productions for either picture condition. To determine if one condition showed overall better results, the mean gain scores across subjects were compared.

Table 4.1 shows the mean gain for subjects in the MPF and Plain Picture conditions. The subject means show an advantage to the MPF condition for all seven subjects who accurately produced the target phoneme an average of 3.23 of 6 productions (SD = 1.14) for MPF. In contrast, when using PP cards, the same children accurately produced target phonemes an average of 2.81 of 6 productions (SD = 1.10).

Table 4.1. Mean Number of Correct / ɪ / Productions for Subjects in the MPF and PP Picture Conditions

Subject	r1	r2	r3	r4	r5	r6	r7	Mean	StDev
MPF	1.18*	4.27*	4.38*	3.83*	4.22*	2.5*	3.23*	3.23	1.14
PP	0.45	2.75	3.42	3.5	4.11	2.33	2.81	2.81	1.10

\*condition generating the greatest number of correct productions

A binomial test measures the probability that a sequence of events will happen by chance alone. The binomial probability that all seven subjects would produce more correct productions in response to the MPF stimuli is  $p < 0.008$ . This result indicates that the pictured representation of tongue configuration for /ɹ/ productions aided the subjects' correct production of /ɹ/.

**Results for /s/.** The seven children receiving treatment for /s/ averaged eight sessions (range 5-9 sessions;  $\bar{x} = 8.42$ ,  $SD = 2.36$ ). Figures 4.8. through 4.14. profile probe results across the sessions. Examination of Figure 4.8. shows that for the MPF pictures, subject s1 scored 3 out of 6 correct or greater for 5 out of 8 probes, reaching a high of 5 correct productions twice. In contrast, using PP cards only achieved a score of 3 or greater three times, with high scores of 4 occurring during the first two sessions. While MPF achieved 5 of 6 on the final probe, the PP elicited only one correct production. Figure 4.9. shows that subject s9 showed variable accuracy across sessions, but the MPF pictures showed more correct productions for 3 of the 9 sessions and one tie. The PP condition showed more correct productions during the initial three sessions and the final session.

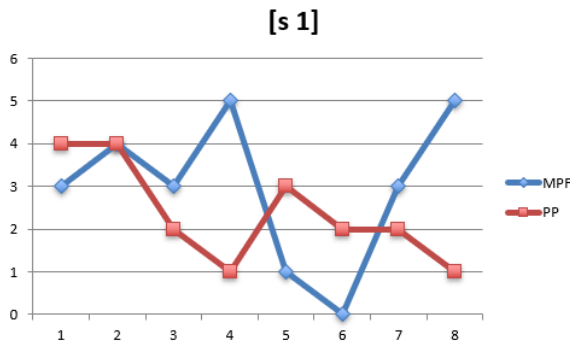


Figure 4.8. Profile of subject s1

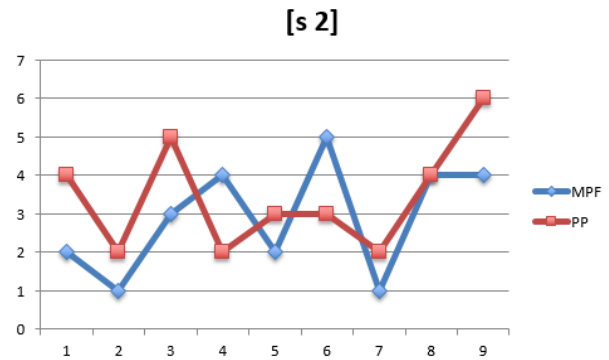


Figure 4.9. Profile of subject s2

Figure 4.10. reveals that MPF showed an early advantage with 4 to 6 correct productions for the first 4 weeks and then a steep fall in accuracy. The PP cards also had four sessions with 4 or 5 correct productions. After a drop on week six, both had 3 correct productions the final week.

Figure 4.11. reveals that subject s4 performed at a high level of correct productions for both picture conditions with a slight advantage to MPF until the final session.

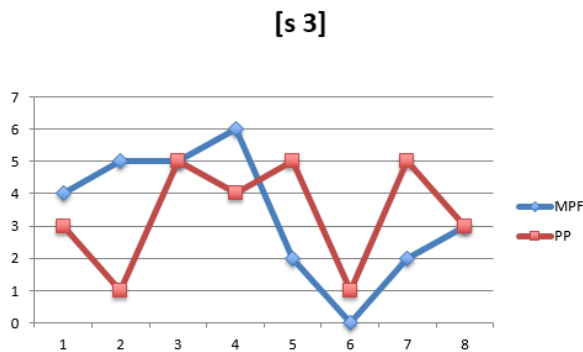


Figure 4.10. Profile of subject s3

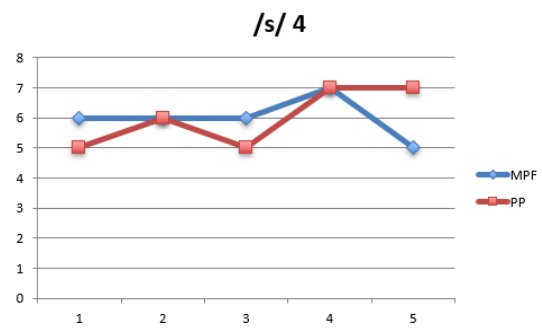


Figure 4.11. Profile of subject s4

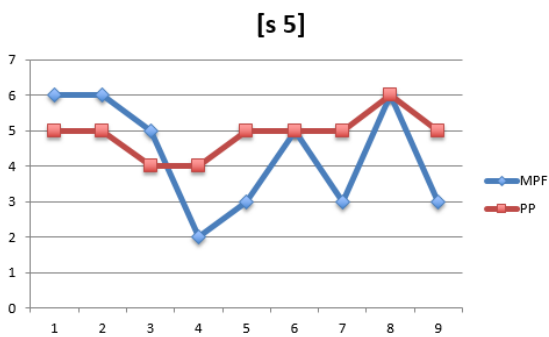


Figure 4.12. Profile of subject s5

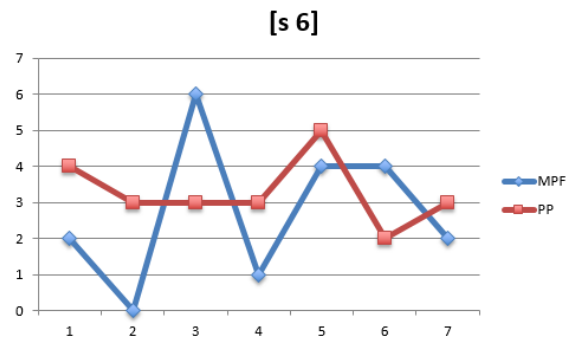


Figure 4.13. Profile of subject s6

Figure 4.11. showed that subject s5 had an initial advantage to MPF for the first three sessions, but variable performance across the final six sessions, while responses to the PP cards were consistent across time. However, MPF elicited 6 out of 6 correct responses three times while PP achieved this level once. Figure 4.12. also shows that for subject s6 MPF pictures elicited greater variability across the seven weeks while the PP showed more consistent and generally higher responses. However, only MPF achieved 6 out of 6 correct responses.

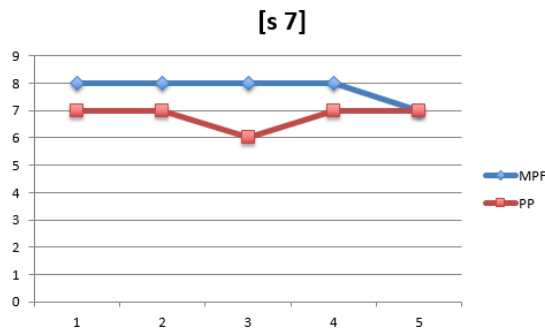


Figure 4.14. Profile of subject s1

Figure 4.13. reveals that subject s7 elicited 8 out of 8 correct responses for the first for weeks compared to s6-s7 for the PP, with both scoring 7 the final session (of 8). Note that subjects s4 and s7 both were at a generalization phase of treatment and thus had fewer weekly sessions according to their Individualized Education Program. Both showed a slight advantage for MPF words until the final session. None of these patterns followed the predicted steady increase in correct productions for either picture condition. To determine if one condition showed overall better results, the mean gain scores across subjects were compared.

Table 4.2. shows the mean gain for s-subjects in the MPF and PP conditions. Children receiving treatment for phoneme / s / accurately produced target phoneme an average of 4.28 of 6 productions (SD = 1.78) when using MPF pictures. Similarly, the same children produced 4.38 of 6 (SD = 1.34) when using PP cards.

Table 4.2 Mean Number of Correct / s / Productions for Subjects in the MPF and PP Picture Conditions

Subject	s1	s2	s3	s4	s5	s6	s7	Mean	StDev
MPF	3.00	2.89	3.38	6.00*	4.20	2.71	7.80*	4.28	1.78
PP	3.13*	3.44*	3.38	5.75	4.90*	3.29*	6.80	4.38	1.34

\*condition generating the greatest number of correct productions

The binomial probability that 4 out of 7 children would produce more correct productions in the PP condition was  $p < 0.09$ . This indicates that the MPF representations of

/ s / production did not improve the subjects' correction of / s /. The MPF representation for / s / may have been interpreted as more of a cue to the auditory "hissiness" of the / s / and cue to tongue placement at the alveolar ridge with a central tongue groove. Thus, children may have perceived that they were producing the pictured sound as opposed to a distortion with similar characteristics. This finding may attribute to the acoustic increase in intensity discussed later in spectral analysis.

**Summary.** For Question 1 we predicted an advantage to MPF pictures because the faces provided speech production cues that could prompt articulatory placement. All seven of the subjects showed greater production accuracy with MPF pictures for the / ɪ / phoneme, an occurrence that was unlikely to occur by chance alone. However, only three of the subjects showed greater or equal accuracy with MPF pictures for the / s / phoneme, suggesting the picture cue didn't sufficiently prompt important features critical to an accurate production of / s /.

## **Question 2**

For the second question we asked whether subjects would recognize more sight words to which they were exposed via the MPF picture words compared to the PP pictures accompanied by the printed words. If the spelling of the words superimposed into the pictures on the MPF resulted in incidental learning without direct instruction, greater gain scores from pretest to posttest in favor of the MPF words would be expected.

Table 4.3. profiles the number of sight words recognized at pretest and posttest for words subjects were exposed to as MPF words and PP words. The means showed the subjects knew more MPF words at pretest, more PP words at posttest, with a total score higher for MPF words. The differences in all cases are small.



Table 4.3. Mean Gain in the Number of Sight Words Recognized in the MPF and PP Picture Conditions

MPF Words							PP Words									
Subject	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
	MPF	MPF	MPF	MPF	MPF	MPF	MPF	MPF	PP	PP	PP	PP	PP	PP	PP	PP
Pre	9	8	1	12	6	24	5	0	7	7	0	11	1	19	3	0
Post	13	9	2	10	4	15	9	0	9	14	1	5	7	27	7	0
Gain	4	1	1	-2	-2	9	4	0	2	7	1	-6	6	8	4	0
Overall Means	Pre = 8.13; Post = 7.75; Total = 7.94							Pre = 6.0; Post = 8.75; Total = 7.38								

To determine if the gain scores represented a significant change from pretest to posttest a 2x2 Two-Factor (time x group; MPF, PP) ANOVA with repeated measures on both factors was conducted. No difference was shown for time ( $F = 1.55$ ,  $df 1, 7$ ,  $p = .25$ ), word type ( $F=0.47$ ,  $df 1, 7$ ,  $p = 0.52$ ), or time x word type interaction ( $F = 1.65$ ;  $df 1,7$ ,  $p = 0.24$ ).

**Summary.** Question 2 predicted an advantage to MPF pictures because the words superimposed into the pictures enabled both print and meaning to overlap in a single visual image. Results showed a nonsignificant gain in sight words for either word type (i.e., MPF or PP).

### Question 3

For question three we asked whether subjects would be able to decode a greater number of CVC, CVVC and CVCe pseudowords following exposure to these word patterns in both picture conditions. If exposure to the words resulted in incidental learning of the patterns without direct instruction, significant gain scores from pretest to posttest would be expected.

Table 4.4 profiles the pretest and posttest scores for each subject who received treatment for /ɪ/ and those who received treatment for /s/. The results show minimal gain scores for all but subject r7. Four subjects in the /ɪ/ condition and two in the /s/ condition showed negative gains.

Table 4.4. Pretest, Posttest and Gain Decoding Scores for Subjects Receiving Treatment for / ɪ / and / s /

	/ ɪ / Subject Scores							/ s / Subject Scores						
Subject	r1	r2	r3	r4	r5	r6	r7	s1	s2	s3	s4	s5	s6	s7
Pre	14	21	22	5	25	17	11	0	2	16	23	35	0	15
Post	14	19	18	6	21	21	32	5	4	11	26	30	0	17
Gain	0	-2	-4	1	-4	4	21	5	2	-5	3	-5	0	2

To determine if the gain scores represented a significant change from pretest to posttest a 2x2

Two-Factor (time x group; / ɪ / / s /) ANOVA with repeated measures on one factor was

conducted. No difference was shown for time ( $F = 0.74$ ,  $df 1, 13$ ,  $p = .407$ ) or group ( $F=0.51$ ,  $df$

$1,14$ ,  $p = .489$ ).

**Summary.** Results indicate that no incidental learning of the phonic patterns present in the words used in the study occurred for either MPF or PP stimuli.

#### Question 4

For Question four we asked whether subjects who demonstrate improved productions according to listener perception also show changes in acoustic formant trajectories for /ɪ/ and intensity for /s/ phonemes. An analysis of pretest and posttest productions of the /ɪ/ phoneme were used to address this question.

**Acoustic Analysis of /ɪ/.** Pre- and post-treatment recordings of subjects r3, r4 and r5 were analyzed for these values and can be seen in Figure 4.15. Subject r4 showed a decrease in F2 that corresponds to reduced lip rounding and a decrease in F3. The decrease in F2 alongside a decrease in F3, causes for the difference of F3 and F2 to adversely shift. Likewise, subject r3 and r4 showed a similar formant trajectory of a decreasing F2 yet maintaining a F2-F3 value. For accurate production, the difference between the third formant and second formant of the r productions compared at pretest and posttest should be smaller for a better /ɪ/ production. The means and standard deviations were taken from the subject as a group.

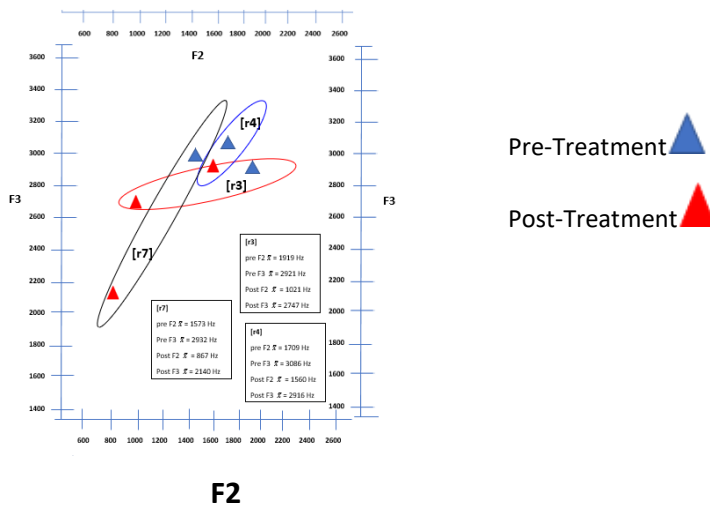


Figure 4.15. Pre- and post-treatment recordings of subjects r3, r4 and r5

The pretest R3-R2 mean was 1246 (SD = 173), while the posttest R3-R2 mean was 1438 (SD = 209). A t-test revealed a nonsignificant finding, with the mean difference increasing rather than decreasing. All participants followed a similar trajectory of lowered F2 and variance in change of F3. It should be noted that the mean number of sessions of these 3 subjects was 9.33 sessions, equivalent to roughly 74 minutes of therapy time. Duration and intensity of sessions could attribute to variation in acoustic changes.

**Acoustic Analysis of / s / .** Figure 4.16. profiles the pre- and post-treatment recordings of subjects s1, s5 and s6. Analysis of phoneme / s / showed that all three subjects increased their degree of intensity. It was posited that the use of MorphoPhonic Faces might better establish a distinct contrast between / s / and the similar fricative / θ /. This can be seen with the marked increased in intensity as shown in Figure 4.16. Spectral Centroid was the second parameter of / s / description and it was found that subjects [s1] and [s5] demonstrated marked increases in these values, suggesting increased brightness or distinction from other similar sounding fricatives. This finding corresponded with weekly / s / post-treatment assessment; s1 and s5 showcasing a positive learning curve as shown in the individual graphs of Figure 4.16.

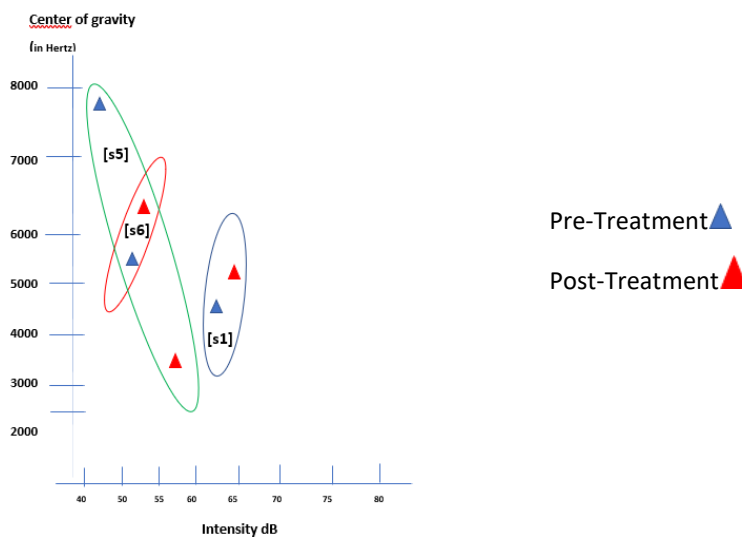


Figure 4.16. Pre- and post-treatment recordings of subjects s1, s5 and s6

Despite these individual changes. T-tests were used to compare the average intensity for three subjects at pretest and posttest, as well as the average center of gravity for the / s / phoneme. Results revealed the average s intensity was 54.81 (SD = 6.75) at pretest and 58.71 (SD = 4.44) at posttest. This difference was not statistically reliable ( $t(2) = 0.68$   $p < 0.53$ ). Similarly, the average center of gravity for / s / was 5905 (SD=1534) at pretest and 1063 (SD = 1063) at posttest. This difference was not statistically reliable ( $t(2) = 0.60$   $p < 0.58$ ).

### **Summary**

Results of the acoustic analyses revealed no differences between pretest and posttest for either phoneme.

## CHAPTER 6. DISCUSSION

This study examined the effects of two picture types on the speech sound productions of children with dyslexia and comorbid misarticulations of the / s / and / ɪ / phonemes. Two premises were assumed in the choice of MorphoPhonic Faces as a picture type that may hold advantages over the traditional plain picture cards. The first is that the onset phoneme of a word is pictured as a face with the letter representing key speech production features such as tongue placement (for both / s / and / ɪ /) and manner as in the waving line to indicate tumbling air emanating from between the teeth of the / s / face. The second is that the MPF cards establish an association between speech sound production and literacy. Letters represent the position of articulators, and thus promote letter-sound associations. Letters are also superimposed with pictures suggesting the meaning of the words for the rime elements, a format that in previous studies has shown positive outcomes for sight word learning (McInnis, 2008; Powell, Hartman, Hoffman, & Norris, 2007; Terrell, 2007; Williams, 2013). Finally, the words practiced within each session all conformed to either a common short vowel pattern (CVC or CVCC) or a long vowel pattern (CVVC or CVCe) that could be exploited by talking about the patterns and examining them in the word spelling as part of the lesson. These advantages could be beneficial to the many children with concomitant reading disabilities and speech sound disorders, including the children with dyslexia in this study.

The first question of this study asked whether the speech production cues provided by the MPF pictures would prompt more accurate speech productions than traditional articulation pictures. All 14 subjects received both types of pictures during the same treatment session, with six MPF and six PP stimulus cards. The results for this question were mixed. All seven children produced a greater number of correct / ɪ / productions in response to the MPF pictures than the

PP pictures. In contrast, no advantage was found for the MPF pictures for the /s/ phoneme. One explanation is that a common substitution for /ɪ/ is the /w/ phoneme. The picture for the MPF /ɪ/ depicts the side of the tongue positioned toward the back of the mouth with the tongue tip elevated. This does not resemble the position of the /w/ phoneme and following a few demonstrations of the differences by the clinician, the picture alone may prompt recognition. In addition, the character's name, Arlene, was used to help children find the correct tongue tip elevation because the transition from the /ɪ/ to the /l/ phonemes when saying the name guided the /ɪ/ into the tongue tip elevated position.

In contrast, the MPF picture was less successful in cuing the correct production for the /s/ phoneme. The MPF shows the tongue high in the mouth directing the airstream past the teeth, thus providing placement and manner cues. However, unlike the /w/ - /ɪ/ contrast, most error productions for /s/, such as /θ/ or a distortion of /s/, are similarly produced as fricatives with high front tongue placement. The MPF does not picture the central tongue groove characteristic of a correct /s/ production. The four students who had fewer correct productions for MPF /s/ were highly variable in their accuracy, with profiles that fluctuated between 0 to 6 correct across sessions while showing more stable productions for PP. More research is needed to more definitively determine whether pictured speech production cues facilitate correct articulation and if there is a differential effect between phonemes.

The second question asked whether greater sight word learning would occur for the MPF words without direct instruction. The overlapping print and pictures depicting the word meaning were a prominent part of the picture cue in the MPF condition and have been shown to prompt word recognition in children as young as two (McInnis, 2008). Both picture types additionally presented the printed word in the top right hand corner of the card. In this study, despite repeated

exposure to the printed words, results showed that students failed to acquire significantly more sight words for either the MPF or PP words to which they were exposed. However, two important differences between this study and others (McInnis, 2008; Powell, Hartman, Hoffman, & Norris, 2007; Terrell, 2007; Williams, 2013) are time and direct instruction. For example, McInnis provided explicit direct instruction on the same 16 words (8 MPF and 8 PP) during 15-20 minute sessions three times weekly for 6 weeks (i.e., 18 sessions). That totaled 4.5 to 6 hours of focused sight word learning instruction. In contrast, subjects in this study received 5 to 12 treatment sessions of approximately 8 minutes each, for a total of 40 to 96 minutes focused on articulation. Furthermore, the picture set was changed each week so the 6 MPF and 6 PP words were only seen 2 to 4 times (16 to 32 minutes of incidental exposure). Future studies need to explore sight word learning concomitant with articulation therapy under conditions of longer sessions, direct focus on both articulation and sight words, and consistent exposure to the same words across time.

Similar considerations also pertain to the third question, or whether incidental learning of orthographic patterns would occur as a result of exposure to words following short and long vowel patterns. The patterns were present in all of the word cards but were not highlighted or explained. Therefore, it would have been surprising if children noticed, learned and generalized the patterns at posttest. Only one subject, who also made the greatest change in articulation of the /ɪ/ phoneme, made a notable change in decoding. Seven of the children made no gain or decreased in decoding nonsense words, a finding that is not surprising for students with dyslexia.

The fourth question asked whether improved speech sound productions according to listener perception would show similar changes in a spectrographic analysis of pretest and posttest speech samples. The results from the six subjects were nonsignificant. For production of



/ɹ/, frequencies F2 and F3 were analyzed for changes that would indicate increased rhoticity. For all three subjects, F2 and F3 values simultaneously decreased. Ideally, as one formant decreases, the other would increase so that the difference between F2 and F3 values became smaller; conversely, the opposite occurred. Subjects r3, r4, and r5 showed decreases in both F2 and F3 values. Thus, positive spectral changes in production accuracy were not achieved. According to the literature, /ɹ/ is notoriously difficult to acquire with its emergence beginning at age three to mastery occurring at age six (Smit et al., 1990). Distortion of /ɹ/ is common among adolescents who display residual speech errors despite years of therapy (Preston & Edwards, 2007). Given the typical amount of time needed to master this speech sound, it follows that approximately nine sessions of articulation treatment would be unlikely to result in changes that generalized from the treatment session to the spontaneous speech sample used for the acoustic analysis. This suggests that an increase in duration and intensity of treatment would be required to facilitate a lasting and stable production of /r/.

In contrast, the values analyzed for production of /s/ demonstrated minimal, though positive acoustic changes. Intensity and Spectral centroid values increased for all three subjects and showed that overall treatment, both PP and MPF, facilitated a positive, though not statistically significant, learning curve for accurate /s/ production. Though the MPF demonstrated limitations in visual representation of the lingual central groove, the wavy line image provided a cue that could explain the increase of intensity during /s/ productions. Similar to /ɹ/, more sessions would be needed to identify a stable acoustic pattern of sound productions.

### **Limitations**

**Setting.** The school where the study took place provides articulation therapy to students via a supervisor and student clinicians from the university. This provided a sizable population of

subjects who had Individualized Education Programs for either the / ɪ / or / s / phoneme. All students received individual therapy focused on the target sound. However, it also imposed restrictions. The school used the 10-minute articulation treatment model that generally amounted to 8 minutes of actual treatment including the probe. Treatment took place in the hallway outside of classrooms throughout the school. Several sessions took place simultaneously and so monitoring for fidelity was difficult. The typical interruptions found in schools occurred with relative frequency, including announcements, bells, distracting noises, and students in the hallway during transitions and bathroom breaks. Students were seen for two-to-four sessions weekly based on their Individual Education Programs, with those displaying higher levels of correct productions receiving less time. This school is a 12-month school, designed to lessen the effects of long vacations on retaining learning for children with dyslexia. However, this results in breaks of one to two weeks distributed across the school year so it was not possible to provide treatment for longer than four weeks. Although efforts were made to find quiet locations for pre- and post-testing, for many subjects the available rooms were shared and noise and distractions were issues. Each of these factors presented potential threats to the reliability of findings.

**Clinicians.** The clinicians who implemented the treatment were nine masters students completing a supervised practicum, including six who were participating in their first clinical experience. Before the study began, training was provided to judge speech sound productions for correctness. Although this resulted in high interrater reliability, these judgments were made in a quiet environment using audio recordings. Making these judgements in a potentially noisy and distracting environment to children with variable attention to the task increased the

possibility of error in judgements, especially with inexperienced raters (Munson, Johnson, & Edwards, 2012).

The clinicians also were provided training in the procedures, including watching a videotape, receiving written instructions, and receiving modeling with their child from the researcher. However, clinicians differed in skill levels, enthusiasm, and ability to elicit speech sounds from children who were not stimuable during treatments. Although one researcher and a supervisor were present to model, provide feedback, and reinstruct as needed, the eight-minute sessions did not allow for one-to-one supervision of the nine masters students daily. In addition, clinicians were scheduled for either Monday-Wednesday or Tuesday-Thursday sessions at the school. Therefore, 12 of the 14 subjects were seen by two different clinicians during the week, potentially introducing inconsistency of treatment implementation.

**Sight Word Task Administration.** Two issues may have contributed to the finding that several subjects decreased word recognition at posttest. First, the 48 words used in treatment plus 16 control words presented a challenging task for children with dyslexia. The words were printed on a single page with four columns of 16 words printed in 24-point font. This many words may have been visually distracting and overwhelming to a child with dyslexia. Individual flash cards may have elicited responses that were more reliable.

Secondly, during pretesting the researcher administered some of the sight word tests to subjects while the clinicians administered others due to time constraints. The task required subjects to read the word lists without prompts within three seconds per word. The finding that several scores at posttest decreased from pretest suggests that clinicians may have allowed more than three seconds, thus allowing time for subjects to decode the words.

## CHAPTER 7. FUTURE STUDIES

Given the short period of treatment with minimal total minutes (ranging from 40 to 92 minutes) and the many potential threats to reliability and validity, this study should be considered a pilot study. All of the procedures, materials, and measures were unique to this study and were generated by the student researcher and mentor within the semester of the study, precluding an early start to the treatment and leaving only five weeks to pretest subjects and implement four weeks of treatment before the student clinician practicum was over. It is encouraging that despite the many challenges encountered, participants receiving treatment for /r/ showed higher levels of production for MPF pictures on daily probes. The study revealed several changes that could be implemented to explore the questions of this study in the future with greater fidelity. These include:

- a) Implementing the study for a minim duration of six weeks;
- b) Lengthening sessions to minimally 30 minutes;
- c) Maintaining the same clinician for all treatment sessions across subjects;
- d) Providing a longer period of training prior to study initiation;
- e) Implementing the study with fewer subjects in a clinical setting where noise and other distractions can be better controlled;
- f) Weekly recordings of speech sound productions from both stimulus types for acoustic analysis;
- g) Establishing a baseline of the subjects' speech sound productions before implementing treatment, including a more complete description of the type(s) of errors exhibited and level of stimulability;

- h) Providing direct instruction to both speech sound productions and print during the session.

### **Concluding remarks**

This pilot study showed indications that the use of speech production cues aided in the production of word initial / ɪ / over the span of 4 weeks of 8-minute intervention sessions. The duration of treatment was not long enough to produce a stable and positive acoustic change; however, the results are promising for both / s / and / ɪ / given that mean changes demonstrated a perceptual change in production accuracy. A future study is needed to explore the efficacy of picture placement cues needed for remediation of / s /. In addition, a study that explores the effects of longer treatment implementation with greater control over external factors to further explore the efficacy of pictured speech production cues in speech sound remediation is warranted.

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**APPENDIX**  
Scripts for Language Elicitation Task

**Four Scripts for / s / phoneme:**

/ s / Script 1: Page A

This is our first story, listen carefully.

“A small sad girl named Sam sat in the sun. Some soap was spilled on her seat. Sam started to sob.” (12/21)

Now, you tell me the story, when I say go. (Turn on recorder) Go.

/ s / Script 2: Page B

Listen carefully to our next story.

“Sally steps on the stairs to give Suzy six sandy socks. Suzy soaks the socks with suds in the sink.” (12/20)

Now, you tell me the story, when I say go. (Turn on recorder) Go.

/ s / Script 3: Page C

(Insert positive feedback, e.g., I like the way you are listening).

Listen carefully to our third story.

“Sara sits in the sun on a stool and sews silk sachels to sell. Her sales cart sits in the sand by the sea.” (12/24)

Now, you tell me the story, when I say go. (Turn on recorder) Go.

/ s / Script 4: Page D

This is our last story, listen carefully.

Seth is six. Seth sits under a tree sipping strawberry soda. He sat up and was sad to see his things soaked in tree sap..” (12/25)

Now, you tell me the story, when I say go. (Turn on recorder) Go.

## VITA

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