4-2-2023

Phonic Faces as a Method for Improving Decoding for Children with Persistent Decoding Deficits

Chantal H Farag hanna
Louisiana State University and Agricultural and Mechanical College

PHONIC FACES AS A METHOD FOR IMPROVING DECODING FOR CHILDREN WITH PERSISTENT DECODING DEFICITS

A Thesis

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Master of Communication Sciences and Disorders

in

The Department of Communication Sciences and Disorders

by
Chantal H Farag hanna
B.S., Texas Woman's University, May 2017
May 2023

ACKNOWLEDGMENTS

First and foremost, I wish to acknowledge my thesis committee, Dr. Janet Norris, Dr. Paul Hoffman and Dr. Julie Schneider for their support, insights and guidance. Dr. Norris, this project would not have been as fascinating and as fulfilling if it wasn't for your tremendous expertise. Thank you for your dedication, patience and support. I am so grateful I had this opportunity to learn from you. And finally, to my parents and brother, thank you for your unconditional love and support. To my dad, thank you for paving the way for me. Thank you for your advices, your playlists and your music that got me through many nights of writing. I would not have had the courage to do this process if it wasn't for you and mom. To my mom, thank you for being my rock, my confidant, my best friend. To my brother, thank you for listening whenever I needed you to. And to my little nephew, I know you cannot read now, but soon you will and I want you to know that your smile has got me through some tough nights. I am grateful for you all, your love and guidance shaped me into who I am today. Finally, I would like to thank all the individuals who participated in this study. This would not have been possible without all of you.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

PF	Phonic Faces
VA	Vowel Accuracy
WA	Word Accuracy

ABSTRACT

Background: Decoding is a foundational skill for reading, contributing to both reading fluency and comprehension (Lyon et al., 2003). Visual enhancements of alphabetic letters such as shaping letters to resemble words beginning with that sound (e.g., “f” drawn as a flower) (Handler & Fierson, 2011) and associating photographs of lips producing the sounds (Lindamood & Lindamood, 1998) have been shown to improve decoding skills. This study investigated whether a more direct pictured association using faces with alphabet letters placed in the mouth to cue speech sounds, termed Phonic Faces (Norris,2001), would enable students with persistent decoding impairment to acquire orthographic patterns in pseudowords, real words, and reading passages. **Methods:** A multiple baseline single subject design assessed the effects of Phonic Faces on learning to decode two orthographic patterns. Three participants were taught the short vowel CVC pattern for five weeks using words and pseudowords displayed using Phonic Faces while two long-vowel patterns (CVCe and CVVC) remained in an untrained baseline condition. On week six, a five-week intervention was introduced for the long vowel pattern showing the lowest scores on daily pseudoword probes. **Results:** The results of the study were suggestive but not conclusive. The graphs of daily probe scores for all three subjects showed significant gains for all three patterns using the two standard deviation method of analysis. However, in all three cases, one or more of the control variables made changes prior to the introduction of treatment. Additionally, pre-to-posttest gains in measures of decoding and contextualized reading showed scores greater than the SEM, indicating true gains.

Discussion: Analysis of patterns of change showed generalization of learning across patterns. Once the long vowel Phonic Faces were introduced, improvements were shown for both long vowel patterns. Likewise, the long and short vowels were embedded in similar patterns of 2-3 letter consonant blends and digraphs, all of which scored at low levels at pretest. However, once the consonant patterns were learned in the CVC words, they generalized quickly to long vowel words, especially for participants who scored

higher on vowel knowledge at pretest. Replication with decoders exhibiting greater impairment is recommended.

CHAPTER 1. INTRODUCTION

According to Lyon (1996) and Jacobson (1999), reading disabilities are deficits that persist over time rather than deficits that are considered a developmental lag. In other words, children who have difficulty acquiring the alphabetic principle that establishes the neurological links between oral and written language are likely to have persistent decoding deficits throughout the school years and beyond. Lyon (1996) showed that children with reading disabilities who were not identified until the third grade continued to exhibit the same difficulties through the ninth grade and beyond, even with explicit intervention provided. A longitudinal study conducted by the Annie E. Casey Foundation (2010) showed that 88% of students who fail to graduate from high school were poor readers in third grade.

Children who have reading disabilities have difficulties with word recognition and production that affects reading and spelling (Lyon et al., 2003). Students with reading disabilities have average intelligence and exposure to literacy but fail to read fluently despite appropriate instruction. These children typically have difficulties in decoding, which reflects deficits in phonological processing. All of these abilities are language related, making the speech-language pathologist (SLP) ideally trained to work with students with reading disabilities. When populations of learning-disabled children have been tested, up to 91% have been found to also have a speech and/or language disorder (Gregory et al., 2009). These findings have resulted in ASHA developing a position statement regarding the critical role of the SLP in the assessment and treatment of reading disabilities (ASHA, 2001).

Children with reading and language disabilities perform poorly on tasks of phonological awareness such as identifying, manipulating, and recalling different speech sounds in a word. Phonological awareness deficits are highly correlated with decoding and encoding, which affect reading fluency, writing, spelling, reading comprehension, and vocabulary acquisition (McArthur et al., 2012). The grapheme-phoneme correspondence (GPC) of letters in the English alphabet is foundational to learning to decode. Transparent

orthographies are present in languages that have one sound and one letter uniquely matched – sounds and letters have a one-to-one ratio. English is a complex language because letters can be linked to more than one phoneme using orthographic strategies involving vowel and consonant digraphs and diphthongs, as well as irregular forms (i.e., a translucent orthography). This results in higher levels of reading disabilities among readers of English compared to languages with transparent orthographies (Adams, 1990; Zarić et al., 2020).

Visual enhancements of alphabetic letters have been shown to assist poor readers of varying etiologies to improve reading skills (Handler & Fierson, 2011). Alphabets have been visually enhanced to show a relationship of a letter to a word beginning with that sound (e.g., Itchy's Alphabet, Larson, 1998) to cue letter-sound associations, but these associations depend on the child having the phonemic awareness skills to make the association on their own (Kaufman et al., 2007). Norris (2001) developed a visually enhanced alphabet where a more direct relationship between phonemes and graphemes is depicted, termed Phonic Faces. Articulatory gestures are depicted in the mouths of faces with elements of the letter suggesting sound production (e.g., the vertical line of letter "P" indicates stopping the sound inside the mouth while the curved line suggests a top lip releasing the sound).

The purpose of this study is to determine whether teaching orthographic syllable patterns using the speech production-cued Phonic Faces alphabet will assist students with persistent decoding impairment to acquire phonological awareness (i.e., phoneme segmentation and blending) and orthographic patterns in pseudowords, real words, and reading passages. The intervention will be delivered via telepractice.

Telepractice Delivery of Intervention

Telepractice, also known as telehealth, is a method for conducting assessments and interventions using internet technology (Akemoglu et al., 2020b; Meadan & Daczewitz, 2015). Delivering speech and language services via technology has been occurring for 45 years in populations such as adult veterans using mechanisms such as radio, satellite, telephone and closed circuit television. References to

telepractice with school-age children occur as early as 1999. However, the availability of broadband internet and modern platforms has made telepractice a common service delivery option that is approved by the American Speech-Language Hearing Association (ASHA) (Troia & Wallace, 2022).

Wales et al. (2017) conducted a systematic review of seven studies comparing telepractice service delivery to in-person delivery for children with speech and/or language impairments. The results showed that the telepractice participants made significant and similar gains to those receiving in-person treatments. Coufal et al. (2018) used data from the ASHA K-12 Schools National Outcomes Measurement System (NOMS; ASHA, 2003) to compare outcomes from 1,331 students receiving in-person treatment for speech sound disorders to 428 receiving telepractice services. No significant outcome differences between the two groups were found. Masaji et al. (2021) conducted a study using NOMS to compare language outcomes for children between six-to-nine years of age receiving in-person versus telepractice services. Outcome measures of both receptive (946 in-person, 254 telepractice) and expressive language (1,214 in-person, 408 telepractice) treatments showed comparable gains.

While the number of studies examining the efficacy of telepractice interventions for school-age children is limited, the data suggests that this service delivery option is valid and effective. Garnett et al. (2021) noted that telepractice delivery has the advantage of being more time-effective for both the person implementing the treatment and for the recipient. In-person interventions require considerable time and effort to travel to the treatment location, sign-in, and reach the treatment room, while telepractice can be accessed at-home using a computer.

Telepractice in this study makes it possible to provide the experimental treatment to three subjects; three times weekly in the time available after school. Telepractice also enables subjects to be recruited that meet the criteria without regard to geographic location, this widening the potential subject pool.

Alphabetic and Orthographic Principles

The primary goal of this study is to determine whether an alphabet that uses speech-production cues to link phonemes to graphemes can enable children with persistent decoding impairment to acquire the foundational skills (i.e., phoneme segmentation and blending) and orthographic patterns in pseudowords, real words, and reading passages. The literature review will discuss current theories regarding the importance and acquisition of the alphabetic principle and orthographic patterns. The studies exploring interventions for decoding syllables using pseudowords will be reviewed. Finally, research exploring different types of alphabets intended to facilitate this learning will be discussed.

Alphabetic Principle and Decoding

The alphabetic principle, also termed the alphabetic code, refers to a connection between letters with their associated sounds used to read and write. To accomplish this, an awareness that speech is comprised of sequences of sounds must be recognized (i.e., phonemic awareness), and letters must be recognized as visual symbols that represent these sounds. Orthography refers to a set of conventions for written language and includes standard rules for spelling, syllable breaks, capitalization, emphasis and punctuation. The challenge for readers and writers of English is to learn the conventions for using letters and letter combinations to represent the 44 sounds of English using only 26 alphabetic letters and to recognize and use them within syllables and words for decoding (i.e., sounding out words) and encoding (i.e., spelling). Phonics is a method of teaching the alphabetic code in progressively more complex units including letters and corresponding sounds, and groups of letters such as blends, rimes (i.e., word endings), syllables and words (Baker et al., 2018).

Mastering the alphabetic principle typically begins with learning the names of letters and associating them with the sounds of the language (Vadasy & Sanders, 2020). If the alphabet were a process of linking visual letters to auditory sounds, the process would be relatively easy. However, the result would be a useless accomplishment. To be useful, the sounds must be linked to cognitive

representations of speech sounds, or phonemes. Phonemes are meaningful units because they are linked to words in the mental dictionary, or lexicon (Ehri, 2005, 2020). As toddlers discover words, they construct phonemic representations of words based on the principle that a change in one phoneme represents a uniquely different word. These distinctions set up phonemic categories (Ladefoged, 2004). The words, differentiated by a single phoneme, represent different concepts (i.e., dog versus log, fog, or hog). Neurologically, they create phoneme distinctions consistent with the language. Likewise, the visual letters must form links to these phoneme categories. These mental representations for letters are termed graphemes (Kohrt, 1986; Lockwood, 2001). The letter sequences for written words form links to words in the lexicon through their connections to phoneme sequences. In this manner, written words access all of the same semantic, syntactic, and conceptual knowledge stored for a vocabulary word. When words are read, they are processed as language and comprehension results (Ehri, 1995, 2005).

This complex integration of phonological and orthographic knowledge allows for decoding to occur. Ehri (1992) refers to this as a process of phonological recoding. Readers see a graphic representation of a word and through the integrated mental representations recode them back into its spoken language form. At early stages of reading, children sound out words using sequential one-to-one correspondences between letters and sounds and scan their mental lexicons for potential matching words. At more advanced stages, they hierarchically decode words by scanning in larger groups of letters that enable patterns such as an “e” at the end of a word to cue a vowel shift to a long vowel sound. As more words are recoded, the expanded print lexicon alerts readers to patterns of letters that have been seen before and their corresponding changes in pronunciation. This self-refining process results in recognition of increasingly more complex patterns in words in a reciprocal interaction between decoding abilities and orthographic knowledge (Share, 2008).

Ehri (1979) proposed an amalgamation process to account for this integration of graphic information into existing amalgams for spoken words. Amalgamation is a process of uniting or merging two

or more things to form a new entity or amalgam. Typically, beginning readers have well established amalgams for spoken words in their lexicon. As children learn to read, they add new amalgams for print (i.e., the visual image of the word) to the pronunciation and meaning amalgams already stored in memory for that word. The mixture, or amalgamation, bonds print images to word pronunciation, thus enabling the print to activate all of the existing amalgams for meaning, grammar, and function. Eventually, a fully integrated amalgamation in memory allows for instant sight word recognition, supplanting the need for decoding. This process evolves gradually across years of development in childhood. Ehri (1995, 2005) profiled this progression in her phases of reading.

Ehri's Phases of Reading Development

According to Ehri (1995, 2005), skilled reading is the result of a prolonged developmental progression of phases that begin in early childhood and gradually evolve toward automatic word recognition and fluent reading. She recognizes four phases that all readers progress through when acquiring alphabetic knowledge. Children progress through the early phases when exposed to environmental print, guided storybook reading, and other sources of print. Higher level phases typically emerge from guided instruction in reading and writing. These phases represent flexible overlapping developments rather than clearly defined stages. However, children are categorized into the phase with which they share the greatest number of characteristics.

During the pre-reading phase, children are focused on meaning, symbols and context. They become increasingly interested in print, but their knowledge is not based on the sound-symbol relationship of the alphabet, but rather on visual features of the word and its meaning. Mason (1980) showed preschoolers "read" logos from brand names or labels, pointing to the brand name on a gum wrapper and reading "gum." She suggested attending to meaning cues serves the important insight that printed words can be read and have meaning. Another important development during this phase is the acquisition of a few real words that are recognized by sight because something in the shape of the letters reminds them of

the word meaning. For example, they may recognize the word “look” because the two “o”s look like eyes. Other examples are recognizing the words “monkey” and “dog” because the final letters look like legs or tails (Gates & Bocker, 1923; Gough, Juel, & Griffith, 1992).

Ehri (1995) emphasized that the accomplishments of this phase do not represent true word recognition. This view has been supported by researchers who created this type of word and found preschool-age children and older poor readers were able to learn sight words taught using this method better than a printed word alone condition (Blischak & McDaniel,1995; Miller & Miller, 1968, 1971). However, learning these words did not lead to alphabet skills or better decoding later in development.

The partial alphabetic phase evolves as children begin to form connections between written words and their pronunciations based on the alphabet. During this phase, a child remembers many, but not all of the letter sounds and matches some letters (graphemes) and their sounds (phonemes). They can read and write some familiar and common words with their partial letter-sound connections and exhibit developmental spelling. Miscues are common in reading as words are detected by first and last letters because the reader cannot separate words into all sequential phonemes, having particular difficulty with vowels and the 20 patterns differentiating long, short, digraph and diphthong vowels. Thus, the word “sent” might be mistaken for set, seat, spit, slat, soon or send (Ehri, 1995, 2005). She calls this word recognition “phonetic cue reading” and shows at this phase children have great difficulty decoding unfamiliar words. Poor readers can get stuck in this phase for years because they cannot identify the segments or cannot match the segments to appropriate sounds. This is particularly problematic for multisyllabic words.

The third phase is the full alphabetic stage, during which the child knows or acquires all of the graphemes and phonemes for the six syllable types, enabling them to decode unfamiliar words and after reading them a few times, enter them into memory where they can be retrieved as sight words. Since all of the graphemes are linked to sounds, miscues are greatly reduced, and self-corrections readily made.

According to Ehri (2020), graphemes and the knowledge of how to spell a spoken word will influence the way a child spells a relatively unfamiliar word (e.g., the child may not be familiar with the meaning but has seen the written word before). A child can spell an ambiguous word from memory once a visual representation has been established. Reading and internalizing the spelling of words may take several exposures before the word is stored into memory. Once remembered, seeing these words will quickly lead to neural activation every time that word is read. Seeing words through repeated exposures facilitates automatic word recognition and subsequently, more fluent reading.

The consolidated alphabet phase is the final stage of reading development, occurring at a point when the reader has analyzed and mentally represented many words. During this process, letter patterns that occur across many words (i.e., rimes, syllables, morphemes, and root words) are consolidated into word segments that are stored independently of the original words. These new hierarchical layers of word units, or chunks, can now be recognized by sight when they occur in unknown words. For example, the rime "-and" learned within the word "band" can be used to quickly recognize words like "stand," "grand," or "demand" without letter-by-letter decoding. These chunks enable decoding and encoding to occur much faster and more accurately than the letter-sound strategies of the full-alphabet stage. With less attention required for word recognition, the reader's resources are available for comprehension and higher-level meaning (Ehri, 1995, 2005).

Development of Orthographic Principles

Orthographic patterns are units that form during Ehri's (1995, 2005) full and consolidate phases. Apel (2011) defined orthographic knowledge as stored memories of the correct way a spoken word is represented in written form. Orthographic patterns include letter-sound relationships (alphabetic principle), the representation of 44 phonemes with 26 letters by using vowel combinations (digraphs, diphthongs, double vowels), and syllable patterns that signal whether a vowel letter will be pronounced in a long or short phoneme form. Orthographic knowledge also includes orthotactic constraints that allow letter

sequences in some word positions (ck in word middles like *cackle* or endings like *duck*) but not word beginnings like ckake (Apel, 2009). Orthographic knowledge is an essential skill because it contributes to automatic word recognition that in turn contributes to fluent reading (Zarić et al., 2020).

Orthographies across languages differ along a continuum in the degree to which graphemes correspond to phonemes. This is described as orthographic depth, and ranges from highly shallow or regular orthographies that maintain a one-letter-one-sound relationship between graphemes and phonemes (i.e., Turkish, Greek and Spanish), to English with one of the deepest orthographies (Katz & Frost, 1992). The English language is unique among alphabetic systems because the spellings of words and their pronunciations vary depending on the orthographic patterns in which they occur. This has led some researchers to argue English orthography should be considered-irregular because it is not pattern-based like regular orthographies. In contrast, Apel (2011) contends English is a patterned-based orthography, meaning not all spellings are letter–sound correspondent but they are overall fixed. This is because English regularity is not only recoded in letter-sound (grapheme-phoneme) correspondence, but also in syllabic, morphemic, and lexical regularities (Ehri, 2020). For example, English preserves phoneme-grapheme correspondence for double vowels, vowel and consonant digraphs, and diphthongs, morphological information in its orthography, spelling the morpheme consistently despite changes in pronunciation (e.g., spelling the past tense morpheme –ed the same in words like *rained* [d], walked [t], and started [id]). The vowel orthography further influences spelling at the syllable level, in that the final e is deleted for words ending in silent e before adding the morpheme (i.e., hope-hoped), and the final consonant in a CVC syllable is doubled before adding -ed if the syllable is stressed (e.g., hop-hopped, prefer-preferred). The spelling of root words is maintained when derivational morphemes are added despite changes in vowel pronunciation, as in melody-melodic or grade-gradual. In this case, the lexical level must be accessed to recognize the stem and shift vowel pronunciations in accord with oral language. Consonant pronunciations may shift as well, as in medic [k] – medicine [s] or donate [t] – donation [sh] (Chomsky, 1970).

Although terminology differed somewhat among researchers studying orthography, Apel (2011) concluded from the literature that the ability to read and spell words is based on the ability to acquire, store and use both mental grapheme representations (MGR) and orthographic rules. A mental grapheme representation is a stored mental representation for a written word or parts of a word (i.e., graphemes, syllables, digraphs, morphemes). Orthographic rules include letter-sound relationships (alphabetic principle), rules for combinations of letters that are and are not allowable in spelling, and orthotactic rules. Orthotactic rules refer to constraints on letter sequences or combinations, including how letters can and cannot be combined (e.g., *hr* is not a legal blend in English) or what word positions letter combinations can appear (e.g., *ck* can appear in word middle and final positions, but not initial) (Apel, 2009). The MGR is similar to Ehri's amalgamation theory in that both propose a mental structure composed of words and separate subunits for parts that unite across words (e.g., all words with the same rime). However, Apel's MGR is specific to grapheme representation, while Ehri's amalgam integrates grapheme information into the lexical word that contains phonological, syntactic, semantic and conceptual knowledge.

Apel (2009) conjectures that acquiring orthographic knowledge results from a combination of both implicit (i.e., acquired from exposure and applied without thought) and explicit (i.e., applied with conscious effort) knowledge. Some readers might acquire both patterns simultaneously and others might learn one pattern due to the other. Zarić and colleagues (2020) agree with Apel's view. They described the patterns as word-specific orthographic knowledge and general orthographic knowledge. Word-specific orthographic knowledge is measured on the lexical level. This means a reader with this ability can automatically access units within words (MGR acquisition). General orthographic knowledge is measured on the sub-lexical level. This describes the reader's awareness of specific letter patterns and the frequency of certain letter combination occurrences (orthotactic patterns). These letter patterns are referred to as phonograms (i.e., letter groups within a word that share a pattern across words. Zarić and colleagues believe that word specific and general orthographic patterns (i.e., phonograms) can co-occur together. This belief is

supported by the Dual-Route Model of reading that suggests an individual can rely on the lexical level when producing a word and/or on the sub-lexical level when presented with a novel word lacking prior mental representations (Wang et al., 2015).

Reading and spelling are evidence of an individual's level of development and ability to apply these two sources of written word knowledge. Words easily read or spelled indicate MGRs are established and can be applied to the task. Words decoded or spelled developmentally indicate that alphabetic, MGRs for word segments, and/or orthographic rules are being applied, either implicitly (without conscious effort) or explicitly (with conscious effort). Both are related to having *orthographic awareness* (Ehri, 1992). Like phonemic awareness, orthographic awareness indicates the individual can engage in mindful and conscious analysis of the structure of words, including MGRs for acquired words, sublexical word segments, and orthographic knowledge. Tasks used to measure implicit orthographic awareness include pseudoword reading and spelling unknown words. More explicit tasks require selecting the correct spelling between two orthographically plausible words, showing a nonsense word and then testing for recall, recognition and spelling, finding real words within a word chain (i.e., girlupgreet), or judging the acceptability of a letter pattern (as cited in Apel, 2011). Improving orthographic awareness would appear to be important to improving decoding skills in individuals with persistent word identification deficits.

Gustafson et al. (2000) provided phonological awareness training to fourth grade poor readers for one year. The training group made significantly greater progress in phonological awareness compared to a control group but their gains in reading skills were comparable to the controls. Analysis of profiles showed only those with good orthographic awareness at pretest made notable gains in reading, and that orthographic awareness predicted text reading before, during and after the intervention.

Summary. The acquisition of the fixed regularities of words, including rimes, morphemes, phonograms and syllable types provides a powerful scaffold for word recognition. Their use in decoding and spelling suggests storage of print information in both whole word MGRs and sublexical word segments.

In Ehri's (1995, 2005) consolidated phase, word segments, including rimes, vowel combinations, morphemes and syllable patterns can be stored and retrieved to recognize and spell unknown words. Readers who have not reached this stage of development will lack fluency in decoding and exhibit poor ability to segment multisyllabic words into syllable types. Research has explored whether interventions can lead to improvements in decoding in both typical and delayed readers.

Syllable Segmentation

Words can be segmented into smaller sublexical units, including onset-rimes and syllables. Oxford dictionary (n.d.) defines a syllable as a unit of pronunciation having one vowel sound, with or without surrounding consonants, forming the whole or a part of a word. When pronounced, it forms a single uninterrupted sound. The nucleus of the syllable is a vowel sound (i.e., vowel, diphthong, or syllabic consonant such as a consonant+Le). The vowel can stand alone as a syllable, or one or more consonants can precede (i.e., the onset) or follow it (i.e., the coda). The number of syllables in a word is determined by the number of vowel sounds (Sherman, 2018).

One syllable segmentation is onset-rime. The syllable onset is the initial consonant, while the rime is the nucleus vowel and an optional coda. The rime is a particularly important unit for decoding because these units are common in many words. Decoding through analogy occurs when the rime is used as a scaffold for pronouncing new word patterns that contain the rime (e.g., and, hand, band, land, stand, demand, expand, understand and so on). Studies have shown that intervention that trained the use of rimes resulted in decoding improvement for second grade readers (Brown et al..1996), and that blending onset and rime units is easier than blending phonemic units (Ehri & Robbins, 1992). Rimes can serve as a strategy for recognizing new words without sound-by-sound decoding and can facilitate the transition from monosyllabic to multisyllabic words decoding and spelling (Brown et al., 1996; Stanback, 1992).

Syllables are among the fixed regularities described by Apel (2009) and among the sublexical amalgams for Ehri (2005). With the exclusion of morphological units, syllables typically follow one of six

orthographic patterns. These patterns were regularized by Webster (1848) when he codified spelling in the first American English dictionary. Stanback (1992) categorized 17,000 common English words to determine the frequency of each syllable type. The syllable types are profiled in Table 1.1 below.

Table 1.1. Profile of the Six Syllable Types in American English Spelling

Syllable Type	Pattern	Description	Examples	Frequency
Closed Syllable	CVC CCVCC	One vowel closed in by one or more consonants; Vowel is short	tap, trap, tamp, tramp	43.3%
Open Syllable	V, CV, CCV	One vowel alone or preceded by one or more consonants; Vowel is long	o-pen, go, pro, ro/de/o	28.9%
Silent E Syllable	VCe	A final e that remains silent but makes the vowel before the consonant long	ate, date, crate, in/side	6.7%
Digraph/ Diphthong	VVC, CVV, CVVC, CCCVVCC	Two vowels used to make one sound, often long. Diphthongs glide from one oral position to another	say, seam, speech, oak cow, oink	9.5%
R-Controlled	VR, CVRC	One or more vowels immediately followed by letter R which creates a new sound	or, bird, air, thorn, farm	10.2%
Final C+Le	C+Le	The consonant+le occurs at the end of words and is its own syllable	pic/kle, i/dle an/gle, a/ble	1.4%

These six syllable types are not comprehensive of syllables in English. There are many additional patterns, such as –igh or –ough that occur with low frequency, a range of inflectional derivational morphemes that may not follow syllable patterns, and words that have more than one pronunciation. However, the six patterns occur with sufficient frequency and predictability in pronunciation to merit establishing orthographic awareness of these units for typically developing and struggling readers (Sherman, 2018). Bhattacharya and Ehri (2004) showed that adolescent poor readers who received instruction for syllable decoding improved in decoding new words, recognizing trained words, and remembering the spellings compared to the control group receiving whole-word instruction who made no better gains than a no-instruction control group. The results suggested the sublexical units can help a reader advance their decoding ability and strengthen memory of newly learned words (Stanback, 1992).

Knight-McKenna (2018) notes that longer words can be decoded more systematically when syllables are recognized as familiar units. They contain the contexts for determining how to pronounce the nuclear vowel (or vowel combinations in spelling) that are the most problematic aspect of decoding. In an analysis of post-first grade readers with deficient decoding skills, the poorest performance was for vowels in the medial word position (McCandliss et al., 2003). This finding is consistent with findings that the vowel system is the most difficult for readers, including the majority of reading errors for normal adult readers (Fowler, Liberman, & Shankweiler, 1977).

These findings have led to a range of studies exploring methodologies used to teach orthographic patterns at the syllable level. Many of these studies have used pseudowords as outcome measures as well as training stimuli.

Use of Pseudowords to Test and Teach Syllables

Pseudowords (also called non-words or nonsense words) are orthographically legal strings of letters that are phonologically similar to real words. Pseudowords adhere to the orthographic patterns of the English words, but have no meaning (Arndt et al., 2008). The words conform to the phonotactic constraints of the language and are easy to pronounce if the orthographic patterns are recognized. A common means of creating a pseudoword is to change at least one letter in a real word. Pseudowords were originally used in research to measure improvements in decoding following training because the pronunciation cannot be recalled from memory. To pronounce them, subjects must decode them using the alphabetic principle and orthographic patterns for various syllable types and complexity (Pullen et al., 2005).

Teaching syllable patterns has been a standard part of the reading curriculum since Webster codified them. They continue to be recommended by national reading education panels including the U.S. Department of Education, Institute of Educational Sciences, and the National Center for Education Evaluation and Regional Assistance (Foorman et al., 2016). However, research in this area has produced mixed results.

Studies Showing Improvements in Decoding Syllables

Pullen et al. (2005) instructed nine first-grade students with persistent decoding deficits on sound blending, sounding out and spelling words. A single-subject design was utilized. Participants read a book while the instructor aided them as needed. Selected target words were used to provide instruction and practice to segment and blend sounds with the use of manipulative letters. Ten lessons each included 25 trials applying phonological awareness and decoding skills during the book reading. Participants then re-read the book. Decoding accuracy and rate were measured daily through pseudoword lists. Results showed improvement in decoding for real and pseudowords for all readers during intervention phases.

Cardenas (2009) hypothesized that using pseudowords to teach orthographic patterns would increase decoding skills compared to the typical real-word instruction. She argued that real words allow the child to use lexical information to guess the word from partial analysis and pronounce the word using the lexical representation. Pseudowords do not have these upper-level structures and thus require the child to apply decoding skills and derive a pronunciation from the rules governing that pattern. This practice results in construction of sublexical structures that provided the reader with units that can be used to decode real words quickly and accurately. Kindergarteners learning to decode CVC words were included in either the real word or pseudoword condition. Both groups received one month of real word decoding, but during the second month, the experimental group switched to pseudowords. During the third month, both groups received real words. Decoding skills were assessed after each phase. Results showed a greater increase in decoding for participants during the second and third phases in which they received the pseudoword instruction. No measures of reading fluency or reading passage comprehension were conducted.

Seiler et al. (2013) provided computer-supported intervention to three 7–8-year-old students in 31 individual sessions over 10 weeks in a single subject study. Stimuli included both real and pseudowords. Responses were elicited using an iPad. Feedback was provided depending on the child's response. This included visually highlighting each letter to cue the child to blend the sound sequence, accompanying the

highlighted letters with corresponding spoken sounds to assist the child with blending, or modeling sound blending. Results showed improvement in pseudoword accuracy and rate, and clinically significant gains on decoding subtests of standardized test instruments.

Studies Showing Lack of Generalization to Reading

Canney and Schreiner (1976) assigned 108 second graders across ability levels to syllabication, phonogram and control treatment groups. Ten sessions of instruction and practice using familiar and unfamiliar multisyllabic words were provided. In the syllabication condition, participants were taught rules for dividing words into syllables rather than specific syllable patterns. The phonogram condition taught high frequency VC patterns (e.g., -ab, -al, -ar, -ay, -es). Results showed that neither treatment group did better than the control group on outcome measures for decoding or comprehension. Despite severe limitations in the design of the study, the authors concluded that instruction in syllabication was seriously questioned.

Decoding speed is related to the ability to fast-map new words to sight words that can be recognized without having to expend resources to decode the words each time they are encountered. Fleisher et al. (1979) sought to determine if rapid decoding was sufficient to improve reading comprehension. In their first experiment, poor readers were trained to read a word list until they recognized the words as rapidly as good readers. They then read a passage that was comprised of practiced words and responded to comprehension questions. Experiment two was the same, except students were trained to read the words rapidly within phrases. Results showed that both conditions significantly increased decoding skills but did not improve comprehension, supporting the findings of Canney and Schreiner (1976).

Hudson et al. (2011) sought to improve decoding and reading fluency of second-grade poor readers. Small groups used a repeated reading intervention that included training in phonemic awareness, letter-sounds, and word families. The accuracy group practiced each page until 98% accuracy was achieved. The accuracy + automaticity group practiced until they also reached a criterion reading rate. The

automaticity group showed significantly better scores in automaticity. No differences were found for decoding accuracy, reading comprehension or grade level reading fluency.

These studies suggest that treatments directed at improving sublexical patterns do improve the decoding on these units, but by themselves do not result in improvements in reading fluency or comprehension.

Studies Supporting Generalized Outcomes

McCandless et al. (2003) examined the failed decoding attempts of poor readers following first grade. Initial consonants were generally accurate, with less success with vowels and codas. A minimal pair intervention was implemented where attention to different positions within the word were focused on by systematically pairing words that changed by one grapheme at a time. Compared to a control group that practiced decoding whole words, the minimal pairs group showed significantly greater gains in standardized measures of decoding, reading comprehension, and phonological awareness. The researchers indicated the minimal pairs strategy engaged children fully in alphabetic decoding. This level of sub-lexical unit building supported development of lexical units, awareness of each phoneme and phoneme position and subsequently reading comprehension, in contrast to Canney and Schreiner (1976).

Werder (2012) used pseudowords to teach eight second graders with persistent decoding deficits to decode syllables containing aw, oi and au. The pseudowords were trained in lists and measured for generalization to untrained real words in lists, untrained real words in passages, and novel real words in generalized passages. Results indicated all eight subjects showed generalized accuracy and fluency for untrained word lists, generalized accuracy when reading /aw/ words in passages and /oi/ words for three of the subjects.

Seiler et al. (2019) provided iPad app-supported instruction to eight 7-to-9-year-old students with persistent reading deficits. The decoding group received 15 treatment sessions for syllable patterns presented within pseudowords ranging from two-six letter words. The computerized program increased or

decreased word complexity depending on the student's patterns of errors or correct responses. Results showed all subjects made significant gains for untrained pseudoword lists, and on standardized measures of pseudoword reading accuracy and speed. Trends in improvement in text-reading accuracy and reading comprehension were observed, but these measures did not reach significance.

Dyslexia and Lexical Representations

Howland and Liederman (2013) compared lexical representation formation during pseudoword learning between adults with dyslexia and typical reading. The groups were presented with 16 pictured pseudowords for which they learned meanings, spellings, and pronunciations. Half of the written words had regular spellings for syllables and half were irregular. They were asked to read half of the words and spell the other half, and then read the spelled words and spell the read words. Results showed that adults with dyslexia decoded fewer pseudowords accurately, verified fewer words that rhymed, and categorized fewer words as regular versus irregular. The authors concluded that compared to typical readers, adults with dyslexia failed to phonologically encode and retrieve detailed information about the pseudowords and could not efficiently switch between decoding and spelling of the same words, or modify their representations to improve accuracy and speed.

Kast et al. (2011) used functional magnetic resonance imaging (fMRI) while presenting two-syllable words and pseudowords to adults with and without dyslexia. Stimuli were either presented aurally, visually (i.e., print), or bimodally (auditory and visual simultaneously). All groups processed the bimodal presentations more accurately and faster, and real words faster and more accurately than pseudowords. Adults without dyslexia elicited stronger responses in critical regions of the brain than those with dyslexia. Those with dyslexia showed less neuronal involvement in areas related to decoding phonological information. The authors proffered that the areas of deficient functioning could be related to poor phoneme to grapheme mapping, probably caused by impaired audiovisual processing in multimodality areas.

Summary. Current models of reading reveal that it is a complex, multifaceted process that takes years to develop. The first hurdle is to learn grapheme-phoneme correspondence for the 26 alphabetic letters, and once learned, to apply this knowledge to decode and spell. Decoding and spelling are word-level skills. It is through experiences in decoding and spelling that letter sequences link to existing lexical representations for spoken words (Ehri, 1995, 2005). Blending the sound sequences results in a pronunciation, that, when heard by the child, becomes recognized as a known spoken word. The printed word then becomes a parallel, but equal modality, for retrieving the lexical representation for the word with access to the stored information about meaning, syntax, morphology and use.

Continued development results in the formation of complex hierarchies of sub-lexical representational units, including rime, orthographic patterns for vowels and vowel digraphs and diphthongs, consonant digraphs, syllable patterns, inflectional and derivational morphemes, and low frequency "irregular" patterns. Each of these subunits provides a scaffold for new words to be quickly and efficiently decoded or spelled using strategies such as analogies to known words. This elaborate structure provides a means for new written words to link to existing lexical items or to create new representations for unknown words. Awareness of these units, beginning with phoneme awareness and expanding into orthographic awareness, appears critical for rapidly and accurately storing and retrieving these units. Those who have a well-established network of orthographic knowledge recognize most words by sight and have multiple tools for processing unknown words.

Insights into the status of the current orthographic structures and their function can be gained by using pseudowords. Pseudowords are words in form only. They follow the spelling rules of the language but have no meaning. They are widely used in research to determine the level of orthographic knowledge individuals have acquired. They also have been used as intervention stimuli in efforts to enable the orthographic network to learn new patterns and to use them more efficiently to decode real words. Many studies have been successful in improving real and pseudoword decoding across age ranges from

kindergarten through adulthood. However, there is mixed evidence regarding whether this has any impact on reading fluency or comprehension. It is likely that higher level language skills will need to be incorporated into a comprehensive model of reading for meaning, and that simply linking written words to lexical representations for words is only a small part of the meaningful reading process. This issue is beyond the scope of this study.

This study is limited to the question of whether readers who are failing to build these elaborated structures (i.e., those individuals exhibiting persistent decoding deficits), could be better assisted in this process through the use of an alphabet that visualizes the links between letters and their corresponding sounds. To pursue this, we will explore what is known about the effects of alphabet cuing systems on learning the alphabetic principle and orthographic patterns.

Learning the Alphabetic Principle

For most children, learning the alphabetic principle is an easy developmental accomplishment. In many homes, exposure starts in early infancy with soft blocks and other toys with alphabet letters, and picture books that are shared within parent-child interactions (Marsh, 2003). Parents of infants sing the alphabet song, and many electronic toys expose the child to the alphabet and the alphabet song. Before three years of age, children chime in with letter names and sing the entire song between 4-to-5 years of age (Lawhon & Cobb, 2002). This helps establish letter shapes and names. The letter names provide clues to the letter sounds. Letters such as b, d, g or p provide a bridge into letter sound learning because they are heard in words (b = bean, bee, beach) while letters such as f, m and n can be heard at the ends of words (n = hen; m = them) (Treiman et al., 1996). Activities such as reading books or citing nursery rhymes create an emerging awareness of phonemes within words, as does developmental spelling and reading (Marsh, 2003). Developmental spelling is often introduced by learning to write one’s own name. Each of these developmental experiences establishes the foundation for learning the alphabetic principle by building the

cognitive structures that unite phonemes and graphemes within a lexical structure, or amalgams (Ehri, 1979).

The process of linking phonemes to graphemes can be challenging for typically developing children, but it presents a daunting task for children with early reading disabilities. One challenge is that speech is not produced as a series of sounds, but rather, overlapping movements shaped by surrounding sounds (Ladefoged,2004). The sounds, when produced alone, are difficult to recognize because their form is different when blended with other sounds. Saying individual sounds in sequence, such as (/d/ /ɔ/ /g/) sounds like three separate sounds rather than the word "dog." To recognize the meaningful word, the child must recover the underlying phonemic representation (Ehri, 2005, 2020). Different types of alphabets have been developed to facilitate this learning. We will review the concept of learning letter sounds through word associations and attempts to link letter shapes with letter sounds to facilitate phoneme-grapheme mapping.

Learning Letter-Sounds Through Word Associations

Letters also are not memorized shapes, but rather mental representations, or graphemes (Kohrt, 1986; Lockwood, 2001). For most children, the representational function of letters emerges when adults assist them to read and write their own name at approximately three years of age (Bloodgood, 1999). They discover the shapes maintain a meaningful relationship to words. The origin of the alphabet also maintained a meaningful relationship to words according to linguistic historians (Hock & Joseph, 1996). The current English alphabet evolved from a Latin-base alphabet that evolved from the Phoenician alphabet, the first to maintain a one-to-one relationship between a sound and letter (other alphabets represented syllables or larger units). Each letter was named for a word beginning with the target sound. The letter shape, in turn, looked like an abstract representation of the meaning of the word. For example, the Phonetian word for fence was "heth," and the letter was in the approximate shape of a fence. Thus, the letter shape represented the /h/ sound, or the first sound of the word "heth." The shape was simplified over time to only include the middle line, resulting in a capital H.

This same principle of associating a letter sound with a word that begins with that letter has been used to teach the letter-sound relationship to children today, primarily in pre-kindergarten and kindergarten (Ehri et al.,1984) but also for older populations with disabilities (Gonzales, 2017). Marsh and Desberg (1978) presented kindergarten children with letters and pictures with the relevant beginning sound (i.e., P = pumpkin), letters and irrelevant pictures, and letters with no pictures. Children remembered the sound when the relevant picture was present but did not transfer to a posttest of letters only. In a second experiment within the same study, they changed the pictured association to an action (i.e., a boy blowing out a candle saying /p/ for letter P). One group was provided the relevant noun picture, another the action picture, and a third no picture. Pictured groups performed better than controls with pictures present, but no groups recalled sounds at posttest with letters only.

Most prekindergarten and kindergarten classes use letter-to-picture associations in materials such as word walls (i.e., "A is for apple, B is for boy) and basal readers. One of the most well-known alphabet programs using letter-pictured word associations is Hooked on Phonics (1987). This program uses songs, chants and pictures to associate letters to letter sounds using pictures that begin with that sound. For example, one tape chants "a" /ah/ apple; "c" /k/ cat, and so forth. To date, there are no controlled studies examining the efficacy of Hooked on Phonics, and claims of success are based on testimonials posted on their website.

Most alphabet books also make use of these associations, often with multiple pictures of words that begin with the letter featured on that page. Halsey (2008) trained parents from low socio-economic families to use dialogic reading of alphabet books during reading with their 4–5-year-old child. Dialogic reading is structured to support learning during adult-child storybook reading by asking targeted questions throughout the reading. The questions focus the child's attention on important concepts and encourage talk, or dialog, between the parent and child. Thirty-one parent/caregiver dyads were randomly assigned to either an alphabet book reading group or a storybook reading control group. Parents were given scripts to

follow during the book readings that occurred four times weekly for eight weeks. Outcome measures included letter naming, letter-sound association, phonological awareness, and oral language skills. Results showed that the only significant outcome measure was picture naming. Parents generated significantly more questions about letter names at a posttest reading compared to pretest, but not letter sounds. This suggests the pictures did not cue the parents to focus on letter-sounds despite training and scripts encouraging them to do so. Instead, they focused on word and letter naming.

No research was found directly testing the efficacy of teaching letter-sounds using letters and associated pictures beginning with the letter sounds. However, evidence can be found in studies examining alphabets with letter shapes superimposed into pictures or words beginning with that letter-sound. In these studies, letter and associated picture alphabets were frequently used as a comparison or control condition.

Combining Letter Shape Plus Sound

Coleman and Morris (1978) tested whether letter-sound associations would be learned more readily by eight 4–5-year-olds if the letter shape and sound were represented in the same picture. The researchers presented letter-shape pictures that looked like letters but had no association with the sound (e.g., f = letter superimposed on a candy cane), pictures that hold an association to the letter-sound but not letter shape (e.g., z = bee), and letters where both letter shape and sound were represented (s = letter shaped like a snake making the /s/ sound). First, the adult would say the letter-sound and ask the child to say it. Children then were told the pictures would help them remember the letter-sounds, and the adult showed the picture, and the child made the letter-sound. The procedure was completed until all 9 sounds were presented, and then the task was completed a second time. The child repeated the letter-sound the shape and sound group produced 7 errors, the associated word group 9.5, and the letter shape 18.25 errors. Differences between the letter shape + sound and other groups were significant ($p<.005$). In a second experiment within the same study, the picture types were given elaborated descriptions. The letter

shape showed a camel with a letter m drawn as two humps and the explanation "This looks like a camel's hump." The sound but no shape showed ice cream and the explanation, "When we see ice cream we say, "m" "m" "m." The shape and sound showed the same camel eating with the explanation, "This looks like a camel's hump and he is saying, "m" "m" "m." The results were the same as experiment one, where the letter plus sound produced fewer errors at $p < .001$. Transfer to plain letters was not tested.

Dilorenzo et al. (2011) studied two curricula used in kindergarten classrooms over an extended time (not specified). The target program, Itchy's Alphabet (Larson, 1998), used an alphabet that incorporated the letter-letter shape-letter sound into a single picture (e.g., letter m [letter] superimposed on two mountain peaks [shape]; "mountain" starts with the /m/ phoneme). It was compared to a program using letters and pictures beginning with that sound (a = alligator). Results showed the Itchy group was significantly better at recognizing initial letter-sounds in words ($p = .001$), segmenting words into sounds ($p = .001$), and decoding nonsense words ($p = 004$). However, the two curricula were different across multiple dimensions during the daily 90-minute sessions (e.g., books read, manipulative materials, worksheets and so forth), so differences cannot be directly attributed to the alphabet.

Dakhiel and Al Rub (2017) compared learning using alphabets differing in cues for poor readers in Saudi Arabia. Participants included 90 children (30 in each of three groups) identified with learning disabilities who were learning to read English (age range not given). Group one presented letters where the letter shape incorporated the sound (s = snake), group two presented the same picture as group 1 but also the printed letter next to it, and group three presented a letter association with a picture beginning with the letter sound but not letter shape. The two groups where letter-shape was superimposed on a picture beginning with the sound were significantly better than the condition of letters associated with pictures beginning with the letter sound but not shape. Further analysis showed the letter shape incorporating the sound along with the printed letter showed significantly better letter-sound learning than the same picture without the printed letter.

The results of these three studies suggest that learning the alphabet principle using plain letters associated with a picture beginning with that sound results in the least effective learning. Using pictures with the letter shape superimposed into the picture (e.g., letter “d” shown as the head and tail of the dog that starts with the /d/ sound) showed significantly better learning of letter names and letter sounds in all three studies. Dakhiel and Al Rub (2017) showed that when s printed letter was additionally placed next to letter-shape-sound combination, the learning was significantly better than the picture shape-sound combination alone. They suggested students were able to form mental links between the picture of the letter-shape-sound combination with the printed letter sufficient to generalize letter-sound recall from the printed letter alone.

Phonemic Awareness and Letter-Sound Learning

Ehri et al. (1984) recognized that phonemic awareness, specifically phonemic segmentation, was important to letter-sound learning. The child must be able to segment the first sound of a word (i.e., onset) and ignore the remaining sounds (i.e., rime) to understand the first sound, and not the whole word, is associated with the letter. They tested the effects of different types of alphabets on making this association. The first experiment compared letters incorporating pictures beginning with the associated sound (i.e., letter f drawn as a flower, with the horizontal line shown as leaves and the flower extending from the curve of the f) compared to the same object (i.e., a flower) not incorporating the letter. Twenty first-graders who were failing to learn the alphabet first received a month of initial sound segmentation training. This was followed by six 20-minute training sessions on five unknown letter-sounds. The instruction took place in small groups in the classroom and was the same for both groups except for the pictures. Significantly more letter-sounds were learned using the letters incorporating pictures (p =.01). Experiment 2 reported in the same stimuli and procedures, but individual instruction was provided by the experimental team and the participants were in kindergarten. A second control group received no picture to test the hypothesis that pictures not embedded into letters were actually distracting. Results showed that all three groups improved at a

significant level with no group differences. However, learning occurred for more of the letters in the integrated letter shape-sound condition. The pictures separated from the letter produced the fewest letters learned, suggesting the pictures may distract from learning rather than assist.

Ehri et al. (1984) considered a focus on phonemic awareness training (i.e., phonemic segmentation) prior to teaching the alphabet is critical. To understand the relationship between a letter and a picture beginning with that sound, whether integrated into one picture or depicted next to each other, requires the learner to recognize that the word depicted has a first sound. They must be able to mentally segment the first sound from the rest of the word and only associate that unit (i.e., phoneme) of the word with the letter. A child who lacks this ability would make the association between the letter "d" and the picture of the dog to be the sound the dog makes (i.e., "woof"). To make the letter association, the child would need to disregard the meaning of the word "dog" and instead treat the word "dog" as a mental object. As a mental object, the word can be segmented into parts (i.e., an abstract part-to-whole relationship) (Norris, 2003). Poor phonemic awareness is one of the hallmarks of individuals with dyslexia (Lyon et al., 2003; Snowling, 2001).

One program designed to address phonological awareness is The Lindamood Phoneme Sequencing Program (LiPS; Lindamood & Lindamood, 1998) (formerly known as Auditory Discrimination in Depth (ADD; 1969, 1975). LiPS was developed to improve phonological abilities in reading, spelling, and speech, including decoding, spelling, and concept imagery. The intervention is implemented through a series of manualized phases that introduce sounds by associating them with mouth illustrations suggesting speech production cues. For example, the cognate pairs /p, b/ are pictured as plosive lips called "Lip Poppers," and /t, d/ are called "Tip Toppers" pictured with an elevated tongue. Those sounds without cognate pairs are the cousins who are related by phonemic features, including "Nose Sounds" /m, n, ng/, "Wind Sounds" /w, h, wh/, and "Lifters" /l, r/.

The vowels also are associated with mouth position features named the “Rounds,” “Opens,” “Sliders.” and “Smiles.” The vowels are introduced using the “Vowel Circle,” or a diagram of the vowels organized from high to low and front to mid to back. The manual systematically introduces the letters through phases of letter and letter-sound recognition, combining sound sequences using colored blocks to represent various syllable patterns, manipulating letter tiles for spelling and reading syllable practice, and finally generalizing to text reading (LiPS; 1998).

LiPS (Lindamood & Lindamood, 1998) has been examined in 48 studies across the age span from preK through adults with mixed results. Most have studied its use in whole classrooms or as supplementary instruction with kindergarten and first grade children. Only two of the studies met the criteria set by the What Works Clearinghouse (WWC) for reliable evidence. The others had methodological flaws. Four studies that examined the efficacy of LiPS for at-risk or low readers will be reviewed below, followed by three studies examining the hypothesis that pictures of mouth positions cue links to the phonemes of speech, providing a mechanism for letters to link to phonemes and words. Only the Torgesen et al. (2010) study met WWC guidelines.

Efficacy of LiPS for Low Performing Readers

Torgesen et al. (2010) provided intervention to 112 low performing first graders across two years, with new cohorts each year. Participants were randomly assigned to either LiPS (Lindamood & Lindamood, 1998), Read, Write & Type (RWT; Herron, 1995) or a control group with no supplemental instruction. Both programs provide explicit and systematic teaching of phonological awareness, letter-sounds and orthographic rules, as well as text reading. Both groups received small group instruction four times per week in 50-minute sessions for one year. The RWT program is a computerized program focused on expressive learning using learning to spell phonemes and applying the orthographic rules to spelling and writing. LiPS includes both receptive and expressive components as described above. Results showed both treatment groups performed significantly ($p < .01$) better than the controls, but no significant

differences ($p < .01$) were found between LiPS and RWT. This suggests both decoding and encoding are effective in establishing alphabet and early reading skills with no advantage for speech production cues.

Pokorni et al. (2004) studied older students with reading disabilities. They compared the LiPS (Lindamood & Lindamood, 1998), Earobics (Cognitive Concepts, Inc., 1998), and Fast ForWord (Scientific Learning Corporation, 1999) programs that each purport to improve phonemic awareness, language, and reading-related skills. The participants, 60 students between seven and nine years who were identified with language and reading delays, were randomly assigned to one of the three intervention groups. The pretest and posttest included measures of phonemic awareness, language, and reading-related skills. Students participated in a 20-day summer program with three 1-hour sessions daily. No other reading instruction was provided, and no books were read within the summer program. Multivariate analyses revealed that the only significant change was in phonemic awareness ($p < .01$). Earobics resulted in ($p < .01$) increases in segmenting phonemes, and LiPS showed significant ($p < .01$) increases in segmenting and blending phonemes, with gain scores in sound blending for LiPS significantly higher ($p < .01$) than the other groups. FastForword showed no significant gains. No group differences were found for language or reading measures.

Torgesen et al. (2001) studied older students with severe reading disabilities. They compared the initial version of LiPS (i.e., Auditory Discrimination in Depth (ADD; 1975) and an Embedded Phonics (EP) approach developed by the researchers. Participants were 60 randomly assigned 8- to 10-year-olds identified with severe reading disabilities. Both programs provided 1-to-1 tutoring, intense practice, systematic cuing of strategies, and instruction for phoneme segmentation and sound blending in words. The ADD program focused primarily on establishing phonemic and articulatory awareness applied to decoding words. The EP program provided explicit phonemic awareness training within spelling and writing activities, and word identification and decoding during reading. Treatment was provided in two 50-minute

sessions daily for 8-9 weeks until a total of 67.5 hours were reached. Thus, greater practice in reading and comprehension was present in the EP condition, while ADD focused on phonemic levels in depth, from articulatory cues to phonemic awareness and decoding.

At the completion of the treatment phase, both groups received eight weeks of generalization training where the trainer held one 50-minute session weekly using classroom materials to help the child apply the skills. Students were assessed before treatment began, following the eight-week generalization phase, and at one and two years following the treatment to determine longitudinal effects. The test battery included measures of phonological awareness, rapid naming, memory, language, and reading-related skills. Results showed that both groups showed significant improvements ($p < .05$) in reading that were stable across the 2-year follow-up. The ADD group showed greater gains in decoding (i.e., reading more accurately and fluently) during the intervention phase, but these differences were not maintained in follow-up. At follow-up, most of the students scored in the average range for reading accuracy and comprehension, although rate remained slow (Torgesen et al. (2001).

McIntyre et al. (2008) compared gains in phonemic awareness and letter-sound correspondence for at-risk and not at-risk students using LiPS (Lindamood & Lindamood, 1998). Participants were 227 first graders who received LiPS training as part of the regular curriculum for one year. The at-risk students were those scoring below the 25th percentile on a screening instrument (i.e., Learning Disabilities Working Committee screener, 2002). Measures on the screening instrument included alphabet knowledge, phoneme identification, and sound blending. Results showed that all students made significant gains between pretest, administered at the end of preK, and posttest administered at the end of first grade. The at-risk students made greater gains than the not at-risk and scored in the average range (i.e., above the 25%ile), indicating they were catching up to peers.

The four studies of low performing readers showed gains in some phonemic awareness tasks and decoding. Two studies showed mean group scores for poor readers that increased to the low average

range. None of the studies showed a clear advantage for LiPS over comparison treatments, although all treatments (except FastForword) outperformed no treatment control conditions. The WWC reported potentially positive effects for comprehension and mixed effects for alphabet skills, including some aspects of phonemic awareness, letter-sound learning, and decoding.

Potential Benefits of Pictured Mouth Positions

Castiglioni-Spalten and Ehri (2003) tested the hypothesis that LiPS is effective because it sensitizes students to the relationship between phonemes and articulatory properties of phoneme production. They proposed that articulatory awareness would cue word reading and spelling. Participants were 45 kindergarten children who had no prior phonemic awareness or reading instruction but knew at least 13 of 17 target letters. They were assigned to either a “mouth condition” that trained the relationship between LiPS mouth position pictures and related sounds, an “ear condition” where colored blocks were used to represent different sounds within words, or a control condition where no treatment was provided. The treatment groups received six sessions in the respective approaches. Results revealed that both groups performed significantly better than the control group at posttest for phonemic awareness and spelling skills. Only the mouth group showed significant gains on the reading tasks immediately following intervention and one week later even though letters were not used in training. The researchers concluded that articulatory gestures facilitate the formation of cognitive links between phoneme and grapheme representations necessary to read words. They recommended longer-term follow-up of the results.

Boyer and Ehri (2011) modified the Castiglioni-Spalten and Ehri (2003) kindergarten study to determine the effects of pictured articulatory gestures (i.e., mouth drawings from LiPS) on phonemic awareness and early reading skills. Participants were 60 younger preschool age (M=4;9 years) students who were nonreaders, knew 15 target letter names, could not segment words into phonemes, nor read nonsense words. Participants matched for pretest scores were randomly assigned to either a group using letters and articulatory (i.e., mouth) pictures, a group with letters only, or a no-treatment control condition. A

battery of tests was administered at pretest, posttest, and one week following the posttest. The tests measured letter names, phoneme segmentation, VC-CV and CVC nonword reading, reading target words, spelling nonwords, vocabulary, and nonwords repetition. Individual training sessions were implemented, lasting 10-20 minutes each. Sessions continued until the child reached the criterion of segmenting the word sets and ranged from 4 to 11 sessions. Results showed that both groups made significantly greater gains ($p < .01$) than the control group on phoneme segmentation, spelling, word reading, and nonword repetition posttests. The LiPS picture group that taught articulation-to-letter segmentation resulted in significantly better word reading ($p < .01$) and this advantage was maintained at the 7-day follow-up test. The researchers hypothesized that the pictured articulatory gestures provide neuro connections to the motoric gestures used in speech.

Research in the development of speech shows that motor speech feedback occurring during babbling and word acquisition form phonetic representations of words in early speech acquisition (Frost et al., 2009). Boyer and Ehri (2011) suggested the mouth production pictures serve to bootstrap neurological links between letter representations (graphemes) and sound representations (phonemes). Once linked, written words can access the phonetic representation of the words and their links to semantic, syntactic, morphological and phonological structures already formed for language processing.

Becker and Sylvan (2021) asked whether the gains shown by previous researchers could be obtained by using pictured articulatory gestures with an entire preschool class. Participants were 17 preschoolers with a mean age of 5;0 years. None were receiving services for speech and/or language. The supplemental instruction focused on using the mouth pictures to teach phoneme segmentation, phoneme-letter correspondence, and word/pseudoword reading using the mouth pictures and the letters. The speech-language pathologist worked collaboratively with the teacher, introducing each step and then dividing up practice time. Forty-five-minute sessions were implemented two days weekly for seven weeks. Each step was introduced to the entire class, followed by small groups and individual prompts. Each step

was repeated the next session, but was not taught to mastery, a practice consistent with classroom teaching. Gains made following intervention were compared to the baseline scores, showing significant changes in phoneme segmentation ($p < .0001$) and the ability to read words and pseudo words ($p < .0001$) that we spelled phonetically. No control group was used so it cannot be determined whether the same changes would have been obtained from supplementary instruction without the pictured mouths.

The results of these three studies are inconclusive but lend credibility to the hypothesis that the mouth gesture pictures provided by LiPS support discovering elements of phonemic awareness, letter learning, and decoding. Research in the development of speech shows that motor speech feedback that occurs during babbling and word acquisition is used to form phonetic representations of words in early speech acquisition (Frost et al., 2009). Thus, the mouth production pictures may serve to bootstrap neurological links between letter representations (graphemes) and well-established sound representations (phonemes) in words. Once linked, written words can access the semantic, syntactic, morphologic and phonological networks required for fluent reading and comprehension (Ehri, 2005, 2020).

Conclusions

To date, the studies exploring the efficacy of using pictured mouths without embedded letters (i.e., Lindamood) show mixed outcomes. While the treatments all made significant gains compared to a control group, they did not produce significantly greater gains than parallel treatments without the mouth pictures for most outcome measures. The outcome measures that addressed reading words and pseudowords more frequently favored the pictured articulatory gestures, leading Ehri (2011) to hypothesize that the pictures serve to established neurological connections to established motoric gestures already formed during speech development. Studies also showed that if letter names were known, even young children were able to begin to associate sounds with the letters to decode simple phonetically regular words and pseudo words. In these studies, two symbol systems needed to be coordinated to perform the tasks. This

is a challenging task because the letters bear no relationship to the sounds. A completely arbitrary shape must be associated with the phoneme and the speech gesture.

We hypothesize that an alternative picture that embeds letters into the mouths of faces to depict the articulatory gestures will produce a representation of letter-sounds that is more successful in establishing phonological awareness and reading skills. Rather than an arbitrary letter-shape, the letters depict relevant speech production features (the letter b is drawn to represent the bottom lip of the mouth, while the p is drawn to represent the top lip). The visual representation of speech sound production linked directly to the letter shape provides a means to directly link letter and sound symbols and hopefully lead to more efficient incorporation of grapheme representation into the oral word amalgams. We will explore earlier studies incorporating Phonic Faces, followed by the questions of this study.

Phonic Faces: A Phoneme-cued Alphabet

Few have used word and picture-shape association alphabets to teach more advanced skills such as decoding syllable patterns, primarily because they involve vowels. While there are five vowel letters in the English alphabet, they must represent 21 distinct vowel sounds (Chomsky & Halle, 1968). To teach these different vowels, LiPS (Lindamood & Lindamood, 1998) used pictures of lip gestures along with a model termed the vowel circle to help children identify and produce these different vowels in reading.

An alphabet termed Phonic Faces (Norris, 1921) is unique because it has different representations (i.e., faces) to represent all consonant and vowel phonemes and their spelling (e.g., short vowels are pictured as babies while long vowels are their respective adults). Each phoneme diphthong has its own face. Digraphs are shown using simple stories that explain the rules (e.g., two babies cannot be left alone because they can run away. The first baby's parent must protect them both and make the long vowel sound). The Phonic Faces cards are manipulated to show these syllable patterns. Unlike other programs that teach the vowel sounds through association with words, Phonic Faces vowels uses mnemonic cues related to how the vowels are produced within the environment. Long and short vowel pairs are

represented as baby-parent pairs who look related (i.e., similar hair, skin, eye color). The explanation of short vowels is that babies are short in stature, while their corresponding parent is tall and long. For example, Baby A is unhappy and makes the baby-cry short a [æ] phoneme sound, while the long a vowel Miss A is happy and says [eɪ] as in "yea." Children can see how one letter represents more than one sound and they thus have a visual representation of each phoneme in their mental phonology linked to the same grapheme.

In this manner, all English phonemes are cued by the letter shown making the gesture associated with the related sound. Thus, while other alphabets cue by letter shape and associated word beginning with the sound, and LiPS cues with lip gestures related to sounds (i.e., indirect links from letters to sounds), Phonic Faces cues by letters positioned in the mouth to cue speech production gestures for that specific sound, or a direct link from letters to sounds.

Terrell (2007) read Phonic Faces alphabet book to 16 toddlers between the ages of 20-24 months. The book was composed of nine letters, each page containing a Phonic Face and four pictures of objects that began with the letter-sound. The book was read individually to experimental subjects three times weekly for six weeks. The control group received no treatment, but engaged in individual play activities for comparable time. Following six-weeks the groups alternated so the former control group now received the alphabet book reading treatment and vice versa. Analyses across pre- and post-assessments showed that children were able to identify letters and letter sounds following repeated exposure within the context of alphabet book reading and the picture support provided by the PF. Differences between the two groups were significant for both phases of the study, supporting the hypotheses that toddlers can learn letters and letter sounds mediated through the context of alphabet book reading using the iconic faces. Particular gains were made in the areas of letter identification, letter discrimination with PF, and sound production. Overall gains were maintained after a six-week period without intervention.

Banajee (2007) sought to determine if children with complex communication needs could learn basic reading skills using Phonic Faces Alphabet Storybooks. Each book tells a story while focusing on a single letter-sound. The books were converted into e-books accessed using a single rocking lever switch. Three subjects, aged 5;0, 6;1 and 8;9 who were within the average range of receptive language and cognitive abilities but exhibited severe delays in expressive language due to cerebral palsy participated. All used digital communication boards without difficulty. A single subject across subject and alternating conditions (ABAB) design was utilized, with each subject working on two letters and their corresponding sounds. One letter was taught using a commercial alphabet storybook while the other was taught using the Phonic Faces storybook. Following 8 sessions, the conditions were reversed so that the commercial book taught the letter formerly introduced with the Phonic Faces book and vice versa. Results revealed improvements on letter/sound and sound/letter identification, and identification of location of sounds in all word positions during Phonic Faces Storybook phases but not in the control phases. Improvement was seen in the pre and posttest scores on seven subtests of The Phonological Awareness Test (Roberson & Salter, 1997).

Brazier-Carter (2008) trained four Head Start teachers to read storybooks interactively to focus on vocabulary, plot, phonemic awareness, and print referencing. The same book was read for a week with five repeated readings of either a commercial emergent storybook or a Phonic Faces Alphabet Storybook. Six different books were read across six weeks. Results showed an increase the interactive reading behaviors exhibited by the teachers across the six weeks of training. Both book types exhibited significant gains in the number of teacher behaviors produced to elicit meaning and form responses (letters, letter-sounds, rhyme, and print concepts) following training. Significantly greater changes were obtained for the Phonic Faces books for meaning, letters, and letter sounds, indicating that the Phonic Faces books were effective in reminding the adult to talk about the alphabet throughout the book reading, but not at the expense of

helping the children to interpret the meaning of the story. The effects of the training were maintained across the six weeks to a greater extent for the Phonic Faces books

Children in both groups improved in vocabulary, print concepts, and phonemic awareness from pretest to posttest, indicating that both books were effective in facilitating developmental reading abilities in four-year-old children. The two book types were equally effective in increasing vocabulary, a measure of meaning. The Phonic Faces condition resulted in greater gains in phonemic awareness, consistent with the focus on letter-sounds throughout the reading of these books (Brazier-Carter, 2008).

Nettleton 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.

Petit (2019) compared the use of Phonic Faces words (i.e., the Phonic Face shows the first letter in the word while the meaning of the word is drawn into the rest of the letters) to plain pictures in therapy for speech sound disorders. A single subject alternating treatment design was implemented. Participants received both plain pictures and Phonic Faces word 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 (i.e., 6 plain picture and 6 MPF). A different set was practiced for a week across four weeks, with multiple exposures to all words during a session. Participants received both types of picture cards during individual 8-minute treatment sessions. A probe at the end of each session was used

to measure whether words taught using either picture set would elicit more correct productions in the probe. Results found that all seven children produced a greater number of correct /r/ productions in response to the MPF pictures compared to the plain pictures. However, no advantage was found for the Phonic Faces pictures for the /s/ phoneme.

To date, Phonic Faces have not been tested for the effects on decoding although clinical results have shown clinically significant gains from pretest to posttest, Thus, the purpose of this study is to determine whether teaching orthographic syllable patterns using the phoneme-cued Phonic Faces alphabet will assist 7–8-year-old poor decoders to acquire phonological awareness and orthographic reading skills. The questions of this study are:

1. Will pseudoword probes read during the intervention phase result in a) a significantly greater number of pseudowords read correctly, and b) vowels within pseudowords read correctly regardless of total word correctness, and will the increases be maintained throughout post testing?
2. Will pseudoword probes read during the intervention phase result in a) a significantly greater number of pseudowords read correctly, and b) vowels within pseudowords read correctly regardless of total word correctness compared to the baseline phase for the alternative syllables (i.e., CVVC or CVCe), and will the increases be maintained throughout post testing?
3. Will a phoneme-cued alphabet result in clinically significant gain scores between pretest and posttest on the Phonological Awareness Test in subtests for phoneme segmentation and phoneme blending, and phonological awareness total test scores?
4. Will a phoneme-cued alphabet result in clinically significant gain scores between pretest and posttest on the Phonological Awareness Test in decoding subtests for CVC Words, Vowel Digraphs (i.e., CVVC), CVCe, and for Phoneme-Grapheme Total test scores?

5. Will gains in decoding skills result in clinically significant gain scores between pretest and posttest on three contextualized reading and oral language measures of the Test of Integrated Language and Literacy Skills (TILLS) (Nelson et al., 2016)?

CHAPTER 2. METHODS

This study used a single subject multiple baseline design replicated across three participants and behaviors to examine the gains made in learning orthographic syllable patterns of written words when phoneme-cued visual representations of letter-sound associations (i.e., Phonic Faces) were used to link grapheme to phoneme representations. The study first taught the short vowel CVC syllable pattern using PowerPoints in which animation demonstrated the rule and pronunciation of words and pseudowords. Following 10 to 12 sessions (depending on participant attendance), a second pattern targeting a long vowel pattern was introduced. Participants 2 and 3 maintained the lowest scores for CVVC and were taught that pattern during the second intervention phase. All participants were scheduled to receive intervention via Zoom three times weekly for ten weeks including four baseline and four follow-up sessions. The sessions were conducted each week on Mondays, Wednesdays and Fridays. All sessions were one hour total and were in succession; Participant 1 started her session at 4:00, Participant 2 at 5:00, and Participant 3 at 6:00. Missed sessions were made up on weekends (depending on the participants' schedule).

Participants

To be considered for this study, participants met the following criteria:

- English is the child's first language
- Parent reported that the letter names and sounds are known for the 26 letters of the alphabet
- The child completed first grade but lacks fluent decoding skills of one-syllable words.

Those who met the initial criteria then received a battery of tests to verify the appropriateness of the intervention based on the child's profile. Three students were recruited to participate in this study. Their parents had responded to an email distributed to local schools for an afterschool program. Because they met the criteria, they were invited to receive intervention through the study instead. The program was

explained to the parents using the IRB approved consent form that described the purpose, participant criteria, benefits, potential risks, time commitments, and researcher contact information. All questions were answered, and the study was explained to the child. If both the parent consent and child assent form were signed, a time for further testing via Zoom was established. Parents also completed an online Child Case History form. Table 2-1 profiles the characteristics of the three participants.

Table 2.1. Profile of Subjects by Age, Gender, Grade, Index Scores for CVC-CVVC-CVCe Subtests of the PAT-2E, Index Scores for TILLS Reading Fluency and Comprehension Subtests, and Nonverbal Intelligence Quotient

Subject	Gender	CA	Grade	PAT-2E % Correct of 10 items			TILLS Reading			TONI-4E
				CVC	CVVC	CVCe	Fluency	Comprehension		
Participant 1	Female	8;0	3rd	60%	10%	20%	0	SR	RC	101
								2	0	
Participant 2	Male	8;4	3rd	70%	20%	40%	7	SR	RC	95
								8	6	
Participant 3	Female	7;7	2nd	70%	30%	70%	1	SR	RC	103
								7	0	

CA = Chronological Age
PAT 2E = The Phonological Awareness Test, 2nd Edition
TILLS = The Test of Integrated Language and Literacy
TONI 4E = Test of Nonverbal Intelligence, 4th Edition
SR = Story Retell
RC = Reading Comprehension

Subject 1 was an 8;0-year-old female in the third month of 3rd grade at the initiation of the study. The case report indicated no relevant diagnosis, however, academically, subject 1 exhibited a delay in reading fluency. The PAT-2 revealed average score (SS = 92) for the phonological awareness total (Rhyming SS = 103; Segmentation SS = 97; Isolation SS = 96; Deletion SS = 90; Substitution SS = 97; Blending SS = 100) and below-average score (SS = 85) for the phoneme-grapheme total (Graphemes SS = 85; Decoding SS = 85). Overall, Subject 1 received a standard score of 88 for the test total's score that is considered within the below-average range (scores below an SS of 90). The percentage of correct responses to the 10 pseudowords on each subtest were used to establish participation. Participant 1's score for the CVC subtest

of the Decoding subtest was 60% (below the 70% cutoff), and CVVC, and CVCe were 10% and 20%, respectively (below the 40% cutoff), indicating eligibility for continuation in the study. Because of time limitations, only the Story Retell, Reading Comprehension and Reading Fluency subtests of the TILLS were administered. Subject 1 received below-average scores for all three subtests (Story Retell SS = 2; Reading Comprehension SS = 0; Reading Fluency SS = 0). The nonverbal index score on the TONI was 101, placing the subject in the 52nd percentile and within the average range.

Subject 2 was an 8;4-yeard-old male in the third month of 3rd grade at the initiation of the study. The case report indicated no relevant diagnosis; however, academically, subject 2 exhibited a delay in reading fluency and reading comprehension. The PAT-2 revealed average score (SS = 93) for the phonological awareness total (Rhyming SS = 106; Segmentation SS = 95; Isolation SS = 94; Deletion SS = 87; Substitution SS = 107; Blending SS = 103) and below-average score (SS = 83) for the phoneme-grapheme total (Graphemes SS = 83; Decoding SS = 85). Overall, Subject 2 received a standard score of 87 for the test total's score which is considered within the below-average range. Performance on the CVC subtest of the Decoding subtest was 70% (at the 70% cutoff), and CVVC, and CVCe were 20% and 40%, respectively (at or below the 40% cutoff), indicating eligibility for continuation in the study. Subject 2 received average and below-average scores for all three subtests administered on the TILLS (Story Retell SS = 8; Reading Comprehension SS = 6; Reading Fluency SS = 7). The nonverbal index score on the TONI was 93, placing the subject in the 32nd percentile and within the average range.

Subject 3 was a 7;7-yeard-old female in the 2nd grade at the initiation of the study. The case report indicated no history of relevant diagnosis; however, the subject's brother has a diagnosis of attention deficit disorder (ADD). Academically, subject 3 exhibited a delay in sounding out words, reading fluency, reading comprehension and spelling. The PAT-2 revealed average score (SS = 91) for the phonological awareness total (Rhyming SS = 109; Segmentation SS = 97; Isolation SS = 89; Deletion SS = 92; Substitution SS = 114; Blending SS = 80) and average score (SS = 93) for the phoneme-grapheme total (Graphemes SS =

95; Decoding SS = 93). Overall, Subject 3 received a standard score of 93 for the test total's score, which is considered within the average range. Performance on the CVC subtest of the Decoding subtest was 70% (at the 70% cutoff), and CVVC, and CVCe were 30% and 70%, respectively. Despite one of the scores not being below the cutoff, the subject was accepted for continuation in the study based on the scores of the TILLS. Subject 3 received below-average and borderline-average scores for all three subtests administered on the TILLS (Story Retell SS = 7; Reading Comprehension SS = 0; Reading Fluency SS = 1). The nonverbal index score on the TONI was 103, placing the subject in the 58th percentile and within the average range.

Test Measures

The Phonological Awareness Test 2nd edition, normative update (PAT-2:NU) (Robertson et al., 2017) assesses skills that are prerequisite to sounding out words and rapid word recognition including phonological awareness, phoneme-grapheme correspondence, and phonemic decoding skills using pseudowords. It was given to provide a profile of decoding and phonological awareness abilities to establish eligibility for participation and pretest levels and posttest gains, and to measure progress from pretest to posttest. It is normed for ages 5;0 through 9;11. Phonological awareness is comprised of six subtests, including rhyming, phoneme segmentation, phoneme isolation, phoneme deletion, phoneme substitution with manipulatives, and blending for syllables and phonemes. Grapheme and syllable knowledge is assessed using supplementary grapheme subtests. The seven phoneme-grapheme subtests include consonants, vowels, consonant blends, consonant digraphs, r-controlled vowels, vowel digraphs and diphthongs. The eight decoding subtests use pseudowords to assess VC, CVC, CVCe, consonant digraph, consonant blends, vowel digraphs (CVVC), r-controlled vowels, and diphthongs. Administration time is 40-50 minutes.

Reliability for the subtests ranges from .83 to .92, with a total index reliability of .96 for phonological awareness and .97 for phoneme-grapheme. Criterion validity was established by correlating results with the

Comprehensive Test of Phonological Processing, second edition (CTOPP-2) (Wagner et al., 2013) Phonological Awareness Composite. Results for the phonological awareness index were .92 and .94 for the phoneme-grapheme index.

The Test of Nonverbal Intelligence, 4th edition (TONI) (Brown et al., 2010) is a language-free measure of nonverbal intelligence. It was given to establish cognitive abilities within the average range and to correlate with gain scores using the visual cues of Phonic Faces. It assesses the ability to solve problems using simple verbal instructions that can be communicated with pantomime or gestures. The stimuli are novel abstract figures that require the test taker to solve visual matching, analogy or other tasks to select the correct drawing from multiple foils. The problems require discrimination between one or more visual characteristics of abstract drawings such as size, shape, rotation, direction, shading and movement. Test takers may respond with pointing, gesturing or other nonverbal or verbal responses. It is normed for ages 6;0 to 89 years and results in a nonverbal intelligence quotient. Administration time is approximately 20 minutes.

The Test of Integrated Language and Literacy Skills (TILLS) (Nelson et al., 2016) is a comprehensive measure of oral and written language designed to identify language/literacy disorders for ages 6-18 years. It was used to establish an overall skill profile of participants, determine if they fall within the range of a language/literacy disorder, and to compare the pretest-posttest profile. The TILLS profiles strengths and weaknesses in listening, speaking, reading and writing at both the sound-word structure and the sentence-discourse levels.

The full test includes 15 subtests yielding 17 scores that are combined to form composites of both oral and written language. The test also establishes an Identification Core Score comprised of nine subtests considered to be core measures. The core score identifies when a student's score is consistent with a language/literacy disorder.

Due to time limitation, only three subtests were administered during pre- and post-testing: Story Retell (SR), Reading Comprehension (RC) and Reading Fluency (RF). The Story Retelling (SR) subtest assesses a student's ability to listen to, comprehend, and retell a story, the Reading Comprehension (RC) subtest assesses a student's ability to read and understand written language with complex academic syntax and relational terminology and to monitor language comprehension and the Reading Fluency (RF) assesses automatic word recognition.

TILLS reports sensitivity and specificity levels separately in yearly increments from 6 to 13 years and 14 to 18 years. The sensitivity scores (true positive) across levels ranged from 81%-97%, and specificity (true negative) scores ranged from 81% to 100%. Reliability across subtests ranged from .79 to .98.

Child Case History Form

The child case history form used by the LSU Speech and Hearing Clinic was adapted to elicit relevant background information in four areas:

a. family structure including parents, their level of education and occupation since this information is related to socio-economic level known to affect a child's school achievement;

b. child developmental history such as birth complications, illness, hearing, speech and language, and medications since these factors are known to be correlated with language and reading disabilities;

c. child school information including grades repeated, a diagnosis of a disability, history of services for speech and language, a support plan such as a 504 or IEP plan, areas of academic difficulty, individual tutoring received at school or outside of school, and teacher concerns;

d. family history of delays or difficulty related to reading disabilities including speech sound disorders, stuttering, language development, ADHD, autism, reading deficits, spelling and other.

Intervention Materials

Introduction to Phonic Faces Consonants and Vowels PowerPoint

The Phonic Faces (PF) used within the Instructional Lessons were introduced using a PowerPoint presentation during the baseline phase. Each of the 38 PFs used in the lessons were presented on a separate slide. Because the letters are drawn in the mouths of the faces to represent speech production cues, they are introduced as contrasting pairs rather than alphabetical order. Thus, the voiced and unvoiced stop plosive letter-sounds /b/and /p/ are introduced first and second, followed by cognate pairs /k/-/g/, /t/-/d/, /s/-/z/ and so forth. Digraphs ch, th, sh, and ng end the consonant presentations. This is followed by the introduction of the short vowels followed by the long vowels. The slides are animated so first only the printed letter is visible.

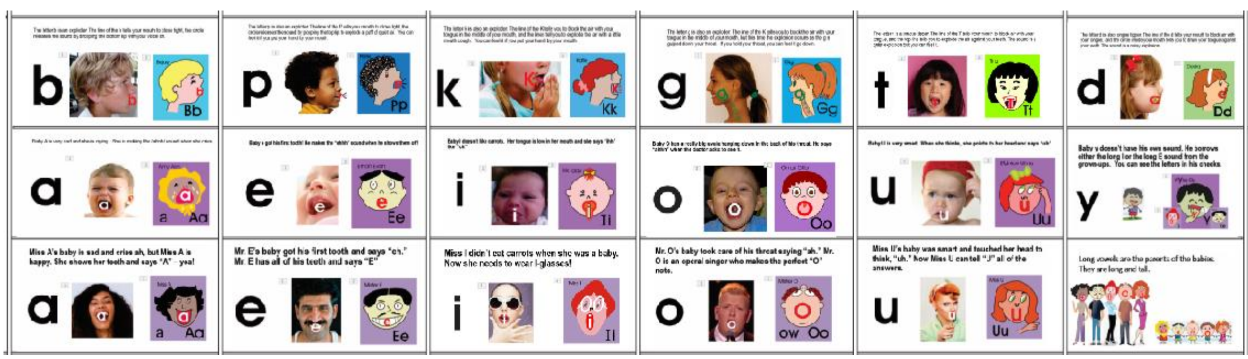

Figure 2.1. Representative slides of Phonic Faces introduced using a PowerPoint presentation

Upon click, a picture of a human face with the letter placed in the mouth appears, and a second click reveals the corresponding PF image. An explanation to be read to the child appears in the title position of each slide (e.g., the letter p is also an exploder. The line of the P tells your mouth to close tight,

the circle releases the sound by popping the top lip to explode a puff of quiet air. You can feel it if you put your hand by your mouth). See representative slides in Figure 2.1.

Pseudoword Probes

Pseudoword probes were used to measure decoding skills during all baseline and intervention sessions, for a total of 32 different probes. Each probe consists of 30 pseudowords, 10 for each of the CVC, CVCe and CVCC syllable types. The ten pseudowords for each syllable type range from simple (e.g., CVC) to successively more complex (e.g., CCVC, CVCC, CCVCC, CCCVCC, CCVCCC) syllable patterns, resulting in 320 pseudowords for each syllable type, or a total of 960 pseudowords, all but 3 unique to avoid repeated exposures resulting in memorization. The probes were designed so that each of the vowels (i.e., a,e,i,o,u) occurred within two of the words in every probe (e.g., hab-blaft, glep-speld, bliv-shrib, poct-scroft, fulb-plucts). Each vowel is positioned in every syllable pattern 6-to-7 times across the 32 probes (e.g., the CVC pattern repeated the aeiou vowel sequence as in h**a**b, g**e**b, t**i**b, p**o**b, f**u**b until the 32nd probe was formed).

The pseudowords for each probe were formatted on a separate PowerPoint for uniformity, speed and ease of presentation on Zoom. The pseudowords are centered within a text box and typed with a 200-point size. Because the pseudowords are scored for both accuracy and time, each pattern of 10 words within the same syllable pattern was administered completely before the next pattern of 10 words is presented. However, the pseudowords within each pattern were randomized in order of presentation using the random number function of Excel (e.g., CCVC-CCVCCC-CCVCC-CCVC, CCCVC, CCVCC, CVC, CCCVC, CVCC versus CCCVCC, CCVCCC, CVCC-CVCC-CCCVC-CCVC-CCVCC-CCVCC-CVC). Thus, difficult patterns were interspersed within easier patterns randomly within every probe. In addition, the sequence of syllable types rotated in order of presentation (e.g., CVC-CVCe-CVVC vs CVCe-CVVC-CVC and so forth) so that each of the six possible sequences occurred six times. At the beginning of each

syllable type, the “ready-set-go” slide will appear to cue the child that the word list is about to begin and for the interventionist to start the timer (see Figure 2.2).

Figure 2.2. Example sequence of CVC probe pseudowords appearing in random order using a PowerPoint presentation

The 320 CVC pseudowords were representative of legal word patterns in English (Seiler, 2013) and each was unique. All pseudowords were pronounceable with the target short vowel. Each of the 320 legal pseudowords in the CVVC syllable type contained either double vowel patterns that occurred in the middle of a word or at the end.

A medial pattern was included for each long vowel sound except letter “i” that has no consistent medial pattern (i.e., A = ai, ay; E = ee, ea; I=ie, y; O = oa, oe; U = ui, ue). The double vowel patterns that occurred in the word ending position also had plural and verb tense variants that commonly occur in spelling (i.e., A = ay and ays variant; I = ie and its variants ies, ied; O = oe and its variants oes, oed); and U = ue and its variants ues and ued). The probe was structured in the same manner as the CVC probe, with each double vowel occurring twice, once in the medial and once in the word ending positions. The limited number of possible “ie” pseudowords resulted in three words that appeared in more than one probe

Each probe in the CVCe pattern was constructed to control vowel occurrence in the same manner as the CVC probe. Plural and past tense morphemes were not added to the pseudowords because many of the words could be decoded as two syllables (e.g., dofe + s could be “dofes” or “do-fes” or “dof-es”). Thus, none of the words ended with consonants. Three of the words in each probe were composed of CVCe patterns (e.g., gime or kape), six were CCVCe (e.g., drime, glofe), and two were CCCVCe (e.g., sprame, threbe). Each long vowel sound occurred twice in each probe, and each vowel was represented an equal number of times within each syllable pattern.

Instructional Lesson Words

A combination of real and pseudowords were used to teach decoding skills during the 24 intervention sessions. These include 12 CVC, 12 CVCe and 12 CVCC lessons, for a total of 36 different lessons. The words and pseudowords for each of the 36 lessons were formatted on a separate PowerPoint for uniformity, speed and ease of presentation on Zoom.

The words are designed to be used for teaching and thus begin with the easiest CVC pattern and progress systematically through all of the words in that pattern group before moving on to CCVC words and so forth. There is no time limit nor randomization of words to enable the child to learn to decode simple words and gradually add complexity.

Each lesson consists of 25 words presenting one syllable type (CVC or CVCe or CVVC) containing words from five syllable patterns ranging from simple (e.g., CVC) to successively more complex (e.g., CCVC, CVCC, CCVCC, CCCVCC or CCVCCC) syllable patterns, resulting in 300 words or pseudowords for each syllable type, or a total of 900 words.

To avoid word memorization, all the words or pseudowords were unique to provide practice at decoding. The lessons were designed so that each of the vowels (i.e., a,e,i,o,u) occurred once in each of the five syllable patterns (e.g., top, lock, flop, cross, scotch), or five times in each lesson as the five patterns are successively encountered.

The first two lessons for each syllable type began with all real words (i.e., 0 pseudowords [PS]) to enable children to listen for a known word as they sounded out the letter-sound sequences. Lesson three introduced 1 pseudoword for the CVC and CVCC patterns, and each successive session introduced more pseudowords until all words were pseudowords by the 12th session as shown in Figure 2.3. This schedule of pseudoword introductions was repeated for the CVCe and CVVC instructional syllable types.

	Lessons											
Patterns	1	2	3	4	5	6	7	8	9	10	11	12
5 CVC	0 PS	0 PS	1 PS	2 PS	2PS	3 PS	3 PS	4 PS	4 PS	5 PS	5 PS	5 PS
5 CVCC	0 PS	0 PS	1 PS	1 PS	2PS	3 PS	3 PS	4 PS	4 PS	5 PS	5 PS	5 PS
5 CCVC	0 PS	0 PS	0 PS	1 PS	1 PS	2 PS	3 PS	3 PS	4 PS	4 PS	5 PS	5 PS
5 CCVCC	0 PS	0 PS	0 PS	0 PS	0 PS	1 PS	2 PS	3 PS	3 PS	4 PS	4 PS	5 PS
5 Other	0 PS	0 PS	0 PS	0 PS	0 PS	1 PS	2 PS	3 PS	3 PS	4 PS	4 PS	5 PS

Figure 2.3. Sequence of the week and number of specified pseudowords introduced for each syllable pattern within instructional lessons

The first two lessons for each syllable type began with all real words (i.e., 0 pseudowords [PS]) to enable children to listen for a known word as they sounded out the letter-sound sequences. Lesson three introduced 1 pseudoword for the CVC and CVCC patterns, and each successive session introduced more pseudowords until all words were pseudowords by the 12th session as shown in Figure 2.3. This schedule of pseudoword introductions was repeated for the CVCe and CVVC instructional syllable types.

The PowerPoint slides for each instructional lesson were comprised of the word typed in the title box of the PowerPoint in AvantGarde 66-point type. When the enter key of the slide is clicked, the presentation of the word in Phonic Faces letters was revealed. The first five words for lesson CVC-3 are shown in Figure 2.4, including the introduction of one pseudoword.

Figure 2.4. Example sequence of CVC real and pseudoword instructional slides designed to teach the CVC pattern for each of the short vowels using a PowerPoint presentation of the word with the corresponding Phonic Faces representations

Other animations were provided in the PowerPoints. For example, consonant digraphs were first displayed as spelled, as in f-i-s-h. When the enter key was clicked, the PF representation of the actual phoneme was revealed (see Figure 2.5).

Figure 2.5. Examples of animation depicting the sounds made by consonant digraphs, including zippers over the mouths of silent letters and the phoneme production cues for digraphs such as sh and ch.

Finally, the PowerPoints had three slides where extra PFs can be retrieved if needed. Slide 3 contains all consonant PFs including digraphs. Slide 4 contains all long, short, r-colored, digraph and diphthong vowels as well as inflectional morphemes. Slide 5 contains animation depictions of the CVCe and CVVC pattern transformations (see Figure 2.6).

Figure 2.6. Slides 3, 4 and 5 of each intervention PowerPoint providing consonant, vowel, morpheme, silent e and double vowel transformation jpegs that can be copied for use in explaining or correcting decoding strategies during instruction

Design

This study used a single subject with multiple baseline designs across participants and behaviors to examine the gains made in learning orthographic syllable patterns of written words. The study was designed to be implemented across 10 weeks (32 sessions), including a 4-day baseline period, two 12-session intervention periods (3 times weekly for four weeks each), and a 4-session follow-up. However, due to longer than anticipated pretesting, subject availability, and other factors such as missed sessions, each participant received a different number of sessions.

Subject 1 received 24 sessions (4 pre-testing and introduction sessions, 10 CVC sessions, 8 Long Vowel sessions and 2 post-testing sessions). Subject 2 received 27 sessions (4 pre-testing sessions, 12

CVC sessions and 8 Long Vowel sessions and 3 post-testing sessions). Subject 3 received 26 sessions (4 pre-testing sessions, 10 CVC sessions, 10 Long Vowel sessions, and 2 post-testing sessions). Each session lasted between 35-40 minutes, including 30 minutes of instruction followed by a 5-10-minute probe period. Sessions ended with a 2–3-minute game or reward for completing the session.

Procedures

Eligibility Testing

Testing for eligibility was conducted using subtests from the Test of Phonological Awareness and was conducted in person or via Zoom. This included completing two of the seven grapheme subtests and the five decoding subtests. The consonants and long and short vowels subtests verified whether letter names and sounds were known. The remainder of the grapheme subtests provided a profile of phonograms including consonant blends and digraphs, vowel digraphs, r-controlled vowels, and vowel diphthongs and were administered if inclusion criteria were met.

Five of the eight decoding subtests that correspond with the syllable patterns of the study were used for the inclusion criteria CVC, consonant digraphs, consonant blends, vowel digraphs, and CVCe words. If inclusion criteria are met, the final three subtests were administered (i.e., VC, R-controlled and diphthongs). A performance of no more than 70% accuracy on the CVC words subtest and 40% accuracy (more than 4 correct of 10 items) on the consonant digraphs, consonant blends, CVCe and vowel digraphs subtests was used to verify eligibility for the study.

Two of the subtests from the phonological awareness section of the PAT-2 also were given to establish readiness for the experimental task (Boyer & Ehri, 2011). These subtests are segmentation and blending.

Week 1 of the study established the baseline obtained using the first four researcher created pseudoword probes. The probes were administered at the beginning and/or end of a session with no training on any syllable pattern preceding them. In addition, pretests were administered to the subject using standardized assessment instruments (i.e., Phonemic awareness subtests of PAT-2, Test of Integrated

Language and Literacy Skills [TILLS], Test of Nonverbal Intelligence [TONI]). Session 4 of this week introduced Phonic Faces using a PowerPoint presentation (i.e., *Intro to Phonic Faces Consonants and Vowels*) that explains the relationship between the manner in which a letter is placed in the mouth of a cartoon figure and the related sound that the mouth position produces.

During weeks 2 through 5 (i.e., 10-12 sessions), the CVC short vowel syllable training was implemented. Stimuli was presented using animated PowerPoints and included both real words and pseudowords in syllables ranging from three to six phonemes in the patterns CVC, CCVC, CCVCC, CCCVC and CCCVCC. Instruction occurred in three 40-minute sessions per week, each child receiving individual treatment via Zoom.

For each syllable type, instruction was begun with the five-word basic syllable patterns (i.e., CVC, CVCe, or CVVC), and in the same sessions, the five-word sets for the other four syllable patterns were taught until the 30-minute lesson time was expended. The number of potential 25 words decoded for each lesson were determined by the child's rate of success. That is, if the child only completed 8 words in 30 minutes, then only the first two patterns were taught that day. It was anticipated that as the patterns of vowels and consonant blends became more familiar, a greater number of the instructional words would be decoded.

Immediately following the 30-minute instructional session, the 30-word daily probe was administered. Ten of the words corresponded with the syllable type taught that day, while 20 corresponded to the two untutored alternative syllable types. It was anticipated that gains would be observed in the CVC probes during the first 12 sessions when that syllable type is taught, while the CVCe and CVVC remained at the baseline level.

Beginning on approximately week 6 through week 9, participant 2 received the second pattern while participants 1 and 3 began the second pattern intervention on approximately week 5 through week 9. The participants received training targeting their lowest scoring long-vowel pattern while the opposite

pattern continued to be assessed each session as a control condition. As with the CVC syllable type, the lessons included both real words and pseudowords in syllables ranging from three to seven phonemes in the patterns VCe, CVCe, CCVCe, CVCCe, CCVCCe, CCCVCe and CCCVCCe or CVV, CVVC, CCVVC, CCVVCC, and CCCVVCC. Week 10 was comprised of two to three follow-up sessions with no intervention. The pseudoword probes were administered at the beginning of the session, followed by post testing of the PAT-2, TONI and TILLS.

Administration of Intervention Lessons

The intervention sessions were recorded via Zoom. The Phonic Faces were introduced during the fourth session of the baseline period following administration of the baseline probe. The PowerPoint *Intro to Phonic Faces Consonants and Vowels* was used to introduce the faces used for instruction. Because criteria required the participants to know letter-sounds, the participants only needed to become familiar with the speech production cues depicted in the faces and how these cues link letters to the speech sounds. These cues reduce the memory load during decoding because the visualization enables the subject to imitate the mouth positions shown in the PFs. This enabled them to produce the sound sequences without having to rely on the auditory modality to recall sounds.

If a participant began to decode incorrectly, immediate feedback was given regarding how the child's production differed from the PF, and they were directed to use the PFs to problem solve and self-correct. This was increasingly important as word complexity increased, and consonant blends and clusters were encountered in both word beginning and ending positions.

Each session began by opening the PowerPoint to the first training word. Only the printed word was visible. Participants were asked to read the word. If they recognized the word by sight or decoded it correctly, the enter key was clicked to reveal the PF presentation of the word. The interventionist then helped the child to decode the word using the faces to "check and see" whether the decoding attempt was correct.

If the participant misread or decoded the word incorrectly, the PF presentation of the word was revealed, and the interventionist provided corrective feedback. Corrective feedback included

a) Having the child produce the sound sequence by imitating the mouth positions shown by the faces

b) If the child correctly imitated the sound sequence but doesn't hear the correct word, provide a binary choice of possible words and use the PFs to determine which word fits the pattern.

c) Use a word-stretching technique to facilitate sound blending by helping the child run the sounds together while saying it very slowly.

d) If the child miscues by producing a sound not actually in the word, retrieve that incorrect PF from slide 3 (consonants) or 4 (vowels) and show the child what they are saying versus the actual sounds in the word.

e) If the child produces two separate phonemes for a digraph (e.g., ch, sh, th, wh) or diphthong (e.g., ng), click enter to reveal the actual phoneme represented (see Figure 2.5).

f) The PFs are entered on a slide individually. Thus, they can be moved together or apart to parse the word into components and then recombined. For example, the word "splash" can be parsed into sp – l – a – sh; then sp – l – ash; then spl – ash; and finally splash.

g) Other strategies

The responses for each word during the intervention were tracked on the Daily Lesson Response Tracking Form (see figure 2.7). These data were used to record percentage of independent correct responses, percentage correct following feedback, and to look for patterns of feedback that may provide insights into word learning.

		WORD RECOGNIZED			CORRECTIVE FEEDBACK STRATEGIES							SUCCESS	
		YES	Decoded	NO -	IMITATE	BINARY	STRETCH	COMPARE	REVEAL	PARSE	OTHER		
			Verify	Use	Mouth	Word	Word to	Error PF to	Digraph or	Word then			
	Word	Sight	with PF	strategy	Positions	Choice	Blend	Correct PF	Diphthong	Recombine		YES	NO*
CVC	top												
	van												
	six												
	mud												
	let												
CVCC	sack												
	push												

*No indicates interventionist provided the word

Figure 2.7. Profile of correctness of responses and strategies used to support the child's decoding attempts. A "No" in the success column indicates the interventionist provided the word because of child frustration

When a child correctly decoded the word, the interventionist moved on to the next word in the series of 25 possible words. Using this process, as many or as few words as the child could complete were taught in 30 minutes. If the child completed all 25, the PowerPoint was repeated until the time is up, encouraging the child to read the printed word without the support of the PFs and then revealing them and moving on to the next slide. After 30 minutes, the pseudoword probes were started.

Administration of Pseudoword Probes

Zoom was recorded throughout administration of probes so scoring could be checked for both accuracy and time. Immediately following the 30-minute instructional session, the daily pseudoword probe was administered. The instructions were located on the second slide for the participant. "I am going to ask you to try to sound out some silly words that have no meaning. Some are very short words, and some have many letters. Try to sound out all the letters in each word as quickly and correctly as you can. After about 10 seconds, I will show you a different word even if you aren't finished so you have a chance to try many words. Do not worry if the word is too hard. You are still learning how to sound out words and this is just practice."

Slide three was presented with the picture of the stoplight (figure 2.8) on the PowerPoint and the participant was asked, "Are you ready to begin? When I show you the lights on the stoplight, I will say 'ready, set, go' and then show you the first word. Try to read each word quickly and correctly." Click the

enter key four times and the animation will light up the ready-set-go light sequence and present the first word on the next slide.

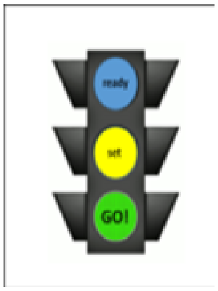

Figure 2.8. Screenshot of the 'Stoplight' Indicating the Beginning of Each Syllable Type Probe List

Because each syllable type (CVC, CVCe, CVCC) was scored for both accuracy and time, the first section of the probe ended after 10 pseudowords, marked by another stoplight. State, "Now we will read 10 more words. Are you ready? Ready-Set-Go!" This cue was repeated when the third stoplight appeared before the final syllable type. Participants had up to 10 minutes to complete the words (i.e., approximately 18 seconds per word or three minutes per syllable type). After 8-10 seconds on a single word, unless the child was close to decoding it correctly, the word was scored incorrect, and the next slide was presented with the next word in the set.

Pseudoword Daily Probe

Participant ID# **Date:**

PROBE 1 Notes: Notes

Pattern **CVC**	Target Word	Word Score	Vowel Score
	blaft		
	shrib		
	plucts		
	speld		
	scroft		
	hab		
	poct		
	bliv		
	glep		
	fulb		
	Total pts		
	Total time:		

Pattern **CVVC**	Target Word	Word Score	Vowel Score
	spluct		
	spalbs		
	scrod		
	briv		
	zamp		
	ged		
	fulb		
	plilk		
	blod		
	cleld		
	Total pts		
	Total time:		

Pattern **CVCe**	Target Word	Word Score	Vowel Score
	blive		
	plobe		
	pove		
	glepe		
	blafe		
	scrofe		
	shribe		
	pluce		
	habe		
	gepe		
	Total pts		
	Total time:		

Figure 2.9. Scoresheet for the Daily Pseudoword Probe Used to Record Word and Vowel Accuracy and Time

The Pseudoword Daily Probe form was used to record a score for the total word, the vowel score, and the time to complete each 10-word section. In the Word Score column, 1 point was assigned for a correctly decoded pseudoword and a 0 for an error in any part of the word. In the Vowel Score column, the vowel was scored as either correct (1 point) or incorrect (0) regardless of the accuracy of the consonants. Finally, the total number of seconds required to read each 10-word probe was recorded (see Figure 2.9).

Reliability and Fidelity

Training sessions were conducted prior to the implementation of the study. Training included conducting standardized assessments, use of the instructional PowerPoints, and conducting probes. A criterion of 90% accuracy in implementation during practice sessions was used. All baseline, instructional and posttest sessions were video recorded via Zoom. Recordings were saved to a university secured BOX folder. Twenty percent of the end-of-session probes were reviewed for reliability of scoring by a student unaware of the study's goals or the specific target of the probe. These checks were conducted using video recordings. The reliability checkers were trained to a criterion of 90% accuracy.

The fidelity of the intervention implementation was checked by the primary researcher who observed 25% of the sessions. If errors in implementation were noted, the primary researcher will provide verbal feedback during the session or will join the session and model correct implementation.

Data Analysis Plan

Pseudoword Vowel and Word Accuracy

Questions 1 and 2. The pseudoword probe data was used to ascertain whether changes that occurred during intervention differed significantly from baseline measures for Vowel Accuracy (VA) and Word Accuracy (WA). An adaptation of the 2 SD band method (Rubin, 2010) was used. First, the variability during the baseline phase was established for each measure using the mean and standard deviation of data points within that phase. The upper limit of the two SD band was drawn on the baseline phase and extended into the intervention and post-intervention phases (Figure 2.10). The probability that the scores in

the intervention phase are higher than those of the baseline phase was calculated using the binomial distribution. The proportion of scores in the intervention phase that are higher than the upper limit of the two SD band was compared to the 50% chance probability that the scores would be above or below the upper limit of the two SD band. For example, finding that five consecutive intervention scores are above the baseline upper limit would coincide with a significant p <.035 that this outcome occurred because of chance variation.

Seiler's profiles showed all participants scored more than six consecutive points above the two SD band for NW rate and NW total, and remained above that level post-intervention, indicating that the intervention resulted in a significant and positive effect on nonword reading

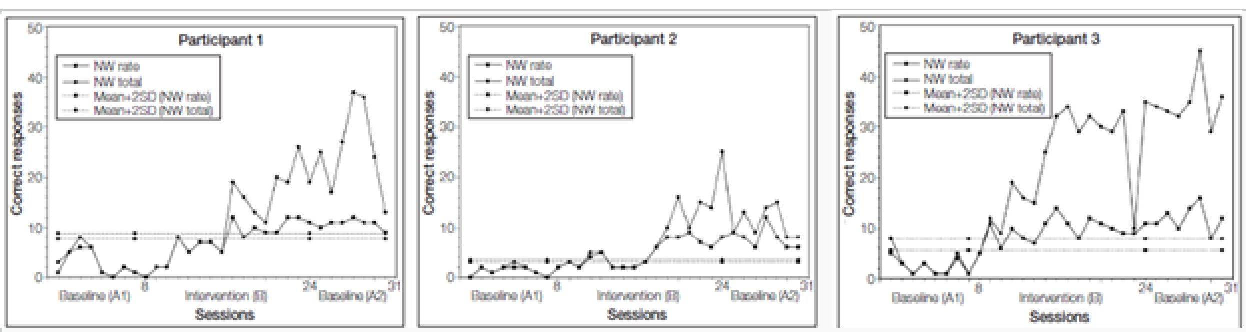

Figure 2.10. Example profiles from data reported by Seiler et al. (2013) for rate (correct responses per minute) and total correct responses demonstrating the two SD band method of analysis

Questions 3 and 4. The criterion of a clinically significant change was used to analyze pretest-posttest changes from the PAT-2 phonological awareness and phoneme-grapheme subtest scores. This measure enables multiple specific subtest changes to be compared from pretest to posttest. Clinical significance is defined as how the end scores compare to socially and clinically significant comparison groups. Jacobson et al. (2009) suggested that clinical significance was represented by a person's score moving from the "dysfunctional population" range into the "functional population" range on a standardized test. The confidence that the change is valid can be determined using the standard error of measurement (SEM), or the range of variability of a subject's true score. The SEM for PAT-2 subtests is one, while the

composite subtest is three. By adding one SEM value to the raw score, the upper range of the true raw score can be found at the 68% confidence level. Adding two SEM provides the range of the true raw scare at the 95% confidence level.

Question 5. The criterion of a clinically significant change will used to analyze pretest-posttest changes from the three contextualized reading and oral language measures Story Retelling, Reading Comprehension, and Reading Fluency Subtests of the Test of Integrated Language and Literacy Skills (TILLS) (Nelson et al., 2016). The procedure of Jacobson et al. (2009) was used to demonstrate clinical significance w by a person's score moving from the “dysfunctional population” range into the “functional population” range on a standardized test.

CHAPTER 3. RESULTS

This study used a single subject multiple baseline design replicated across three participants and three behaviors (i.e., CVC, CVVC and CVCe orthographic patterns) to examine the gains made in learning syllable patterns of written words. Unlike previous studies, during intervention an alphabet termed Phonic Faces was used to present phoneme-cued visual representations of letter-sound associations to link grapheme to phoneme representations. The purpose was to determine whether using the phoneme-cued Phonic Faces alphabet would assist 7–8-year-old poor decoders to acquire phonological awareness and orthographic reading skills.

Six questions were used to address this purpose. The most direct measure was the use of pseudoword probes at baseline, following intervention, and post intervention. Question 1 examined patterns of change for the CVC syllable probes, the first to receive treatment, while Question 2 profiled CVVC and CVCe during an extended 14 session baseline until intervention for CVCe patterns was introduced in session 15. The numeric significance of these changes was measured using the two standard deviation band method adapted from Rubin (2010). If five or more scores are outside of the 2 SD band established during the baseline phase, the changes shown during the intervention phase were considered significant.

While significant changes in outcome measures on the probe task are encouraging, they do not represent normative comparisons that lend insights into the clinical significance of the changes. Clinically significant changes suggest the participants are doing better compared to peers than they were before the intervention. Question 3 used changes in pretest-posttest in two phonological awareness subtests and the Phonological Awareness Composite of the PAT-2 to determine if the participant's outcome score moved significantly closer to the range representing the normal population following treatment. Question 4 similarly used the CVC, CVVC and CVCe subtests and the Decoding Composite of the PAT-2 to determine if the

outcome score moved significantly closer to the normal range for decoding (Jacobson et al., 2009) Gains in the total test score for the PAT-2 was also used to address this question.

Finally, question 5 examined whether gains in decoding skills would have an effect on contextualized reading and oral language. Three subtests of the Test of Integrated language and Literacy Skills (TILLS) (Nelson et al., 2016) were used to determine if the participant's outcome score moved significantly closer to the range representing the normal population following treatment

Analysis of Pseudoword Probes for Vowel and Word Accuracy

The first question of this study addressed whether changes would be shown in the number of correct responses within CVC pseudoword probes once intervention for this orthographic pattern was introduced in the fifth session. Two measures were used to assess the probes. Vowel Accuracy (VA) measured whether the correct short vowel was produced in the probe words, even if there were errors in the consonants produced (e.g., producing "scod" for "scrod"). The correct vowel was an indication that the target short vowel pattern was recognized within the pseudoword. The second measure was Word Accuracy (WA) where a correct response required the entire word to be produced correctly. In this case, learning reflected the ability to produce the correct vowel within pseudowords containing two and three letter blends that may have been in error.

Participant 1

CVC Vowel Accuracy. The graphed probe scores for Vowel Accuracy (VA) are shown in Figure 3.1 for Participant 1. The blue, orange, and grey lines represent the CVC, CVCe, and CVVC vowel patterns, respectively, while the dotted lines mark changing phases (i.e., baseline phase to CVC intervention, CVCe intervention and the post-testing phase). The blue CVC line shows that during baseline, the CVC vowel scores were within the range of 1-4. The average was calculated to be 2.75 with a standard deviation of 2.52. Once the CVC intervention was introduced in session 5 (probe 5), Participant 1's vowel score immediately increased to 7 (out of 10) and continued to increase to 10. When treatment

was withdrawn in session 15, a high level of accuracy (8 to 10) was shown throughout the CVCe intervention and post-testing phases, indicating learning was maintained.

The two standard deviation band method (Rubin, 2010) required five probes during the CVC intervention phase to score higher than 5.27 for the results to be significant. The student received a score of seven and above for all 10 of the intervention probes, indicating significant results for CVC Vowel Accuracy. In contrast, the Vowel Accuracy score for the untreated CVCe probes remained at or below four throughout the CVC treatment phase, and the CVVC remained at or below three for eight of the sessions.

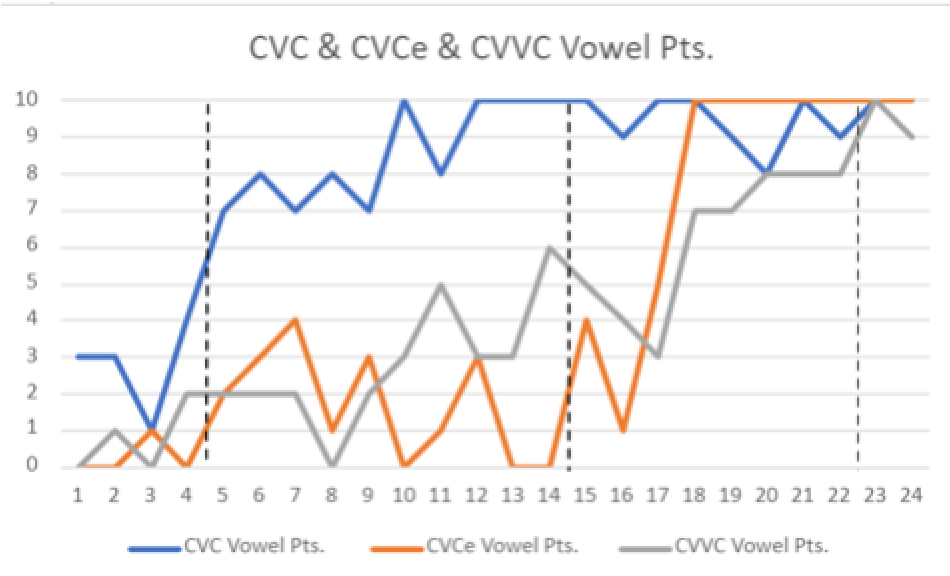

Figure 3.1. Participant 1 Graphed Scores for Vowel Accuracy Obtained During Baseline, CVC, and CVCe Training

CVCe Vowel Accuracy. The graphed probe scores for CVCe Vowel Accuracy (VA) are shown in orange in Figure 3.1. The orange line shows that the vowel accuracy score ranged from 0 to 4 throughout the extended 14 session baseline period, with a mean of 1.29 and a standard deviation of 1.44. Following the introduction of intervention for the long vowel CVCe pattern at session 15, the probe scores showed a slight increase for two sessions, but at the third session showed an immediate jump to all ten probe words correct and remained at that level throughout the remainder of the study.

The two standard deviation band method (Rubin, 2010) required five probes during the CVCe intervention phase to score higher than 4.18 for the results to be significant. The student received a score above the criterion level for 6 of the 8 intervention probes, indicating significant results for CVCe Vowel Accuracy.

CVC Word Accuracy. The second measure used to determine the effect of intervention on CVC word learning was the number of words correctly read (i.e., vowels and consonants) for daily pseudoword probes. The graphed probe scores for Word Accuracy (WA) are shown in Figure 3.1b for Participant 1. The blue CVC line shows that during baseline, the CVC word scores were within the range of 1-3 (out of 10), while the CVCe and CVVC patterns were produced at two or lower. The average was calculated to be 2.50 with a standard deviation of 1. Once the CVC intervention was introduced in session 5 (probe 5), Participant 1's Word Accuracy score immediately increased to 6 and continued to increase with scores between 6 and 10 for 5 of the last 6 sessions (through probe 15). Following withdrawal in session 16, CVC responses maintained high levels of accuracy throughout the CVCe intervention and posttest phases.

The two standard deviation band method (Rubin, 2010) required five consecutive probes during the CVC intervention phase to score higher than 4.50 for the results to be significant. The student received a score of six and above for all 10 of the intervention probes, indicating significant results for CVC Word Accuracy. The errors that did occur included errors in consonant blends and mixing hard and soft /g/ and /k/ sounds. In contrast, the untreated CVCe maintained a Word Accuracy score of 3 or below throughout the CVC intervention phase, while the CVVC scores remained at two or below for six sessions before increasing at a non-significant level using the two standard deviation band criteria.

CVCe Word Accuracy. The graphed probe scores for CVCe Word Accuracy (WA) are shown in orange in Figure 3.2 for Participant 1. The orange line shows that the word accuracy score ranged from 0 to 3 throughout the extended 14 session baseline period, with a mean of 1.21 and a standard deviation of 1.31. Following the introduction of intervention for the long vowel CVCe pattern at session 15, the probe

scores showed variable low scores for two sessions, but at the fourth session (probe 18) showed an increase of 8 to 10 correct words for the remaining probes. The grey line represents the untreated CVVC syllable probes. Ideally, these probes would have remained at baseline levels throughout the study, but they showed gains, although smaller, during the CVCe intervention. This finding suggests generalization to the CVVC pattern once long vowels were introduced.

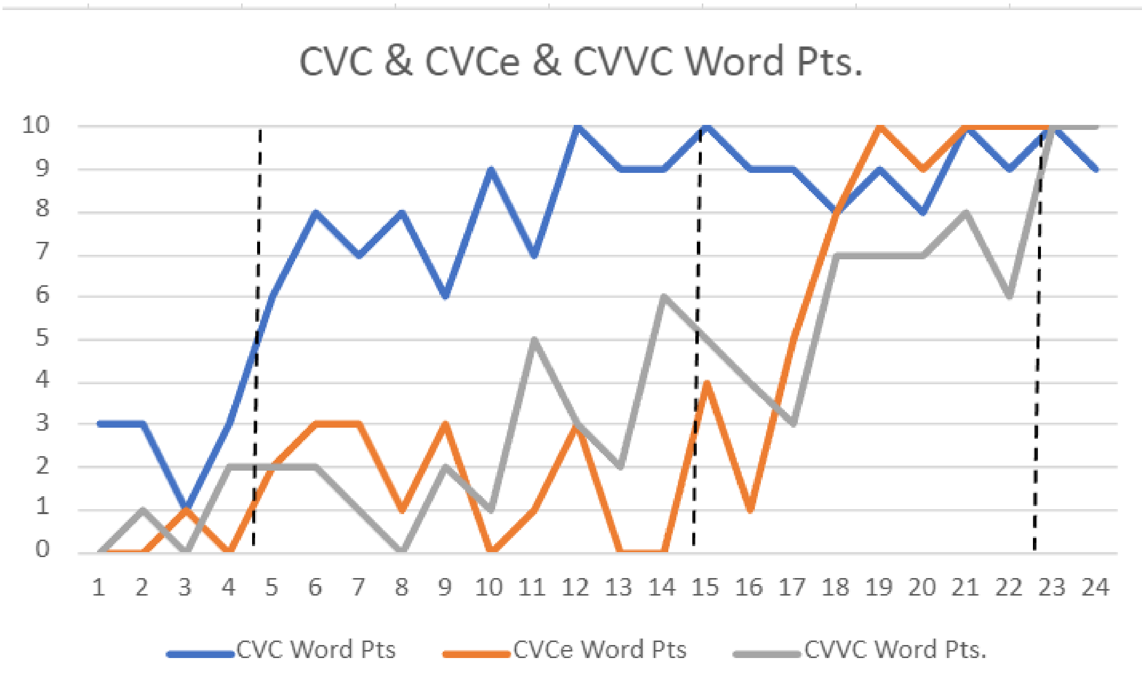

Figure 3.2. Participant 1 Graphed Scores for Word Accuracy Obtained During Baseline, CVC and CVCe Training

The two standard deviation band method (Rubin, 2010) required five probes during the CVCe intervention phase to score higher than 3.82 for the results to be significant. Scores continued to show stability after lesson 14 (probe 18) with scores varying from 8 to 10 for 5 consecutive sessions which indicate that the CVCe intervention was successful for Word Accuracy. Participant 1 received two scores of 10s during the post testing session indicating that learning was maintained.

Participant 2

CVC Vowel Accuracy. The graphed probe scores for Vowel Accuracy (VA) are shown in Figure 3.3 for Participant 2. The blue, orange, and grey lines represent the CVC, CVCe, and CVVC vowel patterns, respectively, while the dotted lines mark changing phases (i.e., baseline phase to CVC intervention, CVVC intervention and the post-testing phase). The blue CVC line shows that during baseline, the CVC vowel scores were within the range of 3-6. The average was calculated to be 4.75 with a standard deviation of 1.25. Once the CVC intervention was introduced in session 5 (probe 5), Participant 2's vowel score immediately increased to 7 (out of 10) and continued to vary between 7 and 10 correct except for probe 6 throughout the treatment phase. This pattern continued following withdrawal of treatment in session 16 indicating that learning was maintained.

The two standard deviation band method (Rubin, 2010) required five probes during the CVC intervention phase to score higher than 7.27 for the results to be significant. The student received a score of seven and above for 11 of the 12 intervention probes, indicating significant results for CVC Vowel Accuracy. As shown in figure 3.3, the baseline for the CVC pattern was rising before treatment was initiated and continued to rise during treatment albeit inconsistently. In contrast, the Vowel Accuracy for the untreated CVVC pattern remained at scores of 0-5 throughout the CVC treatment while the CVC pattern was rising. Despite not being targeted, the CVCe pattern is inconsistent throughout the CVC treatment. It rises to a 9 during the baseline, then shows decreases and increases throughout the duration of the treatment with scores varying between a 2 and 10. This inconsistency within the CVCe pattern is also exhibited for the Word Accuracy scores. This inconsistency does not necessarily suggest a generalization to the CVCe pattern since the scores were already higher than both the CVC and CVVC patterns during the baseline. However, the decreases throughout the CVC treatment could be attributed to its introduction. This is evident by the immediate decrease in the CVCe probe score at the initiation of the CVC treatment (from a score of 7 to a score of 3).

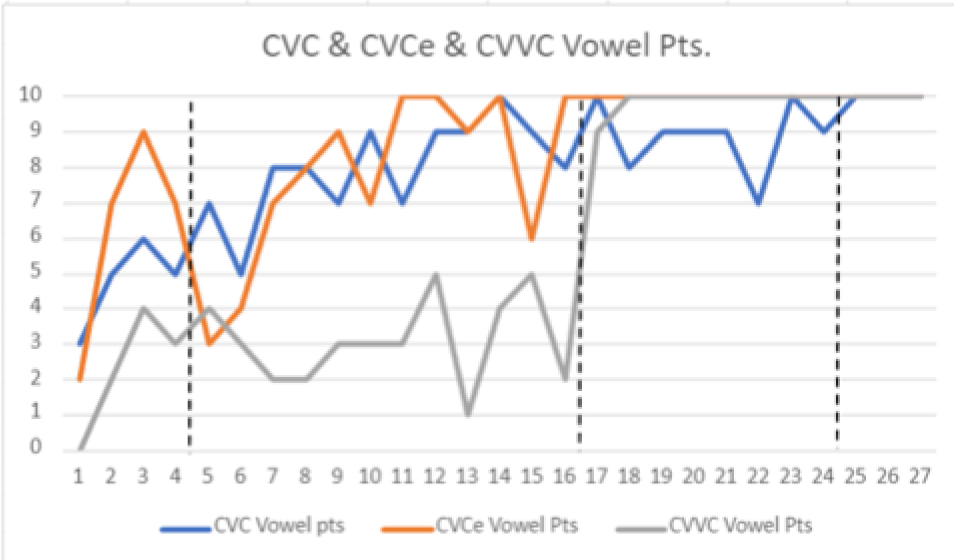

Figure 3.3. Participant 2 Graphed Scores for Vowel Accuracy Obtained During Baseline, CVC, and CVVC Training

CVVC Vowel Accuracy. The graphed probe scores for CVVC Vowel Accuracy (VA) are shown in grey in Figure 3.3. The grey line shows that the vowel accuracy score ranged from 0 to 5 throughout the extended 16 sessions baseline period, with a mean of 2.87 and a standard deviation of 1.36. Following the introduction of intervention for the long vowel CVVC pattern at session 16, the probe scores showed an immediate increase at 9 and remained stable until mastery was achieved on session 18 (probe 19). Mastery was retained following withdrawal of treatment during the post-testing phase.

The two standard deviation band method (Rubin, 2010) required five probes during the CVVC intervention phase to score higher than 5.59 for the results to be significant. The student received a score above the criterion level for the remaining 7 lessons of the 8 intervention probes, indicating significant results for CVVC Vowel Accuracy. In contrast with the CVC pattern, the CVVC pattern exhibits more consistency throughout the treatment duration. The VA scores for the CVC pattern during the CVVC treatment did not fall under a score of 7. Despite its inconsistent increase and decrease throughout the CVC treatment, the CVCe pattern remained stable throughout the CVVC treatment with scores of 10 until

the end of the phase. This consistency could be attributed to the introduction of the long vowel concept introduced during treatment of the CVVC syllable pattern.

CVC Word Accuracy. The second measure used to determine the effect of intervention on CVC word learning was the number of words correctly read (i.e., vowels and consonants) for daily pseudoword probes. The graphed probe scores for Word Accuracy (WA) are shown in Figure 3.4 for Participant 2. The blue CVC line shows that during baseline, the CVC word scores were within the range of 2-4 (out of 10), while the CVCe scores ranged between 2-7 and CVVC patterns were produced between 0-2. The average was calculated to be 3 with a standard deviation of 0.81. Once the CVC intervention was introduced in session 5 (probe 5), Participant 2's Word Accuracy score immediately increased to 5 but dropped back to baseline levels until probe 8. Mastery was not achieved, with scores varying between 5 and 9 for the remaining seven sessions of the CVC intervention phase. This pattern continued throughout the follow-up phase.

The two standard deviation band method (Rubin, 2010) required five probes during the CVC intervention phase to score higher than 4.62 for the results to be significant. The student received a score of five and above for more than 5 probes throughout the intervention indicating significant results for CVC Word Accuracy. The errors that did occur included errors in consonant blends, transposing letters, and omitting letters. In contrast, the untreated CVVC maintained a Word Accuracy score of 3 or below (with one exception) throughout the CVC intervention phase. Although untreated, the CVCe scores showed variable increases during the first baseline phase and then followed a profile of variable increases that paralleled the CVC profile, indicating Participant 2 recognized the vowel contrast without training for this pattern. Learning patterns of consonant blends and other orthographic difficulties were shown in both the CVC short vowel and CVCe long vowel patterns during this invention phase, although neither reached mastery.

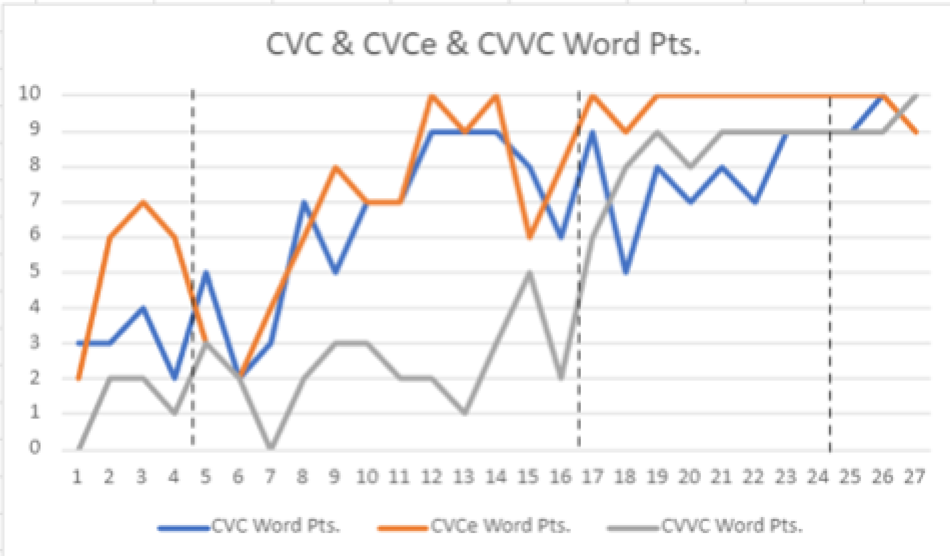

Figure 3.4. Participant 2 Graphed Scores for Word Accuracy Obtained During Baseline, CVC and CVVC Training

CVVC Word Accuracy. The graphed probe scores for CVVC Word Accuracy (WA) are shown in grey in Figure 3.4 for Participant 2. The grey line shows that the word accuracy score ranged from 0 to 5 throughout the extended 16 session baseline period, with a mean of 2.06 and a standard deviation of 1.23. Following the introduction of intervention for the long vowel CVVC pattern at session 16, the probe scores showed immediate increase (from a score of 2 to a score of 6). Within three intervention sessions, WA scores increased to near mastery (8 to 9 correct) and remained at this level throughout the CVVC intervention phase. This level was maintained at follow-up, including one score of 10. The orange line represents the untreated CVCe syllable probes. As indicated above, the CVCe pattern followed a profile of variable increases that paralleled the CVC profile, indicating Participant 2 recognized the vowel contrast without training for this pattern. However, mastery was not demonstrated until the CVVC training phase was introduced in session 17, at which time, the CVCe pattern showed stable and consistent increase of 9-10 across the CVVC treatment phase. The consistency of these scores could be attributed to the introduction of the long vowel treatment CVVC where the Phonic Faces compared and contrasted long and

short vowel sounds. The understanding gleaned from the contrast appeared to generalize to the CVCe pattern.

The two standard deviation band method (Rubin, 2010) required five probes during the CVVC intervention phase to score higher than 4.52 for the results to be significant. Scores continued to show stability after session 16 (probe 17) with scores varying from 9 to 10 for more than 5 consecutive sessions which indicate that the CVVC intervention was successful for Word Accuracy. However, the results are called into question because one of the control variables also increased without treatment.

Participant 3

CVC Vowel Accuracy. The graphed probe scores for Vowel Accuracy (VA) are shown in Figure 3.5 for Participant 3. The blue, orange, and grey lines represent the CVC, CVCe, and CVVC vowel patterns, respectively, while the dotted lines mark changing phases (i.e., baseline phase to CVC intervention, CVVC intervention and the post-testing phase). The blue CVC line shows that during baseline, the CVC vowel scores were within the range of 0-5. The average was calculated to be 2.20 with a standard deviation of 1.92. Once the CVC intervention was introduced in session 6 (probe 6), Participant 3's vowel score immediately increased to 7 (out of 10) and continued to show stable increase until mastery was achieved on session 13 (probe 13). Near mastery was maintained throughout the CVVC intervention phase after CVC treatment was withdrawn.

The two standard deviation band method (Rubin, 2010) required five probes during the CVC intervention phase to score higher than 6.04 for the results to be significant. The student received a score of six and above for all 10 of the intervention probes, indicating significant results for CVC Vowel Accuracy. However, the results cannot be attributed to the treatment because the control variables also increased without treatment.

An unexpected increase in Vowel Accuracy occurred for both the CVCe and, to a lesser degree, the CVVC syllable patterns during the baseline and CVC intervention phases. The CVCe pattern showed

high variability ranging from 1 to 9 during the baseline phase, and then vacillating between lower scores and 10 throughout the remainder of the study. The CVVC varied from 1 to 6 during baseline and vacillated between 4 and 8 throughout the CVC intervention phase. These results suggest Participant 3 had an emerging understanding of short and long vowel sounds and corresponding syllable patterns and was beginning to differentiate between them without direct instruction on the long vowels patterns using Phonic Faces.

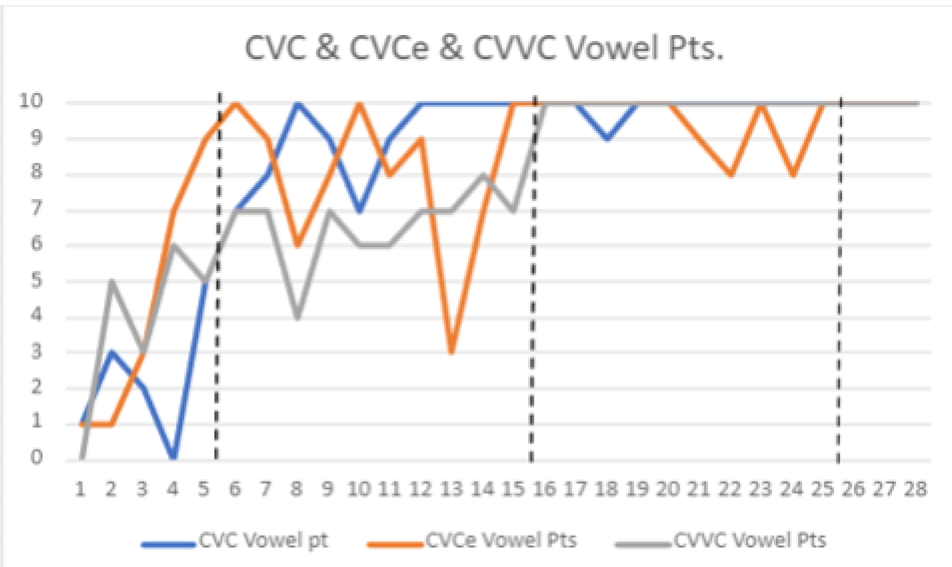

Figure 3.5. Participant 3 Graphed Scores for Vowel Accuracy Obtained During Baseline, CVC and CVVC Training

CVVC Vowel Accuracy. As indicated above, the Vowel Accuracy for the CVVC pattern shown in grey in Figure 3.5 increased more gradually than the CVCe pattern, staying between 4 and 7 for all but one probe during the extended 15 session baseline period. The mean number of correct responses was 5.66 with a standard deviation of 2.05. Only when the Phonic Faces pattern revealed the double vowel rule during the CVVC intervention phase, initiated at session 16, did the accuracy level rise to 10 out of 10 and remain at that level following withdrawal of treatment at post-testing (26-28), indicating the learning was maintained.

The two standard deviation band method (Rubin, 2010) required five probes during the CVVC intervention phase to score higher than 9.70 for the results to be significant. The student received a score above the criterion level for all the 10 lessons, indicating significant results for CVVC Vowel Accuracy. In contrast with the CVC pattern, the CVVC pattern exhibited more consistency throughout the treatment duration. The VA scores for the CVC pattern remained consistent with mostly scores of 10s and one score of 9 during the CVVC treatment. Despite its inconsistent increase and decrease throughout the CVC treatment, the CVCe pattern remained mostly stable throughout the CVVC treatment with scores of 9-10 and 2 scores of 8 until the end of the phase. This consistency could be attributed to the introduction of the long vowel treatment CVVC.

CVC Word Accuracy. The second measure used to determine the effect of intervention on CVC word learning was the number of words correctly read (i.e., vowels and consonants) for daily pseudoword probes. The graphed probe scores for Word Accuracy (WA) are shown in Figure 3.6 for Participant 3. The blue CVC line shows that during baseline, the CVC word scores were within the range of 0-4 (out of 10). The average was calculated to be 1.40 with a standard deviation of 1.67. Following the introduction of intervention for the short vowel CVC pattern at session 6, the score increased to 6 by the second session and reached and remained at 9 by the 5th session. The scores remained between 8 and 10 following withdrawal of treatment in session 16 indicating the learning was maintained.

The two standard deviation band method (Rubin, 2010) required five consecutive probes during the CVC intervention phase to score higher than 4.74 for the results to be significant. The student received a score of five and above for more than 5 probes throughout the intervention indicating significant results for CVC Word Accuracy. However, the results cannot be attributed to the treatment because the control variables also increased without treatment.

An unexpected increase in Word Accuracy occurred for both the CVCe and, to a lesser degree, the CVVC syllable patterns during the baseline and CVC intervention phases. The CVCe pattern showed high

variability ranging from 0 to 8 during the baseline phase, and then vacillated between 3 and 10 throughout the remainder of the study. The CVVC varied from 1 to 5 during baseline and vacillated between 3 and 7 throughout the CVC intervention phase. These results supported the proposed conjecture above that Participant 3 had an emerging understanding of short and long vowel sounds and corresponding syllable patterns and was beginning to differentiate between them without direct instruction on the long vowels patterns using Phonic Faces.

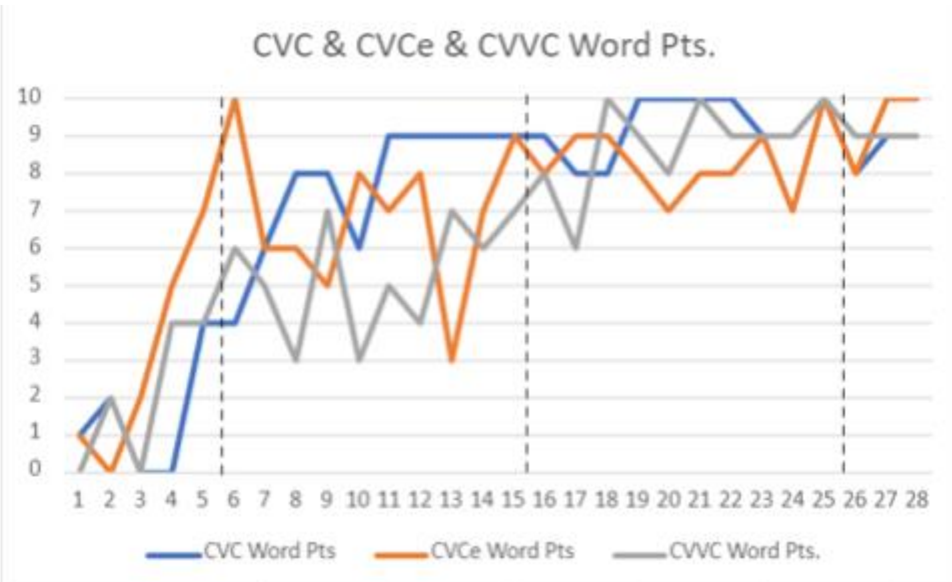

Figure 3.6. Participant 3 Graphed Scores for Word Accuracy Obtained During Baseline, CVC and CVVC Training

CVVC Word Accuracy. As indicated above, the Word Accuracy for the CVVC pattern shown in grey in Figure 3.6 increased more gradually than the CVCe pattern, staying between 0 and 7 for all probes during the extended 15 session baseline period. The mean number of correct responses was 4.20 with a standard deviation of 2.30. Only when the Phonic Faces pattern revealed the double vowel rule during the CVVC intervention phase, initiated at session 16, did the accuracy level rise to near mastery with scores between 8 and 10 for all but one probe. This high level of accuracy remained following withdrawal of treatment at post-testing (26-28), indicating the learning was maintained.

The two standard deviation band method (Rubin, 2010) required five probes during the CVVC intervention phase to score higher than 8.80 for the results to be significant. The participant received a score above the criterion for more than 5 sessions, which suggests that the CVVC intervention was successful for Word Accuracy. However, the results cannot be attributed to the treatment because the control variable also increased without treatment and changes in the CVVC pattern began during the CVC phase, before CVVC treatment was initiated.

Analysis of Changes in Phonological Awareness Subtests of the PAT-2

The third question of this study addressed whether clinically significant gains would be shown between pretest and posttest scores on the Phonological Awareness measures of the Phonological Awareness Test-2, normative update (Robertson et al., 2017). Jacobson et al. (2009) defined a clinically significant gain as improving from a “dysfunctional population” to the “functional population” range, meaning a score that moves from within the below-average range or lower to an average range or higher. The PAT reports the Index score has a mean of 100, with any score between 90-110 rated as “average”.

Table 3.1 profiles the pretest-posttest scores for the three participants for two of the phonological awareness subtests (i.e., Segmentation and Blending) and the Composite Phonological Awareness Score (i.e., Rhyming, Segmentation, Isolation, Deletion, Substitution and Blending) of the PAT-2 (Robertson et al., 2017). Segmentation and Blending were profiled because they have been shown to be highly related (and possibly prerequisite) to success in decoding (Pokorni et al., 2004; Torgesen et al., 2001).

The pretest results showed all participants scored in the average range (but not at the raw score ceiling indicating room for change) for all measures except Blending for Participant 3 who scored below average (index score of 80). This participant’s score at posttest increased to 100, indicating a clinically significant change. No clinically significant changes occurred for participants 1 or 2 on these measures.

Table 3.1. Phonological Awareness Profile of the PAT-2 Pretest-Posttest Index Scores and Descriptive Rating for the Segmentation and Blending Subtests, and the Phonological Awareness Total Score

Participant 1									
	Segmentation Subtest			Blending Subtest			Phonological Awareness Composite		
	Raw/30	Index	Rating	Raw/20	Index	Rating	Raw	Index	Rating
Pretest	23	92	Average	18	100	Average	104	92	Average
Posttest	18	81	Below Average	17	95	Average	94	83	Below Average
Participant 2									
Pretest	22	95	Average	19	103	Average	105	93	Average
Posttest	22	90	Average	18	100	Average	109	96	Average
Participant 3									
Pretest	22	97	Average	13	80	Below Average	98	91	Average
Posttest	22	97	Average	18	100	*Average	107	98	Average

*Clinically significant gain

Participant 1's posttest scores dropped to the below average range for both the Segmentation Subtest and the Composite scores. During post-testing, the participant's internet connection cut out throughout the session, interrupting the testing. Further, the session was two hours in length and cognitive fatigue could have affected performance. During training, the participant did not exhibit difficulty applying these skills, which is a further indication that the results of post-testing were not an accurate representation of the child's skills.

Analysis of Changes in Decoding Subtests of the PAT-2

The fourth question of this study addressed whether clinically significant gains would be shown between pretest and posttest scores on the Decoding measures of the Phonological Awareness Test-2, normative update (Robertson et al., 2017). Subtest scores for the three syllable patterns targeted in this study (i.e., CVC, CVVC, and CVCe) and the Decoding Composite scores are compared in Table 3.2. It should be noted that the Updated Norms of the PAT-2 (Robertson et al., 2017) no longer include individual subtest scores because "… they did not contain sufficient raw score points to build psychometrically sound

standard scores" (p. 1). The 2007 norms for CVC, CVVC and CVCe are presented in Table 3.2 for comparison purposes but should be interpreted cautiously. The Standard Error of Measurement for these subtests is one. The Decoding Composite norms are from the 2017 Update, with an SEM of three.

The pretest results showed Participant 1 scored in the below average range for all measures (6/10 for CVC; 2/10 for CVCe) except CVVC syllables that rated poor (2/10). These results met inclusion criteria and left room for change. Posttest scores showed gains to the average and above average range for the three subtests that would be considered clinically significant gains if norms were reliable. The increase to the average range for the Decoding Composite does represent a clinically significant gain.

Participant 2 scored in the average range for CVC (7/10) and CVCe (4/10) syllables but poor for CVVC (2/10). The Decoding Composite was below average. These results met inclusion criteria and left room for change. Posttest scores showed a gain from poor to average in CVVC that would be considered clinically significant if norms were reliable. The gains in CVC and CVCe, that were treated in intervention, increased to the above average range but would not be considered clinically significant because pretest scores were not in the below average range. The increase from below average to average for the Decoding Composite does represent a clinically significant gain.

Participant 3 scored in the average range for CVC (7/10) and CVCe (7/10) syllables but below average for CVVC 3/10). These results met inclusion criteria except for CVCe syllables and left room for change. The Decoding Composite was average. Posttest scores showed a gain from below average to above average in CVVC that would be considered clinically significant if norms were reliable. The gains in CVC and CVCe that were treated in intervention changed to the above average range, while the Decoding Composite also changed from average to above average. The increase from average to above average for these scores would not be considered clinically significant because pretest scores were not in the below average range but do reflect a notable change in decoding skills.

Table 3.2. Decoding Profile of the PAT-2 Pretest-Posttest Standard Scores and Descriptive Rating for the CVC, CVVC and CVCe Subtests, and the Decoding Total Score

Participant 1												
	CVC Subtest			CVVC Subtest			CVCe Subtest			Decoding Composite		
	Raw	SEM	Rating	Raw	SEM	Rating	Raw	SEM	Rating	Raw	SEM	Rating
Pre-test	6		Below Average	1		Poor	2		Below Average	33		Below Average
Post-test	9	95%	* Average	7	95%	* Average	9	95%	*Above Average	65	95%	*Above Average
Participant 2												
	CVC Subtest			CVVC Subtest			CVCe Subtest			Decoding Composite		
	Raw	SEM	Rating	Raw	SEM	Rating	Raw	SEM	Rating	Raw	SEM	Rating
Pre-test	7		Average	2		Poor	4		Low Average	32		Below Average
Post-test	10	95%	+Above Average	9	95%	* Average	10	95%	+Above Average	68	95%	* Average
Participant 3												
	CVC Subtest			CVVC Subtest			CVCe Subtest			Decoding Composite		
	Raw	SEM	Rating	Raw	SEM	Rating	Raw	SEM	Rating	Raw	SEM	Rating
Pre-test	7		Average	3		Below Average	7		Average	40		Average
Post-test	10	95%	+Above Average	10	95%	*Above Average	10		+Above Average	69	95%	+Above Average

*Clinically significant gain
+Non-clinically significant gain

Table 3.3 profiles the total test scores for the PAT-2 (i.e., Phonological Awareness, Graphemes, and Decoding Components). Results indicated that two of the participants, 1 and 2, made clinically significant changes from the below average to average levels. While the gains in the index score for Participant 3 were equal to or greater than the others, the results were not considered clinically significant because the pretest scores were not in the below average range. Thus, a change greater than the SEM

was obtained, indicating a true gain, but not one that showed improvement from a dysfunctional to an average level.

Table 3.3. Total Test Score for the PAT-2 Including Phonological Awareness, Graphemes and Decoding Components

PAT-2 Total Test Scores									
	Participant 1			Participant 2			Participant 3		
	Raw Score	SEM	Rating	Raw Score	SEM	Rating	Raw Score	SEM	Rating
Pretest	178		Below Average	176		Below Average	182		Average
Posttest	213	95%	*Average	233	95%	*Average	228	95%	Average

*Clinically significant gain

Summary

Questions 3 and 4 examined gain scores in components of The Phonological Awareness Test, 2nd Edition, to determine if clinically significant changes were made. The three participants overall displayed average abilities in phonological awareness in pretest, with the one below-average score improving to the average level at posttest. These scores suggest the participants had prerequisite skills associated with decoding. Participants 1 and 2 displayed poor to below average scores in most measured components and made large gains in the index scores at posttest (17 to 30 points). Both improved to the average or above average range with two-to-five clinically significant changes, including overall test total. Participant 3 started higher at pretest and made smaller gains, but all posttest scores were in the average to above average range.

Analysis of Changes in Contextualized Oral and Written Language Abilities on the TILLS

Three measures of the Test of Integrated language and Literacy Skills (TILLS) (Nelson et al., 2016) were used to determine if gains in decoding skills would have an effect on contextualized reading and oral language. The Story Retelling subtest measures the ability to recall information from an orally presented story and to answer comprehension questions. This ability is compared to Reading Comprehension, where the child must read a short story and respond to comprehension questions. Reading Fluency measures accurate and

automatic word recognition by recording the miscues that are produced when reading a story. Test scores are subject to variation resulting from testing students more than once.

The standard error of the estimate (SEE) accounts for standard score variation that could be expected by chance alone. The True Change Interval (TCI) corresponds to the gains in standard scores needed to show the changes did not occur by chance at the 68% and 90% confidence levels. For the Story Retelling subtest, the SEE values are 2 (68%) and 4 (90% confidence); for Reading Comprehension, the values are 2 (68%) and 3 (90%); and for Reading Fluency the values are 2 (68%) and 3 (90%). If the true standard score is less than posttest standard score, then the criteria for a clinically significant change can be applied (i.e., a change from a dysfunctional range to a "normal" or average range) (Jacobson et al., 2009). We also noted non-clinically significant gains, or scores that did not improve to the average level but moved in this direction (e.g., very poor to poor) Table 3.4 profiles the pretest and posttest scores and ratings to establish pretest ability levels and clinically significant changes.

Table 3.4. Profile of the Pretest-Posttest Scaled Scores and Descriptive Ratings for the Story Retelling, Reading Comprehension, and reading Fluency Subtests of The Test of Integrated Language and Literacy Skills

Participant 1									
	Story Retelling			Reading Comprehension			Reading Fluency		
	SS	TCI	Rating	SS	TCI	Rating	SS	TCI	Rating
Pretest	2		Very Poor	0		Very Poor	0		Very Poor
Posttest	8	90%	*Average	2	68%	+Very Poor	5	90%	+Poor
Participant 2									
Pretest	8		Average	6		Below Average	7		Below Average
Posttest	9	<68%	Average	8	68%	*Average	10	90%	*Average
Participant 3									
Pretest	7		Below Average	0		Very Poor	1		Very Poor
Posttest	10	68%	*Average	11	90%	*Average	12	90%	*Average

*Clinically significant gain
+Significant gain but pretest not in dysfunctional range

The pretest results showed Participant 1 scored in the very poor range for all three measures. The subject was unable to read the age-appropriate passages and scored zero for both fluency and comprehension. Oral language comprehension abilities were only slightly better, indicating a general comprehension deficit. At posttest, all three measures improved, with Story Retelling showing clinically significant gains with low average scores. Word recognition improved from essentially presenting as a nonreader to an emerging reader. Reading comprehension improved slightly, but not commensurate with changes in fluency. Participant 1 had the weakest decoding skills at pretest for words in isolation on the PAT-2 and although important gains were made, reading fluency remains in the dysfunctional range. The dysfluent reading corresponds with the poor reading comprehension that did not improve at the same rate as oral Story Retelling/comprehension.

Participant 2 presented a very different profile, with average oral language comprehension abilities at pretest and below average reading fluency and comprehension. Thus, Participant 2 was a reader but struggled with decoding sufficiently to interfere with comprehension. At posttest, both fluency and reading comprehension showed clinically significant gains, with reading comprehension slightly below the levels of reading fluency or story retelling/comprehension. Participant 2 had stronger decoding skills at pretest than Participant 1 and made greater gains at posttest.

Participant 3 performed similarly to Participant 1 in reading, scoring in the very poor range for both reading fluency and comprehension. However, Story Retelling/comprehension was a relative strength, scoring in the below average range. Participant 3 made the greatest gains on the TILLS, making clinically significant gains from the very poor to average range for both reading fluency and comprehension, and from below average to average for Story Retelling. Participant 3 had the strongest decoding skills at pretest for words in isolation and may have contributed to the rapid and robust gains in reading fluency which in turn corresponded with reading comprehension scores commensurate with oral language abilities.

Summary

Question 5 examined gain scores in components of The Test of Integrated Language and Literacy Skills to determine if clinically significant changes were made that corresponded with gains in decoding. The three participants overall displayed very poor to below average abilities at pretest. Participants 1 and 3 displayed a weakness in oral language comprehension, and both scored in the very poor range for reading comprehension and fluency. This profile reflected greater difficulty with contextualized reading than decoding skills on the PAT-2 at pretest for single words. Participant 2 scored average in oral language comprehension but below average in reading comprehension and fluency, showing difficulty applying decoding skills to reading. All three participants made gains in contextualized reading following intervention and corresponding gains in decoding, with Participants 2 and 3 improving to the average range, a clinically significant finding. Participant 1 improved from the very poor to average range for oral language comprehension, a clinically significant finding, and from very poor to poor for both reading measures.

CHAPTER 4. DISCUSSION

Visual enhancements of alphabetic letters have been shown to assist poor readers of varying etiologies to improve reading skills (Handler & Fierson, 2011). These enhancements have included incorporating pictures of words beginning with the sound associated with the letter (e.g., Itchy's Alphabet, Larson, 1998), and associating properties of letters with photographs of lips producing the sounds (LiPS; Lindamood & Lindamood, 1998). This study investigated whether a more direct pictured association between letters and sounds using faces with alphabet letters placed in the mouth to show articulatory placements, termed Phonic Faces (PF) (Norris,2001), would enable students with persistent decoding impairment to acquire phonological awareness (i.e., phoneme segmentation and blending) and orthographic patterns in pseudowords, real words, and reading passages. Following a discussion of the research questions, a brief examination of participant profiles and performance will be offered, followed by the limitations and conclusions.

Questions 1 and 2

The first two research questions examined the effects of the Phonic Faces decoding intervention on pseudowords ranging from three to six letters and representing allowable orthographic patterns in English. Daily probes were used to assess all three orthographic patterns during baseline, daily intervention sessions, and posttest phases. Question 1 examined the accuracy of the vowels (Vowel Accuracy) while question 2 considered the entire word (Word Accuracy). The ideal profile would show a low level of accuracy maintained for words from all three orthographic patterns (CVC, CVVC, and CVCe) throughout the baseline phase followed by only the CVC (short vowel words) showing gains during the first intervention phase. The two long vowel patterns would continue with low levels of accuracy for five weeks until intervention for one of the long vowel patterns was introduced, at which point only the targeted long vowel pattern would make gains while the second maintained low levels of accuracy.

Participant 1

The first participant demonstrated a profile most consistent with the ideal case. For questions one and two, all vowel patterns and word accuracy were within the low scores of 0 to 4 out of 10 at baseline. Once the short vowel intervention was introduced, the participant exhibited increasing scores for the targeted pattern (CVC) while the untargeted long vowel patterns (CVCe and CVVC) remained at the baseline level. However, a deviation from the ideal profile occurred once the long vowel intervention was introduced, when both long vowel patterns demonstrated gains.

This finding suggests that Participant 1 did not have a good understanding of short and long vowels or the orthographic patterns that differentiated them. At pretest, the child could only provide three of the five long vowel sounds when shown the alphabetic letter, while all five were known at posttest. The Phonic Faces have different pictures for short (baby faces) and long (corresponding parent faces) to show how the same vowel letter can represent two different phonemes. Participant 1 was not able to decode the long vowel patterns until the long vowel intervention was initiated and the adult variant of the vowel was introduced. At that time, the accuracy level for both long vowel patterns began to increase, with the targeted CVCe pattern achieving mastery (10 of 10) for the vowel sound by the 4th session and the entire word by the 5th session. The CVVC pattern changed at the same times, but at a lower level of accuracy (7-8 correct words). This indicated that the concept of a long vowel sound generalized to the second untargeted pattern once the child conceptualized long vowels.

Participant 2

The second participant exhibited more ambiguous results compared to Participant 1. Participant 2 never achieved a stable baseline for any vowel pattern for Vowel Accuracy, showing increases for all three vowels (3 to 6 for CVC; 0 to 4 for CVVC; 2 to 7 for CVVC). Although the CVC vowel accuracy was increasing during baseline, the accuracy level continued to rise once intervention was introduced, showing significant increases compared to baseline for 11 of 12 sessions.

Word Accuracy during baseline was more stable for CVC (2 to 4) and CVVC (0 to 2), but CVCe increased from 2 to 7. Once CVC intervention was initiated, the CVCe pattern also increased in a manner that mirrored the accuracy patterns of the treated CVC pattern. These results suggest that Participant 2 already had a prior understanding of the difference between short and long vowels and was able to apply this understanding to the CVCe pattern. This was supported by the pretest PAT-2 scores where Participant 2 scored in the average range for CVC and CVCe, but poor range for CVVC. As improvements were shown in the ability to decode longer and more complex syllable patterns, gains were demonstrated in both patterns equally.

This understanding, however, did not apply to the other long vowel pattern (CVVC) since it remained within the baseline range until the CVVC intervention was introduced in week 6. The CVVC followed the ideal profile of low accuracy for both Vowel Accuracy (1 to 4) and Word Accuracy (0 to 3 for all but one probe) throughout the 5-week CVC intervention. As expected, increases were shown for Vowel Accuracy (9 to 10) immediately following the initiation of CVVC intervention, with more gradual gains (5 to 9) for Word Accuracy. All gains were maintained when treatment was withdrawn, although the CVC pattern was more variable than the long vowel patterns throughout the CVVC training. However, all three patterns showed scores of 9 to 10 during post testing.

Participant 3

The third participant showed the most problematic pattern of gains compared to Participants 1 and 2. During the baseline phase, all three vowel patterns increased for both Vowel Accuracy and Word Accuracy, with rapid gains for the CVCe pattern (0 to 8). The CVC did follow the ideal profile with scores of 0 to 4 shown at baseline, followed by increases to 8 by the third CVC intervention session and scores above baseline for 11 of 12 sessions. However, both untargeted long vowel patterns also increased during this phase. The CVCe pattern showed variable scores, with seven of the probes scoring between 6 and 10

correct. The CVVC pattern also showed variable scores, with six remaining within baseline levels (3 to 4) but six scoring above (5 to 7).

When the CVVC intervention phase was introduced in week 6, immediate gains were shown for CVVC with scores between 8 and 10 for all but one probe. However, the untreated CVCe pattern also showed gains that mirrored the CVVC accuracy pattern with slightly lower scores. These results suggest Participant 3 had precedent understanding of both short and long vowel rules and was able to apply this knowledge for all three patterns. This was supported by the pretest PAT-2 scores where Participant 3 scored in the average range for CVC and CVCe, and below average for CVVC. As improvements were shown in the ability to decode longer and more complex syllable patterns, gains were demonstrated across patterns. All three patterns showed scores of 9 to 10 during post testing.

While the scores for the short vowel in the CVC intervention phase showed significant gains, the gains cannot be attributed solely to the intervention since both control variables (CVCe and CVVC) showed increases as well. Similarly, while the increases of the CVVC during its intervention phase showed significant gains, the CVCe pattern showed parallel gains. In both cases, some variable other than the Phonic Faces vowel patterns could have caused the changes across patterns.

One possibility is that Participants 1 and 2 were responding less to the Phonic Faces vowel patterns targeted in the lessons, and more to (or at least equally to) the Phonic Faces consonants that modeled how to pronounce the consonant blends. That is, as students used the faces to learn to pronounce the consonant sequences, this skill generalized to all orthographic patterns in which the blends appeared. This would explain why all three patterns improved in parallel, but not to the same extent, during the CVC intervention phase. Since the CVC intervention only presented the blends using short vowels, words in the CVC pattern were read more accurately than the CVVC long vowel pattern for both participants. The CVCe pattern is more similar in spelling to CVC than the CVVC pattern, with the final e establishing a visible contrast. Teachers emphasize the “silent e” rule and the pattern may have been more

familiar to participants. Recall, Participants 1 scored in the below average range and 2 scored in the average range for the CVCe pattern at pretest. Those CVCe probes generally scored in the same range as the CVC pattern, but not the CVVC patterns.

This hypothesis is supported by the finding that the CVVC pattern did not achieve similarly high levels of accuracy until the Phonic Faces CVVC intervention demonstrated how the double vowel spelling represented the long vowel (i.e., Phonic Faces adults) pronunciation. This pattern was unclear to participants until they could see it in the Phonic Faces. Once they saw it, immediate gains were shown, and the correct vowel was produced in syllables with complex consonant blend sequences. It is also supported by scores for the Consonant Blending subtest at pretest and posttest on the PAT -2. Participants 1 and 2 scored in the poor range at pretest while Participant 3 scored in the below average range. At posttest, all three made clinically significant gains with Participant 2 scoring in the average range and Participants 1 and 3 improving to the above average range. To score higher on the vowel pattern probes, participants necessarily needed to increase skills in consonant blending. Once the consonant blends were learned, participants could apply them and achieve high word accuracy as long as the vowel pattern was known. This explains why CVCe probes scored higher without training but CVVC probes did not.

Another possibility gains were different for each participant could be attributed to different number of sessions each participant received. As discussed previously, due to time constraint, each participant received a different number of sessions. The variability of each of their scores compared to one another could be attributed to the number of instructional lessons they received. Participant 1 received less long vowel compared to the Participant 3. If she received more lessons, she could have achieved higher scores on the TILLS, similarly to Participant 2 and 3.

Questions 3 and 4

The third and fourth research question examined the effects of the intervention on the phonological awareness and decoding subtests of the Phonological Awareness Test (PAT-2) (Robertson et al., 2017).

Only one clinically significant change was found for the phonological awareness measures, which was the phoneme blending subtest for Participant 3. This was because the three participants did not score in the clinically dysfunctional range at pretest. As previously discussed, phonological awareness is crucial in the acquisition of the alphabetic principle (Adams, 1990; National Reading Panel, 2000). In order to be able to decode accurately, children must be able to apply the skills of phonemic blending and segmenting (Oudeans, 2003) since they are considered to be predictors of reading ability (Torgesen et al., 1997). The participants' blending and segmentation measures of the PAT-2 were within the average range (except for participant 3). This suggests that the participants already acquired these prerequisite skills that support learning to decode and may account in part for the rapid progress made by all three participants during intervention.

It should be noted that the below-average scores achieved during pre-testing for the phonological awareness subtest for Participants 1 and 2 is due to the long testing sessions which could have led to cognitive fatigue, especially since these are skills that required no training during the intervention which leads us to assume these scores were not an accurate representation of their skills.

Furthermore, most of the participants' scores for the decoding subtest of the PAT-2 (CVC, CVCe, and Vowel Digraphs/CVVC) were also not in the clinically dysfunctional range. Participant 1 had the lowest performance for these three measures with scores ranging from poor to below average. These scores left room for change, and Participant 1 showed clinically significant gains to the average or above average range for all three vowel patterns. These scores mimic the results of the pseudoword probes where the participant made gains in all patterns, including the untargeted long vowel pattern (CVVC).

In contrast, Participants 2 and 3 only showed poor to below-average scores for the Vowel Digraphs (CVVC) subtest and average scores for the other two measures. They made similar levels of change although not considered clinically significant because they didn't start out in a dysfunctional range. The changes were significantly higher at posttest at the 90% level of confidence, rating in the above average

range for CVC, CVCe, with CVVC improving to the average range for Participant 2 and above average range for Participant 3. These changes mimicked the results of the pseudowords probes where all three patterns reached levels of mastery or near mastery.

Question 5

The fifth research question examined the effects of the intervention on contextualized reading skills. Two measures of reading included Reading Fluency, or the level of accuracy and reading rate at which a passage is read, and Reading Comprehension, or response to questions after the child read an age-appropriate passage. The comprehension was compared to a Story Retelling task that measured comprehension and recall of an orally presented story.

All three participants scored in the dysfunctional range on the two measures of reading at pretest, with Participants 1 and 3 both scoring in the very poor range, while Participant 2 scored in the below average range. Participants 1 and 3 also scored in the dysfunctional range for oral Story Retelling, scoring very poor and below average, respectively. Participant 2 scored average for Story Retelling, indicating a deficit specific to reading, and suggesting that the poor performance in reading comprehension may be due to lack of fluent word recognition rather than a generalized language comprehension deficit. At post-test, both the Reading Fluency and Reading Comprehension showed clinically significant gains from the below-average to average range. This is consistent with gains in decoding on the PAT-2 from the below average to average range.

Participant 1 scored very poor across all three contextualized measures at pretest. This was a lower score than his below average decoding scores would predict, indicating a more generalized language deficit. Despite improvements to the average or above average range in all decoding skills measured by the PAT-2 at post-test, generalization to contextualized reading was only emerging, with posttest score only improving to the poor range. While Story Retelling improved to an average range, reading comprehension improved but remained very poor. The profile of continued contextualized reading difficulties despite

improvements in decoding warrant further diagnostic assessment to explore the need for intervention that focuses on higher level language as well as decoding. It should be noted that Participant 1 had the least number of sessions due to time constraint.

Participant 3 presented with the strongest decoding skills at pretest on the PAT-2, with only CVVC scoring below average, and made the most rapid gains across patterns. However, these skills had not generalized to contextual reading as measured by the TILLS, with Reading Fluency scoring very poor, as did Reading Comprehension. Oral Reading scored in the below average range indicating both poor decoding and general language deficits contributed to reading comprehension deficits. Participant 3 made gains in all decoding patterns during the first intervention phase, and this is reflected in a jump from very poor to average in Reading Fluency. Gains were also shown in oral Story Retelling, from below average to average. The changes in decoding and oral language both resulted in gains in reading comprehension, from very poor to average. The gains were all clinically significant, but because they occurred early in the study for targeted and non-targeting patterns it is unclear whether the changes were related to the Phonic Faces intervention.

Limitations

There were many limitations to this study that led to ambiguous results. The primary limitation was that the participants each met part of the eligibility criteria, but not all of them. Students had higher (i.e., average) phonological awareness skills than anticipated and this left little opportunity for clinical change. While their percentage of correct responses to items on the decoding subtest of the PAT-2 were within acceptable limits, they represented scores in the average to below average ranges in some cases, thus not reflecting the degree of deficit that would be more ideal for the study. The level of knowledge regarding the vowel patterns the students already knew enabled the students to increase scores in some cases prior to intervention. However, despite the age-appropriate pretest scores, all students did make significant gains on the PAT-2 post-test, supporting the efficacy of the treatment for phonemic awareness.

It also became apparent that students who were scoring at lower levels on probes did so because of the unknown consonant blend patterns, rather than the vowel patterns. Once the consonant blend patterns were learned, they generalized across vowel patterns resulting in changes in both targeted and non-targeted pseudoword patterns. Further, because both of the control vowel patterns were long vowel patterns, as soon as one long vowel training phase was initiated, the correct responses generalized to both CVCe and CVVC pseudowords. A better control pair would have been the VCCV long vowel pattern versus vowel diphthongs (e.g., au, ow, oi, oo). Another problem was the generalization in learning to the CVCe pattern. The CVCe pattern appeared to be more familiar to the participants than the VCCV pattern and students began responding correctly to it prior to targeted instruction.

Recruitment was a significant challenge. Parent groups and online sites for dyslexia were not successful in eliciting referrals. Timing was also a challenge in that the participants needed to be recruited early in the school year to have sufficient time to complete the study, but parents and teachers may not be aware of student decoding difficulties early in the year.

Conclusion

Overall, the results of the study are promising but replication with participants who better fit the criteria is important to have more conclusive results of the efficacy of the Phonic Faces. The data presented is only suggestive because of the higher than optimal skill levels of the participants recruited. Future research should focus on a) having a larger number of participants who meet the eligibility criteria b) beginning the intervention process at the beginning of the school year.

Future studies that may help to parse out some of the questions raised by this study could include comparing Phonic Faces to plain print training stimuli, or having stimuli only use Phonic Faces for the target pattern rather than the whole word. For example, plain print might be used for consonants while Phonic Faces present the vowels, or consonant blends might be presented using Phonic Faces while regular print represents the vowels.

APPENDIX. INSTITUTIONAL REVIEW BOARD APPROVAL

LSU | Office of Research & Economic Development

TO:	Janet A Norris LSUAM | Col of HSS | Communication Sciences and Disorders | CC00127
FROM:	Alex Cohen Chairman, Institutional Review Board
DATE:	25-Sep-2022
RE:	IRBAM-22-0852
TITLE:	The Use of Phonic Faces to Improve Decoding in Children with Reading Delays
SUBMISSION TYPE:	Initial Application
Review Type:	Expedited Review
Risk Factor:	Minimal
Review Date:	25-Sep-2022
Status:	Approved
Approval Date:	25-Sep-2022
Approval Expiration Date:	24-Sep-2023
Expedited Categories:	07
Requesting Waiver of Informed Consent:	No
Re-review frequency:	Annually
Number of subjects approved:	6
LSU Proposal Number:	
By:	Alex Cohen, Chairman

Continuing approval is CONDITIONAL on:

1. Adherence to the approved protocol, familiarity with, and adherence to the ethical standards of the Belmont Report, and LSU's Assurance of Compliance with DHHS regulations for the protection of human subjects*
2. Prior approval of a change in protocol, including revision of the consent documents or an increase in the number of subjects over that approved.
3. Obtaining renewed approval (or submittal of a termination report), prior to the approval expiration date, upon request by the IRB office (irrespective of when the project actually begins); notification of project termination.
4. Retention of documentation of informed consent and study records for at least 3 years after the study ends.

5. Continuing attention to the physical and psychological well-being and informed consent of the individual participants, including notification of new information that might affect consent.
6. A prompt report to the IRB of any adverse event affecting a participant potentially arising from the study.
7. Notification of the IRB of a serious compliance failure.
8. **SPECIAL NOTE: When emailing more than one recipient, make sure you use bcc. Approvals will automatically be closed by the IRB on the expiration date unless the PI requests a continuation.**

** All investigators and support staff have access to copies of the Belmont Report, LSU's Assurance with DHHS, DHHS (45 CFR 46) and FDA regulations governing use of human subjects, and other relevant documents in print in this office or on our World Wide Web site at http://www.lsu.edu/research*

Louisiana State University
131 David Boyd Hall
Baton Rouge, LA 70803

O 225-578-5833
F 225-578-5983
http://www.lsu.edu/research

BIBLIOGRAPHY

Adams, M. J. (1990). *Beginning to read: Thinking and learning about print*. MIT Press.

Akemoglu, Y., Muharib, R., & Meadan, H. (2020b). A systematic and quality review of parent-implemented language and communication interventions conducted via telepractice. *Journal of Behavioral Education, 29*, 282–316.

American Speech-Language-Hearing Association. (2001). Roles and responsibilities of speech-language pathologists with respect to reading and writing in children and adolescents [Position Statement]. Available from www.asha.org/policy.

American Speech-Language-Hearing Association. (2015). ASHA's National Outcomes Measurement System (NOMS). Retrieved from http://www.asha.org/NOMS/

Annie E. Casey Foundation (2010). *Early warning! Why reading by the end of third grade matters.* Special report from the Annie E. Casey Foundation.

Apel, K. (2009). The acquisition of mental orthographic representations for reading and spelling development. *Communication Disorders Quarterly*, *31*, 42–52. https://doi.org/10.1177/1525740108325553

Apel, K. (2011). What is orthographic knowledge? *Language, Speech, and Hearing Services in Schools*, *42*(4), 592–603.

Arndt, J., Lee, K., & Flora, D. B. (2008). Recognition without identification for words, pseudowords and nonwords. Journal of Memory and Language, 59(3), 346–360. https://doi.org/10.1016/j.jml.2008.06.004

Baker, S. K., Santiago, R. T., Masser, J., Nelson, N. J., & Turtura, J. (2018). The alphabetic principle: From phonological awareness to reading words. Washington, DC: U.S. Department of Education, Office of Elementary and Secondary Education, Office of Special Education Programs, National Center on Improving Literacy. https://improvingliteracy.org/brief/alphabetic-principle-phonological-awareness-reading-words

Becker, R.; Sylvan, L. (2021). Coupling articulatory placement strategies with phonemic awareness instruction to support emergent literacy skills in preschool children: A collaborative approach. Language, Speech & Hearing Services in Schools; 52. 661-674.

Banajee, Meher H. (2007). *Effect of adapted Phonic Faces Story Books on phonological skills of children with severe expressive language disorders.* http://etd.lsu.edu/docs/available/etd-06112007-175920/

Bhattacharya, A., & Ehri, L. C. (2004). Graphosyllabic Analysis Helps Adolescent Struggling Readers Read and Spell Words. *Journal of Learning Disabilities*, *37*(4), 331–348. https://journals-sagepub-com.libezp.lib.lsu.edu/doi/pdf/10.1177/00222194040370040501

Bolden III, W., & Grogan-Johnson, S. (2022). Entering the digital therapy room: Best practices for telepractice interventions with school-age clients. *Topics in Language Disorders, 43* (2), 140-155.

Blishchak, D. M. & McDaniel, M. A. (1995). Effects of picture size and placement on memory for written words. *Journal of Speech and Hearing Research, 38,* 1356-1362.

Bowers, J. S. (2020). Reconsidering the evidence that systematic phonics is more effective than alternative methods of reading instruction. Educational Psychology Review, 32(3), 681-705. https://doi-org.libezp.lib.lsu.edu/10.1007/s10648-019-09515-y

Boyer, N., & Ehri, L. C. (2011). Contribution of phonemic segmentation instruction with letters and articulation pictures to word reading and spelling in beginners. Scientific Studies in Reading, 15(5), 440–470. doi.org/10.1080/10888438.2010. 520778

Brazier-Carter, Patricia Minnis (2008). *Language learning through storybook reading in HeadStart*. http://etd.lsu.edu/docs/available/etd-06032008-133935

Brown, L., Sherbenou, R.J. & Johnsen, S. K. (2010). *Test of Nonverbal Intelligence,* Fourth Edition. Pro-Ed.

Brown, K. J., Sinatra, G. M., & Wagstaff, J. M. (1996). Exploring the potential of analogy instruction to support students' spelling development. *The Elementary School Journal, 97*, 1, 81-99.

Bus, A. G., & Van Ijzendoorn, M. H. (1997). Affective dimension of mother-infant picture book reading. Journal of School Psychology, 35, 47-60.

Camilli, G., Vargas, S., & Yurecko, M. (2003). Teaching children to read: The fragile link between science & federal education policy. *Education Policy Analysis Archives*, *11*(15), 1-51. https://doi.org/10.14507/epaa.v11n15.2003

Canney, G., & Schreiner, R. (1976). A Study of the Effectiveness of Selected syllabication rules and phonogram patterns for word attack. Reading Research Quarterly, 12 (2), 102-124.

Cardenas, J. M. (2009). Phonics instruction using pseudowords for success in phonetic decoding (Doctoral Dissertation). FIU Electronic Theses and Dissertations (Paper 139). https://digitalcommons.fiu.edu/cgi/viewcontent.cgi?article=1176&context=etd

Castiglioni-Spalten, M. L., & Ehri, L. C. (2003). Phonemic awareness instruction: Contribution of articulatory segmentation to novice beginners' reading and spelling. Scientific Studies of Reading, 7(1), 25-52.

Castles, A., Rastle, K., & Nation, K. (2018). Ending the reading wars: Reading acquisition from Novice to expert. Psychological Science in the Public Interest, 19(1), 5–51.

Chomsky, C. (1970). Invented spelling in the open classroom. *Word, 27*, 499-518.

Chomsky, N., & Halle, M. (1968), The sound pattern of English, New York: Harper & Row

Cognitive Concepts, Inc. (1998). Earobics Auditory Development and Phonics Program Step 2. Evanston,IL: Author.

Coleman, E. B., & Morris, G. (1978). Generalization tests: A terminology that focuses attention on fixed-effect restrictions. Journal of Reading Behavior, 10,377-392.

Coufal, K., Parham, D., Jakubowitz, M., Howell., & Reyes, J. (2018). Comparing traditional service delivery and telepractice for speech sound production using a functional outcome measure. *American Journal of Speech-Language Pathology, 27*(1), 82-90.

Ehri, L. C. (1979). Orthography and the Amalgamation of Word Identities in Beginning Readers. Final Report. https://eric.ed.gov/?id=ED188145

Ehri, L. C. (1992). Reconceptualizing the development of sight word reading and its relationship to recoding. In P. Gough, L.C. Ehri, & R. Treiman (Eds.), *Reading Acquisition*, (pp. 107- 143). Lawrence Erlbaum Associates, Inc.

Ehri, L.C. (1995). Phases of development in learning to read by sight. *Journal of Research in Reading, 18,* 116–125.

Ehri, L.C. & Robbins, C. (1995). Beginners need some decoding skill to read words by analogy. *Reading Research Quarterly, 27*(1), 13-26.

Ehri, L. C. (1998). Grapheme-phoneme knowledge is essential for learning to read words in English. In J. L. Metsala & L. C. Ehri (eds.), Word recognition in beginning literacy (pp. 3-41). Routledge.

Ehri, L. C. (2020). The science of learning to read words: A case for systematic phonics instruction. *Reading Research Quarterly*, *55*(S1). https://doi.org/10.1002/rrq.334

Ehri, L. C., Nunes, S. R., Stahl, S. A., & Willows, D. M. (2001). Systematic phonics instruction helps students learn to read: evidence from the National Reading Panel's meta-analysis. *Review of Educational Research, 71*, 393–447. https://doi.org/10.3102/00346543071003393

Ehri, L. C. (2005). Learning to read words: Theory, findings, and issues. *Scientific Studies of Reading*, 9(2), 167–188. https://doi.org/10.1207/ s1532799xssr0902_4

Foorman, B., Beyler, N., Borradaile, K., Coyne, M., Denton, C. A., Dimino, J., Furgeson, J., Hayes, L., Henke, J., Justice, L., Keating, B., Lewis, W., Sattar, S., Streke, A., Wagner, R., & Wissel, S. (2016). Foundational skills to support reading for understanding in kindergarten through 3rd grade (NCEE 2016-4008). Washington, DC: National Center for Education Evaluation and Regional Assistance (NCEE), Institute of Education Sciences, U.S. Department of Education.

Frost, S., Landi, N., Mencl, W., Sandak, R., Fulbright, R., Tejada, E. et al. (2009). Phonological awareness predicts activation patterns for print and speech. Annals of Dyslexia, 59, 78–97.

Galuschka, K., Ise, E., Krick, K., & Schulte-Körne, G. (2014). Effectiveness of treatment approaches for children and adolescents with reading disabilities: A meta-analysis of randomized controlled trials. PLoS ONE, 9(8). https://doi.org/10.1371/journal.pone.0089900

Garnett, R., Davidson, B., & Eadie, P. (2021). Telepractice delivery of an autism communication intervention program to parent groups. Research in Autism Spectrum Disorders. https://doi.org/10.1016/j.Rasd.2021.101902

Gates, A. & Bocker, E. (1923). A study of initial stages in reading by preschool students. *Teacher's College Record, 24*, 469-688.

Gough, P.B., Juel, C., and Griffith, P.L. (1992). Reading, spelling, and the orthographic cipher. In P.B. Gough, L. C. Ehri, & R. Treiman (eds.), *Reading Acquisition* (1st ed.). Routledge.

Gregory J., Benner, G.J., Mattison, R.E., Nelson, J. R., Ralston, N.C. (2009). Types of language disorders in students classified as ED: prevalence and association with learning disabilities and psychopathology. West Virginia University Press. http://www.thefreelibrary.com/Types+of+language+disorders+in+students+classified+as+ED%3a+prevalence...-a0211733737

Gustafson, S., Samuelsson, S., Ronnberg, J. (2000). Why do some resist phonological intervention? A Swedish longitudinal study of poor readers in grade 4. *Scandinavian Journal of Educational Research, 44*, 2,145-62.

Halsey, Heather Noël (2008). "Investigating a parent implemented early literacy intervention : effects of dialogic reading using alphabet books on the alphabet skills, phonological awareness, and oral language of preschool children." Doctoral Dissertations 1896 - February 2014. 5823. https://scholarworks.umass.edu/dissertations_1/5823

Handler, S. M., Fierson, W. M., & Section on Ophthalmology. (2011). Learning disabilities, dyslexia, and vision. *Pediatrics*, *127*(3), E818–E856.

Herron, J. (1995). Read, Write, & Type. San Rafael: Talking Fingers Inc.

Hudson, R. F., Isakson, C., Richman, T., Lane, H. B., & Arriaza-Allen, S. (2011). An Examination of a Small-Group Decoding Intervention for Struggling Readers: Comparing Accuracy and Automaticity Criteria. *Learning Disabilities Research & Practice (Wiley-Blackwell)*, *26*(1), 15–27.

n.a. (1987). Hooked on Phonics. Simon & Schuster.

Jacobson, C. (1999). How persistent is reading disability? Individual growth curves in reading. *Dyslexia (10769242)*, *5*(2), 78–93. https://doi-org.libezp.lib.lsu.edu/10.1002/(SICI)1099-0909(199906)5:2<78::AID-DYS127>3.0.CO;2-8

Kamil, M. L. & Hiebert, E. H. (2005). Teaching and learning vocabulary: Perspectives and persistent issues. In E. H. Hiebert & M. L. Kamil (Eds.), *Teaching and learning vocabulary: Bringing research to practice.* Erlbaum.

Katz, L., & Frost, R. (1992). The reading process is different for different orthographies: The orthographic depth hypothesis. In R. Frost & L. Katz (Eds.), *Orthography, phonology, morphology, and meaning* (pp. 67–84). Elsevier.

Kaufman, E., Norris, J. A., & Hoffman, P. R. ASHA convention, Boston, MA, November 2007.

Knight-McKenna, M. (2008). Syllable types: A strategy for reading multisyllabic words. *Teaching Exceptional Children,* 40(3), 18-24. https://academics.franciscan.edu/wp-content/uploads/sites/18/2022/03/6-syllables-sight-recog-extra-4-wr.pdf

Kohrt, M. (1986), The term 'grapheme' in the history and theory of linguistics. In G. Augst (Ed.), New trends in graphemics and orthography. Berlin: De Gruyter, pp. 80–96. doi:10.1515/9783110867329.80

Ladefoged, P. (2004). Vowels and consonants: An introduction to the sounds of language 2nd edn (Blackwell, Oxford, UK, 2004).

Lalonde, K., & Holt, R. F. (2015). Preschoolers benefit from visually salient speech cues. Journal of Speech, Language, and Hearing Research, 58(1), 135–150. doi.org/10.1044/2014_JSLHRH-13-0343

Larson, B. (1998). Itchy's Alphabet. NMS Creations.

Lawhon, T. & Cobb, J. B. (2002). Routines that build emergent literacy skills in infants, toddlers, and preschoolers. Early Childhood Education Journal, 30, 113-118.

Lindamood, P.C., & Lindamood, P.D. (1998). The Lindamood Phoneme Sequencing Program for reading, spelling, and speech. Austin, TX: PRO-ED.

Lockwood, D. G. (2001), Phoneme and grapheme: How parallel can they be? LACUS Forum 27, 307–316.

Lyon, G. R. (1996). Learning Disabilities. *The Future of Children*, *6*(1), 54–76.

Lyon, G. R., Shaywitz, S. E., & Shaywitz, B. A. (2003). A definition of dyslexia. *Annals of Dyslexia*, *53*, 1–14. https://doi-org.libezp.lib.lsu.edu/10.1007/s11881-003-0001-9

Marsh, J. (2003). One-way traffic? Connections between literacy practices at home and in the nursery. British Educational Research Journal, 29, 369-382.

Mason, J. M. (1980). When do children begin to read: An exploration of four year old children's letter and word reading competencies. *Reading Research Quarterly, 15*, 203–227.

McArthur, G., Eve, P. M., Jones, K., Banales, E., Kohnen, S., Anandakumar, T., Larsen, L., Marinus, E., Wang, H.-C., & Castles, A. (2012). Phonics training for English-speaking poor readers. *Cochrane Database of Systematic Reviews, 12*. https://doi.org/10.1002/14651858.cd009115.pub2

McCandliss, B., Beck, I.L., Sandak, R., & Perfetti, C. (2003). Focusing attention on decoding for children with poor reading skills: Design and preliminary tests of the word building intervention. *Scientific Studies of Reading*, *7*(1), 75–104.

McIntyre, L., Protz, S., & McQuarrie, L. (2008). Exploring the potential of LiPS instruction for beginning readers. Developmental Disabilities Bulletin, 36(1&2), 18–48.Meadan, H., Snodgrass, M. R., Meyer, L. E., Fisher, K. W., Chung, M. Y., & Halle, J. W. (2016). Internet-based parent-implemented intervention for young children with autism: A pilot study. *Journal of Early Intervention, 38*, 3–23.

Meadan, H., Snodgrass, M. R., Meyer, L. E., Fisher, K. W., Chung, M. Y., & Halle, J. W. (2016). Internet-based parent-implemented intervention for young children with autism: A pilot study. Journal of Early Intervention, 38, 3–23.

Miller, A. & Miller, E.E. (1968). Symbol accentuation: The perceptual transfer of meaning from spoken to printed words, *American Journal of Mental Deficiency 76*, pp. 110–117.

Miller, A. & Miller, E.E. (1971). Symbol accentuation, single-track functioning, and early reading, *American Journal of Mental Deficiency 76*, pp. 110–117.

Musaji, I., Roth, B., Coufal, K., Parham, D.F., Self, T.L. (2021). Comparing in-person and telepractice service delivery for spoken language production and comprehension using the national outcomes measurement system. *International Journal of Telerehabiitation, 12*(1), 1-13. https://doaj-org.libezp.lib.lsu.edu/article/330727a08fe847c8ae8510e2f6c1ab3e

National Institute of Child Health and Human Development (April 2000). Report of the National Reading Panel: Teaching Children to Read.

National Reading Panel. (2000). Teaching children to read: an evidence-based assessment of the scientific research literature on reading and its implications for reading instruction. National Institute of Child Health and Human Development. https://www.nichd.nih.gov/publications/pubs/nrp/smallbook#

Nelson, N., & Plante, E., Helm-Estabrooks, N., & Hotz, G. (2021). The Test of Integrated Language and Literacy Skills. Brookes Publsihing.

Norris, J. A. (2001). *Phonic Faces manual*. Elementory.

Oxford Dictionaries (n.d.). Syllable. In *Lexico.com dictionary.* https://www.lexico.com/en/definition/syllable

Petit, Michelyve (2019). Speech Production Cued and Picture Cued Approaches for Speech Sound Learning.

Oudeans, M. K. (2003). Integration of letter-sound correspondences and phonological awareness skills of blending and segmenting: A pilot study examining the effects of instructional sequence on word reading for kindergarten children with low phonological awareness. *Learning Disability Quarterly*, *26*(4), 258–280. https://doi-org.libezp.lib.lsu.edu/10.2307/1593638

Pokorni, J. L., Worthington, C. K., & Jamison, P. J. (2004). Phonological awareness intervention: Comparison of Fast ForWord, Earobics, and LiPS. Journal of Educational Research, 9(3), 147-157.

Portney, L. G., & Watkins, M. P. (2009). Foundations of clinical research (3rd ed.). Prentice Hall.

Pullen, P. C., Lane, H. B., Lloyd, J. W., Nowak, R., & Ryals, J. (2005). Effects of Explicit Instruction on Decoding of Struggling First Grade Students: A Data-Based Case Study. *Education and Treatment,* 28(1), 63-75. https://www-jstor-org.libezp.lib.lsu.edu/stable/42899828#metadata_info_tab_contents

Robertson, C., Salter M. & Salter, W. (2017). *Phonological Awareness Test*, second edition: normative update (PAT-2:UN). Pro-ed.

Rubin, A. (2010). *Statistics for Evidence-Based Practice and Evaluation*, 3rd Edition. Cengage Learning.

Scientific Learning Corporation. (1999). *Fast ForWord companion: A comprehensive guide to the training exercises*. Berkeley, CA: Author.

Salter, W. & Robertson, C. (2007). *The Phonological Awareness Test 2* (PAT 2). LinguaSystem.

Seiler, A., Leitão, S., & Blosfelds, M. (2013). The effectiveness of a computer- supported intervention targeting orthographic processing and phonological recoding for children with impaired word identification: A preliminary study. *Journal of Clinical Practice in Speech-Language Pathology, 15(1), 13-17.*

Seiler, A., Leitão, S., & Blosfelds, M. (2018). *WordDriver-1*: Evaluating the efficacy of an app-supported decoding intervention for children with reading impairment. *International Journal of Language & Communication Disorders*, *54*(2), 189–202. https://doi.org/10.1111/1460-6984.12388

Seymour, P. H. K., Aro, M., & Erskine, J. M. (2003). Foundation Literacy Acquisition in European Orthographies. British Journal of Psychology, 94(2), 143–174. https://doi-org.libezp.lib.lsu.edu/10.1348/000712603321661859

Shankweiler, D., Lundquist, E., Katz, L., Stuebing, K. K., Fletcher, J. M., Brady, S., Fowler, A., Dreyer, L. G., Marchione, K. E., Shaywitz, S. E., & Shaywitz, B. A. (1999). Comprehension and decoding: Patterns of association in children with reading difficulties. *Scientific Studies of Reading*, *3*(1), 69–94. https://doi.org/10.1207/s1532799xssr0301_4

Share, D. L. (2008). Orthographic learning, phonological recoding, and self-teaching. *Advances in Child Development and Behavior, 36,* 31-82.

Sherman, M. K. (2018). Using the six syllable types to teach word attack skills. *Texas Association for Literacy Education Yearbook, 5,* 98-102. https://eric.ed.gov/?id=EJ1291185

Snowling, M. J. (2001). From language to reading and dyslexia 1. Dyslexia, 7(1), 37-46.

Stanback, M. L. (1992). Syllable and rime patterns for teaching reading: Analysis of a frequency-based vocabulary of 17,602 words. *Annals of Dyslexia, 42,* 196-221.

Terrell, Pamela A (2007). Alphabetic and Phonemic Awareness in Toddlers. http://etd.lsu.edu/docs/available/etd-11072007-162300/

Torgesen, J. K., Alexander, A. W., Wagner, R. K., Rashotte, C. A., Voeller, K. K. S., & Conway, T. (2001). Intensive remedial instruction for children with severe reading disabilities: Immediate and long-term outcomes from two instructional approaches. Journal of Learning Disabilities, 34(1), 33-58.

Torgesen, J. K., Wagner, R. K., & Rashotte, C. A. (1997). Prevention and Remediation of Severe Reading Disabilities: Keeping the End In Mind. *Scientific Studies of Reading*, *1*(3), 217.

Torgerson, C., Brooks, G., & Hall, J. (2006). A systematic review of the research literature on the use of phonics in the teaching of reading and spelling (Research Report RR711). U.K. Department for Education and Skills.

Torgesen, J., Wagner, R., Rashotte, C., & Herron, J. (2003). Summary of outcomes from first grade study with Read, Write and Type and Auditory Discrimination in Depth Instruction and software with at-risk children (FCRR Tech. Rep. No. 2).

Torgesen, J.K., Wagner, R.K., Rashotte, C.A., Herron, J., & Lindamood, P. (2010). Computer-assisted instruction to prevent early reading difficulties in students at risk for dyslexia: Outcomes from two instructional approaches. Annals of Dyslexia, 60(1), 40–56. doi:10.1007/s11881-009-0032-y

Treiman, R., Tincoff, R., & Richmond-Welty, E. D. (1996). Letter names help children to connect print and speech. Developmental Psychology, 32(3), 505–514. https://doi.org/10.1037/0012-1649.32.3.505

Troia, G.A. & Wallace, S.E. (2022). Pediatric language assessment and intervention using a telepractice service delivery model. *Topics in Language Disorders, 43* (2), 103-106.

Vadasy, P. F., & Sanders, E. A. (2020). Introducing grapheme-phoneme correspondences (GPCs): Exploring rate and complexity in phonics instruction for kindergarteners with limited literacy skills. *Reading and Writing: An Interdisciplinary Journal, 34*(1), 109-138. https://doi-org.libezp.lib.lsu.edu/10.1007/s11145-020-10064-y

Wagner, R., Torgesen, J., Rashotte, C., & Pearson, N. A. (2013). Comprehensive Test of Phonological Processing, second edition (CTOPP-2). Pearson.

Wang, H. C., Nickels, L., & Castles, A. (2015). Orthographic learning in developmental surface and phonological dyslexia. *Cognitive Neuropsychology*, *32*(2), 58–79. https://doi.org/10.1080/02643294.2014.1003536

Webster, N. (1848). *An American dictionary of the English language.* 1848 edition online. https://doi-org.libezp.lib.lsu.edu/10.1007/s10212-020-00464-7

Zarić, J., Hasselhorn, M., & Nagler, T. (2020). Orthographic knowledge predicts reading and spelling skills over and above general intelligence and phonological awareness. European Journal of Psychology of Education, 36(1), 21–43.

Zhang, Z., & Peng, P. (2022). Reading real words versus pseudowords: A meta-analysis of research in developmental dyslexia. *Developmental Psychology*, *58*(6), 1035–1050. https://doi.org/10.1037/dev0001340

VITA

Chantal Farag hanna graduated from Texas Woman's University with a bachelor's degree in psychology in May of 2017. Chantal anticipates earning her Master of Arts in Communication Sciences and Disorders at Louisiana State University in May of 2023. Upon graduation, she plans to work as a speech-language pathologist for her clinical fellowship year before earning her certificate of clinical competency.