A COMPARISON OF CONTINUOUS VERSUS SEGMENTED SPEECH PRODUCTION IN TEACHING DECODING AND SPELLING TO CHILDREN AT RISK FOR READING DIFFICULTY

by

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A dissertation submitted to the Graduate Faculty in the Speech, Hearing and Language Sciences in partial fulfillment of the requirements of the degree Doctor of Philosophy,

The City University of New York

2010

This manuscript has been read and accepted by the Graduate Faculty in the Speech, Hearing and Language Sciences in satisfaction of the dissertation requirement of the degree Doctor of Philosophy.

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Abstract

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Advisors: Professors Linnea Ehri, Helen Cairns, Joel Stark

The purpose of this research was to compare the effectiveness of two approaches to phonics code-focused instruction upon the acquisition of early decoding and spelling skills in children at risk for learning to read. One program involved continuous speech production and analysis. The other program involved segmented speech production and analysis. The traditional approach to decoding instruction has been to teach children to recite the separate sounds of letters before blending them. However segmented speech creates a problem when stop consonants are produced separately in isolation (e.g. /k / - /æ/ - /t/) and then must be blended. The new continuous approach avoids this problem by teaching children to maintain a continuous stream of speech, thus precluding the need to teach blending. Five and six year-old kindergarten children who had risk factors for difficulty learning to read were assigned randomly to one of three training groups, the

continuous production group, the segmented production group or an emergent literacy narrative-based control condition. Results showed that children receiving continuous speech production training outperformed children receiving segmented speech production training on several outcome measures, and that both groups outperformed the control treatment group. The continuous group showed superior phonological elision, word and non-word decoding and non-word repetition compared to the segmentation group. Both groups gained equally in spelling words and non-words. Findings are important for their potential in identifying a more effective method of teaching phonics to struggling young readers.

Acknowledgments

My dissertation is the culmination of a long and exciting journey. It is the springboard to a new and related expedition! At this transitional milestone I wish to recognize the important individuals who have enhanced the substance of my thinking, have been a source of inspiration, and have provided a network of support along the way.

I thank the faculty and staff of the Department of Speech, Hearing and Language Sciences, past and present, for the instruction, guidance and belief that enabled me to complete my degree.

I especially thank Loretta Walker. Loretta is a cornerstone of the Department who has always informed, prodded and pushed me along.

I thank the parents and children who participated in this study. I so appreciate their dependability, trust, integrity and enthusiasm during the research.

I thank John Dore and Katherine Nelson, whose differing perspectives expanded my conceptualization of language.

I thank Susan Nittrouer, Maria Mody and Jan Edwards, graduates of our program, and outstanding scholars. Their works have broadened my understanding of essential processes that contribute to the development of competence in literacy.

I thank Jen Perri for her assistance in copying, filing, scheduling subjects and maintaining the confidentiality of records throughout this research. Her contribution to this project was invaluable.

I thank Carla Eggers for formatting and completing the post defense presentation of the dissertation manuscript. Her experience as a professional editor saved countless hours.

I thank Peg Lahey, my original advisor and mentor. Her character, wisdom, conversation and insights were invaluable gifts to me. I will forever regret that time and circumstance prevented her place on my final dissertation committee.

I thank Joel Stark, who leaned, nodded and pointed his finger so many years ago. His humor and clinical essence fueled my fervent desire to do intervention research.

I thank Helen Cairns, who taught me to be straightforward and to challenge the research of popular trends. She took the time to meticulously edit my drafts.

I salute my advisor, Linnea Ehri, who gently delivered superior demands. She is a consummate scholar who answers questions, and asks questions based upon what the data reveals. Still, her mind is inquisitive, ever open to the exploration of possible alternative explanations.

I embrace my family with love and gratitude. Mary and Adam were selfless in understanding and accepting this journey as a part of their lives.

Finally, I thank Laureen Leffkowitz Curry and Julia Mount Weitz, my dear friends and colleagues who long ago blessed me with the fruits of their knowledge. Their overwhelming influence led me to the path.

Catherine M. Constable

9/16/10

Table of Contents

List of Tables

List of Figures

Section I

Introduction

Children at risk for learning to read face many hurdles along the way. Three of the major hurdles they first encounter involve the development of decoding and spelling skill: (1) learning the names and sounds of letters, (2) learning to analyze the internal structure of a word into its phonemic constituents, and (3) developing a conscious representation of these units (Blachman, B., 1991, 2000; Bradley & Bryant, 1983; Bradley & Bryant, 1985; Bryant, McClean, Bradley & Crossland, 1990; Ehri, 1987, 1992; Lieberman, 1973; Perfetti, Beck, Bell & Hughes, 1987; Tunmer, Herriman & Nesdale, 1988). These competencies require the ability to hold phonological information in memory and to operate metalinguistically upon such information. Yet, several investigations indicate that many children at risk for reading disorders have poor phonological working memory, poor phonological representation and associated difficulty in using and retaining phonological codes (Gathercole & Baddely 1990; Gillam, R., Cowan, N. & Marler, J., 1998; Lahey & Edwards, 1999; Montgomery, 1995).

There is strong consensus that the ability to analyze the internal structure of a word into its phonemic constituents and subsequently develop a conscious representation of these units is inextricably related to the acquisition of early literacy skill and that developments within these domains are mutually influential (Ehri, 1979, 1983; Liberman, 1973, 1971; McGiness, McGinness & Donahue, 1995; Shankweiler & Liberman, 1972). Beginning readers need to refine their phoneme concepts, to develop phonemic awareness, and to acquire letter-sound correspondences in order to learn to utilize the alphabetic principle to begin to decode words successfully. Importantly, the emergence

of decoding skill further informs metaphonological ability, and the two developments then proceed interdependently.

Difficulty in the phonological domain is a major factor that can disrupt normal acquisition in reading (Liberman & Shankweiler, 1985; Wagner & Torgeson, 1987). Such disruption in poor readers has been found to impede the ability to engage in activities important to decoding and spelling acquisition, such as phoneme manipulation and phoneme segmentation. (See for example, Fox & Roth, 1980; Rosner, J., & Simon, D.P., 1971). In turn, delayed ability to decode and spell impedes the development of more efficient and sophisticated phonemic insight.

Not surprisingly, children with speech sound disorders (SSD), speech and language disorders (SLD), or those who have a history of these difficulties (HSSD) (HSLD) are at a special risk for difficulty in the development of reading skills. A variety of studies have documented the relationship between early speech and/or language difficulty and later problems with literacy development (Aram & Hall, 1989; Bishop & Adams, 1990; DeThorne et al., 2006; and Scarborough 2001). Catts and Kamhi (1999) found that children who evidenced language impairment in kindergarten were 4 to 5 times more likely to exhibit reading disorders in second and fourth grade than children without language impairments. In a longitudinal study of children with speech difficulties and speech and language difficulties, Nathan, Stackhouse, Goulandris, and Snowling (2004) found that preschool language skill was a distinct predictor of the children's phonemic awareness at five years, eight months and that phoneme awareness and early literacy skills at age 5;8 predicted children's literacy at age 6;9. Further, they found that children who continued to have speech difficulty at age 6;9 were still faced

with difficulty in phoneme completion and phoneme deletion tasks, reading and spelling. This study, along with a previous study (Carrol, Snowling, Hulme and Stevenson, 2003), points toward a relationship between imprecise articulation, phonological representation and phonological awareness, which leads to reading difficulty.

Rvachew, Nowak and Cloutier (2004) also found that children who continue to have speech problems past the preschool years are likely to have difficulty with reading. Rvachew (2007), in another longitudinal study, found that children who had a preschool history of speech sound disorders had significantly lower scores in non-word decoding than children without speech sound disorders. In this study children with speech sound disorders (SSD) were grouped according to their *phonological processing score* (PPS). The PPS was derived from scores on The Phonological Processing Test (PAT) developed by Bird, J., Bishop, D., and Freeman, N. (1995) and the Speech Assessment and Interactive Learning System (SAILS; AVAAZ Innovations), a computer game that requires children to make judgments about words that are spoken correctly or misarticulated. Neither of these two assessments requires that children verbalize. Rvachew found that the students with SSD could be differentiated by their PPS. These scores were not related to the severity of children's articulation mistakes. Based upon this finding and the findings of previous studies she concluded that it is speech perception, not articulation that mediates phonological awareness skills.

There are a number of children who may not evidence overt speech or speech and language difficulties, for which reading acquisition poses a significant challenge. Children who have a family history of speech and language disorders are at a high risk for both reading and language difficulty in preschool or during early school years (Flax,

J.F., Realpe-Bonilla, T., Roesler, C., Choudhury, N., & Benashich, A. 2009). In a similar vein, children with parents and/or siblings who have been diagnosed with dyslexia are at a high risk for developing reading difficulties. Carrol and Snowling (2004) found that children with genetic risk factors for dyslexia have poor phonological representation. Others in the same group may have later reading difficulties, even though they may appear unimpaired during the preschool years (Gallagher, Firth & Snowling, 2000; Snowling, Gallagher & Firth, 2003).

Other studies (Scarborough & Dobrich, 1990; Catts, H., Bridges, M., Sittner, Little, Todd, D., & Tomblin, B., 2008) point towards the existence of children whose language skills may be generally weak, and who are at risk for learning to read, but who do not "qualify" as speech and language impaired. This circumstance may result from a general lack of speech and language tests that are constituted by tasks sensitive enough to differentiate performance in critical aspects of speech and language ability.

The many studies documenting the relationship between phonological awareness, phonemic awareness and the development of skilled reading (see reviews by Catts 1993, Vellutino, 1979, Wagner, 1986, & Williams, 1986) have stimulated the design of a large number of training protocols. It is not surprising that some training programs that teach phoneme awareness and phoneme segmentation have been found to facilitate the acquisition of reading in children who might otherwise be 'at risk' for learning to read. Phonics programs, which teach phonemic awareness skills and the application of these skills to reading and spelling (Gillingham & Stillman, 1997), likewise have been found effective in teaching these children to read. Two major meta-analyses document the positive effects of phonemic awareness training and systematic phonics instruction upon

literacy development (National Reading Panel 2000; Bus & van Ijzendoorn, 1999). These analyses included studies with preschoolers as well as studies with kindergarteners and school-age students (Blachman, B., Tangel, D., Ball, E., Black, R., & McGraw, C., 1999). The vast literature on phonemic awareness and code-oriented approaches to literacy includes training with diverse populations. These include children with learning disabilities (Williams, 1980), speech impairment (Gillon, 2000, 2005), economic disadvantage (Blachman, Tangel, Ball, Black, R., and McGraw, C., 1999; Vellutino, Scanlon, Small & Fanuele 2006) and children who are 'at risk' for the development of literacy skill (Foorman, Francis, Fletcher, & Schatschneider, 1998).

There are few experimental studies of intervention designed to facilitate phonological processing, phonological memory, decoding and spelling in kindergarten children who are at risk for learning to read. Yet it is important that children develop these skills early because evidence shows that children who begin as poor readers usually continue to struggle with reading (Catts et al. 2008). Furthermore, despite the fact that code-oriented reading protocols (Brown & Felton, 1990; Iverson & Tunmer, 1993; Tunmer, Herriman, & Nesdale, 1988) and phonemic awareness training protocols have been available for more than two decades, (see for example, Byrne & Fielding-Barnsley, 1995, 1994, 1993; Fox & Roth, 1984, 1976; Lindamood & Lindamood, 1984), many children continue to struggle with reading and spelling throughout the school years. This state of affairs may change as findings from recent research (i.e., Torgeson 2001, Gillon, 2005) are adopted by schools, and the development and refinement of evidenced-based treatments continues to be investigated.

Gillon (2005) has suggested that evidence-based interventions that are successful with specific reading at risk populations (i.e. speech impaired) can be applied to teaching other populations of children at risk for learning to read. However, Dollaghan (2004) cautions that clinical application of intervention research that has not been conducted with a targeted population may be premature and ill-advised. Still, various populations of children at risk for learning to read may share similar underlying characteristics such as poor phonological representation, poor short term verbal working memory, poor phonemic awareness, poor speech perception ability, or difficulty in building primary acoustic-auditory and articulatory representations (Catts, H., Fey, M., Zhang, X., Tomblin, J.B., 2001; Catts, H., Fey, M., Tomblin, J.B., Zhang, X., 2002; Edwards & Lahey, 1999; Gathercole & Baddely 1990; Gillam et al, 1998; Montgomery, 1995; Munson, Edwards, & Beckman, 2005; Rvachew & Grawberg, 2006). It may be clinically beneficial to investigate specific and refined interventions that are successful with a variety of young children who are at risk for learning to read, with the objective of determining which specific tasks within each intervention account for children's success. This research endeavor was suggested as an outcome of The National Reading Panel Report (2000).

An analysis of the tasks comprising the majority of phonemic awareness and phonics training protocols reveals that phoneme segmentation and phoneme blending activities are among the forms of phonemic awareness most frequently taught. According to the National Reading Panel Report (2000, p.2-2), phoneme blending requires "listening to a sequence of *separately* spoken sounds and combining them to form a recognizable word." Phoneme segmentation requires "breaking a word into its

sounds by tapping out or counting the sounds, or by producing and positioning a marker for each sound." These two skills are commonly recognized as essential for learning to decode and spell.

For example, children are taught to produce a sequence of separate sounds such as /d/ /ɑ/ /g/ as an activity to assist them in learning to analyze the phonemic segments of the word *dog* or they listen to the separated phonemes /d/ /ɑ/ /g/ and match these segments to their stored phonological representation for the word *dog* (please refer to Appendix E for a full list of phonemic symbols and their corresponding speech sounds). Historically these activities have been recognized as extremely difficult for individuals with speech and language disorders (Cooper, 1972; Kavanaugh, 1972; Stevens; 1972). Additionally, when young children attempt to blend these individual segments into a word (sound blending); often they produce speech that they do not (cannot) recognize as a word. This is because the acoustic characteristics of segmented word productions are not equivalent to the perceptual characteristics of the individual's stored phonological representations of words. These difficulties are not surprising given that poor phonological representation (Blachman, Ball, Black, & Tangel, 1994; Ehri, 2000; Elkonin, 1973; Helfgot, 1976) or subtle speech perception deficits (Rvachew 2007; Stark & Heinz, 1996) underlie some children's difficulty with reading. One of the long standing major criticisms of a synthetic phonics approach to reading is its 'excessive reliance upon sound blending' (Report of the National Reading Panel, 2000).

In my clinical practice, both children with 'specific language impairment' (SLI) and children who are struggling with learning to read exhibit difficulty with sound blending. Although many of these children have had synthetic phonics training, they

have great difficulty in decoding. Quite often these children will attempt to read a word, such as 'stick', by producing the corresponding sequence of separate sounds: /s/ /t/ /ɪ/ /k/, and then pronounce the novel word /stɪkɪkt/. Of course the reason children attempt to produce a word in this manner is because a program of intervention has taught them to do this. Teaching sound blending in order to decode is only necessary because children have been taught that breaking words apart and putting them back together again is part of the reading process. However there are ways to teach children to analyze the phonemic structure of words and to apply this knowledge to decoding and spelling that eliminate "blending" problems. One way is to teach children in the context of speech that is continuous rather than segmented. Such instruction is expected to provide children with the necessary phonemic insight necessary to read without the added information processing load of having to match related but distorted word productions to existing phonological or lexical representations. As a result of teaching children in the context of continuous speech production, their oral decoding efforts will be characterized by continuous perceivable word productions.

The proposed study will examine the effectiveness of an intervention that includes several components. The objectives of this comprehensive intervention include facilitating primary acoustic and articulatory representations, fostering phonological knowledge, processing, and memory and applying these to the development of decoding and spelling strategy. The components include word production, vowel production, vowel identification, phonemic analysis, spelling and decoding. Two conditions of the intervention will include all these components and will differ only in one respect: In one condition the component tasks will entail segmented word production; in the other

condition the component tasks will involve continuous production. To date, much of the related intervention research has involved comparing treatments that differ along several dimensions (National Reading Panel Report 2000, Report of the Subgroups). This circumstance makes it difficult to determine precisely which features of various treatments are the most essential, "active ingredients" making the program effective. In order to determine which feature of training is most critical, the research methodology here will isolate the way in which children are taught to realize the phonemic segments of words and to compare the effectiveness of two approaches to decoding: one involving continuous production and one involving segmented production.

Section II

Literature Review I: Children at Risk for Learning to Read

There are a large number of reasons why children may be identified as 'at risk' for learning to read. These include but are not limited to the following: having speech and language difficulties; having speech sound disorders (or having a history of either one); having a parent or sibling with dyslexia; living in an economically disadvantaged neighborhood; or most simply, exhibiting difficulty early in the development of reading related skills and reading. In this section I will review some of the relevant literature related to being 'at risk' for learning to read.

Children with Specific Language Impairment. There are several general characteristics that distinguish children who are described by the term 'specific language impairment' (SLI). The first and most notable characteristic is delayed acquisition of talking. Secondly, children with SLI talk less than children who are developing language normally. They often use words in unusual ways or delete words in sentences and thus appear to talk like a younger child (Lahey, 1988). Young children with SLI delete word endings and auxiliary verbs, later they evidence difficulty with complex sentence formulation and expressive narrative abilities (Paul, 2001). Some children with SLI additionally have difficulty understanding language and therefore may misunderstand directions or be confused by the language directed towards them. Rescorla and Lee (2001) report that approximately 40% of children with SLI have delays in their ability to produce speech sounds and combine them into various syllable structures. Finally, the language behaviors of children with SLI are so different from what is normally expected

that they are noticeable to those in the child's environment and have negative impact on social and academic development in one way or another (Fey, 1986; Paul, 2001).

Despite these difficulties, children with SLI do not have identifiable neurological damage or mental retardation. This population does not include children diagnosed with an emotional disorder, sensory-neural hearing loss, or environmental deprivation. Rather these children exhibit difficulty in language despite IQ scores within the normal range of intelligence.

Clinical diagnosis (identification) of SLI is based upon the intellectually normal child's performance on a battery of norm-referenced language tests administered by a certified speech language pathologist. Children who achieve standard scores of minus one to minus two standard deviations below the mean on at least two standardized language measures or score below the 10th percentile on such measures are diagnosed with SLI (Fey, 1986; Lahey, 1988; Lee, 1974; Paul, 2001; Tomblin, Zhang, Buckwalter & O'Brien, 2003). Children with specific language impairment may have deficits in expressive language only, or have deficits in both expressive and receptive language.

Characteristics of Children with Specific Language Impairment. As noted previously, children with SLI are at risk for later learning difficulties, particularly in the areas of reading, writing and organization (Nelson, 1988; Paul, 2001).
These difficulties are not surprising in light of research findings revealing specific areas of difficulty in children with SLI.

Several studies have indicated that children with SLI have slower lexical processing than their peers (Montgomery, Scudder, & Moore, 1990; Stark & Montgomery, 1995). In these studies, children with SLI are slower than normally

developing children in recognizing nouns in sentences that contained various syntactic and semantic relations, or that have been time-compressed or low pass filtered.

Other studies indicate that children with SLI have a limited capacity for processing and storing linguistic information. Further, their ability to shift attention from one linguistic task to another is depressed. Therefore tasks which require simultaneous processing across different domains of language (syntactic, phonological, discourse) exceed the resource capacity that the child with SLI has available. Hence, their working memory is overtaxed, and various linguistic performances break down. For example, a child may be able to recall a specific word from a task, but be unable to process the syntax of the sentence completely. In the very next task, the child may comprehend sentence grammar but fail to recall specific lexical items (Ellis Weismer, Evans, & Hesketh, 1999; Gillam, Cowan, & Day, 1995; Marton & Schwartz, 2003).

Gathercole and Baddely (1990) interpreted SLI children's difficulty in recalling non-words as evidence of poor short term phonological memory. Similarly, Lahey and Edwards (1999) found that naming errors that differentiated SLI children from normally developing children were phonologically based. They interpreted these findings to point towards deficits in phonological processing. Larivee and Catts (1999) found that the children with SLI who were most impaired in their ability to repeat multi-syllabic real and non-words, as well as those who presented difficulty in a variety of phoneme segmentation and awareness tasks, were the most likely to have reduced reading ability. They interpreted this finding to indicate that these children may have underspecified or degraded phonological representation, or have a reduced ability to access phonological representations.

Other research points towards a more specifically linguistic basis for the language differences of some children diagnosed with SLI (Rice, Wexler & Cleave, 1995; Rice, Wexler & Hershberger, 1998). The Extended Optional Infinitive Hypothesis posits that an incomplete specification of certain features of tense may inhibit the development of the grammatical system well into the school years. Specifically children with SLI have a grammatical impairment such that both tense marking on main verbs and auxiliaries and related use of the verbs *be* and *do* is delayed for an extended period of time. This characteristic serves as a clinical marker for SLI and may signal other differences in the grammatical system of these children at various periods of development.

Finally, others interpret linguistic deficits as a symptom of a more generalized deficit in the capacity to process information (Leonard, 1998; Leonard, Eyer, Bedore, & Grela, 1997; Montgomery & Leonard, 1998). Specifically, the difficulty manifests in a slower speed of processing. Hence, children with SLI have difficulty performing all of the linguistic processes necessary to assign morphological status to grammatical morphemes of low phonetic content and brief duration in running speech, such as present tense *-s* or the past tense *-ed* morpheme. This idea of a reduced information processing deficit posits that children with SLI would need more exposure to linguistic elements characterized by brief duration, low phonetic substance, and transparent semantic substance in order to engage in the multiple linguistic processes involved in classifying and storing these elements within their language system. Further, these authors (Leonard, 1998; Leonard, Eyer, Bedore, & Grela, 1997; Montgomery & Leonard, 1998) suggest that the overall complexity of task structure, including linguistic and non-linguistic components, may exceed information processing ability. Such authors suggest

investigating the effect of acoustic manipulation of problematic grammatical morphology (such as increasing duration and amplitude) upon the ability to process the forms.

Children with Specific Language Impairment and Reading. The results of these studies support the prediction that children with SLI will have difficulty engaging in the analytic work necessary to build representations of the phonological structure of words. In light of the aforementioned studies, breakdowns may occur in any one or more mechanisms or processes related to the phonological activity needed for reading development. Certainly, children must be able to hold phonological information in short-term memory in order for it to be accessed by central executive processes. Children need to store and retrieve the results of these analyses in long-term memory in order for them to be accessible across time, and to continue to develop the ability to analyze more phonologically complex stimuli over time. Task structure can become too complex such that phonological stimuli being analyzed may decay during the time it takes for children with SLI to recruit other linguistic resources necessary to comprehend task directions, and to perform non-linguistic activities that may serve to signal their responses. Until children begin to build at least rudimentary representations of phonological structure, the symbols (letters and print) for these representations lack utility.

Most recently, Catts et al. (2001, 2002) included children with SLI in a series of studies exploring factors that predict future reading difficulty in kindergarten children. In these studies, 604 kindergarten students who were part of a larger epidemiologic study were given a large battery of tests in kindergarten. These were followed up with tests in word reading and comprehension at grades two and four, as well as another extensive battery of language tests. The participants included non-language impaired children as

well as two groups of children with language learning impairments. One group, children with *specific language impairments* (SLI) were those who exhibited difficulty in language learning, but who exhibited normal non-verbal cognitive abilities and did not have histories of neurological, emotional or hearing abnormalities. Typically these children had standard scores on language measures that were below a standard deviation of the mean, but standard scores on non-verbal cognitive measures that were within a standard deviation of the mean. The other group, children with *non-specific language impairments* (NLI), also scored more than one standard deviation below the mean on language measures. However this group also performed below a standard deviation of the mean on measures of non-verbal cognitive ability. Children with NLI did not evidence neurological, behavioral or sensory deficits and had I.Q.s above 70. Results of the study indicated that 50% of the children who had language impairments in kindergarten had reading disorders in second and fourth grades. That is, the children with language impairment were 6 times more likely to have a reading disorder than the children who had no language disorder in kindergarten. Within the group of children with language impairment, 65% of the children with NLI had reading disorders in second grade and 40% of the children with SLI had reading disorders in second grade.

Additionally, Catts et al. (2001, 2002) were interested in predicting which children with LI were most likely to develop reading difficulties. In the Catts et al. (2002) study, a series of stepwise multiple regression analyses showed that 36%-37% of the variance in second grade reading ability could be explained by a combination of kindergarten variables. These included letter naming, a grammar composite score

(including sentence imitation, grammatical closure and grammatical understanding measures), non-verbal I.Q., rapid naming and phonological awareness.

In the 2001 study, Catts et al. used a stepwise logistical regression procedure to examine the relationship between kindergarten assessment scores and second grade reading scores. As a result of that analysis, five variables from the kindergarten testing battery were identified as significant in predicting second grade reading disorders. The strongest predictor was letter naming, then sentence imitation, followed by mother's education level, phoneme deletion and rapid automatized naming.

In sum, these findings indicate that children with SLI have difficulty with the development of their reading skills and that this difficulty may result, at least in part, from problems with phonological processing

Children with Speech Sound Disorders and Reading. Difficulties in spelling, reading and phonological processing frequently co-occur within children with speech sound disorders (SSD) (Bird, Bishop, & Freeman, 1995; Larivee & Catts, 1999; Rvachew, 2007, 2006). Children with SSD may be: delayed in acquiring speech sounds; producing speech sounds or patterns that are atypical; and/or exhibiting speech that is significantly less intelligible when compared to their chronological peers. Secondly these children present with no obvious medical or sensory difficulties such as hearing impairment or dysarthria and apraxia related to cerebral palsy, stroke or head trauma.

Nathan, L., Stackhouse, J., Goulandris, N., and Snowling, M.J., (2004) studied the development of literacy skills in children with preschool speech and speech and language disorders from the age of 4;7 to the age of 6;9. They found that language skills at 4;7 were predictors of phoneme awareness at age 5;8 and that phoneme awareness at 5;8

predicted reading at age 6;9. Further, output phonology (speech production) was a unique predictor of spelling, though not reading at 6;9 for children with SSD. Overall children with speech and language impairment and speech impairment only had a greater risk of developing difficulties with literacy than did non speech impaired children with similar non-verbal I.Q.s. In their study, 68% of children with speech and language difficulties and 47% of the children with speech difficulties scored below controls on measures of reading and spelling at 6;9 years of age. In other studies such as Bird et al. (1995) and Larivee and Catts (1999), children with speech impairments were followed for a longer period of time, up to ages 7 and 8. At this these ages the difference between the literacy skills of speech impaired children compared to the literacy skills of typically developing children was greater.

Nathan et al. (2004) conclude that there may be different explanations for difficulties in phonological awareness and emergent literacy for children referred for speech or speech and language problems. In one case it could be that delayed or deviant speech development that co-occurs with poor vocabulary skill impedes metaphono-logical development. In the second case, poor phonological representation and concomitant segmental deficits could be one cause of difficulty with speech output. They conclude that children with persistent or severe speech difficulties are at risk for later literacy problems. Unfortunately it is not always easy to make a clinical determination about which preschool children with speech impairments will continue to have speech impairments two years later. In fact, it has been our experience that too many children who experience successful preschool intervention stop receiving intervention at their kindergarten year. This circumstance occurs as a result of interactions among children's

ages, the instruments used in post treatment speech and language assessment, and differences in local mandates for intervention service at the preschool versus school level. Thus some children entering kindergarten are judged to be "normalized' with regard to speech and language, only later to be re-classified as in need of services a full year later when entering first grade. A lack of intervention at the critical kindergarten year is inconsistent with the implications of research that conclude that some expressive speech difficulties may emanate from underlying difficulties in phonological representation. Intervention that facilitates speech sound development only may improve speech, but not address weak phonological representation.

Rvachew (2007), in a study of phonological processing and reading in children with speech sound disorders, separated children with SSD into two groups based upon their scores on a test of rime, onset matching and onset segmentation, and a test of speech perception. The normative results of these two non-verbal tests were combined to create z scores that were averaged to yield a total phonological processing score (PP). Children with SSD were tested prior to kindergarten, and then were placed into either the SSD low PP group or the SSD high PP group. Later, Rvachew explored the relationship between pre kindergarten PP and reading ability at grade 1. This researcher found that the SSD low PP group demonstrated significantly lower scores on non-word decoding, speech perception and phonological awareness at grade one than did the SSD high PP group, despite having similar severity of SSD. Rvachew (2007) concludes that difficulties in phonological processing and subsequent reading difficulty in children with SSD may not necessarily be explained by articulation, but perhaps more by speech perception. Regardless of this implication, Rvachew concludes that children with SSD, who are most

at risk for difficulties with phonological processing can be identified at the preschool level, and that efforts to improve phonological processing, speech perception and speech production should begin prior to school entry.

Munson, Kurtz, and Windsor (2005) compared children with phonological disorders (PD) to peers without phonological disorders on the effect of phonotactic probability upon non-word repetition ability. Children's non-word repetition ability is the subject of intense study as a clinical marker of specific language impairment, and indicator of poor phonological processing ability and poor phonological memory. Phonotactic probability refers to how likely it is that a sequence of phonemes will occur in real words. Recent studies have found that non-words composed of high probability phoneme sequences will be processed or produced differently than non-words that are composed of low-probability sequences. These studies have concluded that for children with phonological disorders, the strength of the frequency effect that is, the greater difficulty they have repeating low-frequency non-words versus high frequency non-words, is due to poor categorical phonemic representation. An alternate view is that children with PD have deficits at a more primary level of representation. This would be their primary representation of the acoustic-auditory and articulatory aspects of speech. In the first case, measures of vocabulary would be expected to correlate with the size of the frequency effect. In the second case measures of speech production and speech perception would be correlated with the frequency effect.

In the Munson et al. (2005) study, children with PD repeated non-word sequences with less accuracy than their typically developing (TD) peers Yet, they did not show any disadvantage in repeating low frequency versus high frequency non-words. In fact as a

whole the PD group was less sensitive to the frequency effect than the TD children. Further, it was found that children with severe PD showed very little difference between repeating high versus low frequency non-words. Using regression analyses the experimental groups were broken into three groups; one group with the most severe PD (SPD), a second mixed group (MG) with less severe PD children and TD children with small vocabularies, and a third group of TD with large vocabularies. The SPD group performed more poorly than the other groups in non-word repetition, but the advantage of high frequency over low frequency words in their non-word repetitions was negligible. They had equal difficulty producing both types of words. Alternately the children in the mixed group showed a large preference for high frequency words in their responses to non-word repetition, with high frequency non-words repeated more accurately than low frequency words. Finally, the third TD group demonstrated only negligible frequency effect, producing both types of words accurately.

Citing that children in the SPD group demonstrated consistent significant difficulty in measures of speech production and word discrimination, yet relatively the same frequency effects as their TD peers, Munson et al. concluded that some children with severe phonological disorders have a deficit at the primary level of representation of the acoustic-auditory and articulatory aspects of speech and the links between them, rather than at the level of phonemic categorization.

A review of the literature on the relations between children with SSD and their development of phonemic insight and reading related skill indicates that as a group, these children are 'at risk' for learning to read. However, the underlying causes are most likely

varied. As such, interventions to treat these children need to provide a range of activities that can promote growth in various levels of representation.

Children in Poverty and Learning to Read. Shacter and Jo (2005) found that kindergarten children from low income families in urban neighborhoods attain levels at least of one half a standard deviation lower in reading and related skills when compared to their peers nationally, and that this difference increases to nearly two standard deviations by the end of elementary school. In light of this finding, many children who are termed 'at risk' for learning to read come from poor neighborhoods.

Lo, Wang and Haskell (2009) provided emergent literacy training to kindergarten children who they termed 'at risk urban kindergartners.' These children came from a school which had a primarily African American and Latino population in which 94% of the students received free lunch, and 73% of the children came from single parent homes.

Nancollis, Lawrie and Dodd (2005) found that young children raised in poverty were resistant to some forms of phonological intervention if the intervention was administered at the classroom level. They concluded that in addition to some features of their training protocol, critical aspects of the school environment, including personnel that they trained, may have negatively impacted their outcomes. In sum it may be that some children 'at risk' for learning to read may have difficulties developing emergent and early reading skill because of poor nutrition, reduced vocabularies, inconsistent emotional or familial stability, lack of competency in the instructional language they receive, or enrollment in challenged schools. How these circumstances affect children's performance on diagnostic tests and tasks is uncertain. But clearly these children are 'at risk' for learning to read.

Children with Familial History of Reading or Speech and Language Difficulty. Numerous studies point towards the effect of genetics upon reading development and reading related skill (Gayan & Olson, 2003; Harlaar, Spineth, Dale & Plomin, 2005). Children with a parent or sibling who have dyslexia or serious reading difficulty have a greater chance of experiencing difficulty in phonemic decoding, word reading and phoneme awareness than children without a family history (see for example Olson & Byrne, 2005 for an excellent review and Olson, 2002). Further, these studies indicate that the influence of genes and environment can be identified prior to reading, not just in terms of phonemic awareness ability and knowledge of the alphabetic principle, but also in terms of the amount of time it takes children to *learn* how to identify phonemes (Byrne, 2005).

Since twin development is fertile ground for the study of genetic influence on literacy development, in this context the effects of the family environment that twins share have also been studied. Results show that shared environment also has a significant effect upon reading development in twins with low reading ability, though this effect is less than the effects of genetics.

DeThorne, Hart, Petrill, Deater-Deckhard, Thompson, Schatschneider and Davison (2006) recruited 248 same sex twin pairs in order to study the strength of genetic and environmental influence on (the parents' report of) children's speech and language difficulties and to determine the relationship between the children's history of speech and language difficulties and their early reading ability. They found statistically significant heritability for measures of articulation and language, but did not find a significant effect for shared environment.

In order to answer the reading related question, Dethorne et al. divided their children into five groups: children with histories of articulation deficits only; children with histories of expressive language difficulty only; children with histories of both articulation and expressive language difficulty; children with histories of articulation and expressive and receptive language difficulty, and peers without a history of articulation or language difficulty. The reading and reading related measures they used included three subtests of the Woodcock Reading Master Test: Letter Identification, Word Attack and Word Reading. In addition, children completed the rapid letter naming and rapid digit naming subtests from the CTOPP (Torgeson et al., 1999), and the rhyming, initial phoneme isolation, whole-word phonemic segmentation, and phonemic deletion parts of the Phonological Awareness Test (Robertson & Salter, 1997).

The first finding with regard to reading related skill was that children with histories of speech and language deficit scored lower than their peers on early skills related to reading. The differences among the five groups were most significant for phonological awareness with all groups except the expressive language difficulty only group scoring significantly lower than children with no speech and language difficulties. There was wide variation among the groups in word attack, letter identification, and word reading. The children with articulation, receptive vocabulary and expressive vocabulary deficits scored more poorly than children from the other groups. This group of children had the largest deficits in phonological awareness and letter identification. Finally, when the effects of IQ were regressed out of the reading related measurements, observed group differences remained stable. The authors conclude that children with histories of

difficulty with speech and language development are at risk for learning to read but not due to cognitive factors.

It is important to monitor carefully the development of pre-reading and early reading ability in children who may be at 'at risk' for learning to read due to familial histories across the domains of speech, language and reading. Children who struggle early, or who evidence a slow rate of learning will most often benefit from early and intensive intervention (Olson, 2002; Torgeson et al., 2001; Wise, Ring & Olson, 1999). The existence of family history of speech, language or reading difficulty is an important factor to consider in clinical and educational decision making.

Difficulty in Reading and Reading Related Skills. Children who struggle in the early stages of reading are obviously at risk for continued reading problems. Therefore, it may be a child's response to early intervention that will inform researchers, teachers and clinicians about the nature of the child's difficulty. Vellutino et al. (2006) used a beginning kindergarten letter-name knowledge test to identify children as 'at risk' for learning to read. They further documented this assessment with five other tasks: rhyme and alliteration identification, rapid automatized naming time, counting by ones, and number identification. Children in the 'at risk' group were those who scored lower than their grade matched peers. Intervention was initiated for these children during their kindergarten year. Half the group received an experimental small group intervention two to three times a week and half received a school-based remediation. During the following first grade year, children who were still struggling received either experimental one to one training or school based training. Follow up in third grade indicated that most of the children were reading at grade level (Vellutino & Scanlon, 2002). These

struggling readers were identified as those who were reading below the 15th percentile on the Woodcock Reading Mastery Test (1987) Word Identification Subtests and Word Decoding Subtests (Vellutino & Scanlon, 2002). Velletino et al. (2006) suggest that early kindergarten intervention alone or combined intervention at kindergarten and first grade levels can be effective in preventing a long term reading disorder in children who are 'at risk' for learning to read.

In the present study, children who qualified for entry into the training program lacked phonemic decoding and spelling ability and included children from a variety of groups who are typically termed 'at risk' for difficulty learning to read.

Section III

Literature Review II: Phonemic Awareness and Decoding Intervention Programs

Intervention with Children with Speech and Speech and Language Problems.

Several studies have examined the effects of code-oriented training upon the acquisition of phonemic awareness and reading ability in children at risk for learning to read, and children with learning disabilities. Fewer have examined such training for children with speech or speech, language and communication disorders. The studies selected for review and analysis here have been chosen because they report success in facilitating children's phonemic awareness or early reading ability, or both.

While there is some overlap in the content and structure of the training paradigms in these studies, there is also notable variation. In addition, since the experimental populations vary as well, it is not surprising that the effects of training likewise vary across studies. Often, commercial programs are *adapted* for use in these studies. As a result, the instructional procedures tested in the research are not always identical to the instruction marketed to the public commercially. Likewise, commercially available teaching protocols that are *derived from* experimental training procedures often are not a direct reflection of the training studied in the research. This is important because in either case the research findings do not constitute proof of the effectiveness of a commercial program.

In the present review, instruction examined in research, as well as commercially available programs will be considered. The features of the training procedures will be analyzed with regard to this study at hand. Particular attention will be paid to the

strategies employed to teach children to conceptualize consonant-vowel-consonant (CVC) words as having three separate and identifiable phoneme constituents.

van Kleek, Gillam, and McFadden (1998) found that children with speech and language disorders, as well as children with speech disorders only, improved in their ability to understand the phoneme structure of words as a result of training, even in the early preschool years. van Kleeck et al. (1998) conducted the study with 24 preschoolers who had either speech disorders, pragmatic communication disorders, or speech and language disorders. This study was designed to explore the efficacy of phonemic awareness training. These investigators used a pretest - posttest design. Test measures included rhyme identification, rhyme production and rhyme fluency, phoneme judgment and correction, initial sound identification, generating initial sounds, and identifying initial and final sounds and phoneme blending. Two different age groups received treatment: preschoolers, aged 45-52 months (PS), and pre-kindergarteners, aged 57-66 months (PK). A group of older children with speech and language disorders served as a non-treatment control group, ages 60-93 months (C).

The study was conducted for two school semesters. During the first semester the children received training in rhyming, and during the second semester they received training in phonemic awareness. Training did not involve letters. The length of training was predetermined to be for 12 weeks. The intervention was delivered in the classroom in small groups of 3 or 4 students, for 15 minute periods, 2 times per week. For rhyming, five target rhyming pairs were taught during the same eight activities every week for 12 weeks. The five rhyme pairs changed each week. In the phoneme awareness training, children engaged in the same six 'identification of sound' activities for initial sounds in

words every week for seven weeks, using two different phonemes per week. For the next three weeks, they engaged in the same activities except they analyzed 'final sounds' in words. In both the rhyming and phonemic awareness training, children matched words to pictures in the majority of tasks. Pictures lent semantic support to training in phonemic awareness and rhyme, thereby reducing the demands placed upon phonological processing.

During the last two weeks, children engaged in a sound blending activity. Here, trainers used words from the rhyming word stimuli as well as novel words for sound blending. Children listened as trainers spoke three separate phonemes. Then children were to listen, blend the separate phonemes, and then match their perception to a picture.

Children in both age groups made significant gains in phonemic awareness and rhyming from pretest to posttest. Interestingly, despite the investigators predictions, the rhyming gains could not be attributed to the training since these gains fell below the lower boundary of the 95% confidence interval of the control children who received no training. The importance of this finding will be discussed later in this section. However, mean performance of children in the training group was well above the control group in phonemic awareness, indicating that gains in the phonemic awareness domain were due to training. It was not apparent from the data, however, that the children were able to complete the final steps of the program, which required phoneme blending. Furthermore, neither phonemic analysis, nor blending was assessed in pretest or posttest measures. Assessment of phoneme awareness was limited to the identification of initial and final phonemes.

Finally, there was a negative correlation between performance on pretest phoneme awareness tasks and the gain scores from the treatment. The authors reported that the children with speech or speech and language difficulties who performed the most poorly at pretest made the greatest gains from the training. This is not surprising since students who performed higher on pretests due to ceiling effects would have less room to improve when compared with the students who performed more poorly at pretest. Nonetheless, these results are important because they demonstrate the relative ease with which very young children with difficulties in speech, language and communication can learn to identify the initial and final consonants of real words when given the support of picture stimuli. Further, they can transfer this ability to words that were not practiced during training. This is especially noteworthy when the total amount of training time is considered, only thirty minutes per week for 24 weeks. These findings imply that teaching children to identify initial and final sounds in words may be one set of phonemic awareness skills that does not require elaborate materials or an extensive amount of time for children to learn.

In the van Kleeck et al. (1998) study, the researchers did not establish criterion levels to determine when training in the various phases ended, but rather used time intervals. It is not clear how these time intervals were determined. It is possible that children could have learned to identify initial or final sounds in less time than the predetermined 10 weeks, and thus could have moved on earlier to the more complex phonemic awareness tasks, such as sound analysis. Moreover, if these researchers had established a criterion for mastery of individual tasks, children's competency levels could have been monitored and used to determine how much training was necessary on each

task. The use of criterion levels to assess and direct training is essential for making the most efficient use of training time, as well as for assessing the effectiveness of various training studies, and will be used in the proposed study.

Gillon (2000) investigated the effects of a phonological and phonemic awareness intervention upon the phonemic awareness ability, speech production ability and reading ability of children with Spoken Language Impairment (SPLI). Spoken Language Impairment refers to children who have a disordered phonological system. The primary characteristic of these children is that their patterns of speech articulation are atypical. This group of children may or may not exhibit difficulty in expressive language, and therefore may or may not include children diagnosed with SLI. Gillon hypothesized that children with SPLI could make improvements in both speech production as well as phonological awareness skills in response to a program of phonological awareness training.

In this study there were 91 children, whose mean age was 5 years, eight months. The study was conducted in New Zealand where children start formal schooling at 5 years of age. The study used a pretest - posttest design. Tests included 5 different literacy measures, including letter identification, non-word reading, high frequency word reading, decoding and reading comprehension. Phonological awareness tests included: The Lindamood Auditory Conceptualization Test (1979), The Queensland Inventory of Literacy (1996), which assesses syllable identification, rhyme recognition, initial phoneme detection, phoneme counting, phoneme deletion, non word reading and non word spelling. Speech production was assessed using a standardized articulation test and a phonological variability test.

Gillon (2000) had three experimental SPLI groups and one normal control group (Group 4). Each experimental group received a different intervention. Group 1 received a phonological awareness program (PA). Children in this group received individual instruction for 1 hour, two times per week, until 20 hours of intervention were completed. Group 2 received a traditional phonological and language skills intervention (TI), also delivered individually for 1 hour 2 times per week for 20 weeks. Group 3 received a minimal intervention program (MI) wherein speech pathologists consulted with parents once per month and provided them with activities to improve the children's speech. Children were not assigned randomly to the three Experimental Groups, but rather group assignment was based upon transportation constraints, age, and severity of phonological delay. Investigators attempted to balance groups 1 and 2 in terms of severity of phonological delay. On pretests, there were no significant differences among the three SPLI groups on receptive vocabulary scores or word structure scores, indicating that global levels of language competency were similar.

Gillon's (2000) phonological/phonemic awareness training program provided to Group1 included several activities. It included rhyme bingo in which clinicians asked children for words that rhyme with a particular word, or if one specific word rhymes with another word. Further, clinicians explained why words did rhyme or did not rhyme. It included a phoneme identity activity in which children were asked if two pictured words started with the same sound, or ended with the same sound. It included phoneme manipulation of sounds in isolation, which was adapted from the Auditory Discrimination in Depth Program (Lindamood & Lindamood, 1975), which teaches children to use colored blocks to identify the number (i.e., one or two) and type of sounds (i.e., same or

different) heard in various words. It included several activities for teaching phoneme identity, such as matching colored pictures with the same initial or final sounds; identifying and labeling pictures that start with a target sound, and identifying and labeling a picture that starts with a sound differing from the sound in neighboring pictures. It included phoneme segmentation in response to pictures, such as: segmenting a word into *separate* sounds; blending separated sounds into a word; telling the number of sounds in a word, and labeling the words that start with a target sound). These activities, like those in the previous study, used pictures to scaffold children's ability to hold words in short term phonological memory as the words were analyzed. Next, children practiced identifying sound changes in words by manipulating colored blocks to build words and change words (adapted from Lindamood and Lindamood, 1979).

In order to address the speech production deficits in these children, Gillon (2000) also used activities that she adapted from training procedures used in the Lindamood program (1979). The sound and word stimuli varied for each child, depending upon his or her speech goals. For example, training for one child may have focused on final /v/, whereas training for another child may have focused on final /k/. Trainers used an individual's target sounds for speech production as the phoneme stimuli for phonemic awareness instruction. It is difficult to know how this variable may have influenced the relative ease or difficulty of completing phonemic awareness tasks in this study. According to Gillon (2001), the activities in the phonological awareness training were not delivered in a particular sequence, nor were all activities necessarily included in each session, with the following exception:

> Early in the program, the emphasis was on developing rhyme, phoneme identity, phoneme segmentation, and phoneme grapheme rule knowledge, whereas later in the program, tracking sounds with letter blocks, and phonetically regular word games were emphasized (p. 133).

Since the activities were not sequenced, children did not have to reach a performance criterion on one task prior to beginning work on another task. With the exception of tracking sound changes with blocks, any activity *could* be discontinued once the child reached "100% accuracy on all stimulus items on three 'occasions' and the clinician was confident the child had acquired the skill."

In the traditional intervention condition (Group 2) a traditional approach to speech production was provided. Students were taught how to produce phonemes they could not articulate in isolation and in syllables, words, phrases and sentences. In addition they were taught placement and movement patterns of articulators. Groups 1 and 2 completed 20 hours of individual training, 2 hours per week, across a period of 4 ½ months.

In the minimal intervention condition (Group 3) a monthly speech consultation was conducted with parents and teachers, and speech drill sheets were provided to be completed by the child. All groups were receiving a whole language approach to reading in their classrooms.

All groups were posttested at five months. Results indicated that Group 1, the phonemic awareness intervention group, made significantly more improvement on the Lindamood Auditory Conceptualization Test (1979) from pretest to posttest than Group 2. This result is not surprising, since Group 1 was the only group to receive Lindamood

training. There was no difference between the scores of Group 1 and Group 4, the normal control group, on the Lindamood Auditory Conceptualization Test at posttest.

On other posttest measures, Group 1 (PA) showed significantly more progress than Group 2 (TI) on syllable and phoneme awareness, and more improvement than Group 3 (MI) in phonemic awareness and onset-rime. (Onset rime analysis identifies two distinct parts of a consonant-vowel-consonant word; the first phoneme is the onset and the second two phonemes are the rime). Group 4 (the normal control group) made significantly more progress in phonological/phonemic awareness than all experimental groups. Similar to findings in the van Kleeck et al. (1998) study, there were no significant differences between groups in improvements on the task assessing the detection of rhyme pairs. Nor were there significant differences between Group 1 (PA) and Group 2 (TI) on onset-rime task measures.

Although it has been shown that rhyme makes an independent contribution to early reading and spelling ability (Bryant et al. 1990), the findings of both Gillon (2000) and van Kleeck et al. (1998) suggest that phonemic awareness training may not need to include rhyme related activities. It is true that many children with both phonological and expressive language disorders have difficulty with various rhyme related tasks (Bird et al. 1995). However, in our clinical work, several children with SLI and phonological processing disorders have successfully completed programs of training in phonemic awareness, decoding, spelling and text comprehension, and have attained grade level reading performance, while still showing difficulty with certain aspects of rhyming. In all, obtaining competency in rhyme may not be a necessary objective of training in

phonological protocols designed to facilitate early reading and decoding. In the proposed study, rhyming is not included as part of the training.

Performance of the three groups with SPLI on reading measures was analyzed using difference scores between pretest and posttest. Children in Group 1 (PA) made more improvement than the other two experimental groups on word recognition skills, reading and comprehending connected text, and non-word decoding ability. These results demonstrate that a phonological and phonemic awareness training program that includes linking speech to print can facilitate phonemic awareness and early literacy skills in children whose speech production is atypical. With regard to speech production gains, all experimental groups improved. Groups 1 and 2 showed greater gains than Group 3 in the dissolution of phonological processes. This finding implies that phonemic awareness training can have a positive effect on speech production when goals related to speech production are taken into account.

Both the Gillon (2000) and the van Kleeck et al. (1998) studies show that children with speech or speech and language disorders can benefit from training in phonemic awareness. Both studies included a variety of different training activities, although neither study used performance criteria to determine when students could pass from one task to another. In each study however, the term 'phonemic awareness' referred to different competencies. In the van Kleeck et al. (1998) study, children did not engage in phoneme segmentation. Rather, they had two weeks of sound blending training which involved listening to trainers produce three separate sound segments and then matching that production to a picture. Alternately, in the Gillon (2000) study, children segmented words by producing three separate phonemes and placing one block at a time for each

phoneme in a word. They listened to adults produce three separate phonemes for a word, as the adult modeled what the child was to do.

In the Gillon (2000) study, tasks were interspersed and delivered in random order during the initial part of the phonemic awareness training. Alternately, in the van Kleeck et al. (1998) study activities were delivered in sequence, based upon a presumed hierarchy of phonemic awareness skills. Yopp, H. and Yopp, R. (2000) assert that the ability to identify initial and final sounds is prerequisite to and easier than more advanced skills such as phoneme elision and identification of complete constituent structure of CVC words. However they also recommend that children engage in a variety of phonemic awareness activities at different levels of difficulty during the emergence of literacy. The proposed study contrasts with the Gillon (2000) training, and the Yopp H. and Yopp, R (2000) assertion because the training tasks are delivered in a specific sequence. This sequential feature is consistent with the van Kleeck et al. (1998) training. However, unlike their training, the proposed training study requires specific criterion for proceeding from task to task.

Intervention with Children from Low Socio-Economic Status. Whereas the foregoing intervention studies were conducted with children having speech and speech and language disorders, the next study was conducted with children of low socio-economic status. Blachman et al. (1999) conducted a two year intervention study in which they taught phonemic awareness and word recognition skills to children from lower income homes in an urban area. Children in the study attended the lowest performing elementary schools within a large school district. Children began an eleven week phonemic awareness program during their second semester of kindergarten and

continued in a program of phonemic awareness combined with reading instruction in first grade, and reading in second grade. The reading program was designed as an extension of the skills built in the phonemic awareness and word recognition program. A pretest and posttest design was used to assess the effects of the program.

The phonemic awareness program was administered four times per week for fifteen to twenty minutes to groups of four or five kindergarten children. A total of 41 (20 minute) sessions of instruction was provided. It is important to note that the treatment children only knew an average of 2 letter-sound correspondences at the beginning of the program, so letter-sound training was included in the phonemic awareness program.

Activities varied each day and included three activities: *'say it move it'* wherein children moved sound discs to represent one, two, or three spoken phoneme words; a segmentation activity; and a letter-sound correspondence activity to teach a set of eight letter-sound correspondences. The procedures used in the kindergarten treatment were developed into a commercially available program called *Road to the Code (RC)* (Blachman, Ball, Black & Tangel, 2000), which will be reviewed in some detail later in this section.

At the end of kindergarten the treatment children on average outperformed the control children in phonological awareness, letter name and sound knowledge, decoding of phonetically regular words and non-words, and spelling. However, some of the children who received the kindergarten training did not complete the program. They could not yet segment three-phoneme words, nor did they know the 8 letters that

represented speech sounds (phoneme-grapheme correspondences) that were being trained.

The commercially available program called *Road to the Code (RC)* (Blachman, et al. 2000) contains a similar, but modified formalization of the kindergarten procedures used in the Blachman, et al. (1999) study. These procedures evolved over a period of ten years in light of research and clinical findings. As indicated, the program has been used for children in kindergarten or first grade who could not read and who knew few letter-sound correspondences The RC program is intended to precede a code-oriented reading program also designed by the authors of RC. The goals of RC include developing letter-sound knowledge, improving phonological awareness, and developing phoneme analysis and blending skills to prepare children to begin reading a small set of consonant-vowel-consonant words. The eight letter-sound (phoneme-grapheme) correspondences introduced in this program are *a, m, t, i, s, r, b, and f.* However all phonemes are used in activities that do not involve letters.

The RC program has the same three basic components as the Blachman et al. (1999) study: letter-sound instruction, phonological awareness practice and the *'say it move it'* strategy. The *'say it move it '* strategy takes place for five to seven minutes of each lesson. In the beginning of the RC this strategy is a *sound counting activity* (Blachman et al. 2000, p.28). Students learn to say a sound, or sounds, as they move a round blank disc or discs down from a picture across a line to a dot. Students listen and watch as the trainer models. Trainers stress that children must use only one finger for moving one disc to underscore the idea that one disc equals one sound. Children must count and report how many sounds they have used. Children continue to use blank discs

as the *'say it move it'* activity progresses to vowel-consonant words such as 'at' and 'it' and 'up'. The teacher elongates the first vowel as she moves the disc and then quickly says the second sound. Children try to segment words in this way after the teacher models. Children continue to engage in *'say it move it'* activities with two consonants *t…t* or one vowel /æ/ or a vowel-consonant word such as 'it'. In the early part of this activity children have the same number of discs as sounds. Later children have a pile of three discs and must decide on their own how many discs they need for the sound or sounds they hear. Throughout the *'say it move it'* activity speech may be continuous or segmented depending upon whether or not the speech forms begin with stop consonants, continuous consonants, or vowels.

Some researchers have questioned the value of sound counting activities prior to learning to decode (Ehri, 1979; Perfetti, Beck, Bell, & Hughes, 1987; Williams, 1984). These authors suggest that activities such as sound counting, or sound deletion require different information processing abilities than sound blending, and that competency in such activities may be more easily learned as an outcome of learning to decode. In the current study children analyze consonant-vowel-consonant forms without counting. Furthermore, chips and discs are not used to represent phonemes.

The phonological awareness component of the RC program includes various types of activities beginning with sound categorization by rhyme in which children decide which of a group of four words does not belong. A second activity is a word identification activity in which children hear a puppet pronounce words in an extended prolonged manner and then must identify the word they heard. The third activity is another sound counting activity. The teacher pronounces a single or two-phoneme word,

again elongating the word. The teacher extends one finger up into the air as she produces each sound. Children must copy this activity and then use their fingers to indicate if a word had one phoneme or two phonemes. In the beginning these words are vowel-stop consonant words (i.e., *at*), followed by vowel-continuant consonant words (i.e., *as*).

The letter name and sound instruction component uses eight cards which have a letter and a corresponding picture on each. For example the 'm' card has an 'm' and a monkey on it. Children trace letters in the air, think of words that begin with the letter/sound, and play bingo with letter/sound matches.

The *'say it move it'* activity and the phonological awareness activity become more complex in the second half of the program. Children begin to segment three-sound words in the *'say it move it'* activity. Three sounds are introduced using patterns *a/am/ram* or *a/an/van* or *it/fit/lit*. Then the number of sounds in the activity is varied with one, two or three phoneme words. In the present study CVC analysis does not use word patterns based upon the rhyme unit. This decision is based on the presumption that the use of rhyme patterns does not enhance children's attention to the final consonant, but rather reduces their attention to it.

The next *'say it move it'* and phonological awareness activities in the RC program involve segmentation and analysis of CVCs that begin with continuant sounds (i.e., */l/, /m/, /s/*) possibly because CVCs beginning with continuant sounds are viewed as the easiest CVCs to blend. This idea relates to the continuous production concept that underlies the teaching methodology in the current study. However, in contrast to the present study, the RC program quickly adds CVC words beginning with stop sounds (i.e., */p/, /b/, /t/*) to the '*say it move it'* and phonological awareness training. The addition of

these CVC forms is not contingent upon the students' achievement of a criterion level of success in analyzing and segmenting CVCs that begin with continuant sounds.

The current study differentiates CVC forms beginning with continuants from CVC forms beginning with stops. CVCs in the pretest and posttest include real and non-words that begin with continuant consonants as well as those that begin with stop consonants. However during the experimental intervention in the current study only CVCs beginning with continuant sounds are used.

As the Blachman et al. (2000) RC program progresses, children get an increased number of discs to use in order to identify the number of sounds in the words they say. Letters are gradually applied to the discs, one disc at a time. Now as children begin to set up their discs, they must think about where the particular letter fits within the word. Our study differs in that it incorporates letters only after children have demonstrated consistent ability to identify the phonemes that letters would symbolize in CVC words.

The *'say it move it'* task includes instructions similar to the following:

"Remember you can use the *'a'* tile to show me where the /æ/ sound should go… ready?"

"When you *'say it move it'* you can use the *'m'* tile if you think you know where it goes or you can use all blank tiles".

In the current study, the language of instruction is a special consideration and will be discussed in some detail in the next section.

In the RC program, the phonological awareness component continues with a variety of new activities including the following: categorizing words based on the initial

sound; fixing the speech of a puppet who speaks in long drawn out words; recalling words from a poem; and playing a sound guessing game to identify a word.

A fifth activity of the RC program is another adaptation of the Elkonin (1973) method. This activity uses cards with pictures (e.g., a map, a pot, a pin, a jug, a jet) and three 'sound boxes' below them. Children move blank tiles into each square as the say each sound for the word depicted. Then the children say the word normally. Again, the first trials of this activity include words that start with continuant sounds, followed by words that begin with stop sounds. The trainer delivers these activities in mixed order rather than in sequential order.

In the second year of training in the Blachman et al. (1999) study, the experimental group was separated into 3 ability groups. All began first grade with a review of the kindergarten training as well as training in the remaining letter-sound correspondences. These groups required 2 or 4 or 12 weeks of review depending on their ability.

In order to assess the impact and effects of the RC kindergarten training program, the training protocol for first grade and its effects will be discussed. In first grade, experimental group training was delivered in place of the regular school reading program for 30 minutes per day. There were 6-9 children in each group. Control students used the Scott Forseman basal reading program as well as supplemental phonics workbooks. Both treatment and control groups participated in the same phonetically based spelling program.

The first grade experimental program that followed the RC kindergarten program was a total reading program. The first step reviewed sound symbols learned and

introduced sound symbol associations that the children had not learned in kindergarten. Vowels were introduced in a different color. The second step was a phoneme analysis and blending program. In this step, children were taught to pronounce continuant CV units (continuant consonants like /s/, /f/, /l/, /m/, followed by a vowel) in order to prevent letter-by-letter articulation, which often results in the distortion of a word by the insertion of a schwa between the initial consonant and the vowel. Then final consonants were added to make a word. The third step was a perceptually based phoneme analysis and blending task. Children listened to a spoken CVC, then picked out letter cards to represent the spoken word. First the children picked out a letter representing a vowel, then the teacher repeated the word. The children then picked out the sound card to go with the first sound of the word. Then the teacher read the CV unit followed by the CVC and asked the children to listen to the last sound. Then the children selected the final consonant and the whole word was read by the group or by a child.

In this perceptually based activity, it is the first time that children began analysis of a word by identifying the vowel. There are numerous reasons why beginning with vowel identification may be more beneficial than beginning word analysis by identifying the first or last consonant. These reasons will be taken up in the section which discusses the rationale for the vowel-focused training to be used in the proposed study, wherein the children begin phonemic awareness training with vowel production, vowel identification and vowel discrimination.

Posttesting completed at the end of kindergarten and first grade revealed the treatment group performed significantly better than the control group on phoneme segmentation, with the largest difference at the end of kindergarten. The treatment group

out performed the control group for letter names and sounds, the largest difference occurring after kindergarten. On the Woodcock-Reading Mastery Test-Revised Word Identification subtest the treatment group also outperformed the control group, with the most significant growth occurring between the end of kindergarten and the end of first grade. Finally the treatment group outperformed the control group on spelling.

In the follow up reading program Blachman et al. (1999) make reference to a strategy that teachers had to employ to teach children to produce CVCs as *single units*. This strategy adapted from Englemann (1969) had to be taught because children were reading words either sound by sound, or with schwa insertions. It is plausible that teaching children to break words apart, or count individual sounds in order to understand phonemic structure, may have had a negative consequence upon children's ability to read words fluently. Recall that in the training procedures children spent much time counting individual sounds, saying individual sounds of a word separately, and working with individual sounds to construct a word sound by sound. In the proposed training study, the continuous training condition is designed explicitly to prevent children from developing word reading characterized by schwa insertions, silent pauses and sound-by-sound decoding.

There are several similarities among the three phonemic awareness programs reviewed so far. One is that children always learned to identify initial and final consonants prior to learning to identify vowels in the middle of words. Second, the analysis of two-phoneme words was assumed to be easier than analyzing the sound structure of three-phoneme words. Third, in both the Gillon (2000) and Blachman (1999, 2000) procedures, children learned to use speech to produce three separate phoneme

segments in sequential order, before they blended the phonemes to form words. These procedures contrast with the continuous condition of the proposed training study, because children in that condition never learn to respond to a spoken or printed word by separating it into a sequence of three separate phonemes.

Intervention for Children at Risk for Reading Failure. Torgeson et al. (1999) researched the effectiveness of two different interventions designed to prevent reading deficits in kindergarten children who were substantially at risk for reading failure due to their poor phonological awareness and reduced awareness of letter-sound relations. As in the two previous studies segmented production was a feature of the training. The intervention lasted for two and one half years.

There were two experimental conditions and two control conditions. One control condition involved individual tutoring in the reading program used in the classroom, and one control group received no treatment.

The experimental conditions differed with regard to the explicitness and intensity of phonemic awareness instruction. The most intensive condition, referred to as the phonological awareness plus synthetic phonics method (PSAP) used the Auditory Discrimination in Depth Program (Lindamood & Lindamood, 1984) for teaching children to discover and name articulatory features of phonemes and then track those sounds in words. After children were able to track phonemes in words, letters were used to represent sounds. Children first learned to spell syllables with letters and then were taught to blend separate phonemes into words.

The other experimental condition was called embedded phonics (EP). Letter-sound correspondences were taught in the context of reading sight words, writing the

words in sentences and then reading the sentences. Whole word instruction was completed using drills and games. Short vowels were taught by memorization using picture word cards. Phonological awareness training was completed in the context of writing, whereby children had to identify each sound they were about to write prior to writing it. Once children had mastered a repertoire of high frequency words, they began reading in a basal series. The focus however was on developing a larger repertoire of sight words and improving phonemic decoding skills. Once children finished the basal series, more attention was directed toward comprehension. Writing instruction and sight word instruction contained words from the list used in the PASP condition.

Children were trained four times per week for twenty minutes per session for two and a half years. Both certified teachers and teacher aides conducted the training.

At the end of training the PASP group out performed the EP group on untimed single word reading, phonemic awareness, and decoding. However there were no differences in reading comprehension among the PASP, EP and classroom program tutoring conditions.

In this study it was difficult to determine if differences between groups were due to characteristics of the training in phonemic awareness and decoding, or to the difference in the amount of time that each group spent engaged in phonemic awareness and decoding activities. Recall that the percent of time that each group engaged in some activities common to both trainings was different. Further it is difficult to know exactly how much time in the PASP condition was spent on activities that were ancillary to learning to segment words or analyze sound structure or decode. This difficulty is due to the design of the Lindamood (1984, 1994) program which places heavy demands upon

listening comprehension and includes extensive vocabulary training. Since this program was adapted for use in both the Gillon (2000) and Torgesen et al. (1998, 2001) studies, has been adapted for several other studies, and has been widely used clinically, it will be reviewed here.

Commercial Programs Adapted for or Derived from Intervention Studies.

The Lips Program (Lindamood and Lindamood, 1994, 1998). The goal of this program is independent reading. This program teaches children to feel and monitor articulatory movements of the tongue, lips and jaw. The consonant sounds are taught first. Consonant sounds are given special labels related to the movement of the articulators as the sound is being produced. Thus children learn vocabulary such as tip tappers, tongue scrapers, lip poppers and lip coolers. These sounds are ordered and identified to create words by using felt squares or wooden blocks. Children observe the instructor's tongue movements in order to learn to identify a group of nine vowels and diphthongs. Members of this group of sounds are termed, according to the appearance of the mouth, as smile sounds, open sounds, round sounds or sliders (which move from one position to another). Trainers position felt squares on a board to approximate the position of the tongue in the oral cavity (front, back, high, middle, low). Socratic questioning is used to help students monitor the position of the tongue, for example,

"Is /æ/ down or up compared to /i/. Is /ɑ/ down or up compared to /ɪ/."

Students learn to make small changes in words and to use their special sound labels to discuss sound changes.

Later in the program, vowel and consonant sounds are ordered and identified to create nonsense words by using felt squares or wooden blocks

"If that is /ɪp/ make it change to /ɪf/."

"I'm taking out a lip popper and putting in the lip cooler."

Here again there are special terms which refer to the place and manner of articulation of consonants. 'Lip poppers' refer to bilabial plosives and 'lip coolers' refer to labial-dental fricatives.

Finally students track these sounds in syllables or words beginning with two-phoneme words.

"Here's /æ/ and I'll add one. Do you want it before or after? Okay I'll make it change from /æ/ to /æ th/."

Speech production has had positive effects upon decoding and phonemic awareness in previous studies (Wise, Ring and Olson 1999). The training procedures used this study. The contribution of speech production to phonemic awareness and decoding training will be covered in more detail in the next session. In the continuous production training that was researched here, children's articulation was paramount; however the instructional discourse related to speech articulation was significantly less complicated than in the Lindamood and Lindamood (1998) program.

The Lindamood program moves on to have students use colored blocks to track sounds.

"This is 'frekt' how would you make it 'frest'?"

Children produce sounds slowly one at a time pointing to each block and then identifying which block and sound to change.

Colored blocks are replaced with letters as children learn to decode and spell. Children must track the number and sequence of sounds and then say sounds separately

one at a time as they use blocks to spell. Likewise when presented with a word, children produce the sounds one at a time and then attempt to blend them together into a word.

As we have seen, the idea of breaking words into separate phonemes and then teaching children to blend them back together is a procedure that is prevalent among many treatment designs that are used in research and adapted for marketing. Lundberg, Frost & Peterson's (1988) strategy for teaching phonemic awareness to preschoolers was adapted by Foorman, Francis, Beeler, Winikates & Fletcher (1997), and by Foorman, Francis, Shaywitz, Shaywitz & Fletcher (1997) for use with kindergarteners and by Wise et al. (1999) for use with elementary school children with reading difficulties. Adams, Foorman, Lundberg and Beeler developed the adaptations across the studies into a commercial program, *Phonemic Awareness in Young Children*, (Adams, Foorman Lundberg & Beeler, 1998). One noteworthy feature of this program is that it instructs teachers to require students to pause .5 seconds between the sounds in words when learning to analyze and blend.

In the phonemes step of this program, children begin to analyze words and syllables into phonemes and then blend separate phonemes into syllables and words. Similar to the other programs and research studies reviewed here, this program teaches children to use materials (blocks, chips, discs) to represent sounds. First children operate upon two-phoneme words and syllables, and then they learn three-phoneme units.

Teachers repeat phonemes that constitute the words, slowly, with a clear .5 second pause between each. Children are taught to repeat the sounds separately, over and over again, pausing less and less until the phonemes blend into a word. Similarly when children are synthesizing a word they pick a card and *say the two sounds separately*,

placing two blocks underneath a picture. Then they must say the two sounds faster and faster until they have produced the word normally. Later children learn to replace the blocks with letter discs.

Children learn three-phoneme words directly from two-phoneme words. First children move from analysis to synthesis. Children must divide a word (i.e., 'die') into its constituent parts /d/ and /ɑɪ/ using blocks. Children then must produce the new word (dime) by adding the next phoneme and block and stating the word phoneme by phoneme /d/ /ɑɪ/ /m/. Then children must produce each phoneme faster and faster until they produce the word 'dime'. Then children move from synthesis to analysis. The teacher produces a three-phoneme word, phoneme by phoneme /n/, /eɪ/, /m/ (name). Children represent the word with three blocks and repeat them in sequence until they blend the word and recognize it.

Here again, it appears that training students to say words sound by sound necessitates special follow-up training to put words back together. In this case, children must learn how to say three separate sounds faster and faster until they are blended into a recognizable word.

In sum, the programs and studies reviewed here have been successful in training children to acquire phonemic awareness. With the exception of the van Kleeck (1998) study, the programs and research protocols have demonstrated how training in phonemic awareness can precede and be integrated into systematic programs to teach decoding and spelling. These programs have been found to be effective in teaching children at risk for learning to read. For this reason, some of the features of these programs are consistent with the training procedures that will be used in the proposed research.

However there are marked discrepancies between the training in the current study and training used in previous studies reviewed here. The central difference is a focus upon continuous speech production as opposed to segmented speech production. Secondly the current training involves a more prominent focus upon vowel identification. Finally, the training is characterized by less complexity than those reviewed. The instructional language, the number of tasks, and the motoric complexity of each task has been carefully monitored over several years of use in the school and clinic in order to streamline the teaching process and avoid peripheral activities that could potentially divert or diffuse children's attention from phonemic processing, spelling and decoding.

Section IV

The Study - Part I Purpose and Rationale

Purpose and Rationale for Program Components. The purpose of this study was to examine the effectiveness of a *vowel-focused continuous production/perception* training program for the development of early decoding and spelling strategies in *beginning* readers who are at risk for learning to read. The training tested here is part of a larger program which has been specifically designed and used for training children who are at risk for learning to read and struggling beginning readers. The program has been delivered to individuals, small groups, classrooms and school wide settings. The program has been modified and tested in these various settings for a period of twenty years. At its inception, the purpose of this training was to teach young children at risk for learning to read to learn to decode and spell without engaging them in the practice of separating a word into a sequence of separate phonemes and then subsequently teaching them to find a means of blending those phonemes back together to produce a word they recognize. The training was designed to enhance children's representations of the relations underlying speech production and speech perception, enable children to establish more robust phoneme concepts, facilitate development in phonological processing and phonological memory, and to develop children's phonemic analysis of words by the child's repeated production and perceptual analysis of CVC syllables. The analysis of phoneme structure, and hence the identification of the specific phonemes that constitute a word, were derived from intensive work at the syllable level. The hallmarks of this intervention were: (1) to maintain production of syllables in the context of phonemic analysis; (2) to emphasize the role of vowel representation in the analysis of

syllables; (3) to facilitate word recall subsequent to phonemic analysis; (4) to induce a strategy of continuous production when decoding, and phonemic mediation during spelling.

Two principles guided this intervention: (1) *Knowledge of phoneme segments* is augmented by systematic analyses of syllabic production. The syllables or words analyzed always were produced in a continuous fashion. While children learned to analyze the phonemic structure of a syllable, they were *not* taught to do so by articulating a *sequence* of three separately articulated phonemes. Thus, they never needed to learn how to blend a sequence of separately articulated phonemes back together again to make a word. Children never learned to react to a printed word by producing three separate phonemes in sequence. (2) *Knowledge of vowels,* and the relationships that vowels have to syllable segments, enhances children's awareness of how syllables are packaged, and thus how one word differs from another. Vowel knowledge and identification are primary to learning to decode and therefore a full two thirds of the training involved identifying vowels.

The sequence of training steps was critical in this program and began with the identification and production of a limited set of vowels (i.e., three). Various activities at the CVC level ensued, such as practice in the production, identification, or analysis of syllables with different phoneme structures, durational features, articulatory and spectral patterns. The expected outcome was that readers would develop knowledge of phoneme segments and develop phonologically informed decoding strategies that were characterized by continuous production at the outset, never segmented productions. Multidisciplinary perspectives were amalgamated into this program design. Therefore

the research relevant to the development of this program and a detailed rationale for the development of the program are summarized below.

There is nearly universal acceptance of Isabelle Lieberman's thesis (1971, 1973) that the ability to analyze the internal structure of a word into its phonemic constituents, and subsequently develop a conscious representation of these units, is critical to the acquisition of literacy. There is however less consensus about the best methods of facilitating such ability and knowledge. Further there is a wide array of training techniques to teach various kinds of children how to apply this knowledge to decode and spell.

The Development of Phoneme Concepts. It is important to consider how children come to develop phoneme concepts in general, and to recognize that this development is a protracted process that, for some children, extends well into childhood (Edwards, Fourakis, Beckman, & Fox, 1999; Fowler, 1991; Nittrouer 1992). The training method advanced in this research was based upon the developmental perspective that the syllable is the critical unit of speech (Fowler, 1991; Nittrouer, 1996, Nittrouer 1999; Nittrouer & Kennedy, 1987). More specifically, it was based upon the idea that representation of phonemic segments emerges gradually as children learn to differentiate and extract recurrent articulatory and acoustic patterns within these units (Nittrouer, 1999), and develop representations of these (Edwards, 2004). Extracting such patterns begins to develop from the production and perception of syllables that contain segments, which are well differentiated anatomically and acoustically. Continued development is characterized by the progression of differentiated gestures that are more and more proximal and acoustic features that are more and more similar. From this point of view,

children who have persistent difficulties with the representation of phoneme structure need extensive practice in syllable production and perception in order to develop robust phoneme concepts and the conscious representation of these.

Speech Production and Speech Perception. A significant body of research points towards the possibility of subtle speech motor programming deficiency as characteristic of poor readers and of children with SLI who display overt misarticulations that affect speech intelligibility (Baddely, 1986; Catts, 1986; Edwards & Lahey, 1998).

Articulatory gestures for speech are based upon syllabic structures. Various articulators are moving simultaneously in different directions in order to articulate a syllabic unit. The timing of movements of the various articulators to different places or in different directions depends upon the syllable structure. For example, Nittrouer (1999) has found that the place of constriction for fricative production is strongly influenced by upcoming vowels. In the same vein, Davis and MacNeilage (1990) found that in young children the place of stop closure is strongly influenced by the place of vowel constriction. Training that engages children in the production of various syllable structures requires speech motor planning that is more typical of natural speech, than does training in the production of sequences of separately articulated phonemes.

A significant body of research points also towards the possibility of subtle speech perceptual deficits as characteristic of poor readers and of children with SLI (Brady, Shankweiler & Mann 1983; Godfrey, Syrdal-Laasky, Millay & Knox, 1981; Mody 1993; Mody, Studdart-Kennedy & Brady, 1997; Nittrouer 1999; Post, Foorman & Hiscock, 1997; Post, Swank, Hiscock, Fowler, 1999; Read, C., 1991; Stark & Heinz, 1996; Werker & Tees, 1987).

A speech sound wave is a physical continuum, '…an organization of sounds in their timely succession' (Elkonin, 1973, p.558). Duration is an important feature of speech production, and an important acoustic cue in speech perception. When the temporal integrity of the syllable (or word) is disrupted by the interspersion of relatively long (with regard to the speech signal) silent gaps, the syllable or word loses the very information that helps to define, or inform about the constituent phonemes. In order to develop a conscious representation of the phonemic structure of a word, syllables and words should be practiced in a continuous fashion, not a segmented fashion.

The identification of consonants and vowels is aided by the acoustic relationships that exist between them. Much of this information is carried in formant transitions from preceding consonants into the steady state portion of the vowel, and from the steady state portions of preceding vowels into the more constricted positions of following consonants. For example, in the case of stop consonants, it is these formant transitions, along with the frequency of the burst of air that cue the place of articulation for the consonant. Further, cues to consonant voicing are determined by the relative timing of the stop release and the voicing onset of the vowel. Essential transition information should remain available to learners, and not be stripped away as an artifact of teaching strategy.

> Formant transitions form the backbone of the syllable, so to speak, tying together the syllable nucleus with syllable margins. Thus, paying attention to formant transitions could provide a way for the child…to begin parsing the incoming signal (Nittrouer, 2002, p. 241).

Continuous Production. Elkonin's (1973) work has been cited and adapted repeatedly in programs for training phonemic awareness and decoding (Ball and

Blachman, 1988; Blachman, Ball, Black, & Tangel, 1994; Liberman, I. 1980; Williams, 1980). Elkonin (1973) asserted that in order for learners to analyze fluid speech, speech needed to be materialized by concrete materials. Hence the use of chips for representing spoken sounds was initially advanced in the literature by Elkonin. The utilization and adaptation of his technique in other training and research endeavors was motivated not only by the technique's presumed clinical value and intuitive appeal, but also by a need to support its effectiveness with greater experimental rigor.

Elkonin's (1973) claims about the pitfalls of the decoding approach to reading are still timely.

> ….the smallest inaccuracy in the creation of the sound formation on the basis of graphic signs renders the word incomprehensible. The sound formation has to be extremely precise. At the smallest distortion, the incorrect choice of a different version of a phoneme, or the incorrect intonation, the form of the word gets distorted, and its understanding is made difficult or confused (Elkonin, 1973, p. 552).

Elkonin (1973) employed another technique in order to facilitate children's understanding of phonemic structure and how to apply this understanding to fluent reading. He emphasized that children must be taught to produce words with what he called 'stressed intonation and a drawling (lengthened) pronunciation.' By teaching drawled pronunciation, concurrent with the fixation of sounds with counters, children would establish a "parallelism between the word's sound structure and its graphic representation" (Elkonin, 1973, p.570.) In fact, the importance of this extended sort of

production remained essential in aiding children's ability to analyze speech, long after they did not need chips or counters to represent speech sounds.

The intervention examined in the present study taught children to produce syllables with an increased duration, or lengthening. Contrasting normal duration with extended duration of speech stimuli was a central feature of the intervention. Children produced CVCs at a normal rate and then learned to produce these same words with extended duration. This allowed children to focus on precise oral configurations for place of articulation as well as to focus upon the timing of movements of the entire articulator complex. The recurrence of this activity throughout the entire program was designed to promote children's propensity to vary their speech production in ways that promote their ability to recognize words they are attempting to decode.

In order to provide a recurrent pattern for analysis, the Consonant-Vowel-Consonant (CVC) form was the only form used for phonemic analysis and decoding. These forms included both real and nonsense words. *All initial consonants in the program CVCs* were *continuants.* That is, the set of phonemes used in the initial position were those which could be produced with sustained continuous production: /m/, /n/, /s/, /f/, /v/, /l/, /z/, and /dz/, /r/ (in addition these phonemes are most commonly represented in English by only one letter). This feature of the CVCs was selected in order to support the development of continuous production as a central feature of decoding. Both continuant sounds and stop consonants were present in the final positions of the CVC stimuli in the program.

Stop consonants were limited to the final position of CVCs for several reasons. First of all, a major cue to stop consonant identification is the stop burst. However, in

conversation, final consonants often are not released or aspirated, therefore the burst cue is often missing in the acoustic signal (Edwards, et al., 1999). In single word contexts, the burst is present reliably. In order to increase children's awareness of this cue, stops placed in the final position of CVC were *released or aspirated* in the present study.

A final reason that stop consonants in program stimuli were limited to the final position has to do with the facilitation of continuous production as a feature of decoding. As reviewed previously, it is well known that beginning readers' initial attempts to 'blend' or decode words often are characterized by schwa insertions prior to medial vowels or by silent gaps between phonemes. These insertions and gaps distort the representation of the target word, and thus often disrupt word recognition on the part of the reader. The program studied here was designed to ensure that children's first reading attempts were characterized by fluent continuous production. The goal was to develop continuous production as a primary metacognitive concept that characterizes all word analysis and decoding for the child.

The Role of Vowels. Competence in the production, perception and representation of vowels is critical to the acquisition of reading; yet, this competence presents a special challenge to children with specific language disorder, and to children who have difficulty reading. Stark and Heinz (1996) investigated vowel perception in six to ten year old children with and without specific language impairment. They assessed discrimination, identification and serial ordering of two pairs of steady state vowels. Members of the first pair of vowels were acoustically dissimilar, /æ/ and /i/, while members of the second pair, /æ/ and /ɛ/ were acoustically similar. For both groups of children, perceptual tasks with /æ/ and /ɛ/ were more difficult. In fact, language impaired

children had such difficulty in identification of this pair that they could not proceed with serial ordering tasks.

In a pair of related studies (Post et al, 1999; Post, Foorman & Hiscock 1997), difficulties in vowel perception were linked to both poor reading and poor spelling. In the first study, impaired and non-impaired readers were required to identify vowels /i/ or /ɪ/ in a forced choice paradigm. This task discriminated significantly between the two groups. Furthermore they found that that in CVCV structures, more errors were made when the vowel was followed by a voiced consonant that a voiceless consonant. In the second study (Post et al. 1999), 155 children from second through fourth grade were divided into five different groups based upon reading competency. Each child completed four different tasks: vowel discrimination /i/, /ɪ/; the identification of vowels as either short or long in contrasts [(/i/, /ɪ/), (/ɛ/, /æ/), (/u/, /ʌ/), (/ɑ/, /o/)]; the identification of vowels in the contrast (/ɛ/, /æ/); and a vowel spelling task for all short and long vowels. The significant findings included the strong effect of vowel identification. Vowel identification associated linearly with the groups of children. The two lowest groups made seven times as many errors as the highest reading group in identifying vowels. Additionally, short vowels were significantly more difficult than long vowels. On the /ɛ/, /æ/ contrast the poorer readers made more significantly more errors in general, and the greater number of errors was on the vowel /ɛ/. Spelling errors increased linearly, such that the lowest groups of readers made the largest numbers of errors. Both groups made significantly more errors on short vowels than on long vowels. The authors conclude that errors in reading and spelling vowels are associated with difficulty in the perception of

vowels. They posit that poor readers and spellers have limited access to vowels at the oral language level associated with less stable core vowel representations.

Post et al. (1999) recommend that the attention of beginning readers be directed systematically to the impact that adjacent consonants have upon the phonetic quality of the vowel; and likewise to the influence that different vowels have upon adjacent consonants. In addition these authors suggest that learners should be trained to attend to vowel contrasts as opposed to learning to read lists of words that share similar spellings (i.e., fit, sit, mit, wit, bit). These recommendations are consistent with the principles of the vowel-focused training program in this study, which begins by teaching vowel contrasts.

In their extensive series of studies focused on reading errors in monosyllabic words, Shankweiler and Liberman (1972) examined the reading behavior of good and poor readers from eight to twelve years old. There were three interesting findings in the research. The first was that the overall pattern of errors was the same for good and poor readers. That is, though poor readers had a greater number of errors than good readers, both types of readers made the same error types. The second finding was that final consonants were misread more often than initial consonants. Thirdly, vowels were misread more often than consonants. The authors speculated that the greater accuracy on initial word segments was a reflection of children's knowledge of phoneme grapheme relations being in advance of their phoneme segmentation skill. Thus subjects were able to *begin* decoding a word in almost every case, but experienced breakdown due to poor phoneme blending ability.

Two reasons were hypothesized to account for the high percentage of vowel errors: orthographic complexity and phonetic confusion. These hypotheses were explored with word production and word reading tasks. Subjects from the study were asked to repeat each word from a spoken list, and, then, on a different day, asked to read each word from a written word list. Errors in oral repetition of vowels in words averaged 7%, while vowel reading errors averaged 24%. Furthermore, there were fewer vowel errors than consonant errors on the oral word repetition task.

Shankweiler and Liberman (1972) noted that because vowels in the speech stream were more intense acoustically and of longer duration when compared to consonants, it seems likely that consonants would be misheard more often than vowels. However in the orthography of the language, the vowels are not represented in a consistent manner, and in fact are buried in the middle of the printed word. Shankweiler and Liberman (1972) found a relationship between the percentage of errors in reading words, and the orthographic representation of the vowels in those words. They noted that /ɪ/ is represented by 'i', in all reading contexts, whereas /u/ is represented by 'u', 'o', 'oo', 'ou', 'ew', and 'ui'. Not surprisingly then, /ɪ/ had a 7% error rate, whereas /u/ had a 26% error rate.

In exploring a phonetic basis for vowel errors, Shankweiler and Liberman (1972) cite evidence from speech science research. They note that in speech perception, vowels are processed differently from consonants. Vowels are perceived continuously in most cases, whereas consonants have tendencies towards categorical perception. Further, vowels are subject to indefiniteness as phonological entities, influenced by dialect and geographical differences.

A closer examination of the Shankweiler and Liberman (1972) vowel matrix reveals that after /u/, the vowel /ɛ/ had the next lowest accuracy, a 21% error rate. While there was a great variety in vowel substitutions for /ɛ/ the greatest of these substitutions was /ɪ/ for /ɛ/. These facts are not surprising based upon the articulatory features and acoustic features of /ɪ/ and /ɛ/. The similarity and confusability of these two vowels has been substantiated in both the speech perception and speech production literature (Borden & Harris, 1980; Fant 1970; Peterson & Barney, 1952; Stevens & House, 1955).

The treatment of vowels in many programs training phonemic awareness and phonics is specialized to some degree. For example, the LIPS program spends an extensive amount of time teaching the "vowel circle" and how the tongue moves in order to produce various vowels and diphthongs. The Elkonin (1973) program used a different color chip for vowels. However, it is almost universally the case that when children begin learning to identify the phoneme constituents of a word, they begin by learning to identify the first sound, then the last sound, and finally the medial (vowel) sound.

It is not clear why vowel identification would or should be left as the final step in training phonemic analysis. After all, many features of vowels are easy to perceive because vowels are voiced and relatively more intense than other speech sounds. Additionally the fundamental frequency of each vowel is held for a longer duration (at least 100 milliseconds in most cases) (Borden & Harris 1980), than most consonants in running speech. In monosyllabic words and in stressed syllables of polysyllabic words, vowels constitute the greater part of the syllabic nuclei. And, as noted earlier, the character of a vowel often is an important cue to consonant identification. Thus, the first

goal of the intervention here is to develop a steady state representation of the vowels /ɪ/, /æ/, /ɑ/, and to teach children to identify these vowels in syllables.

There are several reasons why these three vowels were utilized. First of all, poor readers read these three vowels with the greatest accuracy relative to other short vowels (Shankweiler & Liberman, 1972). This suggests that these three vowels may be easiest to read for at risk readers learning to read. Secondly, within the set of short vowels, /ɪ/, /æ/, /ɑ/ are the only subset that reveal no acoustic overlap (Liberman, 1977; Peterson & Barney, 1952) (See Figure 1). Thirdly the tongue placement for the production of these vowels provides substantial articulatory contrast (See Figure 2). These latter two facts have the power to facilitate representations or mappings between articulatory and acoustic features of speech.

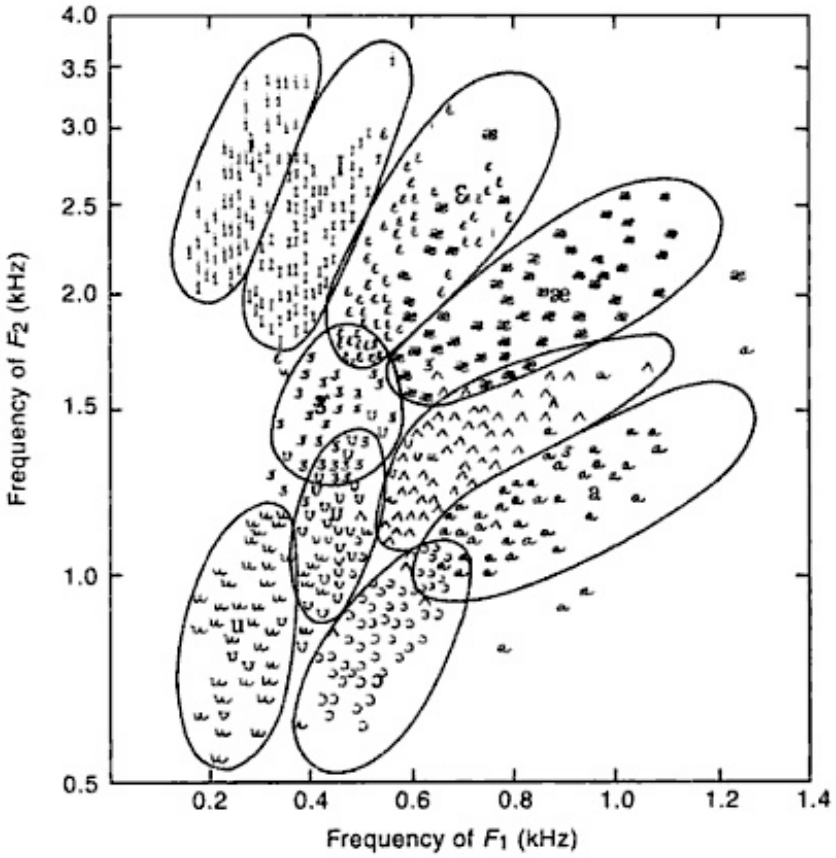

Figure 1. This shows the second formant frequency versus the first formant frequency for 10 vowels spoken by 76 speakers. Notice that there is no acoustic overlap among the vowels /ɪ/, /æ/, and /ɑ/. (Adapted from G.E. Peterson and H.L. Barney Journal of the Acoustical Society of America, 24, 1952 p. 52. Reprinted with permission from G. Borden, K. Harris, and L. Raphael. Speech Science Primer p. 108. Williams and Wilkins, 1994).

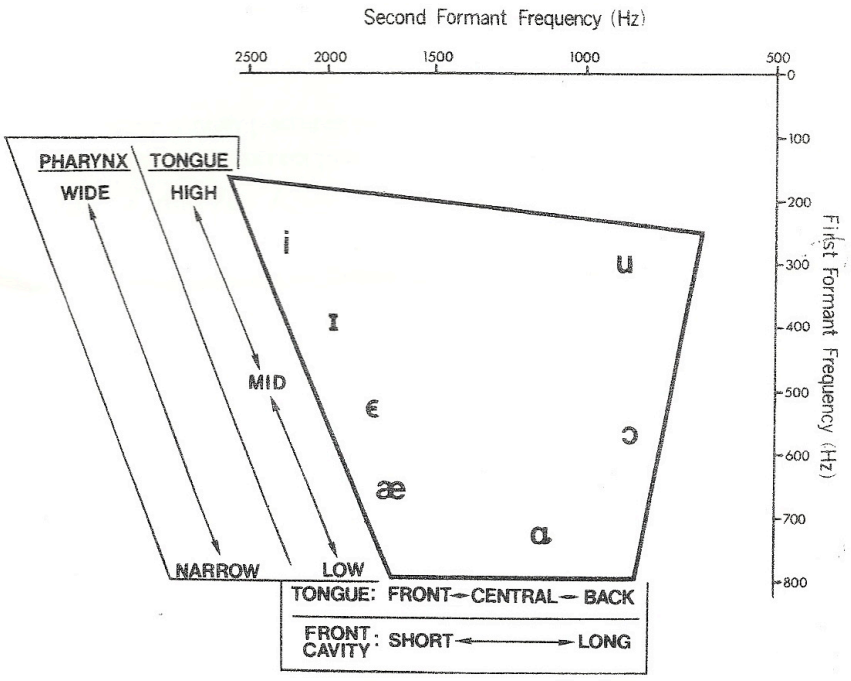

Figure 2. This picture shows the relationships among tongue position, size of the oral cavity and formant frequency for some vowels. Note that the vowels /ɪ/, /æ/, and /ɑ/ have contrasting tongue positions. (Reprinted with permission from G. Borden, K. Harris, and L. Raphael. Speech Science Primer p. 113. Williams and Wilkins, 1994).

Articulatory differences between /ɪ/, /æ/, /ɑ/, as depicted by mouth postures, present the greatest visual contrast of all short vowels (See Figure 3). From theoretical and research bases these three short vowels constitute the optimum content for initial training. Training this group of vowels could help circumvent common vowel substitutions, which are characterized by assimilation to adjacent vowels.

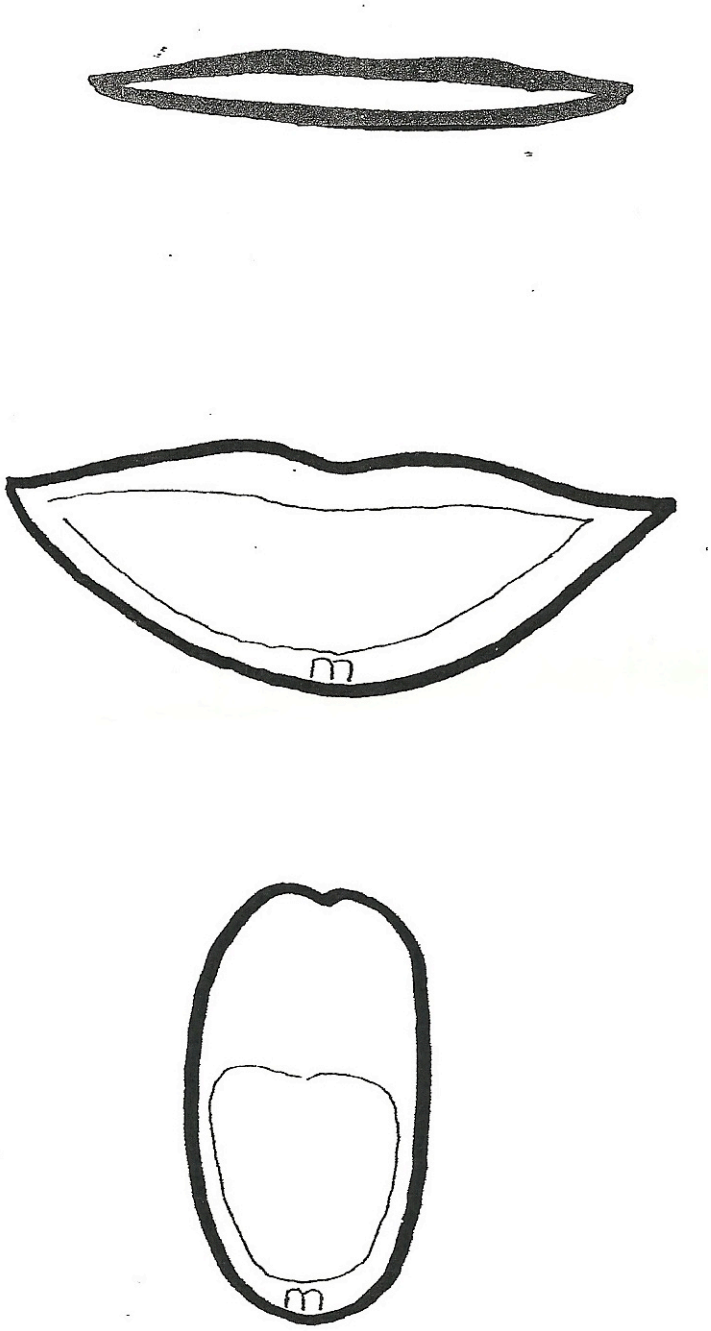

Figure 3. These mouth postures are used as pictorial cues in Phase 1 in order to promote correct production of the vowels /ɪ/, /æ/, and /ɑ/.

In the present training program, Vowel-Consonant (VC) forms / ɪt /, /æt /, and /ɑz/ were used as key words for promoting strong steady state representations of the vowels /ɪ/, /æ/, and /ɑ/. These forms were appropriate because the vowel is stressed when these forms are spoken in the program's key phrases: "you're it!", "at school", and "the wizard of OZ". It is well known that in stressed syllables, the duration of vowels is longer than in unstressed syllables. The increased amount of time it takes to articulate stressed syllables allows articulators to reach the target positions for vowels (see Borden, Harris, & Raphael, 1994).

Representing Segments Along a Continuum of Sound. Various training programs have adapted the Elkonin (1973) idea of moving counters, chips, or materials in order to represent the phonemes of words or syllables. Blachman et al. (2000) for example recommend that children use one finger for each chip in order to emphasize that each chip represents only one sound. In the LIPS program (Lindamood & Lindamood, 1998) different colored blocks are added or taken away from sequences of blocks to create new and different words. Thus, there is an association between the number of blocks moved and the number of phonemes produced or contained in a word. The value of using materials to represent phonemic concepts has been substantiated in the literature. In the author's experience, and in our pilot study with first graders who were at risk for learning to read, the children were able to sustain a continuous verbal production in synchrony with three separate motor movements for chips or tokens representing constituent phonemes. However, in other cases, particularly with children who had SLI, and/ or concomitant motor planning difficulties, the coordination of one continuous set of articulatory gestures in synchrony with three discrete fine motor movements (of chips or

tokens) resulted in confusion. Children evidenced some disruption or dysfluency in the continuous production of the syllable or word. This occurrence led us to develop a different strategy for representing constituent phonemes in the context of continuous production.

Students in the continuous production training program coordinated their verbal production with one continuous hand movement across a large horizontal paper screen divided into three panels (see Figure 4a).

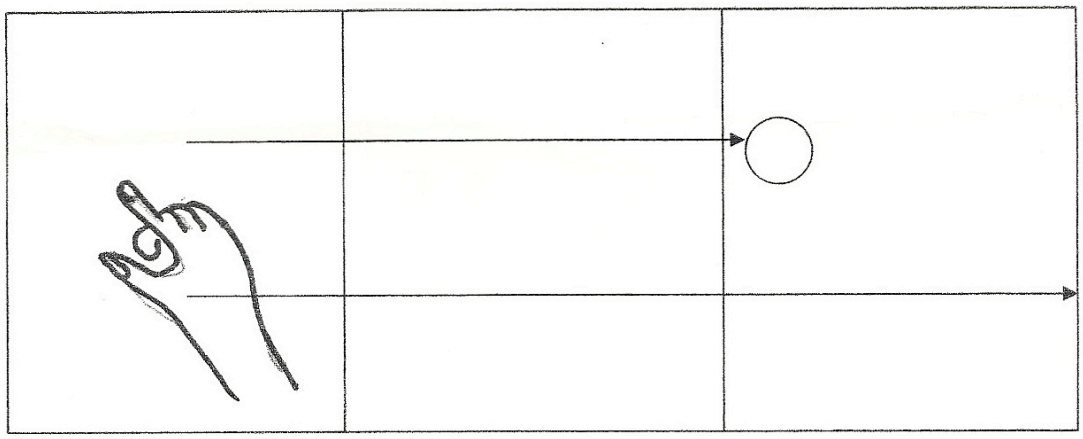

Figure 4a. Subjects use this 3-paneled 30-inch paper strip to coordinate finger and hand movements with speech production. Subjects in the continuous production condition slide their finger across the paper strip in synchrony with production.

Thus for each word or syllable produced there was one continuous motor movement in synchrony with a continuous speech production. This aide for representing and enhancing phonemic structure was more akin to the representation on a speech sound spectrogram. Later in the training process, the middle panel exhibited the three mouth postures for the vowels /ɪ/, /æ/, /ɑ/ (See Figure 5). Still later in the program, these same movements were applied to word reading.

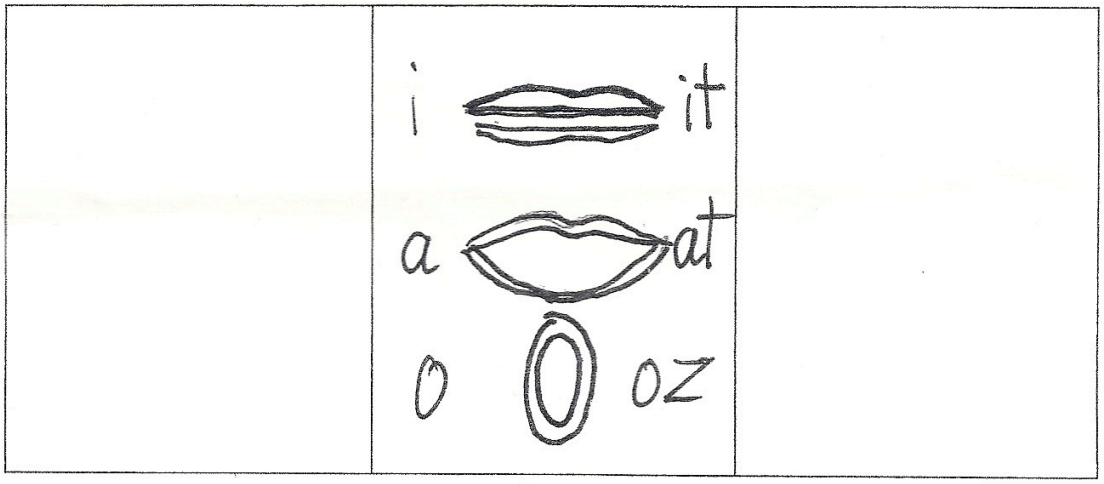

Figure 5. Children use this panel to slide or segment and then write their letter within the horizontal space for the corresponding vowel.

Hence, throughout all phases of training the means of representing three constituent phonemes supported our focus upon continuous production.

Language of Instruction and Memory Load. Children at risk for learning to read have difficulty with many related tasks including, letter naming, word retrieval, and memory for nonsense words. This fact is important to consider when constructing interventions for children who are at risk for learning to decode. An important feature of the program researched here was the systematic and gradual introduction of literate vocabulary. Children *can* use words as cognitive anchors for novel concepts. Children *can* operate with new literate terms if these are introduced slowly and systematically. However, if students must learn a barrage of new vocabulary terms in order to engage in an intervention program, then there is a risk of information processing overload and hence the possibility of inadvertently slowing or interfering with the acquisition of new literacy skills. The present program controlled and organized the language of instruction. The program was highly scripted in terms of the verbal input to the learner. The program gradually introduced the terms 'sound', 'letter', and 'word' in a systematic way. Subsequently the program facilitated students' correct use of these terms as they analyzed their CVCs. The program instructions used these terms in phrases, which promote comprehension by collocating each term with its semantic subordinate. For example: letter 'i' makes the sound /ɪ/ in the word, 'it'. The only letter names that children were required to know in this program were letters 'i', 'a', and 'o'.

Likewise, constraints placed upon memory for CVC were addressed. This program gradually increased the amount of time between the student's production and perception of a CVC; the phonemic analysis of the CVC; and the recall of the CVC. This feature of

the program was important for facilitating children's phonological memory and establishing links between the production, phonemic analysis and recall of spoken and perceived words. The increments in time were introduced systematically in the program format and were contingent upon specified response numbers and accuracies.

Word Reading Strategy. This program taught the direct application of phonemic analysis and segmentation as strategies for spelling and decoding. Some students began this study with some knowledge about reading, for example, using some phonetic cue strategies at pretest. However, even when children have the ability to segment phonemes and analyze phonemic structures, this does not assure that they will apply these strategies in spelling and reading tasks. It was a primary goal of this vowel-focused continuous production training to take the children through a step-by-step process of strategy development, thereby assuring the application of that strategy to both spelling and decoding. While strategy development may seem to be a common goal in many reading intervention programs, strategy application for the purpose of decoding and spelling may not be obvious to learners because this strategic feature is too often buried within many other tangential activities such as categorization of phonemes and learning their various 'nicknames' (Lindamood, C.H., & Lindamood, P.C., 1984), playing phoneme addition and deletion games, changing one word into another, and the like. The force and value of strategic work for the purpose of competency in decoding and spelling was one hallmark of this program.

Hypotheses. In the proposed study, the primary question to be addressed was whether continuous production is an essential active ingredient in a training program to improve phonological memory, and to teach phonemic awareness, decoding and spelling

to students at risk for learning to read. To address this question a vowel-focused continuous production training program was compared to a vowel-focused segmented production program.

Students who received the continuous training program were taught to extend and sustain phonemic constituents to generate continuous productions of the words being analyzed. Students who received the segmented training program were taught to segment words by pronouncing phonemic constituents separately, with pauses between them as they analyzed words. Otherwise, components of the two training conditions were conducted almost identically. A control group was included whose members received a narrative-based emergent literacy treatment which included a variety of syllable segmentation, phoneme awareness, letter name, letter sound, spelling and reading activities. Students were assigned randomly to one of the three conditions.

The following hypotheses are tested in this research:

1. Students who receive either of the two vowel-focused speech production training programs will show greater gains from pretest to posttest in learning to decode and spell words than students in the narrative-based emergent literacy control condition.
2. Students who receive vowel-focused continuous production training will show greater gains from pretest to posttest in learning to read and spell words than students who receive vowel-focused segmented speech production training.
3. Students who receive vowel-focused training that involves continuous production of words will be able to decode untrained CVC words beginning with stop sounds, and CVCC words beginning with continuant sounds more successfully in

the decoding posttest than students who receive vowel-focused training that involves segmented production of words.

4. Students who receive vowel-focused continuous speech production training will reach criterion and progress through the six phases of training more rapidly and with higher accuracy than students who receive vowel-focused segmented speech production training.
5. Students who receive training in the vowel-focused continuous speech production training will show greater gains from pretest to posttest on measures of phonological memory and phonological processing than students in the segmented production group and the control group.

Section V

The Study- Part II: The Method

Participants. A notice was sent by the kindergarten class parent to the parents of 6 kindergarten classes in three neighboring school districts in a suburban county of New York City. The notice was sent at the beginning of the seventh month of kindergarten inviting children who had a history of speech or language difficulty or who were struggling with reading to participate in a reading intervention study.

All parents who replied were invited to meet with the experimenter at a private clinical training site. The experimenter explained the following: Children would receive 4 pretests to determine if they were eligible for the study; children eligible for the study would complete additional pretesting; based upon pretesting children would be assigned to a triplet group of children who demonstrated similar pre-reading abilities; each child in a triplet would be randomly assigned to one of three interventions; activities involved in each intervention have been demonstrated to have positive impact upon pre-reading skills or reading acquisition according to experimental studies; children would have treatment 2-3 times per week for 35 minutes. Following the completion of treatment, children would be post-tested. Parents would not be told any of the specifics of the training during the experiment and were encouraged to refrain from asking children about the specifics of the training; parents were encouraged to contact the experimenter at anytime with questions or concerns; parents would be completely debriefed at the end of the study regarding the training and the findings.

The experimenter informed parents of the legal protections for children as participants in human subjects research. Specifically parents were informed that they and

their child were free to cease participation at anytime during the study. Children could not be forced or bribed to participate. Once permission for participation was granted and parents signed informed consent documents, the children were scheduled for pretesting.

The selection criteria for participation in full pretesting was as follows: (a) knowledge of at least twelve letter-sound correspondences; (b) ability to decode no more than two words from a list of twelve Consonant-Vowel-Consonant (CVC) words (six real, six non-real); (c) ability to spell no more than two from a list of twelve CVC words (six real and six non-real); (d) pass a vocabulary training task; (e) demonstrate normal hearing based upon school and pediatric screening; (f) perform within the average range on the Peabody Picture Vocabulary Test (PPVT).

Children with any developmental disabilities such as sensori-neural hearing loss, cerebral palsy, mental retardation, blindness, Down's syndrome, Asperger's syndrome or autism were excluded from the study.

A total of thirty-five children began the testing process. Two were excluded because they did not know at least twelve letter-sound correspondences. Five were excluded because they could decode more than two CVC (real/non-words). Two were excluded because they could spell more than two CVC words. One was eliminated because he did not want to continue, and one was eliminated due to personal family problems. A total of twenty-four children were retained for the study.

Pretest and Posttest Measures. Participants retained for the study completed a full pretest and posttest battery. Pretest measures included: pre primer and primer reading lists of The Boder Test of Reading and Spelling Patterns (1982); the Phoneme Blending, Elision and Non-word Repetition subtests of The Comprehensive Test of

Phonological Processing (1999); and the Sentence Imitation Subtest of the Test of Language Development 3 (2004).

Participants were matched into triplets based upon age and pretest scores. In all but one triplet, members shared common risk factors. Risk factors included: speech and language impairment; speech sound disorder; history of speech or language disorder; genetic risk factor from a parent with dyslexia; difficulty learning to read and spell. One triplet of struggling readers included three children exposed to multiple languages for at least one year of life, all of whom spoke English as their primary language. Members of each triplet were assigned randomly to a Continuous Production (CP) Training Condition, a Segmented Production (SP) Training Condition or a Narrative-Based Emergent Literacy Control (C) Condition. All subjects received training at a private clinic in the area. Parents or guardians brought the children to the clinic for each training session. Training took place in a small quiet therapy room for 35 minutes each session. Students in all three conditions received training two or three times per week such that all experimental subjects received training the same number of times within each two week period of training.

Materials and Procedures. *Vocabulary Training for Real versus Non-words.* Pretests, posttests, and experimental training utilized both nonsense and real CVC words, so it was important to assure that children understood that some words they encountered would be real and some would not be real (crazy or nonsense). Therefore, students would be trained in this distinction to assure that they understood the difference between the terms "real" word and "crazy/nonsense" word. This training was administered to each student individually. In this training task, the student learned to indicate whether a word

spoken by the examiner was a real word or a crazy nonsense word in response to the question, “Was that a real word or a crazy word?”

The trainer began by stating, “I am going to say some words. Some words will be real words like the word 'bike' and the word 'cat' and the word 'chop'. Other words will be crazy nonsense words like the word ‘shuz’ and the word ‘gite’ and the word ‘lat’. I will say a word, and then you will tell me if the word was a real word or a crazy word.” The experimenter pronounced the following words one at a time; street, ball, mip, lady, jof, baby, baseball, niftim, meedy, and sproke, followed by the question, “Was that a real word or a crazy word?”

In order to participate in the intervention, a student had to answer all questions in the vocabulary training correctly. All participants were able to indentify correctly which words were real words and which words were not real or "crazy."

Pretests and Posttests. Several tasks were administered as pretests to screen students for participation in the study and to assess their language and literacy skills prior to training. These tasks were re-administered as posttests to assess the impact of the training procedures, specifically to determine whether trained students acquired the skills they were taught and whether these skills transferred to untrained stimuli and new tasks not taught. The posttest was given one week after training. Since controls were yoked to students in their treatment groups to formed matched triplets, controls were posttested at the same time as the first member of the triplet completing training was posttested. The tasks were administered individually to the children in the order listed below for pretesting. For posttesting, the pretest order was maintained except that the spelling

posttest was completed last in order to increase the time between the decoding and spelling posttesting.

1. Producing the Names of Letters - Children viewed twenty-six capital letters, triple spaced across three horizontal lines, on plain white 8 1/2"x11" white paper. The top and bottom lines had eight letters each; the middle line had ten letters. Students were asked either, "what is the name of this letter", or "tell me this letter's name." All students' answers were recorded.

2. Producing the Sounds of Letters - Children viewed nineteen capital letters (A,B,C,D,F,G,I,J,K,L,M,N,O,P,R,S,T,V,Z.) triple spaced across three horizontal lines, on plain white 8 1/2"x11" white paper. The top and bottom lines displayed six letters each. The middle line had seven letters. Students were asked, "What sound does this make?" For the letters having more than one sound any of the correct sound correspondences were accepted. For these letters the experimenter further asked, "Is there any other sound that this letter makes?" in order to allow subjects to demonstrate their complete understanding of any letter/sound correspondence. This task revealed the child's ability to retrieve a phonemic representation associated with each alphabet letter.

3. Decoding Words - Twelve (12) words and non-words (FOG, GOK, PiN, TAZ, SiT, NiS, MAK, DOT, RAN, CAM, KiM, MOF) were printed in all capital letters (with the exception of 'i' which was printed in lower case), in Comic Sans font, and listed (triple spacing) on 8 1/2"x11" plain white paper. The experimenter explained that some of the words were real words and that some were crazy nonsense words. Then the experimenter pointed to each word and asked the child to read the word. There was no time limit on word reading. None of these words were used in the training. No student who could read

more than two of the words was admitted to the study. The Decoding Words posttest was expanded to include twelve additional CVCC words: SIST, PAST, LOST, MASK, BOSK, RISK, LIFT, DAFT, NOFT, KASP, VOSP, and NISP.

4. Spelling Words - The experimenter told each child to do her best to spell each word that the experimenter spoke. The experimenter explained that some of the words were real words and that some were crazy nonsense words. A list of twelve (12) words and non-words were spoken in the following order by the experimenter; /mɑf/, /kɪm/, /kæm/, /ræn/, /dɑt/, /mæk/, /nɪs/, /sɪt/, /tæz/, /pɪn/, /gɑk/, /fɑg/. Children wrote their words using a number two pencil on 8 1/2"x11" plain white paper. There was no time limit on word spelling. None of the words were used in the training. No student who spelled more than two of the words correctly was admitted to the study. The spelling words posttest was identical to the pretest.

5. The Boder Test of Reading and Spelling Patterns (1982) - This is a decoding and spelling test that includes both regular phonetically spelled words and phonetically irregularly spelled words (33). Only the Decoding test was administered. Sixteen of the words on the test are characterized as words that can be decoded or spelled based upon "simple, regular, and pervasive sound correspondences". Seventeen of the words are those which "can't be decoded or spelled based upon simple phonic principles." The pre-primer and primer word lists were presented in an alternating pattern with irregularly spelled words having odd numbers and regularly spelled words having even numbers. Unlimited time was allowed for responding. All subjects' responses were recorded and transcribed phonetically.

6. The Comprehensive Test of Phonological Processing (Wagner, R., Torgeson, J. Rashotte, C., 1999) - This is a norm-referenced test, which assesses children's performance in the areas of phonological memory, phonological awareness and rapid naming ability. Tasks include non-word repetition, rhyming, syllable and phoneme segmentation, syllable and phoneme blending and rapid naming of letters, colors, numbers and objects. For the purpose of this research, only the non-word repetition, elision, and phoneme blending subtests were given. On the elision subtest children repeated a word spoken by the examiner, and then said the word that was left when the examiner took a word, syllable or sound away. For example, "Say airplane.....now say airplane without the plane; say cup....now say cup without the /k/." In the phoneme blending subtest, children listened to a recording of individual words, syllables or sounds and then attempted to put these together to make a word. For example, "What word do these sounds make ... /kaen/..../di/ (candy) or what word do these sounds make…/m/…/i/ (my)?" The non-word repetition subtest required children to listen to non-words one at a time, and repeat each word. The list of non-words increased in length from one to eight syllables. This was a measure of short term phonological memory.

7. Sentence Imitation Subtest of the Test of Language Development Primary-4 (Newcomer, P. & Hammill, D., 2004) - On this subtest, each child repeated verbatim a series of sentences spoken one at a time by the examiner. Sentences increased in length and complexity. The test was discontinued when a child reached a ceiling at five consecutive incorrect sentence repetitions. This is a measure of short term verbal memory as well as a measure of morphological and syntactic knowledge.

8. The Word Sequences Subtest of the Detroit Test of Learning Aptitiude-4 (Hammil, D., 1998) - On this subtest, a child must repeat verbatim a series of single, semantically unrelated words spoken by an examiner. The number of words in a series gradually increased. The test was discontinued when a child incorrectly repeated three consecutive series of words. This is a measure of short-term verbal memory. Children scored one point for each series of words correctly repeated.

9. The Peabody Picture Vocabulary Test-4 (Dunn, L., & Dunn, D., 2007) - This test is a measure of receptive vocabulary knowledge. The examiner says a word and the child must point to the corresponding picture on a template of four pictures. Children score one point for each correct picture identification.

Training Procedures. A continuous production training condition (CP) and a segmented production training condition (SP), and a narrative-based emergent literacy control condition (C) were included. Members of triplets were assigned randomly to either the continuous production (CP) condition, segmented production (SP) condition or the narrative-based emergent literacy control condition (C).

Each experimental condition consisted of six training *phases* (I, II, III, IV, V, VI). Each part had two training *segments*. There was a *turn taking segment* (TT) in which the trainer and the student took turns performing the task. During this segment, the trainer not only modeled how to complete the task, but also modeled strategies such as reflection, thinking, sub-vocalizing, and monitoring. The turn taking segment was followed by an *independent segment* (IC), in which the subject completed the task independently and the experimenter provided evaluative feedback.

Phase I of this training has two parts; Part A, Vowel production and Part B, Vowel sequence production. Phase III has two parts Part A, Vowel identification and Part B, Vowel letter identification. Criterion levels for each phase across the continuous production and segmented production conditions are identical, twelve consecutively correct responses. Upon achieving this criterion, the student can move to the next segment of the program.

The two treatment conditions were identical with one exception. In the Continuous Production (CP) condition, trainers taught students to produce consonant-vowel-consonant forms (CVCs) that were extended in duration and which are produced with released or aspirated final stops sounds. In the Segmented Production (SP) condition trainers taught students to produce CVCs by producing three distinct phonemic segments. The following provides an overview of the program methods, which are presented in their entirety in Appendix A. For each of the six training phases the continuous production training procedure precedes the segmented training procedure. The training words for the two experimental conditions are listed in Appendix B.

Phase 1 - Production of Individual Vowels and the Vowel Sequence

Continuous Production

A. Production of Individual Vowels - Students listen to the experimenter model then learn to produce each vowel, either /ɪ/, /æ/, and /ɑ/ with **extended duration** /ɪ/ (1.75 secs), /æ/ (1.60 secs) or /ɑ/ (1.61secs) when the experimenter points to its corresponding picture. The picture of each vowel depicts its mouth posture (see Figure 3). The pictures helped the experimenter train the child how to produce each vowel sound.

B. Production of the Vowel Sequence - Students listen to the experimenter model then learn to produce the sequence of vowels /ɪ/, /æ/, and /ɑ/ with **extended duration** in the sequence /ɪ/ (1.34 secs.), pause (.683 msc.) /æ/ (1.43 secs.), pause (.666 msc.) /ɑ/ (1.23 secs.). Pictures helped train students to produce the vowels in this sequence (see Figure 3).

Segmented Production

A. Production of Individual Vowels - This procedure is the same as the Phase 1 Continuous Production Procedure except that students learn to produce each vowel /ɪ/, /æ/, and /ɑ/ spoken at **normal duration** /ɪ/ (352 ms), /æ/ (486 ms), and /ɑ/ (500 ms). The picture of each vowel depicts its mouth posture (see Figure 3). The pictures helped the experimenter train the child how to produce each vowel sound.

B. Production of Vowel Sequence - This procedure is the same as the Phase 1 Continuous Production Procedure except that students learn to produce all three vowels in the sequence /ɪ/, /æ/, and /ɑ/ with **normal duration** in the sequence /ɪ/ (337ms) pause (1.25 sec.), /æ/ (442 ms), pause (1.17 sec.) /ɑ/ (310 ms). Pictures helped train students to produce the vowels in this sequence (see Figure 3).

Phase 2 - Production of Continuant Consonant-Vowel-Consonants (ConCVCs)

Continuous Production

Production of ConCVCs with Continuous Production and Extended Duration - Students listen to the experimenter model then learn to produce ConCVCs with standard duration (745 msec.) and then with continuous production and extended duration. Children then recall their word after extended production. In the case of ConCVCs with final stop sounds, the final consonants are aspirated and/or released.

The stimulus material is an 8x33 inch horizontal paper sheet, constructed with (3) 8x11 inch paper panels (see Figure 4a). Children move their finger across the panels as they produce extended ConCVCs. The panels reflect the phoneme transitions corresponding with the student's speech production.

Segmented Production

Production of ConCVC in Segmented Form - This procedure corresponds to the Phase 2 Continuous Production procedure except that students learn to produce ConCVCs in standard duration (745 msec.) and then in segmented form in which each constituent phoneme is produced separately with 1.25 sec between each phoneme. Children then recall their word after the segmented production. Instead of using a single sliding finger movement, children use three separate pointing movements, one to each panel of the horizontal paper strip in correspondence order with their production of each separate phoneme (see Figure 4b).

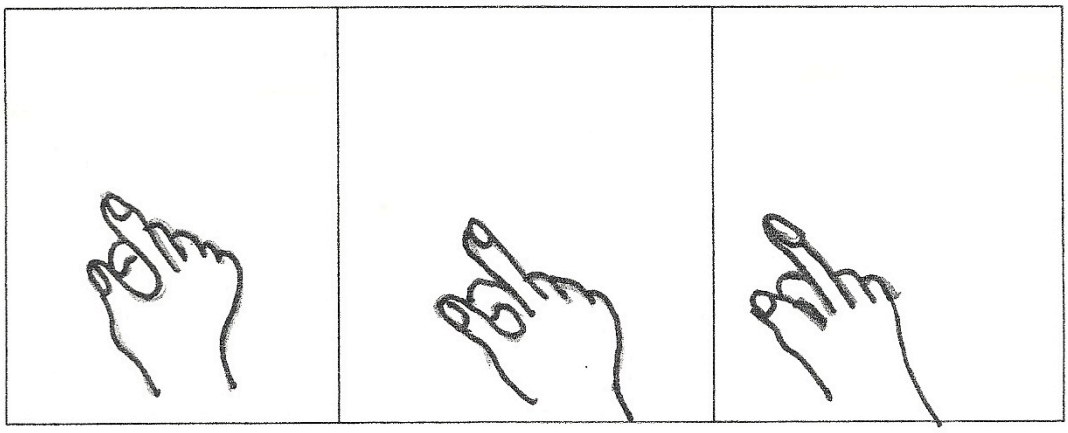

Figure 4b: Subjects use this 3-paneled 30-inch paper strip to coordinate finger and hand movements with speech production. Subjects in the segmented production condition point with their finger to each panel in synchrony with production of each separate phoneme.

Phase 3- Identification of Spoken Vowels and Corresponding Vowel Letters

Continuous Production

A. Identification of Spoken Vowels in **Continuous /Extended** ConCVCs - Students listen to the experimenter model then learn to *identify the vowel*, /ɪ/, /æ/, and /ɑ/, in their own ConCVC **continuous/extended** productions. **Children then recall their word after extended production.** Students produce the ConCVC in standard form and then in **continuous/extended** form while moving their fingers across a segmented paper strip. Then they isolate the vowel and produce the vowel sound while pointing to its corresponding mouth picture on the center segment of the paper strip. Children must recall and produce the ConCVC after they identify the vowel (Figure 4a).

B. Identification of Vowel Letters in **Continuous /Extended** ConCVCs - Students listen to the experimenter model then learn to *identify the letter corresponding to the vowel* produced in the ConCVC. To do this, first students produce the ConCVC in standard form, and then with **extended duration** while moving their finger across the segmented paper strip. Then they isolate and produce the vowel while pointing to its corresponding mouth picture. They identify the vowel letter by pointing to it. Then, they print the vowel letter by its mouth picture. In both cases children produce the vowel sound as they print the letter. Stimulus materials include bingo markers, pictures, pencils, and a paper strip symbolizing the vowel letter, the mouth sound and a corresponding picture (see Figure 5). Then, children had to recall and produce the ConCVC.

Segmented Production

A. Identification of Spoken Vowels in Segmented ConCVCs - This procedure corresponds to the Phase 3 Continuous Production procedure except that students learn to *identify the vowel*, /ɪ/, /æ/, and /ɑ/, from their own segmented productions. Children must recall and produce the ConCVC after they identify the vowel (Figure 4b).

B. Vowel Letter Names in Segmented ConCVCs - This procedure corresponds to the Phase 3 Continuous Production procedure except that students learn to identify the letter corresponding to the vowel produced in their segmented ConCVC. Then, children had to recall and produce the ConCVC (Figure 5).

Phase 4- Phonemic Analysis and Word Memory

Continuous Production

Phonemic Analysis/Word Memory/ - Students listen to the experimenter model then learn to identify the constituent phonemes of Extended ConCVCs they produce. Students produce the ConCVC in standard form and then with **extended** duration while moving their finger across a segmented paper strip. Then they identify and produce the vowel while pointing to the corresponding mouth picture (Figure 4a). After producing the vowel, the student identifies and produces each of the other two constituent phonemes as the experimenter points to its corresponding panel of the paper strip. The student always isolates and produces the vowel first, then isolates and produces the initial and final phonemes in mixed order based upon the experimenter's indication. Students then must recall and produce the analyzed CVC in standard form.

Segmented Production

Phonemic Analysis/Word Memory/ - This procedure corresponds to the Phase 4 Continuous Production procedure except that students learn to identify the constituent phonemes of their **segmented** productions (Figure 4b).

Phase 5 - Spelling

Continuous Production

Spelling - Students observe the experimenter model then learn how to spell ConCVCs in synchrony with **continuous extended** productions. Students produce the standard ConCVC form two times and then they produce the continuous extended ConCVC. Students then coordinate their letter writing with their continuous speech production of the ConCVC.

Segmented Production

Spelling - This procedure corresponds to the Phase 5 Continuous Production procedure except that students learn how to spell CVC s in synchrony with their **segmented** speech production.

Phase 6 - Decoding

Continuous Production

Decoding - Students observe the experimenter model and then learn to decode words using **continuous production** and continuous finger movement (Figure 6a). Then the student produces the word in standard form.

Segmented Production

Decoding - Students observe the experimenter model and then learn to decode words using **segmented** productions pointing to each letter (Figure 6b). Then the student produces the word in standard form.

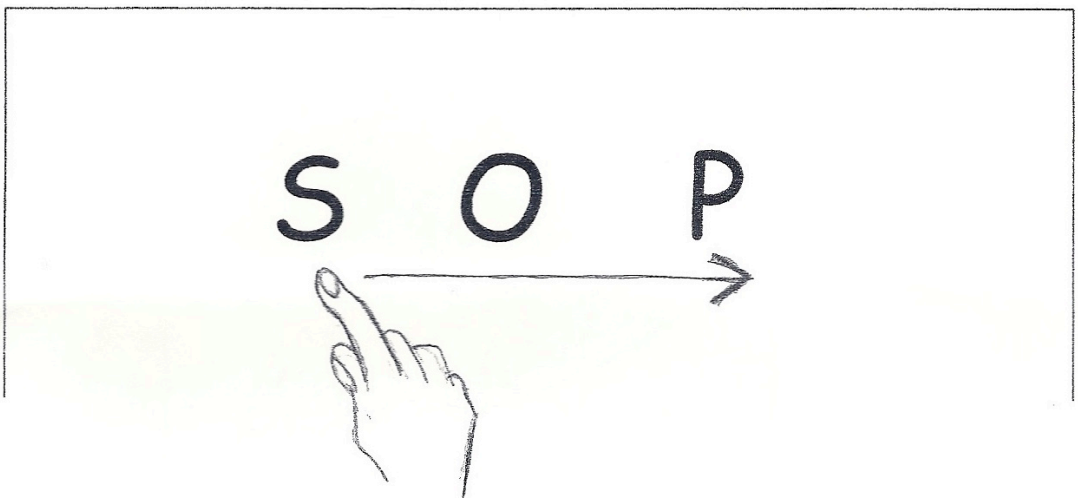

Figure 6a. 3x5 Word Card with ConCVC printed with continuous movement of finger.

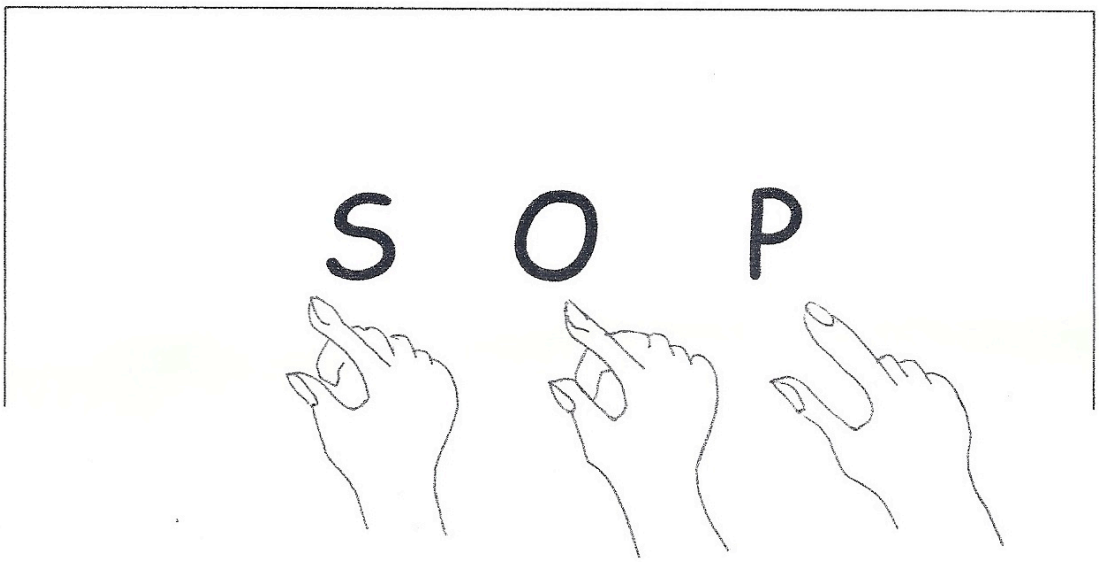

Figure 6b. 3x5 Word Card with ConCVC printed with three separate pointing movements.

The Decoding Words posttest was expanded to include twelve additional CVCC words: SIST, PAST, LOST, MASK, BOSK, RISK, LIFT, DAFT, NOFT, KASP, VOSP, and NISP. This posttest was used to measure transfer effects in reading words with untrained syllable structures.

Narrative-Based Emergent Literacy Control Condition. Children in the control condition came for treatment on the same schedule as the children in the two experimental groups. The trainer and the children engaged in a joint story construction activity. Activities included: telling and retelling, drawing and coloring pictures, segmenting syllables and words using stickers and bingo markers, printing words while learning rhymes such as " 'N' 'O' spells NO!" and " 'H' 'I' spells HI!" and printing small words in talking bubbles. In addition the trainer modeled verbally-mediated spelling, and highlighted connective and transition words such as 'so', 'then', 'next', 'but' and 'because'. There was no direct training in decoding or spelling during the control activity.

Reinforcement Procedures. Children in the continuous production and segmented production treatment groups were allowed to pick an arts and crafts activity (three choices) to work on during the training. During each training session, children spent three to five minutes on their activity as a reward for attending to the training.

Fidelity of Instruction. The stimuli and responses for twenty trials in each phase part for all subjects were recorded manually and digitally for all subjects. The number of responses and accuracy of each response for each subject was computed for each part of each phase. These data yielded a total program response number and a response accuracy for each condition. These data, as well as pretest and posttest difference scores were used to compare the performance of treatment groups.

In order to maintain reasonable fidelity when using live voice, the experimenter trained herself to detect extended and segmented productions of all the word and non-word stimuli by averaging the phoneme durations and silent pauses across three continuous and three segmented productions using Praat speech recordings. Judgments of children's responses were monitored using this instrumentation during one session for each phase and part of training using an HP 1650 laptop computer and speaker system. Audio-taped responses and handwritten transcriptions were compared for two sessions per child during Phase 4 turn taking. Analysis of these indicated a 91% inter-rater reliability. Written transcriptions were used in those sessions that were not recorded. We found the use of the computer to be somewhat cumbersome and distracting during the intervention. In the future it will be important to digitally audiotape the sessions that are not monitored in order to collect additional reliability data.

Since the intervention was scripted, experimenter bias was limited by the specificity of instructions.

Design and Statistical Analysis. The present study was a true experiment with random assignment of participants to treatment and control groups. The independent variable was the vowel-focused training procedure for which there were three levels: continuous production training, segmented production training, and a control narrative-based emergent literacy training.

Several dependent measures were analyzed to assess the effects of training. As training proceeded, the number of trials required to reach criterion by the two treatment groups was compared during each phase to determine whether one procedure was more effective than the other in facilitating learning. Analysis of Variance (ANOVAS) was

used to compare performance statistically across the training phases. The independent variable was treatment group. ANOVAS were also used to assess whether the mean performance of the three groups improved differentially from pretest to posttest. The independent variables were treatment group and test point, the latter a repeated measure.

Section VI

Results

Summary of the Study. The purpose of the present study was to assess the benefits of two types of decoding and spelling training, one involving continuous production of continuant consonant-vowel-consonant words and one involving segmented production of continuant consonant-vowel-consonant words. Kindergartners in their seventh to ninth month of kindergarten were assigned to one of three groups, either to one of the decoding and spelling treatments, or to a control narrative-based emergent literacy condition. To assess the effects of training, two series of posttests were given. The first posttest was a replication of the pre-treatment testing, and the second was a posttest to assess transfer effects of training. Both post-treatment assessments were delivered immediately following the completion of the training. Posttesting required about three thirty-five minute sessions.

To determine whether subjects who received training outperformed the subjects who received control training, and whether one form of training was superior to another form, analyses of variance were conducted. The independent variable was a treatment group with three levels: continuous production training, segmented production training and control emergent literacy training. Standardized tests and standardized effect sizes were used in order to compare treatment effects.

Pre-Treatment. Characteristics and mean performance of the three experimental groups on pretests and test statistics are given in Table 1. Triplets were formed based upon similar scores on pretests, as well as age and 'risk' category. Members were

randomly assigned to conditions. As evident in Table 1, statistical analyses revealed that the groups did not differ on any of the pretest measures.

Table 1

Mean Performance, Standard Deviations, and Test Statistics to Compare the Segmented and Continuant Treatment and Untreated Control Groups on the Pretests

Characteristics and Pretests	Segmented *M* (*SD*)	Continuant *M* (SD)	No T Control *M* (SD)	*F* –Stat
Age (in months)	70.35 (4.6)	70.25 (4.9)	70.12 (3.7)	.01 ns
Gender	4F; 4M	3F; 5M	5F; 3M	
PPVT	110.63 (5.3)	116.13 (8.3)	108.30 (14.5)	1.27ns
TOLD	9.13 (2.9)	8.25 (2.1)	8.25 (2.4)	0.33ns
CTOPP				
Elision	9.25 (1.5)	8.63 (1.8)	9.38 (1.8)	0.43 ns
Phoneme Blending	10.25 (1.0)	9.88 (1.7)	9.00 (1.7)	1.42 ns
Non-Word Rep.	9.13 (1.6)	8.13 (1.7)	9.13 (2.7)	0.62 ns
DTLA	5.88 (3.1)	5.38 (2.2)	4.75 (2.0)	.41 ns
Reading Words (33)	5.50 (4.0)	4.25 (4.4)	3.25 (3.2)	.67 ns
Name Letters (26)	25.00 (0.8)	24.13 (2.1)	25.25 (1.0)	1.38 ns
Letter Sounds (19)	14.88 (3.4)	14.38 (2.3)	16.25 (2.6)	0.95 ns
Reading Words/ Non-Words (12)	0.50 (0.9)	0.50 (0.9)	0.25 (0.7)	0.23 ns

Table 1

Mean Performance, Standard Deviations, and Test Statistics to Compare the Segmented and Continuant Treatment and Untreated Control Groups on the Pretests

Characteristics and Pretests	Segmented *M* (*SD*)	Continuant *M* (*SD*)	No T Control *M* (*SD*)	*F* –Stat
Spelling Words /Non-words (24)	0.88 (1.0)	0.63 (0.9)	1.00 (1.0)	.54 ns

Note. There were eight students per group. ns = not statistically significant at $p<.05$

DTLA= Detroit Test of Learning Aptitude

PPVT= Peabody Picture Vocabulary Test

TOLD= Test of Language Development 4

CTOPP= Comprehensive Test of Phonological Processing

Table 1 reveals the extent of children's development on several language and literacy capabilities. On the Sentence Imitation Subtest of the TOLD, mean performance was below the 50th percentile (standard score of 10) but within one standard deviation of the mean expected for this age group. Each condition also performed within one standard deviation of the expected means on the Elision, Phoneme Blending and Non-word Repetition subtests of the CTOPPS. Groups did not differ on mean raw scores of the Word Memory Subtest of the DTLA. Children knew almost all letter names and approximately 80% of the nineteen letter-sounds that were tested. On the Boder-Jarrico Test of Word Reading, children were able to read a mean of 4.3 words with a median of one (1) word. Seventy-nine percent (79%) of the children were not able to read any real or nonsense CVC words and fifty percent (50%) of the children were unable to spell any of these words. The mean number of CVC real and non-words read was .41 words out of twelve; and mean number of words spelled was .62 out of twelve. These findings indicate that when the children entered the study they were pre-readers with some letter-sound knowledge.

Training Time. Several training sessions were required for children to complete the program. The segmentation group completed a mean of 16.70 training sessions (SD= 3.69) and the continuous production group completed a mean of 14.87 sessions (SD= 2.03). A *t*-test comparing the two means indicated that the groups did not differ significantly, $t\ (14) = 1.26$, $p>.05$. However the effect size favoring the continuous production group was moderate d=-0.61, suggesting that the group took somewhat less time to complete training. Post intervention data analysis revealed that the average number of trials per session per experimental group was 20.1 and 20 for the segmented

and continuous groups respectively, indicating that members in both groups got the same amount of teaching each session.

Performance during Training. Each phase of training was analyzed in order to determine whether there were specific tasks that differentiated the two experimental groups, specifically, whether one group took longer to reach criterion than the other group indicating that this part of training was more difficult for one of the groups than the other. The mean number of attempts necessary to reach criterion for each condition for every phase of treatment is given in Table 2. To determine whether or not the mean number of attempts differed statistically between experimental groups, independent *t-tests* were performed. Test statistics revealed that there were three tasks, out of a total of sixteen, in which the two experimental groups performed differently. Learning trials were comparable for the two experimental groups during the other phases.

Table 2

Mean Number of Attempts to Reach Criterion of 12 Consecutively Correct Responses, Standard Deviations, and Test Statistics to Compare the Segmented and Continuant Treatment Groups During Each Phase of Training.

Phase	Condition	Mean[a]	Std. Deviation	*t* –test	Effect size (df =14)
1a Turn taking Vowel Production	Segmented	28.25	32.95		
	Continuous	29.00	18.91	-0.06 ns	
1a Independent Vowel Production	Segmented	26.26	31.15		
	Continuous	22.50	16.75	0.33 ns	
1b Turn taking Vowel Sequence	Segmented	13.75	4.94		
	Continuous	13.50	2.98	0.12 ns	
1b Independent Vowel Sequence	Segmented	12.12	0.35		
	Continuous	12.00	0.00	1.0 ns	
2 Turn taking Word Production	Segmented	39.000	14.91		
	Continuous	25.500	9.43	2.17 *	*d*=1.11
2 Independent Word Production	Segmented	18.7500	31.15		
	Continuous	14.1250	3.40	1.514	
3a Turn taking Vowel Identification	Segmented	29.500	17.25		
	Continuous	25.7500	10.31	0.53 ns	

Table 2

Mean Number of Attempts to Reach Criterion of 12 Consecutively Correct Responses, Standard Deviations, and Test Statistics to Compare the Segmented and Continuant Treatment Groups During Each Phase of Training.

Phase	Condition	Mean[a]	Std. Deviation	*t* –test (df =14)	Effect size
3a Independent Vowel Identification	Segmented	16.8750	31.15		
	Continuous	14.750	7.01	0.68 ns	
3b Turn taking Vowel Letter Identification	Segmented	16.250	6.30		
	Continuous	18.38	9.86	-0.51	
3b Independent Vowel Letter Identification	Segmented	16.123	7.68		
	Continuous	17.25	6.41	-0.32 ns	
4 Turn taking Segments Id.	Segmented	27.00	10.50		
	Continuous	15.00	4.75	2.95*	*d*=1.57
4 Independent Segments Id.	Segmented	18.00	6.26		
	Continuous	17.75	9.53	0.06 ns	
5 Turn taking Spelling CVC	Segmented	14.25	3.62		
	Continuous	20.88	9.70	-1.8 ns	*d*= -1.01
5 Independent Spelling CVC	Segmented	16.25	7.42		
	Continuous	15.63	7.17	0.17 ns	

Table 2

Mean Number of Attempts to Reach Criterion of 12 Consecutively Correct Responses, Standard Deviations, and Test Statistics to Compare the Segmented and Continuant Treatment Groups During Each Phase of Training.

Phase	Condition	Mean[a]	Std. Deviation	*t* –test (df =14)	Effect size
6 Turn taking Reading CVC	Segmented	28.8	13.41		
	Continuous	24.88	10.02	0.65 ns	
6 Independent Reading CVC	Segmented	15.00	4.99		
	Continuous	21.75	5.26	-2.64*	*d*=-1.32

Note. **$p < .01$; *$p < .05$; ns not statistically significant. There were 8 subjects per condition. *t*-tests were applied to compare means. 2-tailed tests were used. Effect sizes were calculated by subtracting pairs of means and divided by the pooled standard deviation. S = segmented condition; C = continuous condition. [a] The mean includes the 12 consecutive correct.

There were significant differences between the continuous production group and the segmentation group during the turn taking portion of Phase 2. It took the continuous production group significantly fewer attempts on average to learn to produce CVC words with continuous and increased duration by "stretching" than it took the segmented group to learn to produce CVC words by breaking them into three phonemes separated by silent pauses. In both instances children had to recall the CVC after they had completed each continuous, extended or segmented production.

The segmentation group had a total of 112 errors on the turn taking portion of Phase 2. This was three times as many errors as the continuous group. There were nine different types of errors which occurred as segmentation children attempted to segment CVCs into three separate phonemes: incorrect final consonant production, 30%; inability to recall the word segmented, 29%; production of an onset schwa-rhyme (i.e. /s^ɪt / for sɪt) 15%; production of an onset-rhyme, 11%; errors on vowel production, 7%; addition of a schwa to the final consonant, 4%; errors on initial sounds, 2%; production of two consonants only, 1%; and nasal insertion, 1%.

The continuous group produced a total number of 37 errors on the turn taking portion of Phase 2. There were five error categories which accounted for their errors in attempting to produce CVCs with increased duration: duration too short on initial or final consonants, 48%; final consonant error, 33 %; vowel error 7%; related word response (vampire for /væm/); 6%; velar insertion 3%.

The greater number of errors and the greater variety of errors made by the segmented group indicates that learning how to perform the segmentation procedure was relatively hard for children. This task placed such constraints on processing that nearly

one third of the time segmentation children could not recall the word that they had segmented. The fewer trials to criterion and lack of significant difference between groups in the independent part of Phase 2 indicate that the majority of learning for the segmentation group took place by observing and practicing with a model and receiving specific feedback.

In Phase 4 children learned to say a word two times, say the word in either a continuous extended fashion or segmented fashion, identify the vowel, identify the other two constituent phonemes in mixed order, and then recall the stimulus word. During this Phase 4 turn taking task, the length of time and the complexity of phonemic processing were greater between the child's first production of the stimulus word and the child's later recall of that word, than the length of time or complexity of processing in the previous two phases. Children in the continuous production group reached criterion in significantly fewer attempts on average than children in the segmented group. A look at error types indicated that of the nine errors made by the continuous group, six were incorrect identification of the final consonant and three were inability to recall the word after identifying all the phonemic constituents in the word. The segmentation group made 32 errors, more than three times the number of errors as the continuous production group. While the two groups made similar types of errors, in the segmentation group the errors were more evenly distributed. There were 17 errors identifying final consonants. On 13 items the children were unable to recall the word that was analyzed. Within this group one initial consonant and one vowel were incorrectly identified. Overall both groups evidenced improved short-term phonological memory than they did in Phase 2.

However the segmentation group had substantially more errors in recall and final consonant identification.

In Phase 6 children decoded CVC words independently after decoding CVC items during a turn taking procedure. Here children in the segmentation group required significantly fewer attempts to reach criterion than the children in the continuous production group. Once again an error analysis was conducted to gain insight into the difficulties associated with the need for the increased trials to criterion by the continuous group. In the segmentation group only three subjects accounted for the seven errors. These errors were varied including: three final consonant errors, one initial consonant error, two vowels errors, and one difficult to categorize item when the child read "ert" when presented with the word 'ROK'. In the continuous group, all but one child made errors. This group made a total of 22 errors. One child accounted for eight vowel errors. The other errors included six final consonant errors, two vowel errors, two nasal insertions, one reversal of the initial and final consonant, and two initial consonant errors.

As evident, the types of errors in the independent part of Phase 6 were varied in both groups and seem to reflect individual learners rather than outstanding group patterns. As such this error analysis does not contribute much explanatory value regarding the significant difference between trials to criterion. However it appears that the students in the segmentation group were better able to apply what they learned in the turn taking portion of Phase 6 to the independent portion in Phase 6, than were the students in the continuous group.

Inspection of other comparisons that fell short of significance in Table 2 reveals that the mean number of trials to criterion was very similar for the two treatments in most

comparisons. One exception was the comparison in Phase 5 turn taking. Here children were learning to spell by mediating their spelling verbally. The continuous group took notably more trials to criterion than the segmentation group, and number of trials within the group was more varied as revealed by the large standard deviation. Although the difference was not significant, the effect size favoring the segmentation group was large with d= 1.01.

Accuracy During Training. In interventions which require a *consecutively correct* response criterion for task completion, the *number* of trials to criterion is to some extent independent of the overall accuracy during learning. The question of interest was whether in the three comparisons revealing significant differences between treatment groups in number of attempts necessary to reach criterion, the groups also differed in the accuracy of their responses in those training phases. The percent accuracy was the total correct attempts divided by total number of attempts. Standard deviations and effect sizes were computed also for each treatment condition in Phases 2, 4 and 5 and 6. These results are listed in Table 3.

Table 3

Overall Mean Percent Accuracy, Standard Deviations, and Effect Sizes to Compare the Segmented and Continuant Treatment Groups During, Phases 2TT, 4TT, 5TT 6I

Phase	Condition	Mean	Std. Deviation	Effect Size[f]
2 Turn-Taking Word Production	Segmented	68.4	13.1	
	Continuous	82.5	16.817	.93
4 Turn-Taking Segments Identification	Segmented	81.6	7.9	
	Continuous	94	14.1	1.08
5 Turn-Taking Spelling	Segmented	94	8.53	-.16
	Continuous	92	8.02	
6 Independent Decoding	Segmented	95.5	6.4	-.78
	Continuous	89.3	9.2	

[f] Effect sizes were calculated by subtracting pairs of means and dividing the difference by the pooled standard deviation. S = segmented condition; C = continuant condition.

Comparison of the groups' mean percent accuracy in turn taking for Phase 4 and independent reading in Phase 6 revealed that both groups were able to complete these tasks with over 80% accuracy. The groups with the higher mean accuracies were also the groups with the lower mean number of attempts. Effect sizes were large respectively. Interestingly, even though the segmented group achieved a mean accuracy of 81% in Phase 4 turn taking, recall, it took the segmented group almost twice as many attempts to reach criterion as the continuous group. The error profile for both groups was similar qualitatively, but word recall and final consonant identification were substantially more difficult for the segmentation group, accounting for more errors.

There was an especially large difference however between the groups' accuracies in turn taking in Phase 2, with an especially large effect size in favor of the continuous group. The low mean accuracy of 68% for the segmentation group underscores the fact that the significantly greater number of trials needed to reach criterion (see, Table 2) was related to the difficulty of learning to segment words.

Overall Time and Accuracy Measures. Three measures of the overall performance during treatment are listed in Table 4 for both experimental groups. Table 4 reports the mean number of sessions it took children to complete training, the mean number of attempts necessary to complete training, and the mean percent accuracy of performance during training for the segmented and continuous production groups.

Table 4

Mean Performance, Standard Deviations, and Test Statistics to Compare the Segmented and Continuant Treatment Groups on Overall Time and Accuracy of Treatment

Measures	Segmented *M (SD)*	Continuant *M (SD)*	t-Test (df 14)	Effect size[c]
Total Sessions	16.70 (3.69)	14.87 (2.03)	1.25 ns	C vs. S = -.61
Total Attempts*	336.5 (75.20)	308.62 (34.54)	.95[a] ns	C vs. S = -.48
Total Percent Accuracy	83.66 (7.53)	88.62 (1.65)	-1.58 ns	C vs. S = .90

Note: ***p*<.01; *p**<.05; ns not statistically significant. There were 8 subjects per condition. *t*-tests were applied to differences between the means. [c]Effect sizes were calculated by subtracting the Continuant mean from the Segmented mean and dividing the difference by the pooled standard deviation. S = segmented condition; C = continuant condition

In Table 4 mean values indicate the continuous production training group completed training in somewhat fewer sessions and with overall higher mean accuracies. However these differences were not statistically significant. Effect sizes were calculated for the differences between the number of sessions to criterion, the mean number of attempts and the total training percent accuracy for the two experimental groups. Effect sizes were moderate sizes for the segmentation group who required more sessions and more attempts to complete the program than the continuous group. The effect size was large in favor of the continuous production group in total percent accuracy. These findings, though not statistically significant, are consistent with the hypothesis that children in the continuous group would complete the training more quickly and with higher accuracy.

Effectiveness of Training. Pretest measures were repeated as posttests with the exception of the PPVT, which was administered as a pretest only. In addition, a word reading posttest was added in order to assess transfer effects of training to reading real and nonsense words. This posttest entailed reading words with different canonical structures from those studied during training; 12 CVCC real and non-words, and two forms of CCVC words; 9 Continuant-Continuant VC real and non-words, and 9 Continuant-Stop VC real and non-words. Mean performance of the three experimental groups on Pretests and Posttests is given in Table 5 along with the test statistics. ANOVAs were conducted to compare performance of the three groups. Time of test was included as a second independent variable. Of special interest was the presence of significant interactions indicating differential pretest to posttest gains among the groups. When significant interactions were detected, follow up *t*-tests were conducted on each

group separately to localize significant effects. In addition effect sizes were calculated on all pairs of posttest means to compare each treatment group to the control group, as well as to each other.

Table 5

Mean Performance, Standard Deviations, and Test Statistics to Compare the Segmented and Continuant Treatment and Control Groups on the Pretests and Posttests

Measures	Segmented *M (SD)*	Continuant *M (SD)*	No T Control *M (SD)*	ANOVA	Effect Size[c]
Sentence Imitation (TOLD)					
Pretest	9.13 (2.9)	8.25 (2.1)	8.25 (2.4)	T: 0.54 ns	S vs. N: 0.57
Posttest	10.88 (2.5)	10.50 (2.0)	9.25 (3.2)	P: 22.22 **	C vs. N: 0.48
				TxP: 1.06 ns	C vs. S: -.17
Elision (CTOPP)					
Pretest	9.25 (1.5)	8.63 (1.8)	9.38 (1.8)	T: 0.36 ns	S vs. N = 0.15
Posttest	9.63 (2.0)	11.25 (1.7)	9.38 (1.4)	P: 7.44 **	C vs. N = 1.21
Gain[a]	0.38 ns	2.62 **	0.00 ns	TxP: 5.00 *	C vs. S = 0.88
Phoneme Blending (CTOPP)					
Pretest	10.25 (1.0)	9.88 (1.7)	9.00 (1.7)	T: 2.56 ns	S vs. N = 0.87
Posttest	11.25 (1.3)	11.75 (1.5)	10.25 (1.0)	P: 19.70 **	C vs. N = 1.20
				TxP: 0.71 ns	C vs. S = 0.36
Nonword Repetition (CTOPP)					
Pretest	9.13 (1.6)	8.13 (1.7)	9.13 (2.7)	T: 0.01 ns	S vs. N = 0.07
Posttest	9.88 (1.2)	11.00 (2.0)	9.75 (2.5)	P: 10.97 **	C vs. N = 0.56
Gain[a]	0.75 ns	2.87 **	0.62 ns	TxP: 2.91 *	C vs. S = 0.70

Table 5

Mean Performance, Standard Deviations, and Test Statistics to Compare the Segmented and Continuant Treatment and Control Groups on the Pretests and Posttests

Measures	Segmented *M* (SD)	Continuant *M* (SD)	No T Control *M* (SD)	ANOVA	Effect Size[c]
Word Memory (DTLA)					
Pretest	5.88 (3.1)	5.38 (2.2)	4.75 (2.0)	T: 0.30 ns	S vs. N = 0.00
Posttest	6.38 (2.3)	7.50 (3.2)	6.38 (1.8)	P: 12.84 **	C vs. N = 0.45
				TxP: 1.48 ns	C vs. S = 0.41
Word Reading (Boder) (33 max)					
Pre test	5.50 (4.0)	4.25 (4.4)	3.25 (3.2)	T: 1.97 ns	S vs. N = 0.75
Post test	12.88 (5.2)	14.63 (4.4)	8.63 (6.1)	P: 58.31 **	C vs. N = 1.14
				TxP: 2.07 ns	C vs. S = 0.36
Letter Names (26 max)					
Pretest	25.00 (0.8)	24.13 (2.1)	25.25 (1.0)	T: 1.24 ns	
Posttest	25.75 (0.7)	25.75 (0.7)	26.00 (0)	P: 16.64 **	
				TxP: 1.30 ns	
Letter-Sounds					
Pretest	14.88 (3.4)	14.38 (2.3)	16.25 (2.6)	T: 0.16 ns	S vs. N = 0.50
Posttest	18.88 (0.4)	18.38 (1.1)	17.25 (2.5)	P: 30.65 **	C vs. N = 0.63
Gain[a]	4.00 *	4.00 *	1.00 ns	TxP: 3.41*	Cvs.S = - 0.67

Table 5

Mean Performance, Standard Deviations, and Test Statistics to Compare the Segmented and Continuant Treatment and Control Groups on the Pretests and Posttests

Measures	Segmented *M* (SD)	Continuant *M* (SD)	No T Control *M* (SD)	ANOVA	Effect Size[c]
Read CVC Words and Nonwords (12 max)					
Pretest	0.50 (0.9)	0.50 (0.9)	0.25 (0.7)	T: 42.16 **	S vs. N = 3.05
Posttest	8.50 (1.2)	11.00 (0.8)	2.25 (2.9)	P: 267.43 **	C vs. N = 4.73
Gain[a]	8.00 **	10.50 **	2.00 ns	TxP: 36.43 **	C vs. S = 2.50
Pairwise Comp.[b]	Continuant > Segmented > No T				
Reading CVC Words and Non-Words with Initial Stop Consonants (6 max)					
Posttest	3.75 (0.7)	5.38 (0.7)		T: -4.48 **	
Spelling Words and Non-words (12 max)					
Pretest	0.88 (1.0)	0.63 (0.9)	1.00 (1.0)	T: 13.14 **	S vs. N = 1.86
Posttest	10.00 (3.3)	10.88 (1.1)	3.86 (3.3)	P: 131.58 **	C vs. N = 3.19
Gain[a]	9.12 **	10.25 **	2.86 *	TxP: 12.15 **	C vs. S = 0.40
Pair wise Comp.[b]	Continuant = Segmented > No T Control				
Reading Words with Consonant Clusters (Posttest only)					
CVCC (12max)	2.38 (2.8)	6.63 (4.7)		T: 4.92 *	C vs. S = 1.13
CCVC 1st C Stop (9 max)	1.50 (2.5)	1.75 (2.3)		T: 0.84 ns	C vs. S = 0.10

Table 5

Mean Performance, Standard Deviations, and Test Statistics to Compare the Segmented and Continuant Treatment and Control Groups on the Pretests and Posttests

Measures	Segmented *M (SD)*	Continuant *M (SD)*	No T Control *M (SD)*	ANOVA	Effect Size[c]
1st C Con. (9 max)	1.13 (2.5)	3.13 (3.3)		F: 0.88 ns TxF: 2.69 ns	C vs. S = 0.69

Note: $^{**}p < .01$; $^{*}p < .05$; ns not statistically significant. T= treatment P =Pretest vs. Posttest. Post Hoc [a] *t*-tests were applied to compare gains from pretest to posttest for each treatment groups when the interaction term was significant at $p < .05$

[b]Results of Bonferroni pairwise comparisons to localize effects of significant interactions were conducted using ANOVAs applied to posttest means. Only significant effects are reported.

[c]Effect sizes were calculated by subtracting pairs of means on the posttests and dividing the difference by the pooled standard deviation. S = segmented condition; C = continuant condition; N = No Treatment Control condition.

Table 5 reveals that a main effect of test point was detected on all of the measures. Significant interactions were evident on several measures.

On the Sentence Imitation subtest of the TOLD, a significant effect of test point was detected. However there was no significant main effect of treatment, or a significant interaction between treatment and test point. These results indicate that all three groups made significant gains in syntactic productivity and verbal memory over the seven to eleven week period between pretest and posttest.

Two subtests were included to assess phonological awareness. The elision subtest assessed the ability to delete syllables and phonemes from words, a task that was not taught during training. Significant effects of test point and the interaction between test point and treatment were detected. Post hoc *t*-tests were applied to compare gain scores for the three experimental groups in order to locate the source of significant interaction. From Table 5 it is apparent that the continuous production group showed a significant gain in mean scores from pretest to posttest, whereas the segmented and control groups showed no significant gains. In addition effect sizes calculated on posttest scores (see Table 5) were large favoring the continuous group over the control group and the segmentation group but the effect size was small in the comparison of the segmentation group to the control group. These findings indicate that only children in the continuant group improved in their ability to produce new words or non-words created by deleting phoneme or syllable in a presented word. The segmentation group did not show a similar benefit of training. The other phonological awareness measure assessed phoneme blending. This task was taught to the segmentation group only. Table 5 shows a significant main effect of test point but no significant further effects. Mean scores reveal

that all three groups made gains from pretest to posttest in their ability to blend phonemes to form words. Despite training, the segmentation group did not outperform the other groups.

Two posttests were given to assess whether training improved children's phonological memory. On the non-word repetition test, a significant main effect of test point and a significant interaction between test point and treatment were detected. Post hoc *t*-tests were applied to compare gain scores for each of the three treatment groups in order to locate the source of the interaction. From Table 5 it is apparent that the continuant treatment group improved significantly from pretest to posttest whereas the other two groups did not.

The second test of phonological memory assessed children's ability to repeat a sequence of real words (word sequences subtest of the DTLA). As evident in Table 5, the ANOVA revealed a significant main effect of test point but no other significant effects. These findings indicate that all three groups made significant gains from pretest to posttest in repeating word sequences. However, in contrast to the non-word repetition task, the continuant group did not outperform the other groups.

The first test of word reading assessed children's ability to read decodable words and sight words arranged in an alternating pattern (Boder pre-primer and primer word reading). In Table 5, the ANOVA revealed a significant main effect of test point for all three experimental groups. There were no significant interaction effects. While all groups made gains in word reading on this pretest, an examination of effect sizes in the next section will consider the magnitude of the gains.

Two tests assessing children's letter knowledge were given. On the letter name task, children performed close to ceiling on the pretest (see Table 5) so there was little room for gain on the posttest. The mean number of letters named correctly on the posttest was 25.8 out of 26 maximum. The other test assessed children's knowledge of letter sounds. Results of the ANOVA revealed a significant main effect of test point and a significant interaction between test point and treatment. Post hoc *t*-tests were applied to assess whether gains from pretest to posttest were significant in each treatment group. Results showed that children improved significantly in the segmented and continuant groups but not in the control group. These results indicate that both treatment procedures helped children learn letter-sound correspondences.

Children were given a posttest to determine whether they learned to decode CVC real words and non-words. On the pretest few if any children read any items correctly on this test so any improvement was expected to result from the training that was provided. From Table 5, it is evident that results of the ANOVA revealed significant effects of treatment, time of test, and an interaction between these two variables. Post hoc *t*-tests applied to pretest-posttest gains revealed that the two treatment groups made significant gains but the control group did not. An ANOVA was applied to posttest mean scores followed by Bonferroni pairwise comparison tests. Results revealed that the continuant group read significantly more words correctly than the segmented group, which in turn read significantly more words than the control group.

A matter of special interest involved comparing the success of the two treatment groups in reading CVC words and non-words beginning with stop consonants. Both groups only received training on CVC words and non-words beginning with initial

continuant consonants. So initial stop consonants were new to them. Results from Table 5 reveal that the continuous production group significantly outperformed the segmentation group in decoding words that began with stop consonants.

In order to understand further the difference between the two groups on the word/non-word reading posttest, we performed an error analysis of the decoding of CVCs. The analysis was very revealing. In the continuous production group there were eight errors in total, all of which were phoneme substitution errors. The segmentation production group made a total of 33 errors, nine of which were phoneme substitution errors. Phoneme substitution errors for both groups are listed in Table 6.

Table 6

Decoding Phoneme Substitution Errors for Continuous and Segmented Training Conditions during Posttest Decoding

Condition	Position	phoneme	error word /target word	#occurrences
Continuous				
	Initial	dʒ/g*	dʒak/gɑk	(2)
	Medial	æ/ɪ	kæm/kɪm	(2)
		sæt/sɪt		(1)
	Final	s/z	tæs/tæz	(1)
		g/k	gɑg/gɑk	(2)
Segmentation				
	Initial	n/m	næk/mæk	(1)
		v/r	væn/ræn	(1)
		k/g*	kɑk/gɑk	(1)
		dʒ/g*	dʒɑk/gɑk	(2)
	Medial	ɪ/æ	mɪk/mæk	(2)
			sæt/sɪt	(1)
	Final	d/g	fɑd/fɑg	(1)

Table 6 (continued)

Decoding Phoneme Substitution Errors for Continuous and Segmented Training Conditions during Posttest Decoding

Condition	Position	phoneme	error word /target word	#occurrences
Segmentation				
	Final	k/g	fɑk/fɑg	(1)
		d/t	dɑd/dɑt	(2)
		dʒ/k	gɑdʒ/gɑk	(1)
		g/k	gɑg/gɑk	(1)

In addition to phoneme substitution errors, the segmentation group made a variety of additional errors including word substitutions, phoneme insertions and schwa insertions. These errors are listed in Table 7.

Table 7

Decoding Errors in the Segmented Training Condition during Decoding Posttest

Phoneme addition error word /target word	Word substitution error word/target word	Schwa insertion after initial stop
nɪds/nɪs	næds/ tæz[a]	4[a]
krim/kim[a] (2)	sɪd/ / sɪt	
gɑkd/gɑk	darn...darn it /dat[a]	
	tɑd/dɑt[a]	
	mɑp/mɑd	
	don't /dɑt[a]	
	rɑk/dɑt[a]	
	kɪck/kɪm	
	sæm/cæm[a]	

[a] errors on initial stop sounds

On one occasion a child was unable to blend three segments to make a word.*

On one occasion a child produced /æ/ for ræn*

The errors in tables 6 and 7 reveal that the continuous production group was able to transfer the continuous decoding strategy to CVCs with initial stop sounds with little difficulty even though they were trained on continuant initial consonants only. Only two errors related to initial stop sounds were noted in the group. The segmentation group made 13 of their 33 errors on the first sound of CVCs with initial stop consonants. These data support the hypothesis that the continuous production group would outperform the segmentation group on transfer to decoding words with initial stops.

Also a spelling posttest was given to assess children's ability to write words and non-words. As evident in Table 5, significant main effects of treatment and time of test were detected as well as a significant interaction. Post hoc *t*-tests applied to pretest-posttest gain scores revealed that all three groups improved significantly in their ability to spell. An ANOVA was applied to posttest mean scores followed by Bonferroni pair wise comparisons. Results revealed that the continuant and segmented group performed equivalently, and both outperformed the no-treatment control group. This shows that both treatments were effective in teaching children to spell.

There were three consonant blend transfer tasks administered to the treatment groups but not the control group. The tasks assessed children's ability to transfer the strategies learned in order to decode longer words with different canonical forms. The first transfer set consisted of 12 real and nonsense words with final continuant stop blends. There was a significant effect of treatment with the continuant group significantly outperforming the segmentation group in reading words with final blends. This indicates that the children who received continuous production training were better able to apply their decoding strategy to the first list of transfer words.

The second transfer set consisted of 18 real and nonsense words with initial consonant blends, 9 of the words with continuant-stop blends, and 9 with continuant-continuant blends. An ANOVA was conducted with treatment (T) and type of initial consonant blend (F) as independent variables, the second as a repeated measure. As evident in Table 5 there were no significant main effects or interactions in this analysis. These words proved difficult for both groups.

Effect Sizes. Given that the overall sample size was small (*N*=8 per group), there was only limited statistical power to detect differences between means of the experimental groups. To determine whether effects might have proven significant with a larger sample, effect sizes were examined by comparing pairs of means of the experimental groups on posttests. Effect size measures how much the means of the groups being compared differ in standard deviation units. An effect size of 1.0 indicates that a group mean was one standard deviation higher than the comparison mean and 0 indicates that the group means were identical indicating no treatment effect. According to Cohen (1988), an effect size is of .20 is considered small, an effect size of 0.50 is moderate and an effect size of 0.80 or above is large.

An examination of effect sizes in Table 5 reveals that some of the comparisons between the means were large. On the Elision measure, the effect size for the continuous production group was especially large in comparison to both the segmented production group and the control group. A large effect size for the continuous production group compared to the segmentation group was detected also on the Non-word repetition task. Large effect sizes on the Word Reading (Boder) measure distinguished both the continuous group and the segmentation group from the control group indicating that both

forms of training facilitated word reading skills. Effect sizes were especially large for both treatment groups when compared to the control group on measures of decoding CVC words. Further the effect size was especially large for the continuous group when compared to the segmentation group. On the transfer to CVCC reading, continuous training revealed an especially large effect size compared to segmented production training. This finding again points to a greater ability by the continuous production group to transfer decoding skill to untrained word forms.

Not only reading, but also spelling words showed a strong benefit of training. Effect sizes were especially large for both treatment groups when compared to the control group (see Table 5).

Section VII

Discussion

Summary. The findings of this study indicate that a vowel-focused speech production and speech perception training program has a significant positive effect upon the development of decoding ability in children who are at risk for learning to read and spell.

Findings demonstrate that this intervention has greater effects upon decoding ability than a narrative-based literacy program intervention. This finding was expected since the experimental groups were taught using a highly systematic and sequential method to identify vowels, experience the articulatory and perceptual relationships among those vowels, analyze the phonemic content of words and then directly apply that knowledge to a specific strategy for spelling and decoding words. The control group was exposed to an alternate treatment that involved a lesser amount of spelling and decoding activities, which were modeled only, and embedded in an interactive narrative construction activity that included a multitude of phonological and phonemic awareness and literacy activities.

Importantly, results showed that training in continuous speech production and perception was significantly superior to training in segmented production/perception. From Table 5 it was evident that there were significant differences on measures of word reading, phonological processing and phonological memory, with effect sizes ranging from moderate to especially large favoring the continuous production/perception group. Further, the results showed that the students who learned to decode with a continuous

production strategy were significantly more successful in decoding untrained words than students in the segmentation group.

From Table 4 it is evident that the continuous production group completed training with somewhat higher accuracy and in slightly fewer sessions. Comparison of the two treatment groups in their overall performance during the training sessions revealed a moderate effect size (.61) favoring the continuous production group on the number of sessions to complete training, and a large effect size favoring the continuous group in the overall percent accuracy during training.

The two experimental treatments were conducted identically except for the manner in which children learned to recognize the phoneme segments in words and the manner in which children learned to decode and spell, specifically, whether they produced and analyzed words with continuous extended duration or whether they segmented words into separated phoneme units during training. Thus, findings showing that the continuous production treatment outperformed the segmentation group on posttests can be attributed to the continuous feature of training that was the hallmark of the intervention.

Differences in Training Phases. In order to gain insight into why the continuous production group evidenced superior learning, it is important to examine where significant differences occurred during training (see Table 2).

There were three phases of the treatment in which the two experimental groups differed significantly in the mean number of trials they required to reach criterion. Recall that each phase had a specific objective that was taught in two parts. The first part was a turn-taking part. This phase was the dynamic teaching phase in which the experimenter

modeled the specific task the child was learning, as well as modeled sound learning strategies such as monitoring, self-talk and reflection. The turn-taking part (TT) of the training was followed by an independent part (I) in which the child performed each task independently and the experimenter provided feedback. The continuous production group significantly out performed the segmentation group on the turn-taking parts of the following two phases.

Phase 2. *Word Production*. In this Phase of training, the continuous group learned how to produce ConCVC words with extended duration, and the segmented group learned how to produce ConCVC words in segments. In each condition the experimenter produced a ConCVC twice and then demonstrated how to produce the word with an extended duration (for students in the continuous production group), or how to produce the ConCVC with segmented form (for children in the segmented production group). The experimenter and student practiced with the same word until the student could produce the word in the proper way and understood the task. Next the student and experimenter took turns, always with a different ConCVC. During the child's turn, she listened to the experimenter produce her stimulus word with normal duration 2 times, and then she produced her word with normal duration 2 times. Following this, she produced the word with continuous, extended duration or in three separated segments consistent with her treatment assignment. Following each successful production, the student or experimenter had to recall and produce the ConCVC with normal speech duration. In this phase of training students in the segmentation group needed a significantly greater number of trials in order to learn to segment, than students in the continuous groups needed to learn to extend productions.

An error analysis performed for this phase provided insight into performance differences between the two experimental groups. Recall that in Phase 2 the segmentation group had over three times as many errors learning to segment CVC words as the continuous group had learning to extend CVC words. Further the segmentation group had a greater variety of error types than the continuous group. In the continuous group two types of errors accounted for over 81% of the errors. The first was failing to extend the duration of an initial or final continuant sound. This was not surprising because children generally make errors in the beginning of learning a new task. The second error was incorrect final consonant production. In contrast to the continuous production group, the segmentation group had a total of nine different types of errors. Remarkably 29% of the segmentation group's errors involved the children's inability to recall the word that they had just segmented! Nineteen percent (19%) of the errors involved inserting a schwa when attempting to produce three separate individual phonemes.

Mean percent accuracies were computed to determine if the significant difference in length of time was related to task difficulty (see Table 3). In Phase 2 the mean percent accuracy was 82% for the continuous production group, in contrast to 62% mean accuracy for the segmentation group. There was a large effect size for mean accuracy favoring the continuous production group, indicating that there is an inverse relationship between the mean accuracy and amount of time it takes to complete the Phase 2 task.

The greater number of errors and the greater variety of errors made by the segmented group indicates that learning how to complete the segmenting task is relatively hard for children. This task places such a burden on processing that nearly one third of

the time children could not recall the word that they were attempting to segment. There may be two sources of processing difficulty here. First of all the form of the segmented speech production (and perception) differs so greatly from the CVC target word, that the segmented form is not recognized as matching the form of the original stimulus word. In particular, important transition information as well as speech motor information are missing or at least are different in segmented productions of CVC words. Secondly, the time between original word production and word recall is greater in the segmented production procedure than the time between original word production and word recall in the continuous production procedure. Unlike the children in the segmented condition, children in the continuous production group always were able to recall the word that they had vocally manipulated indicating that the activities in continuous production training did not place undue constraint on memory. In both groups the final consonant was most vulnerable to error. This is not surprising since final consonant production and perception are highly influenced by vowel duration and voice onset or offset rime.

From these results it appears that learning to produce a word in three separate but consecutive constituents was harder than learning to produce a word with extended duration. Secondly the greater variation in error types within the segmented group points towards the fact that there exists a large degree of individual difference in how children learn to segment.

Phase 4. Phonemic Analysis. In this phase children learned to identify all of the constituent phonemes of the spoken word, *each time beginning with the identification of the vowel*. During the turn-taking part (TT), the experimenter and child took turns. During the child's turn she listened to the experimenter produce a CVC two times, and

then she produced the CVC two times. Next she produced her word by segmenting it into separate phonemes, or with continuous extended duration. Then the student identified the mouth sound (vowel sound), followed by identification of either the last or the first sound. The experimenter varied the order for first and last sounds across the trials. Subsequent to each phonemic analysis, the student had to recall the original stimulus word. In this phase, compared to earlier phases there was a considerably longer time lapse between the children's first encounter with the ConCVC they were analyzing and the time of recall. The word recall requirement, while taxing, was included as an essential component because it was expected to contribute to improving the children's phonological memory and advancing their phonemic awareness. In this phase, again the segmentation group took a significantly greater number of trials to reach criterion.

Both groups made fewer errors on this phase than in Phase 2, though the proportion of errors was relatively the same. The segmentation group made slightly more than three times the errors as the continuous group. Once again the segmentation group's word recall errors accounted for a substantial percentage (41%) of their total errors. This finding raises the possibility that tasks involving segmenting words into separate phonemes may impede some children's short-term phonological memory. Mean percent accuracies were computed to determine if the significant difference in length of time was related to task difficulty (see Table 3). In Phase 4 the mean accuracy for the continuous production group was 94% in contrast to 81.6% mean accuracy for the segmentation group, with a large effect size d=1.08 favoring the continuous production group. *From this result I conclude that learning about the internal structure of a word is easier through continuous extended word productions than by phoneme segmentation*.

Importantly, this finding demonstrates that children can learn quickly and accurately about phoneme segments without engaging in the common practice of producing sequentially segmented words.

Phase 6 Decoding. In this Phase of training children learned to apply their word production strategies to decoding words. Unlike in the previous two phases reviewed, the difference between the groups in Phase 6 occurred during the independent part. In this phase it was the continuous production group that needed a significantly greater number of trials to reach criterion. At first glance this finding was surprising relative to the overall results of the study which, for the most part, indicated faster and more accurate performance on the part of the continuous production group. However, the number of errors was small, so the error analysis revealed more about individual learners than group patterns. The segmentation group had five children who completed the decoding task with no errors, while the continuous production group had only one child completing the task with no errors. The children who made errors across the groups made two errors per child with the exception one child in the continuous production group who made a large number of /ɪ/ substitutions for all vowels. Mean percent accuracies were computed to determine if the significant difference in length of time was related to task difficulty. In Phase 6 the mean percent accuracy for the continuous production group was 88% in contrast to 96% mean accuracy for the segmentation group. A moderate effect size of d=.78 favored the segmentation group.

From this result I conclude that decoding words directly following a teaching condition was easier for students trained to segment than for those trained to use

continuous production. However the overall number of errors made by children in both conditions was low and the accuracy for independent decoding was high.

Learning to Spell Real and Non-Real Words. All treatment groups made significant improvements in spelling. This is interesting because in the control group children observed the trainer mediate spelling with continuous production, but they were not trained to do so themselves. During the posttest the majority of the control group children did mediate their spelling verbally. Both experimental groups made significant gains in spelling with large effect sizes. During training, both experimental groups were instructed to have their mouths tell their hands what to write. These findings indicate that when a child knows a word, and has learned how to determine its phoneme segments, the difference between using continuous versus segmented verbal mediation of spelling is not a critical distinction, at least for words that are three segments long. Both groups achieved greater than 90% mean accuracy.

Learning to Read Words. All of the children in the study made significant gains in performance from pretest to posttest on The Boder Test of Reading and Spelling (1982) (see Table 5). Pairwise comparisons revealed that the segmentation group and the continuous production group showed large effect sizes, 0.74 and 1.14 respectively, when compared to the control group. However, the continuous production group had a relatively small effect size, .36, in comparison to the segmentation group. The Boder Test presents an equal number of both decodable and non-decodable ("sight") words. In the 8-10 week period between pre and post all children improved substantially in their word reading despite the fact that the treatments did not include practice miscellaneous reading.

Learning to Decode Real and Non-Real Words. Table 5 reveals that both groups made significant improvements from pretest to posttest in learning to decode CVC real and non-real words. Both groups demonstrated large effect sizes indicating that treatment was effective. Pairwise comparisons indicated that the continuous production group made significantly greater gains in decoding than the segmentation group with an especially high effect size of 2.50. Further the continuous production group was significantly more successful at decoding untrained words. They were significantly better at decoding words that began with stop consonants as well as with words that ended in continuant-stop clusters. For words with final clusters there was a large effect size, 1.13.

The error analysis of CVC word reading posttest performance revealed important differences between the continuous production and the segmented production groups (see Tables 6 and 7). The most notable difference was in the large variability of incorrect word forms produced by the segmentation group. More than half of their errors on the posttest included the following: substitutions of a real word for a posttest word, changes in the canonical form of a word by adding or deleting a sound, schwa insertions, as well as difficulty blending. This variety was in stark contrast to the children in the continuous group who kept the syllable structure constant making few errors at the phoneme level only.

These qualitative results also support the hypothesis that the continuous production group would be more successful than the segmentation group in transferring their decoding strategy to words that begin with initial stop consonants. Only two of the eight decoding errors by the continuous production group involved a word that began with a stop sound. In contrast the segmentation group made over one third of its errors

on posttest words beginning with stop sounds. The continuous production group extended CVC words beginning with stop sounds and then decoded the words as they were trained. The segmentation group segmented words that began with a stop consonant but had difficulty blending the sounds to decode correctly. This difference between the groups supports the assertion that children will not segment words into distinct sounds sequentially in an attempt to decode unless they are specifically taught to do so. Further the children in the continuous production group learned that a word is composed of distinct phoneme segments, without learning to produce words in a sequence of separately spoken phonemes. This is an important finding because it demonstrates that breaking words up sequentially into component segments is not the only method for teaching children about the phonemic structure of words.

This contrast in the error profile demonstrates that the children in the continuous condition used a more phonologically informed strategy than children in the segmentation condition. Such a qualitative difference suggests that the total effect of the continuous production treatment was very effective in developing robust phoneme concepts and improved phonological representation. It seems clear that the effect of a continuous production strategy applied to decoding yielded a word that was more easily interpreted lexically than the outcome of a segmented production strategy.

Decoding Untrained Real and Non-Real Words with Consonant Clusters. Three posttest only tasks involved decoding words that contained consonant clusters. The first set of words included CVCC words that ended in final continuant stop clusters. This subtest included words such as 'mask', bosk', ‘visp’. It was not surprising that children in the continuous production group performed significantly better than the

segmentation group when attempting to read these novel untrained CVCCs. Neither group had training in analyzing nor decoding this form of word. As I expected, children in the continuous production group were successful decoding this set of words because their continuous decoding strategy could assimilate these forms easily. In contrast, segmented production is a form of speech that differs greatly from children's typical articulatory and acoustic/perceptual experience. The difficulty that the segmented group experienced was because the sounds they produced in attempting to read the CVCCs were not word like enough. I suspect the novelty was too difficult for the students to recognize either because of the additional silent pause, or because the initial part of the word was lost from memory prior to production of the final sound. As segmented words increased in length, more and more silence was interspersed between phonemes and hence the words became less and less similar to words in the lexicon.

The second set of words included CCVC words, in which the first two consonants were continuant sounds. These words included words such as 'slab', 'flit' and 'smog'. In the reading program developed at the Rye Learning Center these forms of words are introduced after children consolidate their ability to decode words with final continuant consonant cluster forms. Once children consolidate decoding ability for these initial continuant consonant cluster words, the third level of consonant cluster words, with initial continuant stop consonant clusters, such as in the words, 'spin', 'stag' or 'skot', are introduced. At the time of the posttest neither experimental group was able to transfer their decoding strategy to decoding words with initial consonant clusters.

The goal of the continuous production intervention design was to have comprehensive effects including; improving the recognition and representation of the

acoustic and articulatory relationships in speech, thereby fostering the development of robust phoneme concepts and hence better phonological representation, each facilitated in the context of teaching a strategy of word decoding that fosters lexical recognition. The gain score differences on some of the post-tests may shed further light on the interpretation of the intervention effects.

Training Outcomes Related to Phonological Awareness, Word Memory, and Non-Real Word Repetition. We chose the Elision (phoneme deletion), Phoneme Blending and Non-Word Repetition subtests from the CTOPP (Torgeson, 1999) in order to measure phonological processing. The strong psychometric properties of these have been noted in other intervention research (Loeb, Gillam, Hoffman, Brandel, & Marquis, 2009; Morgan, Fuchs, Compton, Cordray, & Fuchs, 2008). In the pilot study children made substantial gains from pretest to posttest on the Word Memory subtest of the DTLA (1999) so we chose to include this test here as well.

Word Memory. All three groups made significant gains in raw scores on this test of word repetition. In this DTLA (1999) subtest, the author indicates that the words in each sequence do not have any obvious semantic or syntactic relationship to any other word in the sequence and that the words are at a first and second grade vocabulary level. This test therefore is proposed as a rote short-term memory for spoken words. The results indicated that the experimental and control treatments all had positive effects on short-term memory for unrelated single syllable real words. This finding is most likely a result of intensive work with words in both the training and control conditions.

Phoneme Blending. There were significant gains from pretest to posttest for all groups on the CTOPP phoneme blending subtest. Again pairwise comparisons revealed

that the segmentation and continuous training groups had large, .87, and especially large 1.20 effect sizes respectively, when compared to the control group. The continuous production group effect size was small, .36, when compared to the segmentation group.

On the CTOPP phoneme blending task, children listened to a digital recording of a person producing a sequence of separated phoneme segments, and were asked to identify the word that was spoken. This task has been identified as important to the development of skilled reading, because children must blend sounds together to make a word. However, the oral phoneme blending task is easier than blending sounds in a decoding task. In the blending task a child learns to blend sounds *produced for her*; not sounds *produced by* her. Secondly, in a decoding task, phoneme blending commences either in synchrony with, or after a series of grapho-phonemic translations. The fact that there was not a treatment effect on this subtest is not surprising for two reasons. First of all, on a continuum of difficulty, phoneme blending is less challenging than phoneme segmentation and elision (Yopp &Yopp, 2000). Of the three CTOPP pretests, both experimental groups had the highest scores on the Phoneme Blending subtest.

Elision. Our results (see Table, 5) show that the continuous production group made significant pre to posttest gains on the Elision (phoneme deletion) subtest of the CTOPP with a large effect size of .88.

This finding is important because it demonstrates intervention effects on phoneme deletion without specific training in phoneme deletion. Current literature suggests that training in one area of phonemic awareness does not generally transfer to gains in another area of phonemic awareness (Gillon, 2005; Loeb et al., 2009; Troia & Whitney, 2003).

Further, phoneme deletion has been described as one of the most difficult phonemic awareness tasks (Yopp, 1988).

Present findings suggest that, extended experience in analyzing CVCs, with special attention to the syllabic nucleus, provides a greater degree of insight into phonemic structure when this experience occurs in the context of continuous speech production rather in the context of segmented speech production. Further this indicates that practice in listening to and producing continuous or extended speech promotes development in discrete phonological sensitivity and facilitates learning to manipulate phonemic structure in novel ways.

Non-Word Repetition. The continuous production group improved significantly from pretest to posttest in their ability to repeat non-real words, while the other two groups did not. The CTOPP non-word repetition subtest used in this research contains 18 items that vary in length from three to fifteen sounds. The examinee listens to a digital recording of made up words, one at a time, and repeats each one exactly as she hears it. The phonemic structure becomes more complex as items proceed. Children's responses are scored as either correct or incorrect. Torgeson et al. (1999) consider this test to be an assessment of phonological memory, as described by Baddely (1986, 1990). That is, the ability to process and maintain phonologically encoded information in a temporary storage system that can be refreshed by articulation.

At the outset of the study I used the Non-Word repetition subtest as a measure of how well children could hold information in short-term phonological memory. I predicted that the intensity of the continuous production training, with its focus on vowels, and the requirement of word recall in situations following greater increments of

time and increased complexity would have a beneficial effect upon phonological short term memory. I had observed this improvement in memory for unrelated real words during my pilot study.

Non-word repetition ability and the underlying mechanisms that this ability represents has been a topic of interest in the past 20 years. Larivees & Catts (1999) asserted that non-word repetition ability is a reflection of the quality of phonological representation. Metsala & Walley (1998) view non-word repetition as evidence of a child's ability to restructure a rich vocabulary. Gupta & Tisdale (2009), Munson, Kurtz & Windsor (2005), Munson, Edwards and Beck (2005), and Munson, Swenson & Matthei (2005) view non-word repetition as a gauge of the bidirectional influences between phonological and lexical development. They posit that first children must develop a symbolic link between 'well-practiced' primary articulatory representations and primary acoustic representations. Then they associate this development with representations of linguistic knowledge in the lexicon in order to make phonological abstractions. These phonological representations further facilitate new vocabulary learning and hence facilitate the recognition of novel lexical items, as in a non-word repetition task.

Decoding Skill, Phonological Memory and Processing and the Impact upon Decoding of Untrained Words. In light of the decoding posttest and the Elision and Non-Word repetition posttests, it was not surprising that children in the continuous production group also performed significantly better than the segmentation groups when attempting to read the novel real and non-word untrained CVCCs (word with final continuant stop clusters). Children in the continuous production group simply extended

their decoding strategy to include the final stop consonant. Further I posit that they were able to match their decoding production to a phonological or lexical representation, because as the training progressed, their phonological representational ability was improving and thus their ability to recognize novel word forms.

Implications for Instruction and Future Research.

Continuous/Extended Speech Production. Children in both experimental groups spent a good deal of time producing, listening to, and analyzing both real and non-real ConCVCs. I suspect that the intensity of this intervention involving work with the group of 120 ConCVC real and non-real words contributed to each child's store of internally represented words much like the more naturalistic growth in vocabulary that was essential to the development of pre-reading skills as suggested by Metsala and Walley's Lexical Restructuring Model (1998). Our findings suggest that what accounts for the improved phonological sensitivity, improved non-word repetition, and acquired ability to decode novel words was related to intense work with speech that was continuous or extended, not with segmented speech practice.

Segmenting as a decoding strategy seems akin to teaching children to break a *known* word into parts, rendering it less *known* and then teaching them how to put the parts back together so that the word became *known again.* My clinical experience and the results of this investigation concur. I have found that poor and at risk readers who produce, perceive, and analyze continuous speech in the context of early reading interventions, do not experience the confusion that peers who have been taught to product segmented speech, reveal.

For some children who are at risk for learning to read, development in sensitivity to phonological structure may be acquired more successfully by continuous production instruction rather than by segmented production instruction.

The educational and clinical practice of continuous versus segmenting speech needs to be experimentally tested further in the population of children with histories of speech and language impairment and children at risk for reading difficulty due to the presence of speech or language disorders.

Representing Speech. I suggest that the use of the three paneled horizontal paper as a visual spatial representation of speech across time is an implicit though productive means of facilitating the understanding of three phonemes. This strategy may communicate more easily this notion of phonemes, rather than explanations using number concepts and terms such as first, middle and last, especially for children with language or learning differences.

Rvachew (2008) and Hartmann (2008) in their discussion of models and measurement of children's phonological working memory suggest that one productive research strategy may be to conduct intervention to improve children's working memory capacity. The present study has important implications for the development of laboratory research focused upon building theoretical models of short-term phonological memory since our intervention demonstrated positive effects upon short-term phonological memory. In addition these findings should be taken into account as part of the continued exploration into the interpretation of non-word repetition as a reflection of phonological processing and as a clinical marker and a clinical measure.

Criterion-Based Sequenced Skill Instruction. Children in both experimental groups had extensive practice in producing, perceiving, and analyzing real and nonsense words. We suspect that the intensity of this experience contributed to the positive outcomes for both experimental groups. One contributor to the intensity of treatment was the criterion of 12 consecutive correct responses for mastery for each phase of intervention.

Intervention research differs from intervention in the clinic. In the clinic a therapist can use her knowledge of individual learners in order to determine what counts as readiness to move from one activity to a more challenging one. In research criterion levels must be the same across experimental treatment conditions. Here a criterion of 12 consecutively correct responses was used to allow for equal distribution of accuracy across all three vowels /ɪ/, /æ/, and /ɑ/. Additionally, consecutive correct criterion requires substantial consistency in performance.

A second contributor to the intensity of the program was that it was highly structured and focused (see Stuart, 1999 and Torgeson et al. 2001). For example, the competency gained from each phase of treatment was necessary in order to complete the objective of the next phase of treatment. The importance of sequencing instructional tasks and instructional stimuli in phonemic awareness intervention was considered to be of high importance by some (Schuele & Boudreau, 2008), but of lesser importance or even discouraged by others (Gillon, 2000, 2005). The use of criterion-based intervention and the relative structure of intervention may be of more or less significant value based upon the goals of intervention.

It is important to note that in the total literacy program used at the Rye Learning Center, this sequenced and structured vowel- focused continuous perception and production task for teaching decoding and spelling is part of an integrated program that includes eight emergent literacy components. Those are: print awareness, narrative interactions, syllable segmentation, vowel identification and discrimination, word and vocabulary work, phonological awareness activity, letter-sound activity and book making and book reading, each designed to sensitize children to speech sound, print and literacy. Thus, this skill oriented vowel-focused activity does not occur in isolation but is delivered concurrently with these other facilitative emergent literacy activities that are not criterion based sequences of skills.

A Focus on Vowel Sounds and Vowel Letters. Children in the experimental groups focused solely upon vowel production and identification in the first two thirds of the intervention leading up to the spelling and decoding phases. Vowel production and perception was established prior to introduction of the letters. Additionally vowels were not introduced one at a time. In the first phase of the program the vowel sounds /ɪ/, /æ/, and /ɑ/ were introduced as a set, emphasizing the contrasts among them. I view this procedure as a critical component of the total program. Recall that in the posttesting (Tables 6 and 7) there were only four vowel errors on a total of 192 CVC words attempted. This accuracy in vowel reading was expected in light of our clinical experience as well as the results of our pilot study.

This intervention is the only decoding program I know of in the literature that *begins* phonemic analysis of words with the identification of vowels and which devotes such extensive attention to vowels (see Lindamood & Lindamood, 2010 for a different

emphasis on vowels). Most interventions begin with identification of the initial phonemes (see for example, Gillon 2000, 2005; Schuele and Broureau, 2008) or upon onsets and rimes.

Not only does the focus on the syllabic nucleus have a strong impact upon decoding and spelling accuracy in the short term. In later phases of our program we use knowledge of the vowel sequence /ɪ/, /æ/, and /ɑ/ and the continuant consonant-vowel-consonant form to teach fluent decoding of other word forms by analogy including CVCs that begin with stop sounds, words that begin with initial continuant blends, words that begin with initial continuant stop blends, and words that end with final blends.

The manner in which vowels sounds and vowel letters are introduced is an important variable to study experimentally and to consider educationally and clinically.

Limitations of the Study. The tradeoff for accomplishing rigorous intervention research was in the numbers. We had a small number of students, N=24 limiting the power of our study. These findings need to be replicated with greater numbers of children.

My original goal for this intervention study was to treat a population of children with language impairment. The participants in this study included participants at risk for learning to read, only six of which were diagnosed with speech and language impairment. The effects of intervention may have had different overall results had the entire subject pool been constituted of a group of children with a speech and language impairment or a history of speech and language impairment.

Finally, I failed to assess our participants in the area of speech perception, which was essential for understanding a child's level of risk for phonological and literacy

growth. In the future, I would adapt a tool such as the Speech Assessment and Interactive Learning System (SAILS; AVAAZ Innovations), a computer game having children make judgments about words that are spoken correctly or misarticulated. This assessment would be important because children do not have to verbalize their responses.

In addition, we did not include a measure of expressive vocabulary. This measure would further help to describe the profile of our subject pool as well as to provide additional insight into the effect of training.

Conclusions. Findings of this study carry important educational and clinical implications. Kindergarten students in the present study had finished eight months of kindergarten but still could not decode words. Each child had a substantial risk factor. However not all of these students were well below average on phonological awareness tests. All of the children in the experimental groups learned how to decode, but children in the continuous production group learned slightly faster, with overall higher accuracies and with substantial gains in phonological processes that support continued reading. The training took a relatively short period of time, an average of fifteen 35-minute sessions. Further the intervention was completed with uniformly substantial accuracy above 80% for both experimental groups.

This finding as well as our clinical and school experience suggests that knowledge about phoneme segments was based upon the facilitation of phonological knowledge that was derived from improved representation and analysis of syllable and word structure, not from practice s-e-g-m-e-n-t-i-n-g. We used continuous speech production, continuous movement, and unambiguous terminology in a turn-taking format to bring children to an understanding of the phonemic constituents of CVCs. The built in

redundancy led the children to spell and read their first words, some with a bit of surprise. Most importantly, when children in the continuous production group decoded their words, they recognized the words that they had read. This was in contrast to the number of times that children in the segmentation group were puzzled by the speech they produced when they attempted to decode.

This study demonstrates that it was important to consider how children with phonological processing, or poor phonological memory learn how to make phonemic abstractions, and how that process impacts how they read. In conclusion I agree with Munson et al. (2005) that "the relationship…between phonological knowledge and phonological processing is symbiotic…The more a child has heard and said a word, the better the child *know*s that word…Similarly, the more words that the child has heard and said…the easier it will be…to abstract…a (particular) pattern…for…the young child, phonological generalization cannot be divorced from the words that (she) recognizes and produces."

Appendix A

Training Scripts and Protocol for the Vowel-Focused Speech Production Training

The protocols and training scripts for both experimental conditions follow. Feedback is provided for every student response. Therefore the feedback options for student responses follow the training script for each phase. In the case of student error responses, students are reinstructed until reaching success.

Continuous Production Condition Training Script

Phase I - Production of Individual Vowels and the Vowel Sequence.

Part A. Vowel Production - Subjects learn to produce accurately the vowels /ɪ/, /æ/, and /ɑ/ with prolonged duration in a turn-taking format with the trainer, and then in an independent segment.

Introduction:

T: I am going to teach you to say three speech sounds. The trainer produces all vowels with duration of 2.25 seconds. The first speech sound is /ɪ/, (the trainer points to figure 3a); the second sound is /æ/, (the trainer points to figure 3b); and the third speech sound is /ɑ/, (the trainer points to figure 3c).

T: Let's look in the mirror. Watch my mouth. /ɪ/, that's a very skinny mouth sound. /ɪ/. Let's say it together.

S: Looks to the mirror and attempts /ɪ/.

T: Provides appropriate feedback.

T: Now we can try /æ/ (the trainer points to figure 3b). Let's look in the mirror. Watch my mouth. /æ/, that's a very wide mouth sound. Now you try /æ/.

S: Looks into the mirror and attempts /æ/.

T: Provides appropriate feedback.

T: Now we can try /ɑ/ (the trainer points to figure 3c). Let's look in the mirror. Watch my mouth. /ɑ/, that's a very long mouth sound. Now you try /ɑ/.

S: Looks into the mirror and attempts /ɑ/.

T: Provides appropriate feedback.

*Turn-Taking Segment**:***

The trainer points to figures 3a, 3b, and 3c in mixed order.

T: I'll point to a mouth and say the sound and then you say the same mouth sound. T points to Figure 3 (a, b, or c) then says the prolonged vowel sound.

S: Produces prolonged vowel sound.

T: Provides appropriate feedback

Criterion: 4 consecutively correct prolonged productions for each vowel (12)

Independent Segment:

The trainer points to figures 3a, 3b and 3c in mixed order.

T: This time you must stretch the mouth sounds by yourself. I will point to a picture of a mouth and you will say that speech sound. You can use the mirror if you wish.

T: Points to mouth picture on figure 3.

S: Produces vowel.

T: Provides appropriate feedback

Criterion: 4 consecutively correct prolonged productions for each vowel (12)

<u>Response Feedback for Part A - Vowel Production</u>

CORRECT /ɪ/

1. Good, you stretched your lips so they are thin like the picture.
2. Great, see this is a very skinny sound.
3. That's right; your tongue is up, pointing to the mirror.
4. That's perfect; you made your tongue stay up behind your top teeth.
5. Right, you made a long stretch.

INCORRECT /ɪ/

1. Not quite, make your mouth real skinny like the picture /ɪ/.
2. No, you watch me in the mirror /ɪ/. Keep your tongue higher, like mine.
3. Spread your lips skinny, like mine /ɪ/.
4. That's the right sound, but stretch it out, /ɪ/.

CORRECT /æ/

1. Right, your mouth was real wide like the picture.
2. Good, you kept your tongue down behind your bottom teeth.
3. Great, your tongue was down and your mouth was wide.
4. Right, you made a long stretch.

INCORRECT /æ/

1. No, not /a/. Make your mouth wide like this (using mirror) /æ/.
2. Not quite, make your tongue touch the back of your bottom teeth. /æ/, see?
3. No, let's try again; look at the picture (points to 3b) or mirror, /æ/.
4. That's the right sound, but remember to stretch it out, /æ/.

CORRECT /ɑ/

1. Good, your mouth was long like mine.

2. Good, you made the /ɑ/ with your tongue back; you didn't touch your teeth.

3. You made your mouth just like this picture (point to 3c).

4. Right, you made a long stretch /ɑ/.

INCORRECT /ɑ/

1. You said /æ/ but I said /ɑ/. Make your mouth long like this.

2. No, keep your tongue back like mine /ɑ/, see (pointing to image in mirror).

3. That's the right sound but remember to stretch it out, /ɑ/.

Part B. Vowel Sequence - Subjects learn to produce accurately the sequence of vowels /ɪ/, /æ/, and /ɑ/ with prolonged duration in a turn-taking format with the trainer and then in an independent segment.

Introduction:

T**:** I will say these three speech sounds in order: /ɪ/, /æ/, and /ɑ/. First /ɪ/ (points to 3a), then /æ/ (points to 3b), then /ɑ/ (points to 3c). T pauses .5 seconds between each vowel production in the sequence. Let's say them together and look in the mirror.

T and S: Say sequence in order.

T: Now you try these speech sounds in order; you can look at the pictures or in the mirror if you want.

S: Produces sequence.

T: Provides appropriate feedback

Turn-Taking Segment:

T: Now we will take turns, I will go first. T says prolonged vowel sequence pointing to corresponding pictures in figure 3. Now it's your turn.

S: Produces prolonged vowel sequence.

T: Provides appropriate feedback

Criterion - 12 consecutively correct prolonged vowel sequences.

Independent Segment:

T: This time you may say the sounds in order by yourself, many, many times. I will point with you the first time and we sill say them slowly together.

T and S: Produce vowel sequence together as they point to figures 3a, 3b, and 3c. Now you can point and say the mouth sounds in order. You can take your time. You say the mouth sounds 12 times in a row. I will count for you.

S: Produces vowel sequence.

T: Provides appropriate feedback

Criterion - 12 consecutively correct vowel sequences.

Response Feedback for Part B - Vowel Sequence

CORRECT SEQUENCE

1. Good, that's the right order /ɪ/, /æ/, and /ɑ/ (T points to 3a, 3b and 3c respectively).

INCORRECT SUCCESSION

1. No, remember /ɪ/ is first, /æ/ is second and /ɑ/ is third (T points to 3a, 3b, and 3c respectively).

Phase II - Production of Continuant-Consonant-Vowel-Consonants (ConCVCs).

The students learn to produce ConCVCs with normal duration and then extended duration (with released or aspirated stops in the case of ConCVCs with final stop consonants). For all extended speech stimuli and extended response productions in Phase II the trainer and student make hand movements across the three paneled paper strip in Figure 5 in synchrony with their speech.

Introduction:

T: I am going to teach you how to stretch and hold the words that you say. You will learn to stretch your words for a long time and say every sound. Ready? First I'll say the word "sit" with normal duration (T says 'sit'.) Now I'm going to stretch the word "sit". Watch me, and listen. (T produces / sɪt / with extended duration and aspirated final /t/ and uses hand movement in figure 4a).

T: Now let's stretch together (T produces the extended ConCVC of 'sit' and uses hand movement in figure 4a).

S: Attempts production with T.

T: Provides appropriate feedback.

Turn-Taking Segment:

T: Now we will take turns. First, I'll say a word and then I will stretch the word. Next I will say a word for you. You will say the word first, and then you will stretch the word. Let's practice your turn before we begin.

T: Say 'fim'.

S: Says 'fim'.

T: Now stretch 'fim'.

S: Produces extended ConCVC.

T: Provides appropriate feedback.

T: Now it's my turn. T produces ConCVC with normal duration, then T stretches ConCVC using figure 4a.

T: Now your word is ConCVC.

S: Says 'CONCVC'.

T: Now stretch ConCVC

S: Produces extended ConCVC

T: Provides appropriate feedback

Criterion - 12 consecutively correct extended ConCVCs

Independent Segment:

T**:** Now this time we won't take turns. I will tell you the word and you will say the word. Then you will stretch it by yourself. I will not have a turn. Are you ready?

T: Your first word is fit.

S: Says fit, and produces with extended duration and aspirated /t/.

T: Provides appropriate feedback.

Criterion - 12 consecutively correct extended productions.

Response feedback Phase 2- Continuous production of ConCVCs with extended duration.

CORRECT

1. Good, you stretched the whole word.
2. Great, you can hold your sounds a long time.

INCORRECT

1. No, you must stretch the word longer. (T models.)
2. Hold this longer (The T points to the corresponding part of the panel, and then models the appropriate word production).
3. Explode this harder (The T points to the corresponding part of the panel, and then models the appropriate word production.

Phase III - Identification of Spoken Vowels and Vowel Letters

Part A- Identification of Spoken Vowels - Subjects learn to identify the medial vowel sound from their own extended productions by pointing to the corresponding picture on Figure 4a. The students continue to slide their fingers across the 3 paper panel when stretching a word. After identifying the vowel the students must recall the stimulus ConCVC.

Throughout Part A and Part B of Phase 3, the student must say the word at normal duration, stretch the word, identify the mouth sound by pointing to the picture and producing the vowel, and then recall the stimulus word. During instructions and feedback, the trainer always collocates the term sound with the identification of the vowel phoneme (i.e., that's the sound /ɪ/, sound /æ/ or sound /ɑ/); collocates the term word with the identification of words, (i.e., that's the sound '/ɪ/', like in the word 'sik'); and collocates the term letter with the letter names i, a, and o (i.e., 'letter I makes the sound /ɪ/, like in the word rif.')

Introduction:

T**:** This time you will learn to tell which sound, sound /ɪ/, sound /æ/ or sound /ɑ/ (pointing to corresponding mouth pictures in Figure 4a) is in the word that

you stretch! Ready? I'll take a turn first. First I will say a crazy nonsense/real word, then I will to stretch that word, and then I will try to figure out the mouth sound that was in my word. (T produces a nonsense or real ConCVC /sɑg/, and then produces it with extended duration). Following this, and prior to identifying the mouth sound, the trainer may model sub-vocalizing in an effort to model a strategy the child may use to recall the vowel.) Now I know! I said the sound /ɑ/ (points to mouth picture in Figure 4a) in my word /sɑg/.

T: Now you have a turn. Say the word /næk/.

S: /næk/.

T: Now stretch /næk/.

S: Continuous /extended production of /næk/.

T: Now point and tell me which sound you said /ɪ/, /æ/, or/ɑ/.

S: Points and says the vowel sound.

T: Provides appropriate feedback.

Turn-Taking Segment:

T: Now we will take turns. I'll say a word, then I'll stretch my word, and then I'll point and say the mouth sound in my word (T models sub-vocalization if desired, and then identifies the mouth sound). Now let me see if I can remember my word (T models sub-vocalizing and looking at the panel or moving finger across, then T identifies the word). And my word was /_____/.

T: Now it is your turn. You're word is /ConCVC/, say /ConCVC/

S: Says /CONCVC/

T: Now stretch your word.

S: Stretches

T: Now point to the mouth and tell me the mouth sound (referring to Figure 4a).

S: Points to a mouth figure and produces vowel sound

T: Provides appropriate feedback

T: And what was your word?

Criterion - 12 consecutive correct.

Independent Segment:

T: I am going to say a word. You say it then you stretch it by yourself. Then point to the mouth sound and tell me your word.

S: Says the word; stretches the word, points to mouth picture, produces the vowel and recalls the stimulus ConCVC.

T: Provides appropriate feedback

Criterion - 12 consecutive correct.

Response Feedback Part A, Phase 3 - Identification of Spoken Vowels

CORRECT

1. That's right, the word /ConCVC / has the sound / / (points to Figure 4a).

INCORRECT

1. No I did not say /ConCVC/ (with substituted incorrect vowel). I said the word /ConCVC/. Let's try that again. Your word was /ConCVC/.
2. No, Let's look in the mirror, I did not say /ConCVC/ (with substituted incorrect vowel). I said the word /ConCVC/. Now let's try that word again.

Part B- Identification of Vowel Letters - Subjects learn to use letters to symbolize the phonemes /ɪ/, /æ/, and /ɑ/. Subjects print or use letter stickers to indicate the mouth sound in their ConCVCs. The trainer refers to Figure 5 throughout Part II of Phase 3.

Introduction:

Now we will learn to use letters and say letter names with our mouth sounds /ɪ/, /æ/, and /ɑ/. (T writes each letter and each word to construct Figure 5).

T: This is letter I, (T prints i), it makes the mouth sound /ɪ/ (T stretches /ɪ/), like in the word, 'it' (T synchronizes writing of graphemes with stretched production of /ɪt/). You're it!

T: This is letter a, (T prints a), it makes the mouth sound /æ/, (T stretches /æ/), like the word 'at' (T synchronizes writing of graphemes with stretched production of /æt/). At school.

T: This is a letter /ɑ/ (T prints o). It makes the mouth sound /ɑ/. (T stretches /ɑ/ like in the word, 'oz' (T synchronizes writing of graphemes with stretched production of /ɑz/.) The wizard of Oz!

T: I'll say a word …/sɪm/. Now I'll stretch my word. My mouth sound was /ɪ/. Letter i (points to i on Figure) makes the sound /ɪ/ (points to mouth picture), like in my word /sɪm/. Now my mouth will tell my hand /ɪ/ and I'll write /ɪ/ (T synchronizes stretched /ɪ/ production with writing letter I by the mouth picture (Figure 5)).*

* Each time the trainer places a sticker or writes her letter near the mouth sound she verbalizes the appropriate statement.

T: Letter i (points to i on Figure 5) makes the sound /ɪ/, (points to mouth picture) like in my/your word /sɪm/.

T: Letter a (points to a on Figure 5) makes the sound /æ/ (points to mouth picture) like in my/your word / /.

T: Letter o (points to o on Figure 5) makes the sound /ɑ/ (points to mouth picture) like in my/your word / /.

Turn-Taking Segment:

T: Now we will take turns. Remember we say the word, stretch the word, and then tell our mouth sound and write our letter.

T: Your word is / /.

S: Says the word, stretches the word and indicates the mouth sound /I/, /ae/, /a/

T: Now write your letter or choose your sticker. Remember your mouth tells your hand what to write.

S: Places letter or writes grapheme while producing the mouth sound.

T: Provides appropriate feedback.

T: Now, lets say Letter ( ) (points to letter on Figure 5) makes the sound / /, (points to mouth picture) like in my word / /.

S: Letter ( ) (points to letter on Figure 5) makes the sound / /, (points to mouth picture) like in my word / /.

T: Provides appropriate feedback.

Criterion - 12 consecutive correct for each letter/grapheme.

*Independent Segment**:***

T: This time I will not have a turn. I will tell you your word. Remember to say your word and stretch your word. Then tell the mouth sound and have your mouth tell your hand when you write the letter.

T: Your word is / /.

S: Says the word, stretches, and indicates, /ɪ/, /æ/, and /ɑ/.

T: Now make your hand tell your mouth sound when you write your letter.

S: Writes grapheme while producing the mouth sound.

T: Provides appropriate feedback

T: Now let's say Letter ( ) (points to letter on Figure 5) makes the sound / / (points to mouth picture) like in my word / /.

S: Letter ( ) (points to letter on Figure 5) makes the sound / /, (points to mouth picture) like in my word / /.

T: Provides appropriate feedback.

Criterion - 12 consecutively correct for each letter name.

Response Feedback Phase 3 Part B - Identification of letter symbols

For identification of vowel phonemes:

CORRECT

1. That's right, the word /ConCVC / has the sound / / (points to Figure 5).

INCORRECT

1. No I did not say /ConCVC/ (with substituted incorrect vowel) I said the word /ConCVC/. Let's try that again. Your word was /ConCVC/.
2. No, Let's look in the mirror, I did not say /ConCVC/ (with substituted incorrect vowel) I said the word /ConCVC/. Now let's try that word again.

For identification of vowel letters:

CORRECT - (referring to Figure 5).

1. That's right, letter I makes the sound /ɪ/ in your word /CONCVC /.
2. That's right, letter a makes the sound /ae/ in your word /CONCVC /.
3. That's right, letter o makes the sound / a / in your word /CONCVC / (referring to Figure 5).

INCORRECT

1. No, letter (correct letter) makes the sound / /, like in your word / /. Letter (incorrect letter) makes the sound / /. Let's try your word again.

Phase IV - Phonemic Analysis and Word Memory

Subjects learn to identify all constituent phonemes of ConCVCs as an outcome of producing them, and to recall the original stimulus ConCVC after completing the analysis. Subjects always identify the mouth sound first followed by isolation and identification of the last and first sounds. The trainer requests identification of first and last sounds in mixed order. Students must be able to recall the original stimulus word following their correct phonemic analysis.

Introduction:

T: Now you can learn all the sounds in your words. Watch and listen carefully. I will say my word then I will stretch my word (using paper, Figure 5). Next I will tell you my mouth sound. Then I can tell you my other sounds.

T: My word is / / (spoken with normal duration).

T: T produces word with extended duration while moving finger across paper (Figure 6).

T: T produces mouth sound and points to mouth picture. My mouth sound is / /.

T: Models phonological mediation[1] or may repeat ConCVC.

T: This is / / (pointing to initial or final consonant space), and this is / /, (pointing to initial or final consonant space).

T: My word was / /. Identifies original ConCVC

Turn-Taking Segment:

T: Now we will take turns. Watch and listen carefully I will go first. I will say my word then I will stretch my word (using paper, Figure 5)[1]

Next I will tell you my mouth sound. Then I can tell you my other sounds.

T: My word is / / (ConCVC spoken with normal duration).

T: T produces extended ConCVC while moving finger across paper (Figure 5).

T: T produces mouth sound and points to mouth picture. My mouth sound is / /.

T: Models phonological mediation 1 or may whisper or sub vocalize ConCVC.

T: This is / / (pointing to initial or final consonant space), and this is / /, (pointing to initial or final consonant space).

T: My word was / /. Identifies original ConCVC.

T: Now it is your turn. Your word is / /. Say / /.

S: Says ConCVC at normal duration.

T: Now stretch your word.

S: S stretches ConCVC and runs finger on paper.

T: Now tell me your mouth sound (pointing to the mouth sounds).

S: Tells mouth sound.

T: And what is this sound? (pointing to initial or final consonant space),

[1] the trainer may model sub-vocalization of a word with speech movements

S: S indicates sound.

T: And what is this sound? (pointing to initial or final consonant space).

S: Indicates sound.

T: Now what was your word?

S: Produces ConCVC.

T: Provides appropriate feedback.

Criterion 12 consecutive correct (4 words for each vowel),

*Independent Segment**:***

T: This time I will not take a turn. I will tell you a word, and then you will stretch the word. Then I will ask you the sounds in your word.

T: Now it is your turn. Your word is / /. Say / /.

S: Says ConCVC at normal duration.

T: Now stretch your word.

S: S stretches ConCVC and runs finger across paper.

T: Now tell me your mouth sound (points to the mouth sounds).

S: Tells mouth sound.

T: And what is this sound? (points to initial or final consonant space)'

S: S indicates sound.

T: And what is this sound? (points to initial or final consonant space).

S: Indicates sound.

T: Now what was your word?

S: Produces ConCVC.

T: Provides appropriate feedback.

Criterion is 12 consecutive correct (4 for each vowel).

Response feedback Phase 4 - Phonemic Analysis and Word Memory

CORRECT

1. That's correct your word was / /. You know all the sounds in / /.

INCORRECT

1. Your word was / /, not / /. Let's try your word again

2. / / has the sound / /, not the sound / /. Let's try your word again.

Phase V – Spelling

In the fifth phase the students learn to spell ConCVCs graphically, concurrently with his production of an extended ConCVC. The students learn to write each grapheme in coordination with the articulatory and phonatory gestures of its corresponding phoneme. Prolonged speech production is required in order to coordinate continuous grapho-motor and speech motor movement. After spelling the word the student produces the word with normal duration.

Introduction:

T: Now you will learn to spell words while you stretch them. Remember, our mouth always tells our hands what to write... Ready? I will go first. I will say a word and then I will stretch it. (T says a CONCVC with normal duration and then produces the ConCVC with extended duration and released or aspirated final stops sliding finger across Figure 4a. Now I will spell the word while I stretch it (T coordinates grapho-motor movements with extended speech production. There, I spelled / / extended production of ConCVC using Figure simultaneously). I spelled the word ConCVC (normal duration).

Turn-Taking Segment:

T: Now we will take turns spelling our words. I will take another turn and then it will be your turn.

T: Now my word is / / (producing ConCVC with normal duration). Then T stretches ConCVC moving hand across paper strip (Figure 4a) My mouth will tell my hand what to write. (T coordinates grapho-motor movements with extended speech production. There, I spelled / / extended production of CONCVC using Figure 4a simultaneously) I spelled the word ConCVC (normal duration).

T: Now it is your turn. I will say a different word. You say the word and then stretch the word. Then you can spell the word while you stretch it. Remember to let your mouth tell your hand what to write.

T: Say / /.

S: Says ConCVC.

T: Now stretch.

S: Stretches.

T: Now let your mouth tell your hand to spell / /.

S: Spells while stretching and coordinating speech motor and grapho-motor movements.

T: Provides appropriate feedback.

Criterion - 12 consecutive correct (4 words for each vowel).

Independent Segment:

T: This time you will spell words by yourself, and I will not take a turn. Remember to say the word and stretch the word while you spell it. Remember your mouth tells your hand what to write.

T: Your word is / /.

S: Says / /, extends / / and then spells / / while stretching and coordinating grapho-motor and speech motor movements.

T: Provides appropriate feedback

Criterion - 12 consecutively correct (4 for each vowel).

Response Feedback for Phase 5 - Spelling

CORRECT

1. That's right, /CONCVC/. (T slides finger under each written letter as he produces the CONCVC with extended duration) You spelled / /. (T produces word with normal duration.)

INCORRECT

1. You wrote / / (extended production while running finger under each letter), instead of / / (extended production while running finger under each letter). Your word was / / (spoken with normal duration). Let's stretch that again. Ok now you can spell / / (spoken with normal duration) again.

Phase VI - Decoding

Reading - In phase six the subjects learn to decode printed ConCVCs with extended production and then with normal duration. The words are printed on 5"x7" plain white index cards. In the turn-taking segment students learn to

decode these by sliding their finger under each letter decoding with extended production, followed by a production of normal duration. In the independent segment children use hand movements (see Figure 6a) as they decode the ConCVCs in an extended manner, followed by production of the word with normal duration.

Introduction:

T: Now we will learn to read the words we can say. I will show you a word (T shows printed word on 5X7 inch white card).

T: We slide our fingers to stretch the word, as in Figure 6a (T decodes the ConCVC with an extended production). Then we say the word (T produces ConCVC with normal duration).

T: Now you try a word (T shows word.) Now use your finger and stretch.

S: Slides finger in coordination with extended production of ConCVC.

T: Now say your word.

S: Says the word.

T: Provides appropriate feedback.

Turn-Taking Segment:

T: Now we will take turns, I will go first. (T shows printed word on 5X7 inch white card). T points and stretches ConCVC, and then T produces ConCVC. I read the word / /.

T: Now it is your turn (T shows word). Now slide your finger and stretch.

S: Slides and stretches.

T: Provides appropriate feedback.

T: Now tell me your word.

S: Tells word.

T: Provides appropriate feedback.

Criterion - 12 consecutive correct.

Independent Segment:

Introduction:

T: This time I will not take a turn. I will show you a word on a card (T shows card with ConCVC). You will look at the word and then stretch the word like this (see, Figure 6a) T stretches the word then says the word with normal duration. I read the word / /. So you will stretch your word and then tell me your word.

T: Are you ready? (T shows word.)

S: Stretches.

T: Provides appropriate feedback.

T: Now tell me your word.

S: Says word with normal duration.

T: Provides appropriate feedback.

Criterion - 12 Consecutive correct.

Response Feedback Phase 6 -<u>Decoding</u>

CORRECT

1. That's right, your word was /ConCVC/ (T slides finger under word).

2. That's right, you read / /.

INCORRECT

1. You said / / (T uses hand motions stretching word), but your word was / /. Let's try that again.
2. Your word was / /. You said / /. Let's try that again.

Segmented Production Condition Training Script

Phase I - Production of Individual Vowels and the Vowel Sequence

Part A. Vowel Production - Subjects learn to produce accurately the vowels /ɪ/, /æ/, and /ɑ/ with normal duration in a turn-taking format with the trainer, and then in an independent segment.

Introduction:

T: I am going to teach you to say three speech sounds. The trainer produces all vowels with duration of .43 seconds. The first speech sound is /ɪ/ (the trainer points to figure 3a); the second sound is /æ/, (the trainer points to figure 3b); and the third speech sound is /ɑ/, (the trainer points to figure 3c).

T: Let's look in the mirror. Watch my mouth. /ɪ/, that's a very skinny mouth sound. /ɪ/. Let's say it together.

S: Looks to the mirror and attempts /ɪ/.

T: Provides appropriate feedback.

T: Now we can try /æ (the trainer points to figure 3b). Let's look in the mirror. Watch my mouth. /æ/, that's a very wide sound. Now you try /æ/.

S: Looks into the mirror and attempts /æ/.

T: Provides appropriate feedback.

T: Now we can try /ɑ/ (the trainer points to figure 3c). Let's look in the mirror. Watch my mouth. /ɑ/, that's a very long mouth sound. Now you try /ɑ/.

S: Looks into the mirror and attempts /ɑ/.

T: Provides appropriate feedback.

Turn-Taking Segment:

The trainer points to figures 3a, 3b and 3c in mixed order.

T: I'll point to a mouth and say the sound and then you say the same mouth sound. T points to figure 3 (a, b, or c) then says the vowel sound.

S: Produces vowel sound.

T: Provides appropriate feedback.

Criterion: 4 consecutively correct productions for each vowel (12).

Independent Segment:

The trainer points to figures 3a, 3b, 3c, in mixed order.

T: This time you must say the mouth sounds by yourself. I will point to a picture of a mouth and you will say that speech sound. You can use the mirror if you wish.

T: Points to mouth picture on figure 4.

S: Produces vowel.

T: Provides appropriate feedback

Criterion: 4 consecutively correct productions for each vowel (12).

Response Feedback for Part A - Vowel Production

CORRECT /ɪ/

1. Good, you stretched your lips so they are a thin like the picture.
2. Great, see this is a very skinny sound.
3. That's right; your tongue is up, pointing to the mirror.

4. That's perfect; you made your tongue stay up behind your top teeth.

5. Right, you said the correct mouth sound.

INCORRECT /ɪ/

1. Not quite, make your mouth real skinny like the picture /ɪ/.

2. No, you watch me in the mirror /ɪ/. Keep your tongue higher, like mine.

3. Spread your lips skinny, like mine /ɪ/.

4. That's the right sound, /ɪ/.

CORRECT /æ/

1. Right, your mouth was real wide like the picture.

2. Good, you kept your tongue down behind your bottom teeth.

3. Great, your tongue was down and your mouth was wide.

4. Right, you made the correct sound.

INCORRECT /æ/

1. No, not /ɑ/. Make your mouth wide like this (using mirror) /æ/.

2. Not quite, make your tongue touch the back of your bottom teeth. /æ/, see?

3. No, let's try again; look at the picture (points to 3b) or mirror, /æ/.

4. That's the right sound, /æ/.

CORRECT /ɑ/

1. Good, your mouth was long like mine.

2. Good, you made the /ɑ/ with your tongue back; you didn't touch your teeth.

3. You made your mouth just like this picture (point to 3c).

4. Right, you made a long stretch /ɑ/.

INCORRECT /ɑ/

1. You said /æ/, but I said /ɑ/, make your mouth long like this.

2. No, keep your tongue back like mine /ɑ/, see? (pointing to image in mirror).

3. That's the right sound /ɑ/.

Part B. Vowel Sequence - Subjects learn to produce accurately the sequence of vowels /ɪ/, /æ/, and /ɑ/ with normal duration in a turn-taking format with the trainer and then in an independent segment.

Introduction:

T: I will say these three speech sounds in order: /ɪ/, /ae/, /a/. First /ɪ/ (points to 3a), then /ae/ (points to 3b), then / a / (points to 3c). T pauses .5 seconds between each vowel production in the sequence. Let's say them together and look in the mirror.

T and S: Say sequence in order.

T: Now you try these speech sounds in order; you can look at the pictures or in the mirror if you want.

S: Produces sequence.

T: Provides appropriate feedback.

Turn-Taking Segment:

T: Now we will take turns, I will go first. T says vowel sequence pointing to corresponding pictures in figure 3. Now it's your turn.

S: Produces vowel sequence.

T: Provides appropriate feedback

Criterion - 12 consecutively correct vowel sequences.

Independent Segment:

T: This time you may say the sounds in order by yourself, many, many times. I will point with you the first time and we sill say them slowly together.

T and S: Produce vowel sequence together as both point to figures 3a, 3b, and 3c. Now you can point and say the mouth sounds in order. You can take your time. You say the mouth sounds 12 times in a row. I will count for you.

S: Produces vowel sequence.

T: Provides appropriate feedback

Criterion - 12 consecutively correct vowel sequences.

Response Feedback Part B - Vowel Sequence

CORRECT

1. Good, that's the right order /ɪ/, /æ/, and /ɑ/ (T points to 3a, 3b, 3c respectively.)

INCORRECT

1. No, remember /ɪ/ is first, /æ/ is second and /ɑ/ is third (T points to 3a, 3b, and 3c respectively).

Phase II - Production of Continuant Consonant-Vowel-Consonants (ConCVCs) in Segmented Form

The students learn to produce ConCVCs with normal duration and then in a segmented fashion (with released or aspirated stops in the case of ConCVCs with final stop consonants). For all speech stimuli and segmented response

productions in phase II the trainer and student point to each panel of the three paneled paper strip in Figure 4b in synchrony with their production of each phoneme in the ConCVC.

Introduction:

T: I am going to teach you how to separate the sounds in the words that you say. You will learn to say each sound in your word. Ready? First I'll say the word "sit" with normal duration (T says 'sit'). Now I'm going to separate the word "sit" into three sounds. Watch me, and listen (T produces /s/, /ɪ/, /t/ and points to each panel as he says each sound, see Figure 4b).

T: Now let's say each sound together. (T produces segmented ConCVC of "sit" and uses pointing in Figure 4b).

S: Attempts production with T.

T: Provides appropriate feedback.

Turn-Taking Segment:

T: Now we will take turns. First, I'll say a word and then I will separate the word. Next I will say a word for you. You will say the word first, and then you will separate the word into three parts. Let's practice your turn before we begin.

T: Say 'fim'.

S: Says 'fim'.

T: Now stretch '/f/, /I/, /m/.'

S: Produces segmented ConCVC

T: Provides appropriate feedback

T: Now it's my turn. T produces ConCVC with normal duration, then T segments ConCVC pointing to each panel on Figure 4b.

T: Now your word is ConCVC.

S: Says 'ConCVC'.

T: Now segment ConCVC.

S: Produces segmented ConCVC.

T: Provides appropriate feedback.

Criterion - 12 consecutively correct segmented ConCVCs.

Independent Segment:

Introduction:

T: Now this time we won't take turns. I will tell you the word and you will say the word. Then you will segment it by yourself. I will not have a turn. Are you ready?

T: Your first word is “fit.”

S: Says “fit”, and segments fit.

T: Provides appropriate feedback

Criterion - 12 consecutively correct segmented productions.

Response feedback Phase 2 - <u>Segmented production of ConCVCs.</u>

CORRECT

1. Good, you segmented the whole word.

2. Great, you can say each sound.

INCORRECT

1. No, you must segment the word (T models.)

2. This sound was / /. (The T points to the corresponding part of the panel, and then models the appropriate sound).

Phase III - Identification of Spoken Vowels and Vowel Letters

Part A- Identification of Spoken Vowels - Subjects learn to identify the medial vowel sound from their own segmented productions by pointing to the corresponding picture on figure 6. The students continue to point for each segment on each panel of the 3 panel paper when producing a word. After identifying the vowel the students must recall the stimulus ConCVC.

Throughout Part A and Part B of Phase 3, the student must say the word at normal duration, segment the word, identify the mouth sound by pointing to the picture and producing the vowel, and then recall the stimulus word. During instructions and feedback, the trainer always collocates the term sound with the identification of the vowel phoneme (i.e., that's the sound /ɪ/, sound /æ/ or sound /ɑ/); collocates the term word with the identification of words, (i.e., that's the sound /ɪ/, like in the word 'sik'); and collocates the term letter with the letter names i, a, and o. (i.e., 'letter i makes the sound /ɪ/, like in the word rif.)

Introduction:

T: This time you will learn to tell which sound, sound /ɪ/, sound /æ/, or sound /ɑ/ (pointing to corresponding mouth pictures in Figure 4b) is in the word that you segment. Ready? I'll take a turn first. First I will say a crazy nonsense/real word, then I will to segment that word, and then I will try to figure out the mouth sound that was in my word. (T produces a nonsense or real CVC /dɑg/, and then segments it. (Following this, and prior to identifying the mouth

sound, the trainer may model sub-vocalizing in an effort to model a strategy the child may use to recall the vowel.) Now I know! I said the sound /ɑ/ (points to mouth picture in Figure 4b) in my word /sɑg/.

T: Now you have a turn. Say the word /næk/.

S: /næk/.

T: Now segment /næk/.

S: Segments /næk/.

T: Now point and tell me which sound you said /ɪ/, /æ/, or /ɑ/.

S: Points and says the vowel sound.

T: Provides appropriate feedback.

Turn-Taking Segment:

T: Now we will take turns. I'll say a word, then I'll segment my word, and then I'll point and say the mouth sound in my word. (T models sub-vocalization if desired, and then identifies the mouth sound) Now let me see if I can remember my word (T models sub-vocalizing and looking at the panel or pointing at the panel). T identifies the word.) And my word was /_____/.

T: Now it is your turn. You're word is /CVC/, say /CVC/.

S: Says /CVC/.

T: Now segment your word.

S: Segments.

T: Now point to the mouth and tell me the mouth sound (referring to Figure 4b).

S: Points to a mouth figure and produces vowel sound.

T: Provides appropriate feedback.

T: And what was your word?

S: Tells the word.

Criterion - 12 consecutive correct.

Independent Segment:

T: I am going to say a word. You say it then you segment it by yourself. Then point to the mouth sound and tell me your word.

S: Says the word; segments the word, points to mouth picture, produces the vowel and recalls the stimulus CVC.

T: Provides appropriate feedback.

Criterion - 12 consecutive correct.

Response Feedback Part A, Phase 3 - Identification of Spoken Vowels

CORRECT

1. /ɪ/ that's right, the word /CVC / has the sound / / (points to Figure 4b).

INCORRECT

1. No I did not say /CVC/ (with substituted incorrect vowel) I said the word /CVC/. Let's try that again. Your word was /CVC/.
2. No, Let's look in the mirror, I did not say /CVC/ (with substituted incorrect vowel), I said the word /CVC/. Now let's try that word again.

Part B- Identification of Vowel Letters - Subjects learn to use letters to symbolize the phonemes /ɪ/, /æ/, and /ɑ/. Subjects print or use letter stickers to indicate the mouth sound in their CVCs. The trainer refers to Figure 5 throughout Part II of Phase 3.

Introduction:

T: Now we will learn to use letters and say letter names with our mouth sounds /ɪ/, /æ/, and /ɑ/ (T writes each letter and each word to construct Figure 6).

T: This is letter i, (T prints i), it makes the mouth sound /ɪ/, like in the word, 'it' (T segments /ɪ/, /t/, in synchrony with writing the letters) You're it!

T: This is letter a, (T prints a), it makes the mouth sound /æ/, like it the word, 'at' (T synchronizes writing of graphemes with segmented production of /æt/) At school!

T: This is letter o, (T prints o), it makes the mouth sound /ɑ/ (T synchronizes writing of letters with segmented production of /ɑz/). The wizard of Oz!

T: I'll say a word …/sɪm/. Now I'll segment my word .My mouth sound was /ɪ/. Letter i (points to i on Figure 5) makes the sound /ɪ/, (points to mouth picture) like in my word /sɪm/. Now my mouth will tell my hand /ɪ/ and I'll write /ɪ/ (T produces /ɪ/ with normal duration (43 sec.) writing letter or placing a letter sticker by the appropriate mouth picture (Figure)*

*Each time the trainer places a sticker or writes her letter near the mouth sound she verbalizes the appropriate statement.

Letter i (points to i on Figure 5) makes the sound /ɪ/, (points to mouth picture) like in my/your word /sɪm/.

Letter a (points to a on Figure 5) makes the sound /æ/ (points to mouth picture) like in my/your word / /.

Letter o (points to o on Figure 5) makes the sound /ɑ/. Points to mouth picture) like in my/your word / /.

Turn-Taking Segment:

T: Now we will take turns. Remember we say the word, segment the word, and then tell our mouth sound and write our letter.

T: Your word is / /.

S: Says the word, segments the word and indicates the mouth sound /ɪ/, /æ/, /ɑ/.

T: Now write your letter or choose your sticker. Remember your mouth tells your hand what to write.

S: Places letter or writes grapheme while producing the mouth sound.

T: Provides appropriate feedback.

T: Now, lets say letter ( ) (points to letter on Figure 5) makes the sound / /, (points to mouth picture) like in my word / /.

S: Letter ( ) (points to letter on Figure 5) makes the sound. / /, (points to mouth picture) like in my word / /.

T: Provides appropriate feedback.

Criterion - 12 consecutive correct for each letter/grapheme.

Independent Segment:

T: This time I will not have a turn. I will tell you your word. Remember to say your word and segment your word. Then tell the mouth sound and have your mouth tell your hand when you write the letter.

T: Your word is / /.

S: Says the word, segments, and indicates, /ɪ/, /æ/, and /ɑ/.

T: Now make your hand tell your mouth sound when you write your letter.

S: Writes grapheme while producing the mouth sound.

T: Provides appropriate feedback.

T: Now let's say, Letter ( ) points to letter on Figure 5) makes the sound / /

(points to mouth picture) like in my word / /.

S: Letter ( ) (points to letter on Figure 5) makes the sound.

/ /, (points to mouth picture) like in my word / /.

T: Provides appropriate feedback.

Criterion - 12 consecutively correct for each letter name.

Response Feedback Phase 3 Part B - Identification of Vowel Letters

For identification of vowel phonemes:

CORRECT

1. /ɪ/ that's right, the word /CVC/ has the sound / / (points to Figure 6).

INCORRECT

1. No I did not say /CVC/ (with substituted incorrect vowel). I said the word /CVC/. Let's try that again. Your word was /CVC/.
2. No, Let's look in the mirror. I did not say /CVC/ (with substituted incorrect vowel). I said the word /CVC/. Now let's try that word again.

For identification of vowel letters:

CORRECT - (referring to Figure 5).

1. That's right, letter I makes the sound /ɪ/ in your word /CVC/.
2. That's right, letter a makes the sound /æ/ in your word /CVC /.
3. That's right, letter o makes the sound /ɑ/ in your word /CVC / (referring to Figure 5).

INCORRECT

1. No, letter (correct letter) makes the sound / /, like in your word / /.

2. Letter (incorrect letter) makes the sound / /. Let's try your word again.

Phase IV - Phonemic Analysis and Word Memory

Subjects learn to identify all constituent phonemes of CVCs as an outcome of producing them, and to recall the original stimulus CVC after completing the analysis. Subjects always identify the mouth sound first followed by isolation and identification of the last and first sounds. The trainer requests identification of first and last sounds in mixed order. Students must be able to recall the original stimulus word following their correct phonemic analysis.

Introduction:

T: Now you can learn all the sounds in your words. Watch and listen carefully. I will say my word, and then I will segment my word (using paper). Next I will tell you my mouth sound. Then I can tell you my other sounds.

T: My word is / / (spoken with normal duration)

T: T produces word with segmented duration while pointing to each panel (Figure 6).

T: T produces mouth sound and points to mouth picture. My mouth sound is / /.

T: Models phonological mediation or may repeat CVC.

T: This is / / (pointing to initial or final consonant space), and this is / /, (pointing to initial or final consonant space).

T: My word was / /. Identifies original CVC.

Turn-Taking Segment:

T: Now we will take turns. Watch and listen carefully I will go first. I will say my word, and then I will segment my word (using paper, Figure 5). Next I will tell you my mouth sound. Then I can tell you my other sounds.

T: My word is / / (CVC spoken with normal duration).

T: T produces segmented CVC while moving finger across paper (Figure 5).

T: T produces mouth sound and points to mouth picture. My mouth sound is / /.

T: Models phonological mediation or may whisper or sub vocalize CVC.

T: This is / / (pointing to initial or final consonant space), and this is / /, (pointing to initial or final consonant space).

T: My word was / /. Identifies original CVC.

T: Now it is your turn. Your word is / /. Say / /.

S: Says CVC at normal duration.

T: Now segment your word.

S: S segments CVC and runs finger on paper.

T: Now tell me your mouth sound. (Pointing to the mouth sounds)

S: Tells mouth sound.

T: And what is this sound? (Pointing to initial or final consonant space).

S: S indicates sound.*

T: And what is this sound? (Pointing to initial or final consonant space).

S: Indicates sound.*

T: Now what was your word?

S: Produces CVC.*

T: Provides appropriate feedback.

Criterion 12 consecutive correct (4 words for each vowel).

*Independent Segment**:***

T: This time I will not take a turn. I will tell you a word, and then you will segment the word. Then I will ask you the sounds in your word.

T: Now it is your turn. Your word is / /. Say / /.

S: Says CVC at normal duration.

T: Now segment your word.

S: S segments CVC and runs finger across paper.

T: Now tell me your mouth sound. (Points to the mouth sounds).

S: Tells mouth sound.

T: And what is this sound? (Points to initial or final consonant space).

S: S indicates sound.*

T: And what is this sound? (Points to initial or final consonant space).

S: Indicates sound.*

T: Now what was your word?

S: Produces CVC.*

T: Provides appropriate feedback.

Criterion is 12 consecutive correct (4 for each vowel).

Response feedback Phase 4 - <u>Phonemic Analysis and Word Memory</u>

CORRECT

1. That's correct your word was / /. You know all the sounds in / /.

INCORRECT

1. Your word was / /, not / /. Let's try your word again.

2. / / has the sound / /, not the sound / /. Let's try your word again.

Phase V Spelling

In the fifth phase the students learn to spell CVCs graphically, concurrently with his production of a segmented CVC. The students learn to write each grapheme in coordination with the articulatory and phonatory gestures of its corresponding phoneme. Segmented speech production is required in order to coordinate grapho-motor and speech motor movement. After spelling the word the student produces the word with normal duration.

Introduction:

T: Now you will learn to spell words while you segment them. Remember, our mouth always tells our hands what to write. Ready? I will go first. I will say a word and then I will segment it (T says a CVC with normal duration and then segments the CVC pointing at each panel on Figure 4b). Now I will spell the word while I segment it (T coordinates grapho-motor movements with segmented speech production. There, I spelled / / segmented production of CVC using Figure 4b simultaneously). I spelled the word CVC (normal duration).

Turn-Taking Segment:

T: Now we will take turns spelling our words. I will take another turn and then it will be your turn.

T: Now my word is / / (producing CVC with normal duration). Then T segments CVC pointing at each panel. My mouth will tell my hand what to write. (T coordinates grapho-motor movements with segmented speech production.

There, I spelled / / segmented production of CVC using Figure 4b simultaneously). I spelled the word CVC (normal duration).

T: Now it is your turn. I will say a different word. You say the word and then segment the word. Then you can spell the word while you segment it. Remember to let your mouth tell your hand what to write.

T: Say / /.

S: Says CVC.

T: Now segment.

S: Segments.

T: Now let your mouth tell your hand to spell / /.

S: Spells while segmenting and coordinating speech motor and finger pointing.

T: Provides appropriate feedback.

Criterion - 12 consecutive correct (4 words for each vowel).

Independent Segment:

T: This time you will spell words by yourself, and I will not take a turn. Remember to say the word and segment the word while you spell it. Remember your mouth tells your hand what to write.

T: Your word is / /.

S: Says / /, segments / / and then spells / / while segmenting and pointing. Then S says the word with normal duration.

T: Provides appropriate feedback

Criterion - 12 consecutively correct (4 for each vowel).

Response Feedback for Phase 5 - <u>Spelling</u>

CORRECT

1. That's right, /CVC/. (T points to each letter as he segments the CVC). You spelled / / (T produces word with normal duration).

INCORRECT

1. You wrote / / (segmented production while running finger under each letter) instead of / / (segmented production while running finger under each letter). Your word was / /. Let's segment that again. Ok now can you spell / / again?

Phase VI - Decoding

Decoding- In Phase VI the subjects learn to read printed CVCs with segmented production and then with normal duration. The words are printed on 5"x7" plain white index cards. In the turn-taking segment students learn to read these by pointing to each letter decoding with segmented production, followed by a production of normal duration. In the independent segment children use hand movements (see Figure 6b) as they decode the CVCs in a segmented manner, followed by production of the word with normal duration.

Introduction:

T: Now we will learn to read the words we can say. I will show you a word (T shows printed word on 5"x7" inch white card).

T: We use our fingers to segment the word, as in Figure 6b (T decodes the CVC with a segmented production). Then we say the word (T produces CVC with normal duration).

T: Now you try a word. (T shows word). Now use your finger and segment.

S: Points in coordination with segmented production of CVC.

T: Now say your word.

S: Says the word.

T: Provides appropriate feedback.

Turn-Taking Segment:

T: Now we will take turns, I will go first (T shows printed word on 5"x7" inch white card). (T points and segments CVC (Figure 6b) then T produces CVC with normal duration.) I read the word / /.

T: Now it is your turn (T shows word.). Now use your finger and segment.

S: Points and segments (Figure 6b).

T: Provides appropriate feedback.

T: Now tell me your word.

S: Tells word.

T: Provides appropriate feedback.

Criterion - 12 consecutive correct.

Independent Segment:

Introduction:

T: This time I will not take a turn. I will show you a word on a card (T shows card with CVC). You will look at the word and then segment the word like this (see, Figure 6b) T segments the word then says the word with normal duration. I read the word / /. So you will segment your word and then tell me your word.

T: Are you ready? (T shows word).

S: Segments.

T: Provides appropriate feedback.

T: Now tell me your word.

S: Says word with normal duration.

T: Provides appropriate feedback.

Criterion - 12 Consecutive correct.

Response Feedback Phase 6 -Decoding

CORRECT

1. That's right, your word was /CVC/.
2. That's right, you read / /.

INCORRECT

1. You said / / but your word was / / (T points to sounds, Figure 6b). Let's try that again.
2. Your word was / /. You said / /. Let's try that again.

Appendix B

Continuant Vowel Consonant Real Words and Non-Words Used for Training

SOG	MOG	NOG	ROG	ZOG	FOK	ROK
SOK	MOK	NOK	ZIN	RIN	VIM	FIM
LIM	VAZ	MAZ	LAZ	SAZ	RAZ	SIP
SIF	SIM	SIV	SIK	RIS	MIS	LIS
RIS	MIS	LIS	ZIS	FIB	VAK	FAK
NAK	LAK	JAK	JOT	MOT	SOT	VOT
VAN	LAN	JAN	ZAN	NAN	VAM	FAM
LAM	FAM	ZAM	LIM	SIM	ZIM	FIM
RIM	LOF	SOF	ROF	JOF	NOF	SOP
JOG	LOG	RIG	SIM	LAG	LIG	VIG
VAL	VOG	JOK	MOP	NOP	SOP	RAV
MOP	NOP	SOP	RAV	LOD	VOT	MOV
VIT	NID	RIK	RAK	NOG	MAV	ZIF
FIG	SAF	MAP	RIT	JAZ	JOB	JIK
RAD	JID	SAV	MOD	ROD	ZOD	NOD
FOD	ZOD	FAG	MAG	NAG	RAG	SAG
VAG						

Appendix C

Written Parental Consent Form
To: Parent or Guardian of Elementary Student

From: Catherine Constable, M.Ed. CCC-SP, Doctoral Candidate
Dr. Linnea C. Ehri, Distinguished Professor of Educational Psychology,
The Graduate Center of the City University of New York

Re: CONSENT FORM

My name is Catherine Constable, and I am a doctoral candidate in the Speech-Language-Hearing Sciences PhD. Program at The Graduate Center of the City University of New York. I am the Principal Investigator of this project entitled "*A Comparison of Segmented and Continuous Speech Production in a Decoding Training Program for Children with Specific Language Impairment."* This is a study of methods on how children with language learning difficulties learn to read words, and what types of instruction might strengthen their learning. The study is expected to last 8 weeks. I wish to obtain written permission to include your child in my study.

I will work with your child two or three times per week in a quiet room at school during the day. Each work session will be about thirty-five minutes. During the first two sessions, I will give children some tasks to see how far along they are in learning to read and spell, and to determine if they would benefit from participating in the study instruction. Children who are appropriate for the study will continue to come to training sessions for about six to eight weeks. The training will involve, identifying and producing sounds and learning how to read words. In some cases your child may listen to stories and talk about them. During the last two sessions I will give your child some reading tasks to see if my teaching helped them. If you consent, your child may be audio taped in order for me to be sure I recorded your child's responses accurately. If you

consent your child may be videotaped in order for me to use the tape to train other teachers. All written, audio, or video records are strictly confidential and will be stored in a locked file cabinet to which only I and my advisor will have access. No one else will have access to this information without your written consent.

The risks from participating in this study are no more than those encountered in everyday life at school. The training given to the children will be similar to the kinds of activities that they perform during their reading at school. Students who participate in the study may benefit from learning to read words they have not read before. Most children enjoy the individual attention that they receive as they work on the new tasks.

You should know that any child who participates is free to withdraw from the study at any time, without any consequence. Information that is useful for your or your child's teacher will be shared at the end of the study if you wish. I may publish the results of my study, but the names of children or any identifying characteristics will not be used in any publication. If you would like a copy of the study, please provide me with your address and I will send you a copy in the future.

If you have any questions about this research you can contact me at The Rye Learning Center, 914-921-0317, or at cconst007@aol.com. You may reach my advisor, Dr. Linnea Ehri, at 212-817-8294, or at lehri@gc.cuny.edu. If you have any questions concerning your child's rights as a participant, you may contact Kay Powell, IRB Administrator at The Graduate Center, City University of New York, 212-817-7525 or kpowell@gc.cuny.edu. Thank you for your participation in this study. You will receive a copy of this form prior to the start of the study.

I agree to allow audio taping of my child. Please circle one: Yes No

I agree to allow videotaping of my child. Please circle one: Yes No

_____
Child's Name

_____ _____
Parent's Signature Date

_____ _____
Investigator's Signature Date

Appendix D

Verbal Script for Oral Assent

The research staff will obtain an oral assent/dissent from each subject at the initial session (attached). The verbal text will be as follows:

"I would like you to come with me some days to do some talking and learning. Your mom and/or dad (or guardian) and your teacher think it will be fun. I think you will have fun learning here too. Is that okay?"

Child response – *no* Researcher response – *Okay, then you can stay here with your* _____

(parent or guardian)

Child response – *yes* Researcher response – *That's great!*

Appendix E

Phonetic Symbols and the Corresponding Speech Sounds

Symbol	Examples
æ	‘at’, ‘sad’
ɛ	‘Ed’, ‘red’
ɪ	‘it’, ‘sick’
ɑ	‘ox’, ‘not’
ʌ	‘up’, ‘cut’
eɪ	‘ate’, ‘same’
i	‘eat’, ‘seem’
ɑɪ	‘five’, ‘eye’
o	‘so’, ‘road’
u	‘blue’, ‘food’

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