The Acquisition of Conventional Spelling Patterns by Pre-Conventional Spellers:

A Developmental Analysis

By

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Abstract

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This study involves a comparison of the experiences that enable young children who are still in the phase of "inventing" spelling to acquire conventional spelling patterns. A micro-genetic methodology was employed to analyze students' acquisition of specific spelling patterns over a 3-week, 6-session training period in order to identify factors that affected the rate of acquisition. Kindergarten and first grade students underwent a series of seven literacy pretests and were given exposure to nine words that contained difficult spelling patterns. Three of the words contained spelling patterns where the underlying phonology makes it challenging to identify the correct grapheme, three contained targeted spelling patterns where the orthographic patterns have no phonological trace and the final three words were non-words with either uncommon or illegal English spelling patterns. One group of students was taught to read the words containing the targeted spelling patterns on flash cards. A second group was taught to segment the same words by moving letters into Elkonin boxes. A third group of students, the minimal treatment control, group was asked to practice inventing spellings of these same words. Spelling tests were administered at the beginning and end of each training session and used to model growth curves of the acquisition of the conventional spelling patterns

Results indicated that students trained in segmentation and word reading outperformed those in the minimal treatment control but were not statistically different. When analyzed by the

three different types of spelling patterns, students who received the segmentation training did better learning the phonological spelling patterns, those who practiced reading the words on flashcards did better learning the non-word spelling patterns, and both groups performed similarly on the orthographic spelling patterns. Literacy skills also differentially predicted by spelling pattern—phonological skills best predicted learning phonological spelling patterns, word reading best predicted learning orthographic words and vocabulary knowledge had a negative effect on learning non-words. Word reading was found to be the best predictor of overall growth over the training period.

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Chapter I Introduction

Young children's spelling, particularly before they receive formal literacy instruction, is fraught with errors. The opaque nature of English orthography, combined with children's limited phonemic awareness, and lack of formal instruction and systematic understanding of the alphabetic principal spawn seemingly peculiar inventions: for example, spellings of JRGN[1] for *dragon*, and HN for *chicken* (Gentry, 1982; Read, 1971; Treiman & Bourassa, 2000).). As children's understanding of the alphabet principal becomes more developed, they typically begin to invent spellings of increasing complexity reflective of their underlying understanding of the grapho-phonemic system. A child who has learned letter sound correspondence may invent a spelling that is complete and phonetically plausible, such as JRAGN for *dragon*. If the word in question has a simple phonetic structure, these inventions can even be orthographically correct as is the case with many CVC words. However, since many words in English defy the basic rules of phonics, there is a limit to the number of words that can be derived from basic grapho-phonemic rules. In spite of these difficulties, most children do learn to spell these non-derivable spelling patterns, often in the early years of school (kindergarten and first grade), even without direct instruction in these spelling patterns (Graham, 2000). The purpose of this study was to analyze the processes involved in the acquisition of correct spelling patterns.

How does somebody learn to spell a word correctly? In Ehri's (1987) phase theory, there are three ways to spell a word: by memory, by analogy and by invention. Given the variability of letter sound relationships in English, the method that produces the most consistent correct spelling would be to spell from memory provided that the memorized spelling was correct.

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[1] When representing children's invented spelling uppercase letters are used. To indicate constituents of pronunciations phonetic symbols between slashes are used. In this case, the initial consonant cluster is written by the child as JR to represent the phonemes / d͡ʒr /.

However, one simply cannot memorize every word in the English language. So the question becomes how does one go about forming the correct representation for the spelling of a word? Based on her phase theory, Ehri (1997, 2005) argues that through the application of alphabetic knowledge, the speller forms a bond between the pronunciation of the word and its spelling to form what she refers to as spelling-sound amalgams. This is similar to the process of forming a representation to read a word from memory. However, spelling is more complex because the relationship between graphemes and phonemes is asymmetrical in that going from grapheme to phoneme is relatively regular while going from phoneme to grapheme is not (Bosman & Van Orden, 1997). For example, the letter K when read in words is almost always pronounced /k/, whereas there are multiple ways to spell the sound /k/ sound including: K, C, CK, and CH.

Spelling skill does not move from incorrect inventions to correct spellings in one jump, but develops progressively and is best described as a series of phases. Although there are various stage/phase schemes that describe the development of children's spelling, I drew on Ehri's phase theory (1997, 2005) that portrays the phases in terms of the underlying alphabetic knowledge that children use in producing spellings. First is the pre-alphabetic phase, when children have little knowledge of the alphabetic principal and scribble, draw or write random letters or symbols to represent words. Children progress to the partial alphabetic phase when they can use letter sound or letter name knowledge in their spellings, e.g. C for seed. The full alphabetic phase emerges when children acquire more complete alphabetic knowledge, including vowels. They begin inventing spellings by selecting plausible graphemes to represent most of the phonemic segments in a word. The final phase is the consolidated alphabetic phase where children begin to incorporate their knowledge of spelling patterns in words and apply it in their spellings. Phases are intended to characterize the predominate type of spelling strategies that

beginning spellers use in that phase. For example, full alphabetic phase spellers will use mostly phonetic strategies. However, they will also use strategies from earlier and later phases but to a lesser extent (Treiman & Bourassa, 2000). The study focuses on how beginning spellers, partial and full alphabetic, transition from their unconventional spellings of specific spelling patterns to conventional ones.

Research on spelling development highlights many of the specific strategies and pitfalls of early spellers (Gentry, 1982; Read, 1971; Treiman & Bourassa, 2000). Children make errors that arise from the articulatory features of the words. The phonemes represented by T or D before R (i.e. *truck* or *drag*) are particularly difficult because they share articulatory features with the affricates /tʃ/ or /dʒ/ and this leads children to spell them as CH or J, respectively. Children also have difficulties with consonant blends, both at the beginnings and endings of words, particularly nasalized consonants such as the N in the word *bend*, often spelled without the nasal letter, as BED. Children also have difficulty with orthographic features that are unmarked phonologically, such as the final silent E pattern, final double consonants, and phonologically redundant digraphs like CK to represent final /k/. While these types of errors are well documented, the process by which children learn the correct spellings of these patterns is not as well understood.

For children to be able to transition from the inventive phase to the alphabetic phase, they need to experience the conventional spellings of words containing the difficult features and they need to be ready to attend to, process and remember the features. Research has focused on several methods of exposure: exposure to conventional forms through reading, exposure to conventional forms plus some level of grapho-phonemic analysis (such as phonemic awareness training), and practice in invented spelling with corrective feedback. In addition, there is a line of

research that analyzes how correct spelling develops through the promotion of invented spelling without corrective feedback.

In research that analyzed the impact of reading on spelling memeory, Ehri (1980) and Ehri and Wilce (1986) found that 2nd grade students learned the spellings of pseudo-words after learning to read them with 69% of the correct spellings remembered in Ehri (1980) and 84% in Ehri and Wilce (1986). Furthermore, Ehri and Roberts (1979) found that 1st grade students learned significantly more correct letters when they read 16 words in isolation on flash cards than when they read them in context. Additional work done with students reading pseudo-words embedded in text found that third graders retained knowledge about correct spellings after only one exposure to the word, even up to one month after the exposure to the word (Share, 2004).

In addition to research showing that reading improves spelling, there has also been research showing that the more detailed word analysis that is included in some methods of phonics and phonological awareness training also improves spelling acquisition. Evidence from two meta-analysses by the National Reading Panel (NRP) (2000) indicate that both phonemic awareness training (Ehri, Nunes, Stahl, & Willows, 2001) and phonics instruction (Ehri, Nunes, Willows, Shuster, & Yaghoub-Zadeh, 2002) improve spelling skill, at least as measured by invented spelling tests. This makes sense in that the act of inventing a spelling involves a combination of phonological and phonics skills—phonological in that the word needs to be segmented into sounds and phonics in that letter sounds need to be applied to those segments.

Because the act of inventing spellings involves the integration of these two literacy skills, invented spelling has been encouraged as instructional practice. Findings indicate that encouraging students to invent spellings in the absence of spelling instruction improves their acquisition of correct spelling at least as much as providing spelling instruction (Callaway,

McDaniel, & Mason 1972; Clark 1988; Klesius, Griffith, & Zielonka 1991). In these studies the students were encouraged to invent spellings but were not explicitly instructed in the specific skills of invented spelling. In two studies that taught these skills specifically, Ehri and Wilce (1987) and Uhry and Shephard (1993) instructed students to segment and spell either phonetically simplified words (Ehri & Wilce) or real words (Uhry & Shepard). In both cases, students who received this training produced better invented spellings than students in the control groups. In additional work on the efficacy of invented spelling to promote spelling acquisition, Rieben, Ntamakiliro, Gonthier and Fayol (2005) found that students who both practiced invented spellings and received corrective feedback learned more orthographically correct spellings than students who copied correct spellings or practiced inventing spellings without feedback.

It is with this research as a guide that the present study was designed. A micro-genetic methodology was employed. This procedure entails an intensive trial-by-trial analysis of the period of expected change. It was used to analyze students' acquisition of specific spelling patterns known to be difficult for beginners. The learning period lasted for three weeks and consisted of six training sessions. The purpose was to identify factors that affected the rate of acquisition. To do this, kindergarten and first grade students, after a series of seven literacy pretests, were given practice working with nine words that contained spelling patterns particularly difficult for the beginning speller. Three of the words contained spelling patterns where the underlying phonology makes it difficult to identify the correct grapheme—e.g. the DR in *drag*. Three of the words contained targeted spelling patterns where the orthographic patterns have no phonological trace—e.g. the SS in *pass*. The final three words were non-words with either uncommon or illegal English spelling patterns—e.g. the RR in *rret*. One group of students

was taught to read the words containing the targeted spelling patterns on flash cards. A second group was taught to segment the same words by moving letters into Elkonin boxes. A third group of students, the minimal treatment control group, was asked to practice inventing spellings of these same words. Spelling tests were administered at the end of each training session and used to model growth curves of the acquisition of the conventional spelling patterns.

To investigate the factors that influence the rate of acquisition, a two-level hierarchical linear model was employed. This was used to analyze the effectiveness of the different treatment conditions, the contribution of literacy skills to the rate of acquisition, and the impact of different types of spelling patterns on the odds of acquisition. A transfer task was given after the final training session to investigate whether the learned spelling patterns transfer to similar words containing the same targeted spelling patterns. Two posttests were given: a delayed recall test to assess long-term learning and an orthographic choice test to assess the possibility that orthographic learning had taken place but was not evident in production tasks.

The present study addressed the following five research questions:

1. Do students learn new spelling patterns after being exposed to them?
2. Is the acquisition affected by the way students interact with the words?
3. Is acquisition influenced by spelling features of the words (i.e. phonetic, orthographic or non-word features)?
4. Is acquisition affected by prior literacy knowledge?
5. Do the students transfer this knowledge to similar untaught words?

Additionally, the implications of the findings were considered for both pedagogic and curricular changes in early childhood education and on cognitive models of spelling acquisition, particularly connectionist theory.

Chapter II Literature Review

Spelling Processes

The term spelling is ambiguous—it can be a verb and refer to the act of spelling a word or it can be a noun and refer to the sequence of letters used to form the spelling of a word (Ehri 1997). Both meanings are used here. According to phase theory (Ehri 1997, 2005) when faced with the task of writing a word, the writer's options are dictated by whether or not the word is familiar to the writer. If the word is familiar the writer will produce the spelling by accessing lexical memory and recalling its letters. If the word is unfamiliar, the writer may "invent" a spelling by drawing on knowledge of the alphabetic system, or he or she may draw on knowledge of similar words to spell the word by analogy.

The first work on inventive spelling came when Charles Read (1971) analyzed the spellings of some precocious kindergarten students in a Montessori school in New England. As Read points out, spelling may emerge in most children before they even learn to read. Although these spellings are not "correct" they are based on the children's rudimentary knowledge of the grapho-phonemic system. It is the interplay between the children's understanding of the articulatory features of a word (the phonology) and their knowledge of the orthographic system that allows them to produce spellings before they have the knowledge to read or write words correctly. Given the phonological nature of invented spelling, it is not surprising that there is a strong and stable relationship between invented spelling and phonological awareness (McBride-Chang, 1998; Silva & Martins, 2003, Ouellette & Sénéchal, 2008a) and that instruction in phonemic awareness contributes to growth in invented spelling skill (see later discussion of spelling instruction). Additionally, invented spelling has been linked to future reading ability (Clarke, 1988; Ehri & Wilce, 1987; Lombardino et al., 1999; Morris & Perney, 1984; Ouellette

& Sénéchal, 2008b; Richgels, 1995; Shatil, Share, & Levin, 2000; Treiman, Sotak, & Bowman, 2001; Uhry, 1999). However, the process of segmenting a word into phonemes and selecting the best graphemes to represent these phonemes does not produce many correct spellings in English.

Given the opaque nature of the writing system in English, the process of producing a correct spelling is much more complex[2]. One major issue is that while English is relatively consistent from grapheme to phoneme (i.e. 69 % of all low frequency one syllable words are consistent), it is highly inconsistent in the other direction with 72% of these same words being inconsistent from phoneme to grapheme (Bosman & Van Orden, 1997). As they point out, the /i/ sound can be written as Y, EY, EE, EA, EI or just plain E as seen in the words: *entry, key, deep, leaf, chief,* and *she*. The speller, when faced with choosing a letter to represent an unknown long /E/ sound, thus has 6 options of which only one yields a correct spelling. Yet people rarely write the word SEE with the spelling SY—so where does this knowledge come from?

One source is from a person's knowledge of how to read words. According to phase theory (Ehri 1997**,** 2005), to read words automatically the reader, through exposure and repetition, retains a spelling-sound amalgam in memory. At the most basic level readers bond graphemes to phonemes. As they become more experienced larger syllabic chunks of the words are bonded to the pronunciation. For example, a beginning reader, when reading the word chest, would form the connections between each grapheme and phoneme—CH→/CH/, E→/E/, S→/S/, and T →/T/. A more advanced reader with greater orthographic knowledge would use larger

[2] I refrain from referring to words that do not follow basic grapheme to phoneme rules as "irregular". For example the word DANCE might be considered "irregular" by some because it has a silent E at the end that does not make the preceding "A" a long vowel. However the E is there as a systematic marker for the letter C to indicate that it is to be an /S/ sound and not a hard /K/ sound (see Venezky 1999 for a more detailed discussion). Additionally Ehri (1997) makes the case that even ambiguous sound to spelling relations are systematic in that there are only a handful of possibilities and that once learned represent a broader word based regularity.

units to form the amalgam in memory, for example, CH→/CH/ and EST→/EST/ (example taken from Ehri 1997). While these spelling to sound amalgams provide the necessary information to read a word quickly, because of the asymmetry in spelling to sound correspondences, they are not adequate to completely explain correct spelling. Once the alphabetic principle is learned, letter- sound correspondences provide a strong mnemonic for remembering spellings and with a few exposures the spelling pronunciation amalgam is easily formed and recalled when needed for reading. However, in spelling a word, there is no visual cue to help with recall, so sounds in pronunciations are all the speller has to draw on. While it may be adequate to spell words with more conventional sound-to-spelling relations, for more complex words such as ones that contain schwa vowels and silent letters, techniques such as over-learning or additional strategies like memorizing spelling rules or developing special spelling pronunciations may help. Once knowledge of correct spellings is developed, it can be used to spell other words by analogy (e.g. spelling *beak* by analogy to *peak*), but a correct spelling will only be produced if the analog is a true analog and not a rhyme with a different spelling (e.g. trying to spell *beak* by analogy to *peek*), and if the speller has a correct representation of the word to be analogized.

In summation, there are three ways that words might be spelled: from memory, by analogy, and by invention. Invention relies on spellers' grapho-phonemic knowledge and often results in incorrect spellings, whereas spelling from memory relies on word specific knowledge, and analogy uses a bit of both (i.e. word specific knowledge to access the analog in memory and grapho-phonemic knowledge to spell the rest). While these processes may seem to be independent, they are really part of the same developmental progression. The goal of this study was to investigate the development of word specific knowledge that is used to spell words correctly from memory by the beginning speller who relies primarily on invention to spell words.

Phases or Stages?

Children's spelling skill develops along a predictable trajectory described as stages or phases by various researchers (Bear & Templeton, 1998; Beers & Henderson, 1977; Ehri, 1987, 1997; Frith, 1985, Gentry 1982, 2000; Templeton & Bear, 1992). While the theorists have different labels for their stages or phases of development, there is general agreement about the underlying phenomena (see Table 1 for a side-by-side comparison of the major systems). However, these differences in labels, both in the distinction between phase vs. stage and for the particular levels are not completely inconsequential. While all describe a progression from spelling inventions using random symbols and pseudo-letters to conventional spelling, Ehri's, 1997 phases are labeled in "reference to student's knowledge of the alphabetic system because this is the key capability that distinguishes among the levels and underlies development" (p. 253). In contrast, the Gentry and Bear and Templeton stages describe the behavior of the speller. For example, a stage or phase 3 child in all systems might spell the word opener as “OPENR”. This meets Gentry's criteria for a phonetic speller since all phonemes are represented with a plausible grapheme and Bear and Templeton's criteria for a letter name speller since each letter represents a sound and letter names are used to spell both vowels and consonants, in this case the long /O/ and the syllabic /R/. These are descriptive of the behavior of the speller but do not explain the underlying knowledge that is required to produce a spelling like this. However, Ehri describes the knowledge that the full alphabetic speller has at his or her disposal:

Table 1

Stages and Phases of Spelling Development

Gentry 2000		Bear & Templeton (1998)		Ehri (1998)		Frith (1985)	
Stage 1	Precommunicative	Stage 1	Prephonemic	Phase 1	Pre -Alphabetic	Stage 1	Logographic
Stage 2	Semiphonetic	Stage 2	Semiphonemic	Phase 2	Partial Alphabetic		
Stage 3	Phonetic	Stage 3	Letter name	Phase 3	Full Alphabetic	Stage 2	Alphabetic
Stage 4	Transitional	Stage 4	Within-word Pattern	Phase 4	Consolidated Alphabetic	Stage 3	Orthographic
Stage 5	Correct	Stage 5	Syllabic Juncture				
		Stage 6	Derivational Consistency				

> "[S]tudents need to be able to segment words into constituent phonemes...need to know conventional grapheme-phoneme units, particularly how vowels are symbolized with letters...to take full advantage of the alphabetic system for reading and spelling" (p. 255)

Ehri informs us not just what the speller does, but how. The speller with this knowledge will have the capability to produce spellings that are more complete than a speller in the partial-alphabetic phase: However this is not always the case as young spellers often display spelling behaviors from more than one phase (Lauterbach, 2004; Devonshire and Fluck, 2010; Rittle-Johnson and Siegler, 1999; Varnhagen, McCallum & Burstow 1997).

Both Gentry as well as Bear and Templeton put forth models that are stage based. According to Bjorklund (1995 as quoted in Gentry 2000) developmental stages must meet certain criteria:

1. Differences among stages must be qualitative in nature.
2. There must be substantial homogeneity of functioning within a stage.
3. The transition from one stage to the next must be abrupt. (p. 89)

Gentry (2000) argues that his stages do meet these criteria. From Table 1, it is easy to see that there are qualitative differences in the types of spellings that children in each of these stages are expected to produce. His argument for the second criteria is that "we do not see a child using a hodgepodge of strategies indiscriminately—spelling one word by ear, the next word by eye, then listing random letters and so forth" (p. 322). With no precise definition of "abrupt" he argues that the third criterion is met by the fact that once children attain a certain level of spelling, they are not likely to revert back to a less advanced form of spelling. However, there is research that argues against this strict definition of developmental stages both in general and in

the case of spelling development in particular.

Rittle-Johnson and Siegler (1999), using a micro-genetic methodology in which they observed overt behaviors and student self reports, and analyzed the spelling strategies that 1st and 2nd graders used over time. Automatic retrieval and sounding out were the two most prevalent strategies, used by over 90% of all 1st and 2nd graders. Retrieval as defined by Rittle-Johnson and Siegler is the ability to quickly produce a spelling with no overt behavioral signs or self-reporting of back-up strategies, like sounding out or spelling by analogy. Retrieval could be interpreted as a stage 5 strategy in Gentry's model since it produced 86% and 96% percent correct spellings in 1st and 2nd grade respectively. However, at the same time that students were using this strategy they were also using a sounding out strategy that only produced 15% and 34% correct spellings of which only 50% and 68% of the spellings were even "liberally" coded as phonemically correct for first and second graders respectively. While they do not disaggregate their data to analyze individual students, it is clear that some 1st and 2nd graders produced correct spellings while at the same time producing poor phonetic spellings.

The simultaneous use of multiple strategies was also observed in work that Devonshire and Fluck (2010) did in teaching morphological spelling strategies to 5-11 year old students. Using a self-report strategy similar to Rittle-Johnson and Siegler's (1999), students were asked to write down the strategies they used to spell particular words. They found that 82% of 5-year olds and 100% of 6 to 10-year olds used more than one strategy, with sounding out and retrieval being the top two strategies used by all age groups followed by meaning based strategies and visual strategies.

In re-analyzing data from the pilot for this study (Lauterbach 2004), I observed examples of children using random letter strings (pre-alphabetic phase) after demonstrating partial

alphabetic spelling ability and correct spellings intermingled with phonetic spellings. While this may not be the "hodgepodge of strategies" that Gentry (2000) described, it does call into question both the homogeneity of strategy use and abruptness of transition. This is particularly true since the transition from sounding out to retrieval appeared to be relatively slow in the Rittle-Johnson and Siegler (1999) study, with 1st graders using retrieval 39% of the time and sounding out 49% of the time compared to 2nd graders who used retrieval 62% of the time and sounding out 18% of the time. Additionally, Devonshire and Fluck (2010) found that 90% of 11-year old students still sounded out words.

The purpose of the present study was not to discredit spelling stage theorists, but to develop a more accurate way to conceptualize children's progress in spelling development. One of the major shortcomings of the Rittle-Johnson & Siegler (1999) study was that they gave very little information about the quality of the students' spellings. What is clear is that students were producing correct spellings automatically. Because many of the words on the spelling list for the study contained orthographic patterns that could not be remembered by applying just grapho-phonemic knowledge (e.g. *kite*, *moon*, and *letter*), the students may have been applying knowledge of larger-unit spelling patterns characteristic of Ehri's consolidated alphabetic phase to produce their most advanced spellings, while at the same time producing spellings using strategies best described by the full alphabetic phase. It is clear that children use strategies from non-dominant phases when spelling. Other studies show that young spellers draw on knowledge that is considered beyond their current phase—pre-alphabetic spellers using letter name knowledge to read and write, and partial alphabetic spellers demonstrating orthographic knowledge such as letter placement rules and the doubling of letters (Ehri, 2005; Treiman & Bourassa, 2000; Wright & Ehri, 2007). While some might argue that this discredits phase

theory, I would argue that it suggests that the phase a particular child is in represents the knowledge and strategy used for a preponderance of their spellings but that other knowledge and strategies, both more and less advanced, are also being used.

One way to think about this is provided by Siegler's (1996) overlapping waves theory of development, in which children use multiple strategies simultaneously within a domain area, slowly weeding out less adaptive ones and more frequently utilizing more adaptive ones. We can think of this metaphor in spelling terms. As children develop spelling skill, their early writings are pre-alphabetic—but even this skill develops progressively, from random shapes that vaguely resemble letters, to well formed pseudo-letters, to accurately produced random letters. As their knowledge about letters and their grapho-motor abilities progress, their pre-alphabetic writing becomes more refined. However, as this knowledge for producing spellings is being acquired and used as their primary strategy for producing spellings, the child is also acquiring alphabetic and orthographic knowledge that will come to influence strategy choice. Over time the new strategies based on the new knowledge will prove to be more adaptive, i.e., will produce better, more readable results than the previous strategies, and therefore will be used more frequently while older strategies will fall out of favor, but perhaps never be fully extinguished. For example, an adult speller attempting to spell an unfamiliar word will necessarily rely on these earlier strategies.

Kwan and Varnhagen (2005) found evidence for this pattern of development in a micro-genetic study that taught both children and adults to spell non-words and examined their strategies. There was a shift from back-up strategies, like invention and analogy as reported strategies for spelling, to spelling from memory as a strategy. However, this development was not linear in that participants would go back and forth between strategies over trials. Those who

were more successful with back-up strategies were slower to shift. While this does shed light on the process of change, it does not discount the importance of phase theory in describing the knowledge and preponderance of strategies that the child brings to the task of spelling.

Phases of Development.

While there are many phase/stage theorists, for reasons mentioned earlier I focused on Ehri's 1997 phase descriptions[3], though I also drew on other research for evidence about spelling behavior demonstrated at the various levels.

Precommunicative/Prealphabetic Phase.

In the pre-alphabetic phase, children's writing is based upon visual features of the writing system (Tolchinsky-Landsmann & Levin, 1985, 1987). That is, children produce marks that are designed to look like writing but have no basis in the alphabetic system. Analyses of the written responses to various dictation tasks have identified pre-alphabetic writing that progresses in the following way (Ferreiro & Teberosky, 1979; Gombert & Fayol, 1992; Levin, Korot & Amsterdamer 1996; Levin, Share & Shatil, 1996):

1. Scribbles with certain characteristics of writing like distinct units and left to right production.
2. Pseudo-letters, which have the characteristic shapes of letters but do not represent actual letters.
3. Letters from the child's name written in random order unrelated to the phonemic properties of the word.

[3] Ehri (1997) discusses parallel developmental theories on sight word reading and spelling with each phase having its own title. Though this project focuses on spelling, much of the work I am drawing on relates to her theory of sight word reading. That is why each section describing the developmental phases has a double title separated by a slash representing both the reading and spelling titles for the parallel phases.

4. Random letters unrelated to the phonemic properties of the word.

While children at this phase do not write using the alphabetic principal, they are engaged in the act of conveying meaning. Children often include semantic cues in their pre-alphabetic writing by varying the length, shape and number of "letters" or "words". At this phase children read using visually salient cues because they do not possess letter knowledge and therefore are unable to use letter names or sounds to make alphabetic connections to read words (Ehri, 1997).

Semiphonetic/Partial Alphabetic Phase.

Children transition into this phase once they begin to develop some knowledge of the alphabetic system. This knowledge is often initially based on letter names and basic phonological skills necessary to detect word boundaries (Ehri, 1997). Children in this phase produce spellings of words that are partial representations of the phonological structure of the word, often focusing on salient vowels and consonants such as initial and final consonants and sounds represented by letter names (Ehri, 1997). Spellers at the beginning of this stage might represent the word BEAVER initially with only the letter B or with the initial and final consonants BR. As they progress, they may add consonants at syllable junctures like BVR (Ehri, 1997; Gentry, 1982; Read, 1971) and even include front vowel letter names like BEVR (Read, 1971). Many phonological features such as affrication and flaps appear in spellings that seem, at the surface level, inconsistent with a plausible phonetic representation of the word, for example HRN for the word *train* (Read, 1971; Treiman & Bourassa, 2000). However, as Read demonstrated, beginning spellers make the selection based on the detection of affrication so that the letter name "aich" (the letter H) is a reasonable approximation of the voiceless affricate /tʃ/ followed by an /r/ detected at the beginning of *train*.

Phonetic/Full Alphabetic

As knowledge of the grapho-phonemic system increases, children progress into the phonetic/full alphabetic phase. In this phase, the full array of phonemes is represented by plausible graphemes. Although the selection of graphemes is based predominantly on phonemic units, some orthographic knowledge may appear at this phase (Ehri, 2005; Treiman & Bourassa, 2000; Treiman & Cassar, 1997; Wright & Ehri, 2007). While children's spellings at this stage are phonetically plausible and usually can be read, they are not yet close to standard English except in highly regular cases. Phonetic features written unconventionally in the previous phase, like affrication, tense and lax vowels, pre-consonantal nasals (BU*M*P), syllabic sonorants (C*AR*), and flaps (LE*TT*ER) can still present challenges to the phonetic speller, yet are often systematically though not correctly represented (Gentry, 1982; Read, 1971; Treiman & Bourassa, 2000). (These features will be discussed in more detail subsequently.) In sum, the key point about this phase is that the child is primarily processing words at the individual phoneme to grapheme level when spellings are invented.

Transitional/Consolidated Phase

With exposure to more conventional spellings of words, children begin to process longer letter sequences within words. Instead of processing a suffix like -ABLE as separate graphemes and phonemes, it gets consolidated into one unit for both reading and spelling purposes (Ehri, 1998), though Frith (1985, 1986) makes the case that it occurs in reading before spelling. The key change in thinking or strategy use for spellers is that in the previous phase they were focusing on phoneme to grapheme relationships and on mapping one-to one correspondences, whereas in this phase they are consolidating consistent letter strings into units and using morphemic patterns and broader regularities that English affords to spell words.

Although Gentry (2000) posits a final phase of correct spelling, logically it makes more sense that consolidation better typifies the final phase of development. Some empirical evidence can be offered that we never arrive at a phase of completely correct spelling. A room of graduate students was asked to spell the word ZEITGEIST. None of the 15 students got it right, suggesting that one's knowledge of spelling continues to improve over time as long as there is continued exposure. While Henderson, Beers and Templeton, in their long line of research (see Bear and Templeton's 1998 review for a detailed history) document the further development of different types of consolidations—syllable juncture, within word patterns—they are just providing details of this broader process and, while important educationally, they do not describe a sufficiently different way of thinking to justify a new phase.

In sum, while there is debate as to what to call the various stages or phases and disagreement on the developmental process, there is really far more agreement than there is disagreement. All of the proposed stages/phases bear a striking resemblance and the disagreement on developmental processes may be more a function of the authors' focus (whether it is descriptive or process oriented) rather than an irreconcilable difference. It is clear that beginning writers follow a developmental progression from producing spellings that do not make use of the alphabetic principle to spellings that follows the conventions of English orthography, and that while there may be differences about how bumpy the path is, everyone is in basic agreement on the direction of the path. More importantly, spelling ability does not develop in a vacuum. Spelling is a cultural construct and it only develops through formal and informal literacy instruction and experiences. The next section looks at these experiences and how they promote spelling development.

Learning to Spell

Spelling instruction, particularly for young children, Pre-K through 1st grade (the grade range of interest in this study) is often handled indirectly. For example, the act of reading has been put forth as a way to promote spelling development. Additionally, instruction in other literacy areas, such as phonemic awareness, phonics, and reading are posited to promote spelling development as well. There have also been investigations into more direct forms of spelling instruction such as promoting invented spelling, copying, or giving indirect or direct feedback on invented spelling. This section reviews these various literacy activities and how they relate to spelling development. But before examining these practices, it is important to examine the underlying learning processes.

In the previous section on spelling mechanisms, the formation of spelling-sound amalgams was discussed (Ehri 1997, 2005). These spelling-sound amalgams represent word level knowledge but how these amalgams are formed is still debated. Given that the phoneme to grapheme relationship is not one-to-one, how do beginning spellers learn which grapheme to apply to a particular phoneme when more than one will do the job yet only one is orthographically correct?

There are two competing theories for how this information is learned. One is that spelling sound rules are learned and generalized to words with regular spellings and exceptions are memorized as isolated cases e.g. like *save* and *gave* as regular words with *have* having to be memorized (Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001). These rules can be used to support the reading of unfamiliar or non-words.

A second group of theories is based on probabilistic associations between spellings and sounds. These theorists argue that irregular words are not random but their spelling sound

correspondences are informed by other words with related patterns and that certain conditions *usually* trigger one pronunciation over another and are in a sense quasi-regularities as opposed to traditional regularities (Pacton, Purruchet, Fayol, & Cleeremans, 2001; Pollo, Trieman, & Kessler, 2008; Seidenberg, 2001; Trieman & Kessler, 2006). The most common of these models are connectionist models. Connectionist models of reading and spelling are computational models designed to simulate the neural behavior of learning to read. In a connectionist model (there are connectionist models for many learning situations not just reading) knowledge is distributed in neuron-like nodes that are grouped together with related knowledge in layers. In the case of reading, Harm and Seidenberg's (1999) model includes phonological, orthographic, and lexical layers in which connections are formed between the information in each layer in the development of literacy knowledge. Mathematically this works by calculating the probability that the activation of one node will activate another related node. These probabilistic weights determine the response to any input and are modified through exposure to new words either through passive means such as reading or active means such as instruction. Additionally, the biggest change in the activation rate should occur with the first exposure, which is consistent with Share's 2004 study, which found significant orthographic learning after only one exposure (this study is discussed in more detail later in this section).

It is easy to see how this could explain the learning of correct spellings. Using the /dʒr/ sounds in the word *drag* as an example, an inexperienced speller when asked to spell, often writes the initial consonant cluster as JR. Though there are alternative graphemes that could be chosen, connectionist theory posits that the grapheme or graphemes (contained in a neural node located in the orthographic layer) to be chosen (activated) are those with the highest weight connecting it to the sounds /dʒr/ (located in the phonological layer). Exposure to the correct

spelling over time should modify the activation weight away from JR to the DR.

These alternative views have ramifications for the present study. First of all, results were expected to shed light on this debate. If the connectionist mode is correct, then the growth curves should reveal a logistic shape with rapid initial growth that levels off asymptotically with mastery of the skill. If the rule based model is correct, then slower initial growth should be followed by a period of rapid growth after a certain number of exposures. The second ramification is that because prior knowledge plays an important role in connectionist explanations of learning, effects should be evident. There are two ways that effect might be detected. Since there was no way to control for prior exposure to the real words in this study, the inclusion of non-words with illegal spelling patterns provided a way to assess the effect of prior knowledge. A second way was to look at the frequencies of these spelling patterns in kindergarten and first grade reading materials to see if patterns that are more common, i.e. the silent E, were learned faster than less common one, i.e. the DR pattern.

Connectionist theory explains how new information is learned and connected to prior knowledge. However, it is not at odds with phase theory in that the bonding of graphemes to pronunciations could be explained equally well either through a connectionist approach or a rule-based model of learning. The next sections examine the mechanisms that have been shown to influence the learning of spellings.

Reading to Learn Spelling

Reading and spelling are closely related—Ehri (1997) reports correlation coefficients between the two skills in the range of .77 to .86. This close relationship makes sense given that the underlying knowledge to spell or read a word is drawn from the same source according to phase theory. It is the asymmetry between spelling-sound and sound-spelling associations that

makes spelling a more complex task and accounts for the differences. Furthermore, Frith (1985) asserts that the development of reading and spelling skills proceeds at an uneven pace with the two skills alternating as the driver for development of the other skill. She argues that logographic reading precedes logographic spelling, alphabetic spelling precedes alphabetic reading, and, in the transition of interest for this study, orthographic reading precedes orthographic spelling. This theory carries two major implications for the present study. First, it suggests that skill in orthographic reading precedes and perhaps predicts development of consolidated/orthographic-level spelling. Second, it suggests that reading in and of itself may be one way that the word level knowledge develops to support these more advanced spellings.

The simplest proposition based on this theory is that reading words helps one learn how to spell words. In his 2000 review of spelling instruction, Graham analyzes studies that examined the effect of reading on spelling. In a series of studies by Gilbert (1934a, 1934b, 1935) and Omrod (1986a, 1986b), which investigated 7th grade through college age readers' ability to learn spellings from reading passages, there is a confluence of findings. High school and college students learned spellings from reading words in passages. This learning was increased if there was priming, whether in the form of a pretest immediately preceding the reading of the passage (Gilbert 1934a, 1934b, 1935) or in the form instructions to read the passage to learn the spellings (Omrod 1986a, 1986b). Additionally, they found that the students who were initially better spellers made most of the gains. Finally, according to Graham, the gains, while statistically significant, were rather modest. However Graham warns,

> "[I]t is important to note that these studies may underestimate the power of reading in spelling development, as readers encounter many words repeatedly and these encounters are spread across a range of materials over time" (p. 241).

While this modest evidence is interesting in that it does support the proposition that spelling is learned from reading, it does not shed much light on the population of interest for this study.

Much research has demonstrated that younger students do indeed transfer knowledge from reading to spelling. In Ehri (1980, reported in Ehri 1997) 2nd grade students learned to read 8 pseudo-words. The students learned one or another of two phonetic equivalents, such as *wheople* or *weepel*. After a four-minute delay, the students were given a spelling test. Not only did the students recall 69% of the spellings they had seen correctly but their misspellings represented the patterns that they had seen rather than phonetically equivalent patterns they had not seen. For example, students who learned the "weeple" spelling never misspelled it with a WH. Additional evidence comes from Ehri & Wilce (1986) where 2nd graders either learned to read 12 words with medial flaps or listened to and pronounced the words. Medial flaps sound the same, more like a /d/, but can be spelled with a D as in *mo<u>d</u>ify*, DD as in *mi<u>dd</u>le*, T as in *wa<u>t</u>er*, TT as in *pa<u>tt</u>ern*. Students in the group that read the words outperformed the listening group 84% to 64% in a spelling test the following day.

Even the conditions under which reading takes place influence the transfer of specific letters. Ehri and Roberts (1979) taught 1st graders to read 16 words. Half read the words in the context of sentences and the other half read the words in isolation on flash cards. Although there was no pretest on spelling to see how much students improved through the reading, a spelling posttest was given. The flash card readers spelled slightly more words correctly than the contextual readers (5.1 to 4.9 out of 16,) but this difference was not statistically significant. However, the students who read from the flashcards spelled significantly more letters correctly: 67.7 to 63.9.

In a line of research looking at the self-teaching mechanism, the effect of reading a new

word was examined to investigate its effect on word reading speed and orthographic learning. Share (1999) had 2nd grade Hebrew speaking students read aloud short stories with embedded pseudo-words. Students were exposed to the words either four or six times. Given that Hebrew is an orthographically transparent language with one or another of two graphemes available to represent one phoneme and that vowels are either marked with diacritics or completely omitted, all the target words could be spelled correctly in one of two ways. Three days later students were given a series of posttests including a spelling test. The spelling test was scored two ways, whole word scoring where the whole word had to be correct, and letter-by-letter. In both case, students wrote the correct spelling or letter better than predicted by chance with little difference between the students who read the words four or six times. A similar study done with English speaking 2nd graders found that students produced the correct spelling 70 % of the time after six exposures (Cunningham, Perry, Stanovich, & Share, 2002). Share (2004) used the same exposure method for Hebrew speaking 3rd graders exposed students to target words only one, two or four times, and administered the spelling posttest at either 3 days, 7 days or 30 days later. Overall, spelling scores were significantly better than chance. There was no significant improvement by adding more exposures and no significant decrease in memory for spellings over time. Amazingly, students with only one exposure still performed better than chance even after 30 days. However, this did not hold true for younger readers, that is first and second graders, whose spelling performance was not significantly better than chance in the second and third experiments in this study.

Together this body of evidence, from both the work with older students and younger students, shows that readers do acquire word-specific spelling knowledge from reading. However, the effects were not uniformly strong, particularly with younger readers. The next

section explores the possibility that more explicit reading instruction could have a stronger effect on learning spellings.

Reading Instruction to Learn Spelling

Two influential forms of reading instruction are phonemic awareness training and systematic phonics instruction. Phonemic awareness (PA) is the ability to identify and manipulate individual phonemes in spoken words. Research has focused primarily on 6 phonemic tasks requiring the isolation, identity, categorization, blending, segmentation, or deletion of phonemes. Phonics is the teaching of letter-sound correspondences and their use to decode and spell. Though these may seem very different in practice, the boundary between PA training, particularly when letters are used, and phonics is blurry. A typical PA activity may include blending sounds (represented with letters) into a word—which resembles the phonics activity of decoding However, in a PA training activity the letter-sound and word reading instruction is incidental to the PA instruction focused on manipulating phonemes in speech. In a phonics activity, the lesson is focused around the teaching of the letter-sound correspondences and their use for reading. Since the process of producing a spelling when the correct spelling is unknown is partly dependent on the accurate segmentation of the word to be spelled and the other part is the correct application of letter-sound correspondences, it makes sense that training in PA, particularly in segmentation, and systematic phonics would aid in the development of spelling skill. This is borne out in the results of two meta-analyses performed by the National Reading Panel (NRP) (2000) and reported by Ehri et al. (2001) and Ehri et al. (2002) for PA and phonics, respectively.

Through searches of electronic databases and hand searches of review articles, the NRP found 52 studies on PA training and 38 on phonics instruction that met their criteria for high

quality experimental research. Since many of the studies compared multiple grades or treatments, they were separated to form 96 cases comparing individual treatments to control groups. In the PA analysis, 39 investigated the impact of instruction on spelling skill. In the phonics analysis, there were 66 comparisons of which 37 included spelling as an outcome measure.

A meta-analysis provides a method to compare the results of different studies on the same topic in a standardized way. Effect size is the statistic used to evaluate the strength of findings—an effect size of 1 means that the pool of treatment group means was one standard deviation above the pool of control group means (represented as *d*). In judging an effect size Cohen (1988) suggests that an effect size of .20 is considered small, an effect size of .50 is considered moderate, and above .80 is considered large.

In the 39 comparisons analyzing the impact of PA instruction on spelling, there was a strong effect of PA training (*d*=.86) on immediate post tests, a moderate effect on the first follow-up tests (*d*=.37), and a small effect on the second follow-up tests (*d*=.20), with all effect sizes significantly greater than zero. However, as an investigation of the homogeneity of effect sizes revealed, the effect sizes were not homogeneous, meaning that there was additional variance in the results that could be further explained through a consideration of other characteristics of the experiments (moderator variables). While not all of the moderator variables were germane to the present study, there were some that did have a direct bearing on it.

The first finding was that PA instruction exerted the strongest effect on spelling during kindergarten and first grade (*d*= .97 and .52, respectively) with the effect for second through sixth graders being insignificant (*d*= .14). This effect may be due to a variety of reasons. One possibility suggested by Ehri et al (2001) is that older children already have more PA and would

therefore have less to gain from PA instruction. Another possibility is that grade is confounded with reading ability since most of the studies on second through sixth graders were done to help disabled readers (14 out of 18) and the effect size for disabled readers was not significantly different from zero (*d*= .15). While the exact causal relationship is not elucidated, it is clear that younger (kindergarten and first grade) non-disabled readers stand to make the most gains in spelling from PA training.

Of primary interest for the current study were the characteristics of PA training that exerted the strongest effects on spelling acquisition. Since the participants of the present study were kindergarten and first grade non-disabled readers, the information provided on this subset within the meta-analysis is relevant. One moderator variable that Ehri et al (2001) examined was the number of PA skills taught. The effect sizes on spelling for one skill, two skills, and three or more PA skills being taught were .77, .89 and .93, respectively (see Table 5 in Ehri et al, 2001). Although they were all significantly different from zero there was not a significant difference between skill sets. Likewise there was no significant difference between studies that taught blending and segmentation only and those that taught three or more skills (.85 and .93 respectively). However, one factor that made a clear difference in how PA training transferred to spelling skill was the use of letters in a training program. Without the manipulation of letters there was a moderate effect size (*d*=.57), but with the manipulation of letters there was a large effect (*d*= 1.00) with the contrast being statistically significant. In summary, PA training is most effective in developing spelling skill in kindergarten and first grade for non-disabled readers when letters are manipulated regardless of the number of PA skills taught.

In the analysis of systematic phonics instruction, Ehri et al (2002) found an overall effect for the impact of phonics instruction on word spelling ability (*d*= .35). When analyzed by grade

level there was a moderate effect for spelling transfer in the 13 studies that investigated kindergarten and first grade (*d*= .67). However, similar to the findings in the PA study, the results for the older students were weaker and in this case the findings for 2nd through 6th grade were not significantly different from zero (*d*= .09). Spelling scores were not examined separately for other moderator variables so the effects of instructional moderators cannot be linked to spelling outcomes.

Findings in these two meta-analyses provide strong evidence that spelling skill can be improved through indirect means such as PA and phonics instruction. However, since the act of creating an invented spelling is a PA and phonics activity—the segmentation of the word into individual phonemes, applying letter sound correspondences to produce a spelling, and blending the phonemes into a pronunciation to check the spelling—this result is not surprising, particularly since many of the spelling outcome variables were invented spelling tasks. In addition, some of the studies actually taught spelling as part of the intervention**.** The next section reviews studies that taught spelling with either the goal of better spelling or better reading.

Spelling Instruction to Improve Reading

Ehri and Wilce (1987) taught children with beginning literacy skills (on average they knew about 24 letters of the alphabet and could read 4 out of 22 preprimer words) to spell words with simplified phonetic spellings. The simplified phonetic spellings were constructed with 6 consonants and 4 long vowels to form words like TE (pronounced tea) and SITS (pronounced sights). The children were taught to spell through a process of placing letter tiles on an L shaped frame and saying the sounds of the letters as they placed them (a phonemic segmentation activity). Corrective feedback was given for misspellings, and helpful hints were provided such as advising the children to look for sounds in the letter names and to pay attention to the

articulator features of the words. The children were taught to spell seven word lists ranging from CV words to CVCC words. Children in the control group received instruction in letter sound correspondences pertaining to these same 10 letters.

The main focus of the investigations was to see if instruction in spelling improved reading ability with similar but untrained words. Following spelling training the children practiced reading phonetically simplified words made up of the 10 letters in the training, but that were not taught in the training, such as STON (pronounced stone) and SOP (pronounced soap). Children in the spelling training group did learn to read significantly more words (*M*=4.8) than children in the control group (*M*=2.7). Although this difference was significant, it was somewhat truncated due to similarities in the words and the reliance on phonetic cue reading as a word reading strategy. However, children who were trained in spelling were able to spell non-words better than controls (*M*=9.0 words vs. 3.4 out of 12), to recognize misspellings better (*M*=10.2 vs. 6.1 out of 12), and to segment words into phonemes better (*M*=6.5 vs. 1.9 out of 11)(all p's< .01).

In a study that extended this idea of spelling training to improve reading, Uhry and Shepherd (1993) implemented a 6½ month long program to train 1st graders to segment and spell phonetically regular words. In two 20 minute sessions a week, students in the training program segmented words using Elkonin boxes and blocks or moveable letters, spelled CVC words from dictation, and played computer games focused on spelling, while the control group spent the same amount of time on instruction and computer games focused on letter sound instruction and word reading. The results were similar to Ehri and Wilce's (1987) study, in that the students in the segmentation and spelling condition not only made significant gains in both word and non-word reading as measured by the *Woodcock Reading Mastery Tests* and oral reading as measured

by the *Gray Oral Reading Tests*, but also performed better in spelling and phonemic awareness tasks as well. Even though the students received training in correctly spelled words rather than phonetically simplified spellings, the spelling outcome measures (the *Spellmaster Diagnostic Tests*) were scored using a system that gave credit for partially correct spellings, thus providing a measure of invented spelling. Students who received the spelling and segmentation training performed similarly to those who received reading training on the CVC word spelling measure (however, both groups were close to the maximum score possible). In spelling **CVC or CVCC** words and in spelling words with what was referred to as "orthographic or analogy spelling" (pg. 226) the spelling/segmentation group performed better than the reading group, M = 46.2 to 43.8 (maximum score 50) and M = 80.6 vs. 73.9 (maximum score 130), with both differences being significant using initial spelling as a co-variate.

A final study in this line of research was conducted by Ouellette and Senechal (2008b) who examined the effects of teaching invented spelling on learning to read. One group received instruction and feedback on constructing invented spellings for the 20 target words. A second group was trained to match initial sounds from the target words and also to segment the same words into Elkonin boxes using tokens. A third group drew pictures of the target words as a control. After nine sessions spanning a four week period, the children in the invented spelling group showed significant improvements (after controlling for initial status) over the phonological awareness group in invented spelling ($t(66) = 2.70$, $p < .01$) and in reading words with practice ($t(66) = 3.32$, $p < .001$). However, there was no difference in reading new words ($t(66) = 0.85$, $p = .40$) and in phonological awareness ($F(2,66) = 0.23$, $p = .80$).

Collectively these results indicate that teaching beginning spellers to segment words into their constituent phonemes and teaching either invented, correct or phonetically simplified

spelling leads to better invented spelling and reading. That teaching invented or correct spelling leads to better invented spelling may not seem remarkable, unless one considers that this training helped children spell unfamiliar words. That is, training to spell specific words helped teach children a general skill enabling them to analyze and spell new words. What these studies do not pinpoint is which specific experiences help beginning spellers make the transition to correct spellings.

Invented Spelling to Teach Spelling.

In his 2000 review of spelling instruction, Graham addressed the question of whether natural learning of spelling should replace spelling instruction. While most of the article focused on spelling instruction for older children, he did look at first-grade spelling instruction, which is the grade most analogous to the population of interest in the present study. He identified 3 studies that had correct spelling as one of the outcome measures. Callaway, McDaniel, and Mason (1972) randomly assigned 5 first-grade teachers to 5 different spelling trainings, two of which were based on traditional weekly spelling lists and the other 3 were asked not to teach spelling. Of the non-spelling groups, one group had the students write about their readings, another wrote about unrelated materials, and the final group was asked to minimize writing altogether. They found a small but significant difference on a spelling vocabulary test for the group with no spelling instruction that wrote about their readings over the rest of the groups. However, Graham points out methodological problems, such as the use of individual students' scores as opposed to the classroom score, as the unit of analysis that make these results hard to interpret. Additionally, the use of one teacher per intervention introduces the possible confound that what is being measured is teacher effects. While Graham posits "the natural spelling method can be as effective as traditional spelling instruction in promoting spelling achievement at the

first grade level" (Graham, p. 237), I would argue that these results must viewed as only suggestive due to the methodological issues.

Similarly, Kleisus, Griffith, and Zeilonka (1998) analyzed 6 intact first grade classrooms—three that used a whole language approach and three that used a traditional spelling program. There was no formal spelling instruction in the three whole language classes whereas the three traditional classes had weekly spelling tests. At the end of the school year there were no differences between the students on a standardized spelling vocabulary test.

The final study Graham examined was a quasi-experimental study that compared 4 first grade classrooms—two that encouraged invented spelling over the course of the year and two that encouraged correct spelling (Clarke, 1988). Over the course of the year writing assignments were given to assess students' spelling skill in a naturalistic way (i.e., not a spelling test). The children in the invented spelling classrooms wrote significantly longer passages (M=40.9 vs. 13.2 words on average). However, the proportion of correct spellings was far lower in the invented spelling groups than in the correct spelling groups (M=58.4 vs. 94.0, t= 8.90). On standardized measures of reading and spelling, the students in the invented spelling classrooms outperformed students in the traditional classroom on every test except for word reading in the flash condition. However, further analysis revealed that almost all of the gains were from low achieving students.

Taken together, findings of these studies suggest that encouraging invented spelling in first grade is as effective as traditional methods of spelling instruction and is perhaps more helpful for beginners in helping them develop a better understanding of the grapho-phonemic system. Yet, in the Clarke (1998) study, the students in the invented spelling classrooms misspelled almost half of the words in their writing passages. This could be explained by the

fact that their instructional environment encouraged them not worry about correct spellings, so they did not feel constrained in their word choice. Additionally, this could account for the much longer passages written by the students in the invented spelling classrooms. However, it does not offer evidence that encouraging invented spelling helps first graders advance to the level where most of their spellings are correct. At best it seems to offer evidence that allowing children to invent spellings is not harmful to the spelling development of more advanced children and is probably helpful to children in the earlier phases of development. Others have looked at how to support spelling using more direct practices than invented spelling.

Direct Feedback to Teach Spelling.

This section reviews two studies that provided direct feedback to spellers. The feedback that spellers received ranged from seeing or learning to read the correct spelling, to practice in segmenting the correct spelling, to instruction on the orthographic patterns contained in the correct spellings.

Rieben et al (2005) examined various word-writing practices to see which promote development in the literacy domains of phonological (invented) spelling, correct spelling, and word reading. Four groups of French-speaking first graders were exposed to different instructional conditions for 18 twenty-minute sessions over the course of 6 months. The treatments consisted of practice either inventing spellings or copying spellings, or inventing spellings with feedback on orthographic patterns, or drawing practice. Those in the invented spelling condition were asked to write labels for pictures presented by the experimenter. Each word was written twice. In the invented spelling with feedback condition, the children were given the same task as in the invented spelling condition except that after their first attempt, the experimenter complimented the child on his or her spelling and then offered corrective feedback

by writing the correct spelling and highlighting orthographic features of the word, like silent endings, but not phonological aspects. In this condition the children were only asked to write the word once as opposed to the invented spelling and copied spelling conditions. In the copied spelling condition children were presented with the picture and the correct spelling and were asked to copy it twice. In the drawing condition, the children worked on art projects unrelated to the words being used in the study. Outcome measures consisted of letter production, phonemic awareness, reading, and spelling. Multiple scores were derived from the spelling and reading tasks to assess different aspects of the learning. The spelling posttest was broken down into two lists. One consisted of words that were practiced as part of the treatment, and the other list consisted of words that were new to the children. These were then scored two ways. One method was to award a point for every phonologically plausible grapheme used in the spelling (phonographic spelling). The other method was to award a point for particular orthographic features (orthographic spelling) like silent letters and particular vowel spellings (i.e. O, AU, and EAU all producing the long O sound). A similar system was used for the word-reading task with an additional derived score for correct readings of the words.

Of these 12 outcome measures a MANOVA revealed only three significant main effects. The invented spelling with direct feedback group outperformed the other groups on the measures of orthographic spelling for new words, orthographic reading of practiced words, and correct reading of practiced words. Planned comparisons of these three significant results revealed that of the 9 possible contrasts between the treatment conditions (e.g. invented spelling with feedback vs. the other three conditions individually) 7 of them were significant. The significance of the orthographic measures makes sense because the feedback given to this group was concerned with these particular orthographic features. However, these gains, while significant, did not

represent a move to correct spelling. Of the 13 possible correct orthographic features, the group receiving feedback on average only got 2.2 correct (SD= 1.9). It is noteworthy that the group that received feedback outperformed the other groups on every outcome measure although most did not reach statistical significance. This may be explained in part by the fact that 18 twenty-minute sessions over six months (less than 20 minutes a week) is a relatively weak intervention. Perhaps with a more concentrated intervention, the movement towards correct spelling would be stronger.

Pilot Study

The pilot study for the present investigation (Lauterbach, 2004) took a different approach. It consisted of one long intensive training session as opposed to short spread out sessions. The purpose of the study was to investigate whether young spellers in the partial alphabetic phase would learn the conventional spellings if they practiced reading them on flash cards or if they practiced segmenting them into phonemes. The training words contained spelling patterns that typically trip up children in this phase of spelling. For example, words that presented a phonetic challenge such as *train* and *drag* with initial consonant clusters that are often misspelled by beginners, and words that contained difficult orthographic patterns, for example *rock* with redundant graphemes representing the final /k/ sound were employed. The focus of the analysis was on the following hypotheses:

- Kindergarten children will demonstrate growth in the acquisition of conventional spelling patterns after being exposed to them in either condition.

- The segmentation with letters condition will lead to more growth in conventional spellings than the word reading condition.

- Invented spelling, alphabetic naming, speed, and word reading will be, in that order, the best predictors for both rate and amount of growth.
- Phonetically based spelling patterns will be easier to acquire than orthographically based patterns.

Twelve end-of-the-year kindergarteners and two early 1st graders were pre-tested on a range of literacy skills—letter naming, letter sounds, vocabulary, a numerical RAN test, phonemic awareness, invented spelling, and word reading. Nine of the 12 students were drawn from public funded day care centers and the remainder came from inner-city parochial schools. There was a wide range of literacy skills as can be evidenced in Table 2. An interesting and important aspect of this group was the distribution of the reading scores. The mean was not very high-2.9-and there was a bimodal distribution, with one
group of four students reading between 4-8 words and the other group reading no words except for one student who read the word *the*.

There were two training conditions, one in which the students learned to read the words on flash cards and the other where the students segmented the words into Elkonin boxes. After each trial the students were given a spelling test. The alternating training and test trial sequence was repeated up to four times. The targets were words that present particular challenges to beginning spellers, either phonologically (e.g. the DR in *drag* or orthographically like the silent E at the end of *wine*). The study was a repeated measures design. The two types of training took place back-to-back with training conditions and

Table 2.

Performance on pretest measures in the pilot study

	Minimum	Maximum	Mean	Std. Deviation	Possible Score
Letter Name	46	52	49.56	2.068	0-52
Letter Sound	6	26	18.78	7.446	0-26
Letter Naming Flash	33	51	42.33	6.364	0-52
PPVT	47	85	67.63	12.165	0-294
RAN	11	19	14.75	2.866	n/a
Phonemic Awareness	0	42	17.00	14.765	0-42
Spelling	22	114	66.22	37.549	0-164
Reading	0	8	2.89	3.516	0-15

Note. There were 12 students tested.

word lists counterbalanced across participants. Additionally, there was a spelling transfer test of untrained words containing the taught spelling patterns that was given as a transfer task and a recall test, was given a day after the training.

Students were awarded a point each time they correctly represented a taught spelling pattern that they misspelled on the pretest. This was used to calculate a growth score for each trial. So a participant who got 2 of the spelling patterns correct on the pre-test and then got 2 more correct on the first trial would have a growth score of two on the first trial. While this scoring method could attenuate the scores of the better spellers because they would have less opportunity to show improvement, this was not a problem as few students received high scores on the pre-test and none of the scores was close to ceiling.

The first analysis was performed to investigate whether there were any differences in the number of spelling patterns learned in each condition. A univariate GLM analysis revealed that the flash card group and the segmentation with letters group did not differ significantly on the number of spelling patterns learned. The growth scores were then collapsed across condition to create a total growth score (e.g. a student who had a growth score of 2 in the first trial of the segmentation with letters condition and a growth score of 1 in the first trial of the flash card condition would now have a growth score of 3 for the first trial for the remainder of the analysis). A two level HLM growth model (Raudenbush & Bryk, 2001) was developed to explore the rate of growth over time and what literacy skills best predicted growth. An exploratory analysis confirmed that word reading was the best and only variable for making predictions about growth[4,5]. Thus, a model was developed to analyze individual growth with reading as the predictor for both the intercept, which in this case is modeled as the final outcome[6], and growth, which is the slope for each individual's growth curve. The final model looked like this:

Level-one:

$$Y_{ij} = \beta_{0j} + \beta_{1j}\,(\text{time}) + r_{ij}$$

And the level-two equations are:

$$\beta_{0j} = \gamma_{00} + \gamma_{01}\,(\text{reading}) + u_{0j}$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}\,(\text{reading}) + u_{1j}$$

[4] Exploratory univariate analysis of a final growth score revealed that phonemic awareness (R^2= .62, *B*=.18), spelling (R^2= .70, *B*=.07), and reading (R^2= .82, *B*=.84, all *p* values less.01) all made contributions to growth with reading accounting for almost all of the unique variance.

[5] HLM does an exploratory analysis for all potential predictors and reading was the only one with a *p* value under .05.

[6] This is a technique where reverse time coding is used so that the intercept represents the final score instead of the initial one and so that the interpretation of the intercept represents the main effect of the training at the end of the trials.

The level one equation is for the individual and the level two equations are the equations for the slope and intercept of the individual. The results show that the intercept was 3.2 with a reading coefficient of .9[7] and a growth slope of 1 with a reading coefficient of .3, all p values were less than .001. To translate into real terms, a participant with a 0 reading score was expected to learn about .6 spelling patterns over 4 trials yielding a slope of about .15 new patterns per trial. A student with a reading score of 8 (the highest in this group) was expected to learn about 6 conventional spelling patterns over 4 trials with a learning slope of about 1.5 new patterns per trial.

Regression models are convenient in that they help to make order out of chaos—in this case "nice" regression lines that predict the growth in the acquisition of conventional spelling patterns. The reality is that the growth was inconsistent and rare (only about 33% of the potential spelling patterns were ever produced even once) and much of what was learned did not crystallize into information that was remembered consistently or transferred to other words. Within the experimental learning tasks, students would write the spelling conventionally on one trial and revert to their invented spelling on the next. One participant even spelled the ST correct on the pretest and then spelled it with only an S after being exposed to the correct spelling. Recall of the taught patterns one day later was not particularly strong. Of the 13 patterns produced in the segmentation with letters condition only 8 were recalled a day later. Of the 18 patterns produced in the word reading condition only 8 were produced in the recall test a day later.

To test the final hypothesis about whether phonetic patterns were more easily learned than orthographic patterns, three patterns (phonetic, orthographic and medial vowels) were

[7] The reading scores were centered for this analysis so any student below the average had a negative score.

compared. Medial short vowels were categorized differently because they proved to be extremely difficult. Only 6 times in 35 opportunities were they written correctly compared to 23 out of 59 for phonetic consonants and 15 out of 40 for orthographic consonants. The Chi Square was partitioned with phonetic and orthographic patterns being compared first. This difference was not significant ($c^2 < 4$, $p > .05$ for both), so they were combined and compared to medial vowels. This difference proved significant ($c^2=5.29$, $p=.021$).

To summarize the findings, participants did demonstrate some ability to acquire conventional spelling patterns after repeated exposures. There was also evidence of retention and transfer though these results were not strong. There was no difference in the amount of growth based on the method of exposure. Word reading and segmentation with letters seemed to work equally well except in terms of transfer where segmentation with letters was more effective. Although this finding was very small and statistically not significant, it may be indicative of a potential trend. Reading, spelling, and phonemic awareness were all significant predictors of growth, though word reading accounted for almost all of the unique variance. Reading was also the best predictor of the slope of the participants' growth curves.

It was expected that segmentation with letters would promote more growth in correct spelling than word reading. One explanation why this did not happen is that the treatments were not all that different in their impact on the readers who demonstrated almost all of the growth. For them, reading the word may have activated processes that were equivalent to those activated when words were segmented. This is supported by the research on the self-teaching hypothesis where the process of phonological recoding while reading an unfamiliar word would have many of the same learning properties as segmenting the word (Cunningham et al., 2002; Share, 1999, 2004).

There are two caveats to this. First, transfer was better in the segmentation with letters condition. One explanation is that segmenting and fully analyzing the word better highlighted the sound to spelling rule to be learned and caused the rules to be generalized better. However, generalizing rules from one exemplar seems unlikely unless the student already had prior knowledge about the spelling pattern. Another way to explain this would be through the lens of connectionist models of spelling. In the pilot study, reading the words may have shifted the weights away from a JR spelling to a DR spelling, and segmenting the word may have shifted the weights to a greater extent creating a greater likelihood that the DR would be activated in the transfer task (Cunningham et al., 2002; Harm & Seidenberg, 1999; Share, 1999, 2004)..

The second caveat is that the amount of growth in general was minimal and among the poorer readers (those who scored a 1 or less on the word reading pretest) almost nonexistent. Perhaps if the treatment had occurred over a longer period of time, segmentation with letters may have been more helpful to the nonreader, a possible treatment by ability interaction. For those poorer readers, a full analysis of the words should have been more helpful than seeing words on flash cards and reading them using partial phonetic cues.

While neither the Rieben et al (2005) or the Lauterbach (2004) studies had strong effects, both indicated that giving beginning spellers feedback in correct spelling in various ways, helped the spellers to acquire conventional (orthographic) spelling patterns. Their results also suggested that a more intensive treatment might promote significant growth in the development of conventional spelling.

Summary

In summary, if refinement of spelling skill involves the process of developing more precise spelling pronunciation amalgams, as suggested by phase theory (Ehri, 1997, 2005), then

there is evidence of multiple routes for this refinement. As was demonstrated, the act of word reading helps to develop spelling skill (Cunningham, Perry, Stanovich, & Share, 2002; Ehri, 1980; Ehri & Roberts, 1979; Ehri & Wilce, 1986; Gilbert, 1934a, 1934b; Omrod, 1986a, 1986b; Share, 1999, 2004). Furthermore, reading in isolation rather than in context helps to reinforce spelling better (Ehri & Robbins 1979). Although these gains were consistent, the effects were rather modest. However, Ehri and Ehri & Wilce demonstrated strong effects, not for overall correct spellings, but for particular spelling features within the words. Reading instruction, in the form of phonemic awareness training and phonics instruction (Ehir et al., 2001; Ehri et al., 2001) makes a strong contribution to spelling development. Spelling instruction that incorporates phonemic awareness skills is effective as well (Ehri & Wilce, 1987; Ouellette & Senechal, 2008b; Uhry & Shepard 1993). Another line of evidence, best supported by Clark (1988) and moderately supported by Callaway et al (1972) and Kleisus et al (1998), suggests that merely allowing students to invent spellings will improve spelling skill. Rieben et al (2005) present evidence that that process is augmented by feedback on orthographic features, whereas Lauterbach (2004) provides evidence that for children with basic reading skills even short term exposure to the correct spelling via either segmentation with letters practice or word reading supports growth in the acquisition of correct spelling patterns. All this evidence supplies the underlying rationale for the particular treatments in the present study to be discussed in the next section.

Chapter III Rationale and Hypotheses

The plan for this study was to investigate three treatment conditions—segmentation with letters, word reading, and invented spelling—to address the following questions:

1. Do students learn new spelling patterns after being exposed to them?
2. Is the acquisition affected by the way students interact with the words?
3. Is acquisition influenced by spelling features of the words (i.e. phonetic, orthographic or non-word features)?
4. Is acquisition affected by students' prior literacy knowledge?
5. Do students transfer this knowledge to similar untaught words?

To answer these questions seven pretests were administered and three independent variables were manipulated: spelling instruction, spelling features in the target words, and reading level of the participants.

The seven pretests (letter production, invented spelling, word identification, vocabulary, letter naming fluency, phonemic segmentation and non-word reading) were given for two purposes. The first purpose was to screen students to make sure they had the appropriate knowledge and skills to be included in the study. The second purpose was to use pretests as predictor variables in the growth model. The two variables being used to screen students were the letter production and invented spelling task. The letter production task was used to assess whether the students were able to write all of the letters being used in the experimental task, the transfer task and the posttests. Only students who were able to write all 21 of the letters used in these tasks were included in the study. The invented spelling task was used to insure that the students did not already know the target spelling patterns. All seven of the pretests were used as potential predictors for the growth model. Their selection was based on basic literacy skills that

have shown a strong relationship with spelling development (Clarke, 1988; Ehri & Wilce, 1987; Lombardino et al., 1999; McBride-Chang, 1998; Morris & Perney, 1984; Richgels, 1995; Shatil, Share, & Levin, 2000; Silva & Martins, 2003; Treiman, Sotak, & Bowman, 2001; Uhry, 1999).

There were three levels of spelling instruction: word reading, segmentation with letters, and the minimal treatment control. The word reading condition is supported by a line of research demonstrating that the act of reading the correct spellings and writing the words without corrective feedback is sufficient for the developing speller to learn these difficult spelling patterns (Cunningham et al, 2002; Ehri, 1980; Ehri & Roberts, 1979; Ehri & Wilce, 1986; Gilbert, 1934a, 1934b, 1935; Omrod, 1986a, 1986b; Share, 1999, 2004). The segmentation with letters condition is supported by other research (Ehri, 1987; Rieben et al., 2005; Uhry, 1999) which suggests that a more detailed analysis of the spellings of words, such as segmenting them, provides better support for learning the correct spellings. The invented spelling condition was a limited-treatment control group. While Rieben et al (2005) make the case that this is a weak intervention at best, Callaway et al (1972) Clark (1988) and Kleisus et al (1998) make the case that inventing spellings can make a positive contribution to the development of correct spelling. However it was important to assess the invented spellings of these students with the same schedule as those in the treatment conditions because this allowed for the modeling of growth curves for spelling development in the absence of explicit instruction or exposure.

The second independent variable was the type of spelling feature in the target words. There were nine words that were practiced in the study and each had a target spelling pattern that is typically unknown to students of this age yet not so complex as to be impossible to learn. Three of the words had target spelling patterns in which the underlying phonology created difficulty in identifying the correct grapheme. Three of the words contained target spelling

patterns where the orthographic pattern had no phonological trace, at least to beginners unfamiliar with higher order spelling patterns. The final three words were non-words with spelling patterns either uncommon or not used in English.

In the first category were spelling features that Read (1971) identified in his analysis of the invented spellings of young children as particular areas of difficulty. In a word like *drag*, the DR is affricated bringing the pronunciation closer to /dʒr/ though it is still marked orthographically by DR. This leads children to produce spellings like JRAG for DRAG. This is similar to the TR in TROT, which is also a post-alveolar affricate, pronounced much closer to /tʃr/. The nasal consonant following a vowel in a consonant cluster is often omitted, because its pronunciation overlaps and co-occurs with the nasalized vowel making it difficult to detect the consonant as a separate phoneme. This leads to invented spellings of BUP for the word *bump*. In all these cases, students can accomplish the shift from their deviant phonological inventions to correct spellings of the words by revising their phonological analyses. Hence the difficulties are regarded as phonological.

The words in the orthographic category were either silent letters, in this case the silent E in *fine,* or redundant letters (geminates or pseudo-geminates) the CK at the end of luck, and SS at the end of *pass*. While there is a principled reason for each of the spellings—silent final E indicates that the vowel preceding the consonant before the E is given the long pronunciation, CK is a 15th century replacement for KK and only occurs after single letter short vowels, and SS is used to spell the /s/ sound at the end of monosyllabic words. There is nothing in the pronunciation that signals the need for the additional letter (Venezky, 1999).

A final category of non-words was added for the proposed study—three words with spelling patterns of interest that are illegal or uncommon in English. *Rret* (pronounced /ret/) with

an illegal initial doublet RR, *khib* pronounced /kib/ with the uncommon but legal silent H after the K (e.g. *khaki*), and *nwg* (pronounced /nʌg/) with the W being used as the medial vowel, were included in the experimental spelling task. This was done to investigate the role of prior knowledge and exposure to spellings. Although the students participating in this study were tested to ensure that they did not write any of the target spelling patterns correctly, this did not mean that they had not been exposed to these spelling patterns before. Because unmeasured prior exposure could exert an influence on the acquisition of real words, non-words were included to control for prior exposure. The final independent variable to be manipulated was that of reading level. In the pilot for the study (Lauterbach, 2004), students who could read even a few words (two or more) accounted for almost all of the growth in learning new spelling patterns. To ensure that readers and non-readers were equally represented in all the conditions, students were divided into two groups based on the word reading pre-test and randomly assigned to each condition.

There were four major models and outcomes tested. The first was the growth model that analyzed the spelling scores across trials. By utilizing the scores from each trial and creating a longitudinal growth model for each student, this allowed assessment of effects of the treatment conditions as well as the contribution of the predictor variables from the pretests. Additionally, this model allowed for the analysis of the relative difficulty of the various spelling patterns. The second outcome measured was the transfer training task given in a session after the last training trial. This task was the same training as the first trial in each of the training conditions, which involved three repetitions of the training task except new words with the same spelling patterns were taught. This allowed for the rate of learning in the first training session to be compared to the rate of learning in learning in the transfer session to examine if the rate of learning improves

with a second exemplar of the spelling pattern.

The final two measures were administered one-week after the final training session. The first was a delayed recall test of the taught words and an additional transfer task on similarly spelled but untaught words. They were scored in two ways. One was based on whether students correctly represented the spelling patterns of interest in both the taught words and the untaught words. It was also scored in the same way as the invented spelling pretest to examine the possibility that students' spelling inventions, while not orthographically correct, became more complex and accurate. The final outcome measure was an orthographic choice test where students were asked to choose the best spelling of a word from two options. Each of the words contained one of the spelling patterns of interest with one choice being written correctly and the other choice representing a typical invention e.g. DRAGON and JRAGON. This allowed for determining whether orthographic learning took place even when students were not yet able to represent it in the spellings they produced.

Not only was the selection of variables important in this study but also the methodology and design presented unique challenges as well. Often educational research relies on a classic pretest, treatment, posttest design. While that works well in many situations, in this case, that design was not optimal. The investigation focused on cognitive change, specifically from a phonetic strategy of spelling to the formation of spelling-pronunciation amalgams that help learners remember correct spellings. To best capture this, it was considered more informative to look at the process of change in as much detail as possible, not just the beginning and end points. One such methodology is that provided by the micro-genetic method (Siegler, 1996). According to Siegler, the key components of a micro-genetic analysis are that: "(a) the observations span the period of rapid change in the competence of interest; (b) the density of observations is high

relative to the rate of change in the competence; and (c) observations are subjected to intensive trial-by-trial analysis, with the goal of inferring the processes that gave rise to the change." (Siegler, 1996 p.178). In other words, a micro-genetic study is an intensive longitudinal study over a short period of time, where one expects to observe a change in behavior. It is also a method that is designed to look at the process of change instead of just initial and final status.

In redesigning the pilot to develop this study, these issues were taken into consideration. To address the first issue, the time of the study was lengthened to encompass enough trials that the average student (according to a linear projection of growth based on the pilot data) should be able to learn most of the word spellings without suffering from the fatigue of too many trials in one session, as was the case in the pilot. To address the second issue, the number of observations was increased so that the process of change can be observed in detail and to maximize the likelihood of being able to model stable growth curves. Finally, use of a two-level HLM model (Raudenbush & Bryk 2002) allowed for the intense trial by trial, spelling pattern by spelling pattern analysis that revealed the process of change[8]. This aspect of the micro-genetic methodology is crucial to this study. As student responses are not expected to be stable (Bear & Templeton, 1998) it is important to look at the entirety of the student responses so that that period of instability can be captured and not missed if the student happens to miss the answer on the posttest.

The comparisons examined in this study are not merely esoteric academic questions. Given that teachers only have a limited amount of time to teach, it is important to investigate which instructional practices are more efficient and whether certain literacy skills develop on

[8] This represented an improvement in that it allowed for the simultaneous analysis of spelling pattern, literacy skills and individual growth in contrast to the pilot study that analyzed them separately.

their own with minimal instructional intervention. It was also considered important to see whether instructional practices are better implemented when students possess a certain level of background knowledge and whether features of the material to be taught differentially affect the optimal instructional practices. Another key consideration of educational research is whether or not the taught skills transfer.

The rationale supporting the selection of treatment conditions, design, and stimuli as well as the rationale for the necessity for a study of this nature justified the use of specific methods that were substantially different from the pilot. Given the theoretical and evidentiary support for these changes, it was expected that the methods detailed in the next section would lead to a study that answered the following research questions with their concomitant hypotheses:

1. Do students learn new spelling patterns after being exposed to them?
    a. Students will demonstrate growth in learning the target spelling patterns in the two training conditions but not in the minimal-treatment condition.
2. Is the acquisition affected by the way students interact with the words?
    a. Students in the segmentation condition will learn the spelling patterns better than those in the word reading condition.
3. Is acquisition influenced by spelling features of the words (i.e. phonetic, orthographic or non-word features)?
    a. Words with phonetic spelling features will be easier to learn than orthographic features, which in turn will be faster than non-words.
4. Is acquisition affected by prior literacy knowledge?
    a. Word reading skill will be the best predictor of learning.

5. Do the students transfer this knowledge to similar untaught words?

    a. Students will demonstrate faster growth in the transfer task than in the initial training session.
    b. Students in the segmentation condition will show greater transfer of learning than those in the word reading condition.
    c. Data patterns in the transfer task will support probabilistic learning theories (e.g. connectionist and statistical learning theory) over rule-based learning theory.

Chapter IV Methods

Participants

The 49 students for the study were kindergarten and 1st grade students from three urban schools. Fourteen came from a private kindergarten program that primarily serves families in public housing. The remaining 35 students came from two inner city parochial schools. Kindergarten students (N = 35) participated in the spring (between March and May) and 1st graders (N = 14) participated in the fall (between October and December) of the school year.

While individual information on the students' socio-economic status (SES) was unavailable, all of the schools were in low SES neighborhoods and served primarily low SES populations. The two parochial schools both received title I funding (Federal funding for schools serving disadvantaged populations) and, while the kindergarten programs were administered by a private organization, the funding and oversight was provided by the Administration for Children's Services, an agency which provides free and low cost child care based on economic need. All schools employed kindergarten and first grade curricula that emphasized code based instruction. However, there were some differences in instruction that did relate to features of the present study. One key difference was that students at the private kindergarten were given opportunities to free write during free time at the writing center. While this presented a chance for students to practice invented spelling it was not supported by the teachers and students were mostly observed drawing at the writing center. The second key difference was that the Parochial schools employed a very structured curriculum with scripted lessons and work books, whereas the private kindergartens employed a less structured code based instruction program, which in the researcher's interactions within the classroom, had less fidelity.

Students who returned consent forms (see Appendix A) had to meet basic requirements to qualify for participation in the study. First, students had to demonstrate on the letter production pretest (see below) the ability to write the letters to be used in the experimental task (i.e. all the letters but Q, X, Y and Z). This was to ensure that lack of motor control did not prevent children from writing correct spelling patterns (Puranik & Apel, 2010). A second qualifier was that the students could not represent correctly any of the targeted spelling patterns on the spelling pretest. This was to insure that the students did not already posses secure knowledge of the spelling patterns to be taught. Finally, to ensure that linguistic issues, such as lack of English language skill, were not interfering with the treatment conditions, students whose standard score on the Peabody Picture Vocabulary Test, Fourth Edition (PPVT-4) was more than one standard deviation below average were excluded from the study.

Seventy-four students returned the consent forms of which 49 met the requirements for participation in the study. Of those that did not meet the requirements, 13 were 1st graders and 12 were kindergartners. Twelve of the 1st graders were disqualified for knowing one or more of the spelling patterns to be taught, and the other 1st grader was disqualified for a low vocabulary score. Four of the kindergartners were disqualified for knowing one or more of the spelling patterns to be taught, seven for low vocabulary scores, and one for not being able to adequately write his letters. Those students who did not meet the requirements were not informed of this but rather were given small group spelling instruction similar to the intervention. This was done because they had made the effort to fill out the consent form and expected to be included in the study. The investigator considered it ethical to provide them with some sort of spelling intervention rather than drop them from further participation, so a fun spelling instruction program related to the intervention was provided. the requirements.

Students who returned the consent forms and met the requirements were given the rest of the pretests, and then divided into two groups based on word reading scores. Those with scores higher than two were the high group and those with scores of two or below were the low. Students were randomly assigned to one of the three conditions. The stratified sampling method helped to insure that reading ability was as evenly distributed across the conditions as possible. The reading score selected was based upon results of the pilot study and represented the cut off in reading skill that influenced growth in spelling acquisition. This cutoff point is somewhat arbitrary. However, given that in the distribution of reading scores all students read either fewer than two words or more than four words (see pilot section for fuller discussion of the distribution), it allowed for the use of rolling cohorts of subjects. The random assignment was done on a cohort by cohort basis with 40% of each cohort assigned to one of the treatment conditions and 20% of the students assigned to the minimal treatment control group. The uneven group size was based on a very large predicted effect size between the treatment groups and the minimal-treatment control groups and a moderately large effect size between the two treatments.

Due to attrition and uneven cohort sizes the final group numbers did not quite match these percentages. There were 18 students in the segmentation condition, 20 students in the word reading condition and 11 students in the minimal control group.

The average age in months was 70.61 for the total group with no more than two month's difference between any of the conditions. Seventy-one percent of the subjects were kindergarten age. One reason for the uneven split between the kindergartners and the 1st graders was that there were two spring sessions to work with kindergarten students and only one fall session to work with first graders. Additionally, it was much more difficult to find 1st graders who did not already know one or more of the targeted spelling patterns. As mentioned before, 12 potential 1st

grade subjects were disqualified for this reason, whereas only four potential kindergarten students were disqualified for the same reason. Fifty-seven percent of the participants were female. Fifty-seven percent of the participants were Hispanic, 31% were Black (not Hispanic), 6% were White, and 6% were other (Asian, Middle Eastern, or mixed heritage).

Pretests

All pretests were administered individually in a quiet place outside of the classroom. All posters, wall charts and any other items that might assist the student were removed or covered. Letter production and invented spelling tests were administered first. Those who meet the criteria were administered the remaining pretests.

a. Letter Production

The students were given a blank piece of paper and were asked to write the letters of the alphabet as the experimenter said them. The letters were presented in random order. If a student hesitated longer than five seconds or said that he or she did not know how to write a letter, he or she was told that it is "OK and just move on to the next one." Upper and lower case letters were scored as correct as well as reversals. This served as a screening tool to ensure that the student was able to write all the letters needed in order to perform the experimental tasks that required writing the correct spellings of words. Possible score for this screening was 0-26.

b. Invented Spelling:

An invented spelling test was given consisting of the nine words (six real words and three non-words) that were taught in the experimental spelling task. The real words were*: drag, trot, bump, pass, luck* and *vine*; and the non-words were: *nwg* pronounced /nug/, *rret* /ret/, and *khib* /kib/ (see Appendix B for complete script). The students were told that they would be given a spelling test of real and made up words. The test administrator then demonstrated how to write a

word if they did not know how to spell it. After modeling how to segment the word *beaver* into sounds and to spell it inventively as BEVR, the correct spelling was given. Students were instructed to write the correct spellings of the words if they knew them or to write the sounds they heard as shown in the example. If students did not write anything or said they did not know how to spell a word, the test administrator asked them to do the best they could and to write any sounds that they heard in the word.

This test was scored two different ways—for plausible phonetic spellings, and for correct representation of the spelling patterns of interest. The correct spelling score was regarded as the first trial of the experimental task. To be considered a correct representation on the target spelling pattern, the letter or letters had to appear in the correct location without intervening letters (see Appendix C for scoring details). To assess the plausibility of phonetic spellings, a scoring system developed by Oldrieve (2003) was used. Each phoneme was scored individually and given anywhere from 0-4 points based on the accuracy and location of the orthographic representation. For example, if *mix* was spelled correctly it was worth 12 points, but if it was spelled MIKS it was worth 11points because KS was the phonemic equivalent of X and thus only worth 3 rather than 4 points. (See Appendix C for complete details of the scoring rubric.) Possible scores range from 0-136. Phonetic plausibility scores were used as a predictor variable to assess the relationship between skill in inventing plausible phonetic spellings and the acquisition of correct spellings. Reliability for this measure was calculated using the scores for each word for a total of nine items. Results showed that this measure was highly reliable, with alpha = .90

c. Word Identification:

Each child was given a word identification task. Fourteen of the pre-primer words from

the Boder word list (Boder & Jarrico, 1982) and 18 words that contained the spelling patterns of interest were presented to each child. The Boder words were high frequency words that did not have simple decoding patterns (i.e. they included long vowel patterns and digraphs). These words assessed students' sight word reading.

The 18 words that contained the spelling patterns of interest, such as *draw, game, jump, grass,* and *duck,* were included to assess familiarity with these spelling patterns. Words were presented on flash cards in lower case letters. Since scores were expected to be low, colors and shapes were mixed in so that children had some success in the task (see Appendix D for complete word lists and Appendix E for script and score sheet). Possible scores ranged from 0-14 for the Boder words and 0-18 for the words with the spelling patterns of interest.

d. Vocabulary:

The Peabody Picture Vocabulary Test, Fourth Edition (PPVT-4) (Dunn & Dunn, 2007) was administered to assess vocabulary skills. The PPVT-R is an individually administered receptive vocabulary test. The administrator says a word and the student must select the picture that best represents that word out of an array of four pictures. This was used primarily as a method to identify and exclude students with low English language skills from participating in the study. Additionally, it was used to assess the effect of vocabulary on the rate of acquisition of new spelling patterns. According to the test manual, estimates of internal (split half) reliability range from .61 to .88 depending on the population and alternate form reliability from .71 to .91. Standard administration and scoring protocols were used.

e. Word-Attack

The word attack subtest from the Woodcock Reading Mastery Test--Revised II (W-RMT II) (Woodcock, 1987) requires the subject to read nonsense words of increasing difficulty. It

assesses the ability to apply decoding skills to pronounce unfamiliar words (e.g., *ree* and *tay*). Students were asked to read two practice words for which they received corrective feedback. Then they were asked to read six non-words on each of the pages. Testing was discontinued after 6 consecutive incorrect responses ending with the final item on a page. This test was used to analyze the contribution of decoding to the acquisition of correct spelling patterns. Standard administration and scoring were used. Raw scores were used for the analysis. According to the test manual, the average reliability coefficient for the word attack test is .87. Scores can range from 0-45.

f. *DIBELS Assessments*

The Dynamic Indicators of Basic Literacy Skills 6th Edition (DIBELS) is an individually administered battery of literacy tests designed to monitor growth and assess risk of failure in the development of literacy skills from kindergarten through 6th grade. All testing materials, administration and scoring protocols were available free of charge at http://dibels.uoregon.edu/. The materials used for the study were alternate forms of the fall 1st grade level materials.

1. Letter Naming Fluency and Knowledge

The letter naming fluency subtest from the DIBELS is an individually administered standardized measure of letter knowledge and processing speed (Kaminski & Good, 2002). Students are presented with a page of upper and lower case letters arranged in random order and asked to name as many as possible before the administrator says stop after one-minute. If a student hesitates for more than 5 seconds, the test administrator tells the student to go to the next letter. If the student has not had the opportunity to name all upper and lower case letters within the minute, the test administrator marked the one-minute point on the score sheet and allowed the student to continue until they had the opportunity to name all the letters. This was used to assess

letter knowledge and letter fluency. According to the test manual, the one-month alternate form reliability for the fluency score is .88 in kindergarten. Scores range from 0-110 (the number of letters on the page) for the timed fluency score and from 0-52 for the untimed letter knowledge measure. Standard administration protocols were used except that students were allowed to continue until they had been exposed to every letter.

g. Phonemic Segmentation

The phoneme segmentation fluency subtest from the DIBELS is an individually administered, standardized measure of phonemic awareness (Good, Kaminski & Smith, 2002). The participant is asked to verbally produce the individual phonemes of a 3 or 4 phoneme word orally presented by the examiner. The student is presented with two training items. The test administrator segments the first item, SAM, and the student imitates the response modeled by the test administrator. The student is asked to segment the second item, *log*, on his or her own. If the student incorrectly segments the word, the test administrator will segment it for the student and then asks him/her to try again. If during the test the student does not respond to a word for 5 seconds, the test administrator presents the next word. Traditional scoring is based on the number of correct phonemes produced in a 1-minute period and ranges from 0-75. In the present modification students were allowed to finish the first twelve test items if they did not get to that point before one minute, so that two scores were produced, a timed and an untimed score. The untimed portion was limited to the first twelve items so that students who were having difficulty did not have to attempt all of the test questions to get their untimed score. According to the test manual alternate form reliability is .88 and the one-month alternate form reliability is .79. Standard administration and scoring protocols were used except for the extra untimed procedure.

Table 3.

List of training, transfer and posttest stimuli.

	Experimental List	Transfer List	Untaught list	Pattern of Interest
Phonetic	Drag (3)[a]	Drip (3)	Drop (2)	DR
	Trot (3)	Trim (3)	Trap (3)	TR
	Bump (2)	Limp (3)	Lamp (3)	MP
Orthographic	Pass (2)	Boss (2)	Hiss (4)	SS
	Luck (3)	Pack (2)	Sock (2)	CK
	Vine (2)	Hive (3)	Ripe (2)	IcE
Non-word	Khib /kib/	Khep /kep/	Khag /kag/	H (silent)[b]
	Rret /ret/	Rrog /reg/	Rrab /reb/	RR (illegal initial doublet)
	Nwg /nug/	Fwt / fug/	Lwd / lud/	W as medial vowel

[a.] The number in parenthesis refers to the Harris and Jacobson (1982) reading level of the word.
[b.] While the silent H after a K is not illegal in English, it is uncommon and makes only one appearance in the Harris and Jacobson reading vocabularies list, khaki, an 8th grade word.

Experimental Spelling Tasks

There were two experimental conditions, word reading and segmentation with letters and a minimal-treatment control group. Both experimental conditions followed the same format. Participants either read or segmented and blended the nine target words and practiced spelling them. All of the students were trained on the same spelling list. The words are given in Table 3. Two to four days after the final instructional session a transfer task was given (See Table 4 for an implementation calendar). This was more than just an opportunity to attempt to spell new words with the same spelling patterns. It was a training activity identical to the first training session

Table 4.

Schedule for intervention

Pretests	Administered over two days.	1-2 weeks prior to training sessions
Training Session 1	Two tests, one in the middle and one at the end of the session.	
Training Session 2		
Training Session 3		
Training Session 4	Two tests, one at the beginning and one at the end of each session.	2-4 days apart
Training Session 5		
Transfer Session	Three tests, one at the beginning, one in the middle and one at the end of the session.	
Follow-up	• Test of trained words • Transfer test for new words • Orthographic choice test	7-9 days after final session

following the treatment protocol for whichever condition the student was in. Students were taught with a new word list containing the same target spelling patterns as the words they had practiced. The transfer words are listed in Table 3. The minimal-treatment control group received the same pre-tests and posttests; however, students were not given any spelling instruction or corrective feedback. They were asked to spell the nine words one time per session. Sessions occurred every two to four days. They were also given the opportunity to spell the

transfer words and took the posttests. The purpose of this group was to guard against Hawthorne effects and to provide data for the calculation of growth curves for control students.

Spelling Instruction: Word Reading Condition.

The word reading instructional condition investigated whether students would learn new spellings by reading the words on flash cards. During the initial session, the child was taught to read the nine words. The nine words were written on cards and laid out in a column in front of the child. Each of the nine words was pointed to and read aloud by the researcher. After each word was read, the participant was asked to point to the word and repeat it. This procedure was done only once at the beginning of the first session. Then the researcher spoke each of the nine words and the student pointed to the word, for example, "Can you point to the word *bump*?" After identifying all the words, the researcher picked up the flash cards and had the student read them one at a time. If the student responded incorrectly or did not respond, the researcher gave the student the answer. After going through the identification and reading of the flash cards, the student was asked to write the words from memory. This sequence of steps—identify, read, spell—was repeated twice during the first session. At the beginning of the next four sessions, the students were asked to spell the words once. Then they practiced the identify-then-read sequence three times and then spelled the words again. Responses to all trials were recorded and scored for correct target spelling patterns. The administration script was adhered to and only procedural questions were answered. Nothing substantive about the spelling patterns or the words were explained. Students received no corrective feedback on the spelling tests.

The initial spelling test before the practice began was included to assess retention from the prior session (between-session learning), and the spelling test at the end of the practice session was included to assess within-session learning. Following the last training session, the

participant was given a transfer task. The transfer task was an additional training session that was identical to the first session except that the target words consisted of nine new words containing the same spelling patterns (see Table 3). (See Appendix E for the complete script).

Spelling Instruction: Segmentation with Letters Condition.

The word reading instructional condition investigated whether students would learn new spellings by reading the words on flash cards. During the initial session, the child was taught to read the nine words. The nine words were written on cards and laid out in a column in front of the child. Each of the nine words was pointed to and read aloud by the researcher. After each word was read, the participant was asked to point to the word and repeat it. This procedure was done only once at the beginning of the first session. Then the researcher spoke each of the nine words and the student pointed to the word, for example, "Can you point to the word *bump*?" After identifying all the words, the researcher picked up the flash cards and had the student read them one at a time. If the student responded incorrectly or did not respond, the researcher gave the student the answer. After going through the identification and reading of the flash cards, the student was asked to write the words from memory. This sequence of steps—identify, read, spell—was repeated twice during the first session. At the beginning of the next four sessions, the students were asked to spell the words once. Then they practiced the identify-then-read sequence three times and then spelled the words again. Responses to all trials were recorded and scored for correct target spelling patterns. The administration script was adhered to and only procedural questions were answered. Nothing substantive about the spelling patterns or the words were explained. Students received no corrective feedback on the spelling tests.

The initial spelling test before the practice began was included to assess retention from the prior session (between-session learning), and the spelling test at the end of the practice

session was included to assess within-session learning. Following the last training session, the participant was given a transfer task. The transfer task was an additional training session that was identical to the first session except that the target words consisted of nine new words containing the same spelling patterns (see Table 3). (See Appendix E for the complete script).

Spelling Instruction: Segmentation with Letters Condition.

In the segmentation with letters condition, participants were given the opportunity to segment each word into its constituent phonemes, first by orally segmenting the word and counting the sounds by raising a finger for each sound, and then by moving letter tiles into Elkonin boxes. During the first trial, the experimenter modeled the segmentation orally by raising his fingers as he pronounced each sound. Then he selected the correct Elkonin sheet displaying either three or four sound boxes for words containing three or four sounds. He pushed letters symbolizing sounds in the words into the Elkonin boxes as he said the sounds. After placing the letters in the boxes, the experimenter blended the sounds to say the word as he ran his finger under the word. Silent letters were explained by saying "Sometimes words have letters that make no sound."Double letters and CK were explained by saying "Sometimes it takes two letters make one sound." After modeling these steps, the experimenter asked the student to perform them. If the student did not respond or made a mistake, the experimenter modeled the task again for the student. This instructional procedure was only done at the beginning of the first session.

In the first session, after children completed one trial segmenting all the words orally and then moving their letters into Elkonin boxes, they were asked to write all the words from memory. The segment-and-spell trial was repeated twice. During each of the next four sessions, the students were first asked to spell all the words. This was followed by two segment-and-spell

trials. Having students spell first before they practiced the words was included to assess retention from the prior session (between-session learning). The spelling test given at the end of the session was included to assess within-session learning.

Following the last training session, participants were given a transfer task. The transfer task was an additional training session identical to the first session except that the target words consisted of nine new words containing the same spelling patterns (see Table 3).

During all of the training sessions, the experimenter followed a script and only answered procedural questions. He did not explain anything substantive about the spelling patterns or letter-sounds in the words. Students received no corrective feedback on the spelling tests. Responses to all trials were recorded and scored for correct target spelling patterns. (See Appendix F for the complete script).

Minimal Treatment Control.

In the minimal treatment control condition, the participants were asked to write the list of nine words once (see Table 3 for list and Appendix G for script). The procedure was similar to the invented spelling pretest and was repeated five times on the same schedule as the other two conditions. Following the last session with the original words, participants were given a transfer task. The transfer task was conducted identically to the other sessions except that the target words consisted of nine new words containing the same spelling patterns as the practice words (see Table 3). The administration script was adhered to and only procedural questions were answered. Nothing substantive about the spelling patterns or the words was explained. Students received no corrective feedback on the spelling tests. Responses to all trials were recorded and scored for correct target spelling patterns.

Posttests

Two posttests were individually administered one week after the completion of the experimental training. The purposes of the posttests were to assess student memory for the spellings of the words they studied and their ability to transfer knowledge of the spelling patterns to novel words.

a. Spelling Test

A spelling test of the training words and similar untaught words containing the target spelling patterns was given one week after the final training session (see Table 3, columns one and three). This was done to test recall of the taught words and the transfer words. Directions were the same as the spelling pretest without the example. The test was scored to assess the correct representation of the spelling pattern of interest. One point was awarded for the correct representation of the spelling patterns. Scores could range from 0-18 (0-9 for the taught words and 0-9 for the untaught words).

b. Orthographic Choice Test

This was a multiple-choice test. Students were presented with two spellings of the same word, one with correct orthographic pattern and one that contained a typical invented spelling. Students were asked to choose the best one. The test stimuli consisted of words that contained the taught spelling patterns, but had not been taught or appeared in any of the pretests or posttests. For example: *dragon* and *jragon* or *joke* and *jok*. For the non-words, one choice was spelled with the pattern that was trained and the other choice was the orthographically legal or correct form—*rrom* vs. *rom* or *dwp* vs. *dup*. Students were presented with the two spellings of the word, told that these are two ways that other children have spelled this word, and were asked which is the best way. This test assessed recognition of the taught spelling patterns. There were

27 items on the test, three for each spelling pattern. Items were scored as either correct or incorrect. (See Appendix I for complete word list and script.)

Procedures

School sites with an interest in working on this project were identified and letters of consent were sent home to all students in the classroom. After consent was obtained students were individually administered the invented spelling, the PPVT and the letter writing pretest. This was done in a quiet room outside of the classroom where all of the print was either covered up or removed. If the student met the requirements for being in the study (see Participants section) they were administered the remaining pretests in the same conditions on a different day. Both sessions took between 15 and 20 minutes.

Once a cohort (between 5 and 12 students depending on the site) was identified and pretested, the students were divided into two groups based on scores on the reading test—those with scores higher than 2 were the high group and those with scores of 2 or below were the low group. Students within these two groups were randomly assigned to one of the three conditions. The stratified sampling method helped to insure that reading ability was as evenly distributed across the conditions as possible. The reading score selected was based upon results of the pilot study and represented the cut off in reading skill that influenced growth in spelling acquisitions.

Once assigned to a condition, students were given the scripted treatments and posttests according to the treatment schedule (see Table 3 and Appendixes D, E and F for scripts). Training and posttests were administered individually in a quiet room, separate from the classroom, with all print removed or covered. If a student missed a session it was made up on the next possible day[9]. The variability in the days between sessions, though not ideal, was

[9] No student missed more than one session consecutively.

necessary to accommodate school schedules i.e. field trips, three-day weekends, parent conferences, etc.

At the end of the posttest session students were debriefed about the nature of the tasks and thanked for their hard work. They were told that the RR letters at the beginning of words and the W used to spell a vowel sound in the middle of a word were not "normal" spelling patterns and that they should not use them in trying to spell real words. It was also explained that the H after the K as in *khib* was very uncommon but that they would see it in the word khaki.

Data Analysis and Design.

This study employed an experimental design, two treatments and one control condition, using a micro-genetic methodology—essentially a short-term intensive longitudinal study that exposes the participants to five training sessions 2-4 days apart.

Independent Variables.

The independent variables were: conditions with three levels (Word Reading, Segmentation, and Minimal Control[10]) and the scores on the pretests (invented spelling, vocabulary, phoneme segmentation—timed and untimed, letter writing, letter naming—timed and untimed, reading words—Boder list and Pattern list, and Non-word reading. All of the pretest independent variables were continuous scores.

Dependent Variables.

Table 5 displays the sources for the dependent variables for the two treatment groups. Each training session included both a pretest and a posttest, or in the case of the first session and

[10] Ideally the minimal treatment control condition would be part of all of the analyses. However, since most of the students had no correct answers on any of the possible dependent variables (except for the orthographic choice test) the distribution of scores violated too many assumptions for the statistical tests employed and were removed from the analysis. This is explained in detail in the results section.

Table 5.

Sources of dependent variables for segmentation and word reading conditions

Session 1	Session 2	Session 3	Session 4	Session 5	Transfer	Posttests
Pretest[a]	Pretest	Pretest	Pretest	Pretest	Pretest	Delayed Spelling Task
Mid-test					Mid-test	• Trained Words
Posttest	Posttest	Posttest	Posttest	Posttest	Posttest	• Posttest Words
						Orthographic Choice Task

[a]The pre-score for session 1 comes from the invented spelling pretest though it is necessarily zero since not knowing any of the targeted spelling patterns was a requirement for participation.

the transfer session, a pretest, midtest, and posttest. The minimal treatment control group only had one test per session, since they received no training, but they completed the same posttests. Each of the nine words was scored as either correct (one point) or incorrect (zero points) based on the scoring rubric in Appendix C for a total possible score of nine.

Student Learning.

The first determination to be made was whether or not students learned the spelling patterns through either of the training conditions. The initial analysis was to establish whether the treatments had an immediate effect on student learning. This was done by modeling the posttests of each learning session to determine whether scores at the end of each session improved across session and whether there was a difference between condition and/or word types. The second analysis was to ascertain whether or not there was long-term learning, i.e. did students remember what they learned from the previous session by the time they got to the next session and did this differ by condition and/or word type. The final analysis was to see if students remembered what they learned 7-9 days after the final training session and did this

differ by condition and/or word type.

These three analyses involved similar modeling techniques. An initial univariate GLM test (repeated measures for the first two analyses) was employed to determine if there was a main effect of condition based on the total test score. Second, to understand whether treatment condition, the type of spelling pattern—phonetic, orthographic, or non-words—or prior literacy knowledge played a role in the acquisition of the targeted spelling patterns, a more complex multi-level model was developed. As the data at the word level is binary—either they produced the targeted spelling pattern or not—the data were modeled using a Bernoulli distribution and the logit link function available in HLM 6.1 (Raudenbush & Bryk, 2002). The word types—phonetic, orthographic, or non-word—and time (for the two training session analyses) were modeled as variables at the first level. This allowed for the independent variables (condition and pretest scores) to be modeled as predictors for each of the word types. Modeling was done through a "backwards" methodology where models were saturated and then the least predictive variables were removed until a parsimonious model remained.

Transfer.

Transfer of learning was assessed in three different ways. First there was the transfer training session where students were taught new words, with the same training they had been receiving, that contained the same targeted spelling patterns, using the same treatment conditions. The second way that transfer was assessed was through a delayed spelling test of untaught words that contained the same targeted spelling patterns. The final way was through an orthographic choice test where students had to choose between two competing spellings to identify the "best" spelling of the word.

To analyze the transfer training session, the mid-test of the transfer task was compared to

the mid-test of the first training session, and the posttest of the transfer task was compared to the posttest of the first training task. This was to determine whether students learned the targeted spelling patterns in the transfer session faster after having the same amount of exposure to the particular words but having been exposed to the spelling patterns in the training sessions. A multi-level Bernoulli model similar to those used to analyze the growth over sessions was used with word types—phonetic, orthographic, or non-word—and time modeled as variables at the first level and the independent variables (condition and pretest scores) modeled as predictors for each of the word types and time. Modeling was done through a "backwards" methodology where models were saturated and then the least predictive variables were removed until a parsimonious model remained.

To analyze the posttest for untaught words, a multi-level Bernoulli model similar to those used to analyze the growth over sessions was used with word types—phonetic, orthographic, or non-word—modeled as variables at the first level and the independent variables (condition and pretest scores) modeled as predictors for each of the word types and time. Modeling was done through a "backwards" methodology where models were saturated and then the least predictive variables were removed until a parsimonious model remained.

To analyze the orthographic choice test, a binomial test was employed to determine whether each student's scores were significantly higher than would be expected by chance. After determining which students performed at an above-chance level, a logistic regression was used to explore whether treatment differences or literacy skills explained differences in response patterns.

Chapter V Results

Characteristics of Participants

The demographic characteristics of this group were noted in the previous chapter (see Table 6 for details). To ensure that the distribution of students in the three conditions was not skewed in terms of race, sex, or grade level a χ^2 test was performed for each of these categories. None of the χ^2 tests was significant ($\chi^2_6 = 2.13$, $p > .05$) for race, $\chi^2_2 = 0.12$, $p > .05$ for sex, and $\chi^2_2 = 0.80$, $p > .05$ for grade level) demonstrating that that these demographic characteristics were relatively evenly distributed across conditions. Additionally, an ANOVA (Age x Condition) was performed showing no significant differences in age across conditions (F (2, 46) = 0.63, $p > .05$).

The results of the pretests can be seen in Table 7. It is evident that children in the segmentation group had consistently higher scores on average than those in the word reading group who in turn had higher scores than those in minimal control group. Although a multivariate test was not significant (Wilks' Λ (22, 72) = .691, $p > .05$), tests of mean performance on individual measures revealed one significant difference, which involved the word attack test. (F (2, 46) = 3.23, $p < .05$). However, when analyzing the differences between the groups using a Scheffe post hoc analysis none of the pairwise group differences was significant.

In addition to comparing the groups on pretest performance it is important to understand this population in terms of its overall development. While the average standard score for vocabulary (PPVT) was in the normal range (M = 95.90), the distribution of scores was skewed due to the cut score of 85. The median standard score was 93 indicating that almost 50% of the sample was in the low normal range (85-92 according to the test manual), indicating that overall this population was relatively weak in terms of its receptive vocabulary development.

Table 6

Demographic characteristics of participants by treatment condition

Characteristics		Condition			Total
		Segmentation	Word-Reading	Minimal Control	
		n =18	n = 20	n = 11	N = 49
Age (months)					
		71.72 (4.16)	70.50 (6.10)	69.00 (9.23)	70.61 (6.30)
Grade					
	Kindergarten	12	14	9	35
	1st Grade	6	6	2	14
Sex					
	Female	10	12	6	28
	Male	8	8	5	21
Race					
	Black (not Hispanic)	6	6	3	15
	Hispanic	11	11	6	28
	White	1	1	1	3
	Other	0	2	1	3

Table 7

Mean pretest scores by treatment condition with (*SD*) and univariate *F*

	Condition			
Pretest	Segmentation	Word Reading	Minimal Control	Univariate *F*
Invented Spelling *max 136*	69.39 (27.83)	61.70 (28.60)	61.45 (22.65)	0.47
PPVT				
Standard Score	96.06 (10.38)	96.30 (10.01)	87.18 (16.59)	0.07
Raw Score	93.67 (14.64)	92.70 (10.84)	94.90 (10.63)	0.84
Segmentation				
Untimed *max 35*	23.38 (6.93)	22.55 (9.83)	20.45 (6.50)	0.45
Timed *max 75*	20.77 (14.60)	20.55 (14.55)	15.81 (9.27)	0.54
Letter Knowledge				
Untimed *max 52*	50.33 (2.35)	50.45 (3.83)	50.09 (2.83)	0.06
Timed *max 100*	47.33 (16.58)	46.50 (16.46)	44.73 (9.82)	0.10
Writing *max 26*	25.94 (0.23)	26.00 (0.00)	26.00 (0.00)	0.85
Reading				
Boder Words *max 14*	7.83 (4.78)	6.00 (4.71)	5.45 (4.11)	1.15
Target Pattern Words *max 18*	4.89 (5.86) (.42)[1]	3.05 (3.87) (.45)[1]	2.27 (2.45) (.36)[1]	1.37
Non-Words *max 45*	5.83 (5.78) (.17)[1]	3.15 (3.28) (.40)[1]	2.09 (2.07) (.36)[1]	3.23*

Notes. *p <.05; Segmentation n = 18, Word Reading n = 20, Minimal Control n= 11. [1]Proportion of zero scores

Students displayed a wide range of invented spelling scores, as indicated by the large *SD*, and a wide range of strategies as revealed by their spellings. Strategies ranged from spelling only initial consonants typically associated with the semiphonetic/partial alphabetic phase, to representing all of the phonemes with plausible graphemes (though necessarily not the correct ones for the targeted spelling patterns) demonstrating skill typically associated with the phonetic/full alphabetic phase. If children spelled only initial sounds in words this would limit this score to 36. Only 18% of the students had scores of 36 or less indicating that most students were using a strategy more complicated than the most basic semiphonetic one.

In terms of reading ability only four students did not read at least one word correctly on either of the word lists. A comparison of scores between the two word lists revealed that four students (8%) did not read any of the high frequency sight words from the Boder word list whereas 21 (42%) did not read any of the List Pattern words, not surprisingly because better decoding skills were required to read the latter words if the student was not familiar with them. Additionally, 15 students (31%) did not read any non-words correctly on the Word Attack test. While most students had some familiarity with reading print, a large proportion of this group did not have the decoding skills to read unfamiliar words indicating that many of the students were at the partial alphabetic phase of reading development characterized by reading only parts of words (Ehri, 1997).

Seven students who completed the training did not participate in the posttest session. The most common reason for the attrition (6 of the 7) was early departure for vacation. In these six cases, the students all left a week before vacation began without notifying the researcher and were therefore unable to take the posttest as too much time had elapsed by the time the researcher could possibly administer the posttest. The other case of attrition was a student who

transferred schools in the intervening week between the final training session and the posttest. Fortunately, the attrition was relatively evenly distributed among the treatment groups and reading ability—two from the segmentation group and minimal treatment control group and three from the word reading group, with one student from each group reading 2 or fewer words.

Student Learning

During the five sessions, student learning took place through one of the two treatment conditions. The two conditions consisted of either segmenting words with letters or reading words on flash cards during the five practice sessions. Two tests were given in each session, one at the beginning and one at the end. Learning within sessions and between sessions was examined. The final measure of student learning was obtained in the spelling posttest that was administered 7-9 days after the final training session. This test assessed students' memory for the spelling of the training words. Performance of the two treatment groups on the final two measures of learning, the between session and the spelling posttest, were compared to performance of the students in the minimal treatment control group to establish a baseline for learning rates.

Comparison to Minimal Treatment Control Group.

Before any further discussion of student learning, an immediate difficulty arose with the minimal treatment control group. The minimal treatment control did not get many of the spelling patterns correct—3 correct target spellings in 792 opportunities between all of the minimal treatment students across all the trials (.006% compared to 23.3% in the two treatment conditions). Clearly having children simply invent spellings repeatedly without any guidance or scaffolding produced no improvement in the quality of their spellings.

While this was not unexpected—the effect size between the minimal treatment control

group and the two treatment conditions was predicted to be large—the almost complete lack of correct answers posed technical difficulties. The lack of variance precluded any GLM analysis, due to violation of the homogeneity of variance requirement. Non-parametric rank-order tests had similar problems in that the minimal treatment control group members were essentially tied for last. It was more problematic in the analysis for predicting learning by word type, which involved using a logit link function, where the zero odds of an event happening made it mathematically impossible to model the minimal treatment control group. After much effort and discussion (Rindskopf, personal communication December 2009), it was decided to leave the minimal treatment control group out of most of the statistical analyses. This allowed for a clearer analysis between the two treatment conditions rather than a complicated and less clear analysis that included the minimal treatment control. Performance of the minimal treatment control group was still included in the error analysis and the orthographic choice posttest, since they provide a baseline for these comparisons.

Within-Session Learning.

The within-session learning was measured by whether or not students remembered the targeted spelling patterns as evidenced by a correct score on the spelling test given at the end of each session. Only the target pattern was scored as correct or incorrect with a maximum possible of nine correct. Table 8 contains the mean scores for these tests by spelling pattern and when plotted over time, one can see the average number of words that they knew at the end of each training period in Figure 1. A two-way repeated measures ANOVA was conducted with treatment and time of tests as the independent variables. Results revealed there was a significant main effect in the amount of within session learning over time (F 4, 144 = 6.61, $p < .01$) but there was no significant main effect of training condition over time (F 1, 36 = 0.03, $p > .05$) and

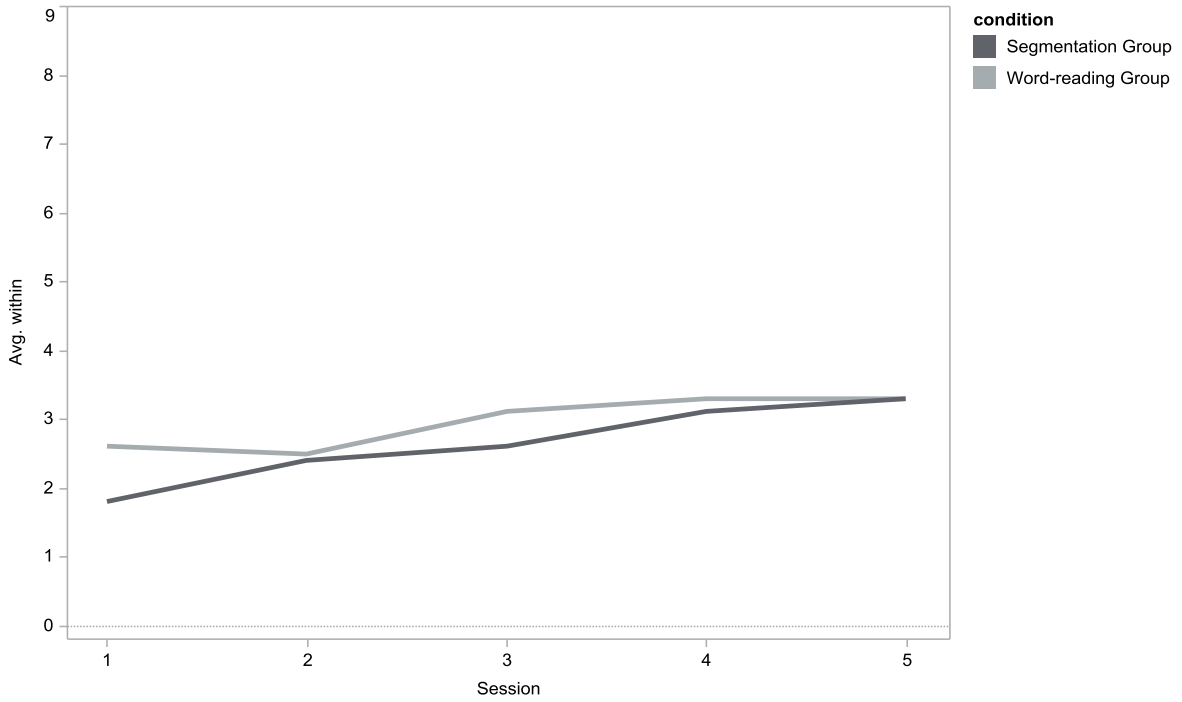
Table 8

Means and (*SD*) scores for number of correct spellings of target patterns on the initial and final spelling tests by word type and condition within each training session

		Phonetic		Orthographic		Non-words	
	Condition	Pre	Post	Pre	Post	Pre	Post
Session 1	Segmentation	0	0.94 (0.99)	0	1.11 (1.08)	0	0.22 (0.54)
Session 2	Segmentation	1.00 (1.24)	1.17 (1.25)	0.78 (0.94)	1.33 (1.08)	0.17 (0.38)	0.38 (0.69)
Session 3	Segmentation	1.06 (1.06)	1.22 (1.26)	1.00 (1.03)	1.27 (1.13)	0.44 (0.62	0.50 (0.99)
Session 4	Segmentation	1.38 (1.33)	1.33 (0.90)	1.33 (1.08)	1.44 (1.09)	0.61 (0.98)	0.83 (0.99)
Session 5	Segmentation	1.38 (1.33)	1.38 (1.37)	1.44 (1.25)	1.38 (1.37)	0.67 (0.97)	0.72 (1.02)
Session 1	Word-Reading	0	0.75 (0.96)	0	1.10 (0.96)	0	1.00 (0.79)
Session 2	Word-Reading	0.35 (0.67)	0.60 (0.88)	0.65 (0.88)	1.00 (0.97)	0.30 (0.57	1.10 (0.85)
Session 3	Word-Reading	0.45 (0.82)	0.90 (1.07)	0.90 (1.02)	1.10 (1.02)	1.00 (0.97)	1.35 (1.14)
Session 4	Word-Reading	0.75 (0.91)	0.90 (1.16)	1.00 (0.85)	1.20 (1.06)	1.15 (1.03)	1.50 (1.15)
Session 5	Word-Reading	0.75 (0.91)	0.80 (1.11)	1.10 (0.91)	0.80 (1.11)	1.35 (0.93)	1.50 (1.00)

Note. Maximum possible score for each test is three. Segmentation n = 18, Word-Reading n =20

Figure 1. The average number of correct spelling pat terns on the post-session spelling tests by training con ditio



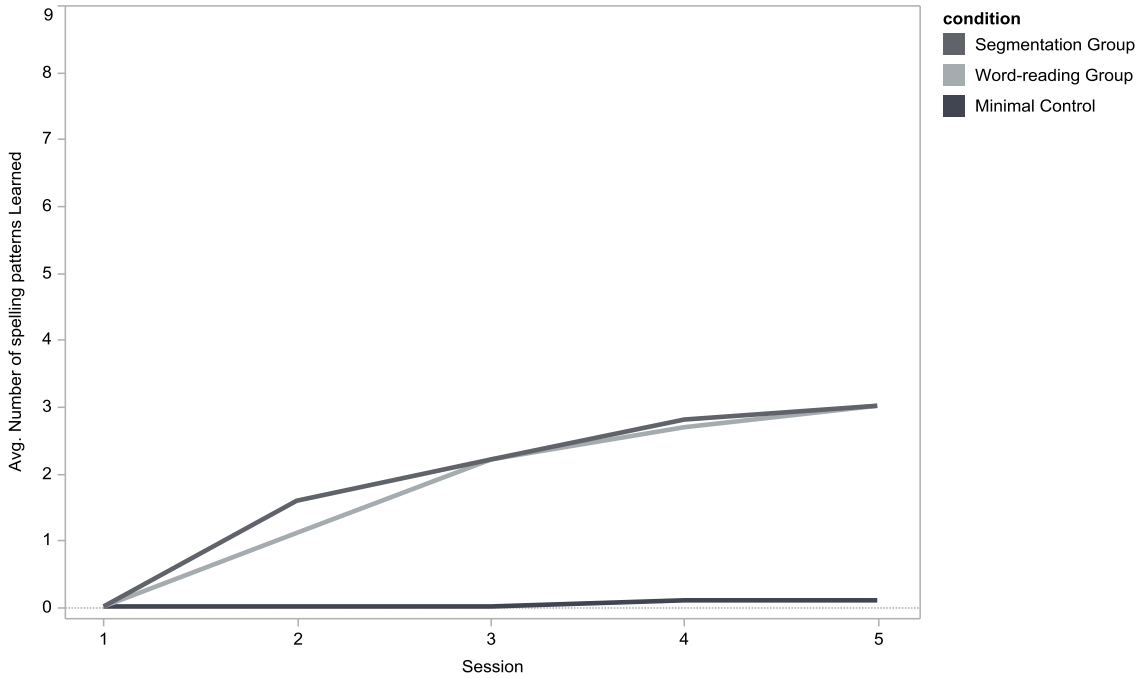
The growth curves of within-session learning by condition These are the tests given at the end of each session to measur within session learnin

no significant interaction (F 4, 144 = 1.26, $p > .05$). As evident in Figure 1, there was an immediate effect of the treatment in that the students remembered what they just learned and the learning carried over from one session to the next.

Between-Session Learning.

The between-session learning was measured by the number of correctly spelled targeted patterns on tests given at the beginning of sessions 2-5. The pretest was used as the initial session score and was necessarily zero since anybody who knew the targeted spelling patterns was not included in the study. Table 8 contains the mean scores and figure 2 shows mean performance of the two treatment conditions and the minimal treatment control condition over the five training sessions. A two-way repeated measures ANOVA was conducted with the two

Figure 2. The average number of correct spelling pat terns on the pre-session spelling tests by training con ditio



The growth curves of between-session learning by condition The first session score is based on the pre-test and is necessar ily zero

treatment conditions and time of test as the independent variables. The results showed that there was a main effect for time (F 4, 144 = 44.45, $p < .001$), no main effect for condition (F 1, 36 = .005, $p > .05$), and no significant interaction (F 4, 144 = 0.36, $p > .05$). As evident in Figure 2, mean recall of spelling patterns increased for both treatment groups over sessions at roughly the same rate, demonstrating that both groups were recalling spelling patterns from the prior training session.

Predictions for Learning

The previous section reported the learning of spelling patterns in the aggregate. To understand whether treatment condition, the type of spelling pattern (i.e phonetic, orthographic, or non-words) or prior literacy knowledge played a role in the acquisition of the targeted spelling

patterns, a more complex model was developed. The data at the word level is binary, that is, either students produced the targeted spelling pattern or they did not. The data were modeled using a Bernoulli distribution and the logit link function available in HLM 6.1 (Raudenbush & Bryk, 2002), where:

$$\acute{\eta}_{ij} = \log\left(\frac{\varphi_{ij}}{1-\varphi_{ij}}\right)$$

and φ_{ij} is the probability of success on any given attempt to produce a targeted spelling pattern. This allows for a level one model to be constructed as follows:

$$\acute{\eta}_{ij} = \beta_{0j}(\text{Orth}) + \beta_{1j}(\text{Phone}) + \beta_{2j}(\text{Non}) + \beta_{3j}(\text{Trial})$$

where Orth, modeled as the intercept in the dummy coding system, indicates performance spelling the orthographic words, Phone indicates the phonological words, Non indicates the non-words, and Trial is overall growth in spelling all types of words over trials, modeled with the final trial as time 0 so that the coefficient β_{3j} represents the score at the end of the intervention. Each term in the equation represents the log of the odds (logit) of the student correctly recalling a spelling pattern for that particular category.

The first level of the model allows for the exploration of differences of the word type and for differences in growth. The second level of the equation allows for student level predictors to be introduced for each term in the first level equation. To answer the research questions posed in

the introduction, pretest scores[11] and treatment condition status were all introduced into the model as predictors for each coefficient. The method employed for modeling was to introduce all the pretest variables along with treatment group status and remove the least significant pretest scores to develop a parsimonious model.

However, there was a problem with the modeling due to multi-colinearity of the pretest scores. Table 9 reveals that the pretests were highly correlated, so the creation of a factor score or scores was explored. Exploratory factor analysis of all the pretests indicated that a two-factor solution fit the data. Two Eigen values over 1, 5.07 and 1.37, explained 71% of the variance cumulatively. While a one-factor solution was possible, a pared down set of variables was employed (the reading and phonological based pretests) and a two factor solution was selected to maximize the explanatory power of the models. While this necessarily oversimplified the factor structure, the gains in explanatory power outweighed the slight gains in fit of more complex but less interpretable models or an all encompassing one factor-model. Factor loadings are given in Table 10. However, in confirmatory factor analysis, it is just as important to obtain a theoretical fit as well as a mathematical fit (Diamantopoulos & Siguaw, 2007). Additionally, the goal is to be able to use as many variables as possible to best explain growth in spelling development rather than to come up with a complex factor model that "best" fits the data at the cost of reducing the explanatory power of the pretests. In looking at the relationships between the variables, the most parsimonious model was to have the pretests that involve word reading skills (Boder word list, List Pattern reading and word attack) load onto one factor and the pretests that involve phonological processes (timed and untimed segmentation and invented spelling) load

[11] Letter writing was not used as a predictor since there was almost no variance with all but one student receiving a perfect score.

Table 9.

Correlation of Pretest Scores

	1	2	3	4	5	6	7	8	9	Mean	*SD*
1 Invented Spelling	−	.								64.47	26.82
PPVT											
2 Raw Score	.531**	−								91.82	13.65
Segmentation											
3 Untimed	.753**	.568**	−							22.38	8.09
4 Timed	.588**	.565**	.752**	−						19.57	13.47
Letter Knowledge											
5 Untimed	.510**	.138	.345*	.330*	−					50.33	2.83
6 Timed	.469**	.161	.477**	.362*	.398*	−				46.41	15.03
Reading											
7 Boder Words	.633**	.277	.538**	.358*	.595**	.472**	−			6.55	4.63
8 Target Pattern Words	.570**	.235	.450**	.450**	.621**	.375**	.834**	−		3.55	4.53
9 Non-Words	.555**	.395	.599**	.559**	.491**	.438**	.776**	.835**	−	3.90	4.40

Notes. *p <.05, **p<.01. N = 49.

Table 10.

Factor Loadings for Exploratory Factor Analysis with Oblimin Rotation

Pretest	Reading	Phonological
Invented spelling	.66	.93
Segmentation Untimed	.54	.90
Segmentation Timed	.42	.83
Boder Words	.94	.52
List Pattern Words	.95	.48
Word Attack	.91	.58

N = 49

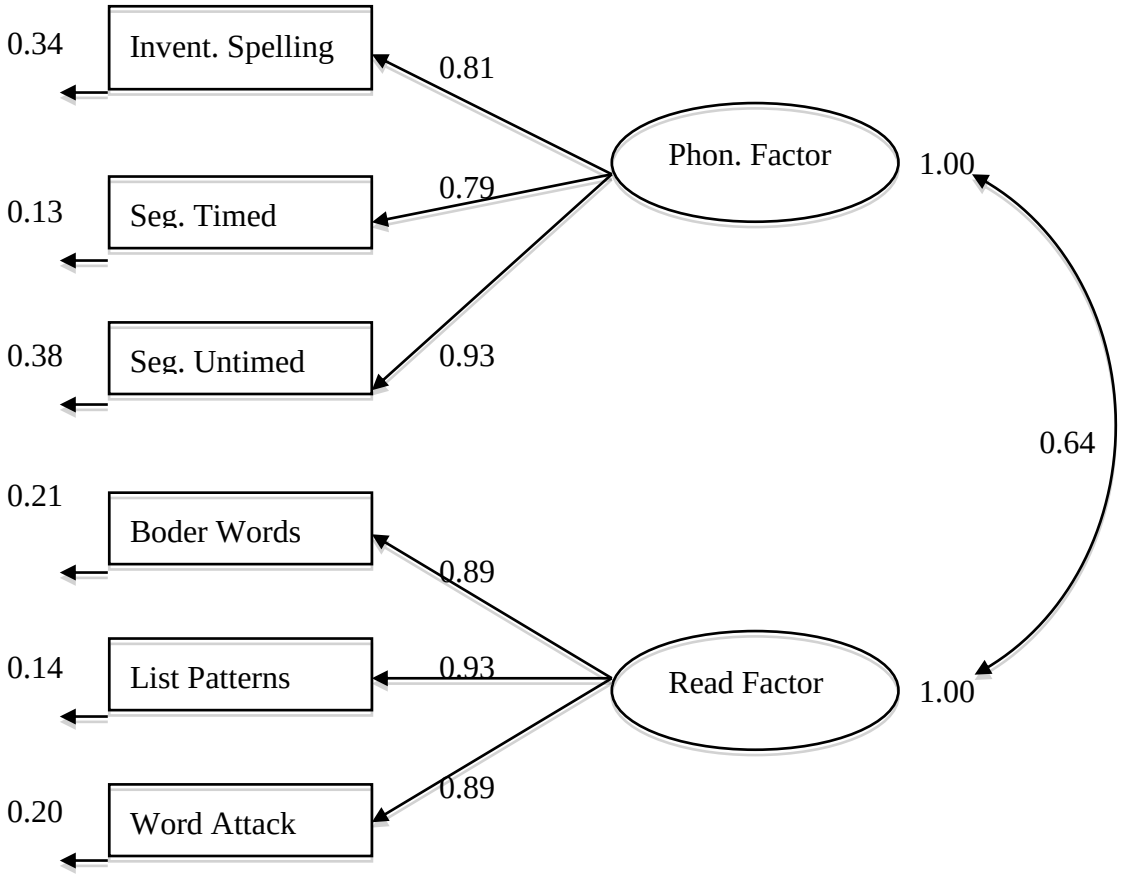
onto a second factor[12]. While the underlying skills measured by the alphabetic task (identification and speed) and vocabulary pretests arguably contribute to both reading and phonological skills, these were left out of the final model. This created factor scores that were theoretically straightforward and allowed the modeling of vocabulary and letter skills as individual predictors.

Figure 3 shows the final model with standardized path scores. This allowed for the creation of the two factor scores, *reading* and *phonological*, which have a mean of zero and a standard deviation of one. Mean factor scores were calculated for each treatment and are shown in Table 11. Although the trend is similar to that found for the individual pretest scores—the segmentation group having the higher scores followed by the word reading and then the minimal control group—none of the differences was statistically significant.

[12] While an argument could be made to have invented spelling load onto both factors, it made both theoretical sense and analytic sense to have two separate factors.

Figure 3.

Path Model with Standardized Coefficients for the Phonological and Reading Factor Scores



$N = 49$, $\chi^2 = 24.10$, $df = 8$, $p < .01$, RMSEA = 0.205

With the factor scores now taking the place of six original pretests, the available level two predictors were: PPVT raw scores[13], letter naming timed, letter naming untimed, reading factor score, the phonological factor score and treatment. To develop the level two models a modeling methodology was employed where all of the predictors were entered into the model and then non-significant ones were removed one at a time until a logical parsimonious model emerged. The only exception was that the dummy variable for the treatment condition was always left in so that the effectiveness of the treatment could be ascertained for each coefficient

[13] Raw scores were used because the important aspect in predicting performance was overall vocabulary skill not age normed relative skill.

Table 11

Means and (*SD*) for Pretest Factor Scores by Treatment Condition

	Condition			
Factor Score	Segmentation	Word reading	Minimal-Control	*F* value
Phonological	0.15 (0.94)	0.00 (1.16)	-0.25 (0.77)	.54
Reading	0.35 (1.24)	-0.14 (0.86)	-0.33 (0.61)	1.96

Notes: None of the F values associated with differences by condition were significant.

of the level one equation. The dummy coding for the treatment variable was zero for the word reading condition and one for the segmentation condition, meaning that an odds ratio higher than one indicated that the segmentation condition was superior and an odds ratio below one indicated that the word reading condition was superior.

The first model that was developed was to examine the within-session learning. This was modeled using the targeted spelling patterns test scores from the end of each training session. After analyzing all the potential predictors, the following final model was arrived at:

Level 1

$$\acute{\eta}_{ij} = \beta_{0j}(\text{Ortho}) + \beta_{1j}(\text{Phone}) + \beta_{2j}(\text{Non}) + \beta_{3j}(\text{Trial})$$

Level 2

$$\beta_{0j}(Ortho) = \gamma_{00} + \gamma_{01}(Timed\ letter) + \gamma_{02}(Reading\ Factor) + \gamma_{03}(Treatment)$$

$$\beta_{1j}(Phon) = \gamma_{10} + \gamma_{11}(Phonological\ Factor) + \gamma_{12}(Treatment)$$

$$\beta_{2j}(Non) = \gamma_{20} + \gamma_{21}(PPVT\ raw) + \gamma_{22}(Treatment)$$

$$\beta_{3j}(Trial) = \gamma_{30} + \gamma_{31}(Reading\ Factor) + \gamma_{32}(Treatment)$$

As can be seen in Table 12, students with better scores on the timed letter-naming task and on the Reading factor had significantly better odds of learning the orthographic spelling patterns (β_{0j}). While those in the segmentation treatment condition did have better odds of learning these spelling patterns than those in the word reading condition, it was not significant (p = .18). To learn the phonetic spelling patterns (β_{1j}) only the phonological skills measured in the phonological factor score contributed significantly. In learning the non-word spelling patterns (β_{2j}), both higher vocabulary (PPVT) scores and being in the segmentation condition rather than the word reading condition had a negative effect, significantly decreasing the odds of learning the spelling pattern. In predicting the rate of growth over trials (β_{3j}), only the reading factor score made a significant contribution to the odds of improving over trials.

The second model developed was created to analyze between-session learning—how much students remembered from one session to next. Using the same modeling techniques as used for the last model, the following final model was developed:

Level 1

$$\acute{\eta}_{ij} = \beta_{0j}(\text{Ortho}) + \beta_{1j}(\text{Phone}) + \beta_{2j}(\text{Non}) + \beta_{3j}(\text{Trial})$$

Level 2

$$\beta_{0j}(Ortho) = \gamma_{00} + \gamma_{01}(Timed\ letter) + \gamma_{02}(Reading\ Factor) + \gamma_{03}(Treatment)$$

$$\beta_{1j}(Phon) = \gamma_{10} + \gamma_{11}(Untimed\ Letter) + \gamma_{12}(Phonological\ Factor) + \gamma_{13}(Treatment\ )$$

$$\beta_{2j}(Non) = \gamma_{20} + \gamma_{21}(PPVT\ raw) + \gamma_{22}(Treatment)$$

$$\beta_{3j}(Trials) = \gamma_{30} + \gamma_{31}(Reading\ Factor) + \gamma_{32}(Treatment)$$

Table 12.

Final estimation of fixed effects for within-session learning

Equation	Fixed effect	Coefficient	Odds Ratio	p value
Intercept β_{0j}				
Orthographic	Intercept γ_{00}	-0.92	0.40	0.03
slope	Timed Letter Meas. γ_{00}	0.05	1.05	0.01
	Reading Factor γ_{02}	1.39	4.02	0.01
	Treatment Cond. γ_{03}	0.76	2.13	0.18
Phone slope β_{1j}				
	Intercept γ_{10}	-1.02	0.36	0.00
	Phon. Factor γ_{11}	0.83	2.29	0.00
	Treatment Cond. γ_{12}	0.12	1.43	0.26
Non-word slope β_{2j}				
	Intercept γ_{20}	0.36	1.43	0.87
	PPVT raw Meas. γ_{21}	-0.03	0.97	0.00
	Treatment Cond. γ_{23}	-2.52	0.07	0.00
Trials slope β_{3j}				
	Intercept γ_{30}	0.12	1.12	0.05
	Reading Factor γ_{31}	0.10	2.29	0.02
	Treatment Cond. γ_{32}	0.12	1.42	0.20

Note. Treatment condition was dummy coded with Segmentation = 1, and Word-Reading = 0. Positive coefficients represent better odds for the segmentation group and negative coefficients represent better odds for the Word-Reading group.

Table 13.

Final estimation of fixed effects for between-session learning

Equation	Fixed effect	Coefficient	Odds Ratio	p value
Intercept β_{0j}				
Orthographic	Intercept γ_{00}	-0.03	0.97	0.93
slope	Timed Letter γ_{01}	0.03	1.03	0.04
	Reading Factor γ_{02}	1.28	3.61	0.00
	Treatment Cond. γ_{03}	-0.14	0.87	0.77
Phone slope β_{1j}				
	Intercept γ_{10}	-1.26	0.28	0.00
	Untimed Letter γ_{11}	0.22	1.24	0.00
	Phon. Factor γ_{12}	0.47	1.61	0.02
	Treatment Cond. γ_{13}	1.12	3.05	0.00
Non-word slope β_{2j}				
	Intercept γ_{20}	0.04	1.03	0.87
	PPVT raw γ_{21}	-0.05	0.95	0.00
	Treatment Cond. γ_{23}	-1.76	0.17	0.00
Trials slope β_{3j}				
	Intercept γ_{30}	0.72	2.06	0.00
	Reading Factor γ_{31}	0.29	1.33	0.00
	Treatment Cond.γ_{32}	-0.07	0.93	0.57

Note. Treatment condition was dummy coded with Segmentation = 1, and Word-Reading = 0. Positive coefficients represent better odds for the segmentation group and negative coefficients represent better odds for the Word-Reading group.

As can be seen in Table 13, students with better scores in the timed letter-naming task and on the reading factor had significantly better odds of learning the orthographic spelling patterns (β_{0j}). For learning the phonological spelling patterns (β_{1j}), letter knowledge, phonological factor skill, and being in the segmentation rather than the word reading treatment condition all made significant contributions. For learning the non-word spelling patterns (β_{2j}), having higher vocabulary knowledge (PPVT) and being in the segmentation rather than the word reading condition had a negative effect reducing the odds that one would learn these spelling patterns. For learning over trials (β_{3j}), reading skill factor made the only significant contribution.

Another measure of student learning was obtained in the spelling posttest that was administered one week after the final training session. This test assessed the students' memory for the spellings of the nine taught words. A breakdown of mean scores by treatment condition can be seen in Table 14. An ANOVA comparing mean scores of the two treatment conditions condition was not significant (F 1, 31 = 0.09, p = .76)[14]. As evident in Table 14, students in the two treatment conditions recalled more spellings of the trained words on average than the students in the minimal control group, but the treatment means were all very low.

A similar Bernoulli model was used to analyze the effects of the treatment conditions and the pretests on the different word types. However, there was no *trial* term at the first level since there was only the one delayed learning task. After analyzing all the potential predictors, the following final model was arrived at:

[14] Recall that the minimal control group was not part of the analysis due to extreme low scores and lack of variance.

Table 14.

Mean scores (*SD*) of correct spelling patterns on the one-week delayed Spelling Posttest of taught words by Condition

Condition	Phonological *Max* = 3	Orthographic *Max* = 3	Non-words *Max* = 3	Total *Max* = 9
Segmentation	0.94 (1.23)	1.38 (1.26)	0.56 (0.89)	2.88 (2.78)
Word-Reading	0.47 (0.94)	0.88 (1.05)	1.24 (0.97)	2.59 (2.55)
Minimal-Control	0.22 (0.44)	0.11 (0.33)	0.00 (0.00)	0.33 (0.71)
Total	0.59 (1.01)	0.90 (1.12)	0.71 (0.94)	2.21 (2.54)

Note. Segmentation n = 16, Word-Reading n = 17, Minimal-Control n = 9, total N = 41.

Level 1

$$\acute{\eta}_{ij} = \beta_{0j}(\text{Ortho}) + \beta_{1j}(\text{Phone}) + \beta_{2j}(\text{Non})$$

Level 2

$$\beta_{0j}(Ortho) = \gamma_{00} + \gamma_{01}(Timed\ letter) + \gamma_{02}(Reading\ Factor) + \gamma_{03}(Treatment)$$

$$\beta_{1j}(Phone) = \gamma_{10} + \gamma_{11}(Phonological\ Factor) + \gamma_{12}(Treatment)$$

$$\beta_{2j}(Non) = \gamma_{20} + \gamma_{21}(Treatment)$$

As can be seen in Table 15, students with better scores on the timed letter naming task and better scores on the reading factor score had significantly better odds of learning the orthographic spelling patterns (β_{0j}). To learn the phonological spelling patterns (β_{1j}) only the phonological skills measured in the phonological factor score contributed significantly. In learning the non-word spelling patterns (β_{2j}), being in the segmentation rather than the word reading condition had a negative effect, significantly decreasing the odds of learning the non-word spelling pattern.

Table 15.

Final estimation of fixed effects for spelling posttest

Equation	Fixed effect	Coefficient	Odds Ratio	p Value
Intercept β_{0j}				
Orthographic	Intercept γ_{00}	-0.93	0.39	0.05
slope	Timed Letter γ_{01}	0.04	1.04	0.05
	Reading Factor γ_{02}	1.00	2.71	0.00
	Treatment Cond. γ_{03}	0.29	1.34	0.65
Phone slope β_{1j}				
	Intercept γ_{10}	-1.66	0.39	0.02
	Phon. Factor γ_{11}	1.18	3.25	0.03
	Treatment Cond. γ_{12}	-0.09	0.92	0.92
Non slope β_{2j}				
	Intercept γ_{20}	0.72	2.06	0.14
	Treatment Cond. γ_{21}	-2.76	0.06	0.00

Note. Treatment condition was dummy coded with Segmentation = 1, and Word-Reading = 0. Positive coefficients represent better odds for the segmentation group and negative coefficients represent better odds for the Word-Reading group.

To illuminate how the effects for the types of spelling patterns were being produced, an analysis was done of individual spelling patterns from the spelling test given before the final training session. This test was chosen because it has the highest scores on average for any test that did not immediately follow a training session, and in that sense represents the peak of learning. Since each spelling pattern was either correct or incorrect, the mean represents the proportion of students for each condition who got that spelling pattern correct. Additionally, an

Table 16

Proportion of children who produced correct spelling patterns with *F* values and effect sizes for the spelling test prior to the 5th training session by condition

Spelling Pattern	Segmentation *n* = 18	Word Reading *n* = 20	*F* value	η^2
Phonological				
DR	.44	.30	0.82	.02
TR	.33	.20	0.84	.02
MP	.61	.25	5.54*	.13
Orthographic				
SS	.61	.75	0.82	.02
CK	.50	.20	3.97	.10
IcE	.33	.15	1.75	.05
Non-words				
H	.16	.15	0.02	.00
RR	.27	.65	5.79*	.14
W	.22	.55	4.55*	.11

Note. * indicates $p < .05$

ANOVA was conducted and an effect size calculated for each spelling pattern. As can be seen in Table 16, the only spelling patterns with significant differences and moderate to large effect sizes were *MP* (segmentation > word reading) and *RR*, and *W* (word reading > segmentation). However it is interesting to note that for all the real word spelling patterns, with the exception of

SS, the segmentation group performed better. While on the non-word spelling patterns the word reading group performed significantly better on two out of the three patterns.

Transfer

Transfer was measured in three ways. First students in the two training conditions received training to learn nine transfer words in a session that followed 2-4 days after the fifth training session. Procedures used were identical to the initial training session except that new words were taught. The second measure was obtained during the posttest session where students were asked to write nine new words that contained the targeted spelling patterns. (See Table 3 for a list of these transfer words). The final transfer measure was obtained in an orthographic choice test in which students were shown new unseen words and were asked to choose between two spellings of the words, one containing the targeted spelling pattern and the other containing either a competing invented pattern, for example: DRAGN vs. JRAGN.

The initial plan for analyzing the transfer session was to compare the growth curves of the 1st session to the transfer training session (see Table 17 for scores from the two sessions). However, this proved to be mathematically untenable to compare two growth curves in this situation (D. Rindksopf, personal communication, December 11th, 2008). Instead a Bernoulli model, similar to those used in the previous analysis, was developed to compare the 3rd test of the initial training session to the 3rd test of the transfer session. Additionally this model included all the word type by time interactions to explore the possibility that some word types transferred better than others. The rational for this model was that if the students learned more of the spelling patterns by the third test of the transfer session than they did by the third test of the initial training session, it would indicate an effect from exposure to the spellings throughout the training.

Table 17

Means and (*SD*) for number of correct target spelling patterns in the spelling tests on the 1st training session and transfer training session by treatment condition

	1st Session			Transfer session		
	Test 1	Test 2	Test 3	Test 1	Test 2	Test 3
Segmentation	0	2.22 (1.99)	2.28 (2.24)	1.56 (1.68)	2.39 (2.37)	2.71 (2.54)
Word-Reading	0	2.05 (1.85)	2.85 (1.93)	.647 (0.99)	2.47 (2.24)	3.12 (2.71)

Note. Segmentation n = 18, Word-Reading n = 20. Maximum possible score = 9.

Table 18

Mean score and (*SD*) for the number of correct representations of spelling patterns for the third/final spelling tests of the first training session and the transfer task session

Word Type	Condition	Initial Session	Transfer Session
Phonological *max = 3*	Segmentation	1.00 (1.00)	1.00 (1.06)
	Word Reading	0.61 (0.84)	0.44 (0.78)
Orthographic *max = 3*	Segmentation	1.17 (1.07)	1.23 (1.09)
	Word Reading	1.11 (0.96)	1.39 (1.33)
Non-Words *max = 3*	Segmentation	0.23 (0.56)	0.47 (0.79)
	Word Reading	1.05 (0.80)	1.33 (0.90)
Total *max = 9*	Segmentation	2.41 (2.23)	2.70 (2.54)
	Word Reading	2.77 (1.83)	3.16 (2.64)

Note. Segmentation n = 18, Word Reading n = 20.

Table 18 contains the mean scores for each test in both the initial training session and in the transfer session distinguished by word type for students who participated in the transfer task. As can be seen, the differences between the final tests in each session were not large and there was no evidence of a word type by time interaction. This was borne out in the analysis. While the Bernoulli model was large and included seven level-one factors and the concomitant level two predictors, the model was mainly characterized by the lack of significance for the questions of interests. There was no main effect for time (t = -1.02, p > .05) meaning that students did no better on the third test of the transfer task than on the third test in the initial session. It confirmed previous findings showing similar effects of the treatment groups in

Table 19

Means and (SD) of correct spelling patterns on the Spelling Posttest of Untaught Words

Condition	Phonological *Max.* = 3	Orthographic *Max.* = 3	Non-words *Max.* = 3	Total *Max.* = 9
Segmentation	0.69 (1.01)	0.56 (0.96)	0.12 (0.34)	1.38 (1.67)
Word Reading	0.29 (0.69)	0.17 (0.39)	0.12 (0.33)	0.59 (0.80)
Minimal Control	0.22 (0.44)	0.11 (0.33)	0.00 (0.00)	0.33 (0.50)
Total	0.43 (0.80)	0.31 (0.68)	0.09 (0.30)	0.83 (1.23)

Note. Segmentation n = 16, Word Reading n = 17, Minimal Control n = 9, and total N = 42.

learning the different spelling patterns i.e., (segmentation > word reading for phonological words $t = 3.37$, $p < .01$, segmentation = word reading for orthographic words, $t = -0.23$, $p > .05$, and segmentation < word reading for non-words, $t = -2.78$, $p < .01$). However, these results did not address the issue of transfer as scores were combined across from both sessions. The final analyses of interest were the word type by time interactions. However, none was significant (all *t*'s between .18 and -.71, all *p*'s > .05).

The second way that transfer was analyzed was through the delayed spelling posttest in which students were asked to write words with similar spelling patterns that they had not been trained on, one week after the final training session. The results are given in Table 19. As can be seen the amount of transfer was limited, just over one word on average for the segmentation condition and less than one word for the other two conditions. However, this was not the only opportunity to spell untaught words after the training—the first spelling test of the transfer session provided the same opportunity one week earlier. Use of both data sources, by combining the scores on the two tests, provided a more complete model of transfer that allowed for

Table 20

Final estimation of fixed effects for Spelling Posttest of Untaught Words

Equation	Fixed effect	Coefficient	Odds Ratio	p Value
Intercept β_{0j}				
Orthographic	Intercept γ_{00}	- 2.16	0.12	0.00
slope	Reading Factor γ_{01}	0.57	1.82	0.00
	Treatment γ_{03}	0.40	1.49	0.44
Phone slope β_{1j}				
	Intercept γ_{10}	-1.65	0.19	0.02
	Timed Letter γ_{11}	0.16	1.18	0.05
	Phon. Factor γ_{12}	1.53	4.64	0.01
	Treatment γ_{13}	0.71	2.02	0.32
Non slope β_{2j}				
	Intercept γ_{20}	- 1.37	0.25	0.04
	Treatment γ_{21}	- 0.36	0.69	0.67

Note. Treatment condition was dummy coded with Segmentation = 1, and Word-Reading = 0. Positive coefficients represent better odds for the segmentation group and negative coefficients represent better odds for the Word-Reading group.

comparison of treatment conditions, word type, and literacy skills.

To model this, a multi-level Bernoulli model similar to the ones used in the prior analysis was employed. After a preliminary analysis, the following level one model was arrived at:

Level 1

$$\acute{\eta}_{ij} = \beta_{0j}(\text{Ortho}) + \beta_{1j}(\text{Phone}) + \beta_{2j}(\text{Non})$$

While it was possible to model the difference in the two time points of the spelling tests there was not a significant difference between the two tests. So for the simplicity of the model, phonological words and non-words were modeled with dummy codes leaving the orthographic words represented by the intercept.

Level 2

$$\beta_{0j}(Ortho) = \gamma_{00} + \gamma_{01}(Reading\ Factor) + \gamma_{02}(Treatment)$$

$$\beta_{1j}(Phone) = \gamma_{10} + \gamma_{11}(Letter\ Naming) + \gamma_{12}(Phonological\ Factor) + \gamma_{13}(Treatment)$$

$$\beta_{2j}(Non) = \gamma_{20} + \gamma_{21}(Treatment)$$

As can be seen in Table 20, students with better scores on the reading factor had better odds of learning orthographic words. Students with better scores on letter naming and the phonological factor score had better odds of learning the phonological based words. Transfer for the non-words was low and nothing predicted performance in learning these new words. It is important to note that for all word types there were no significant effects for treatment for any of the words

The final way that transfer was assessed was through an orthographic choice task given one week after the training session. With three opportunities to select the correct choice from two alternative spellings for each spelling pattern, there were 18 questions. Only the spelling patterns from the real words were used for this analysis, since performance on the non-word patterns would be difficult to interpret. For real words the taught patterns match orthographic regularities and the choice of the correct spelling pattern represents better orthographic knowledge. However, in the case of non-words, what represents the correct choice, the pattern they were just taught for six sessions or the orthographically correct one? Given this ambiguity it was decided to analyze only the real words.

It was determined that a score of 13 or higher would occur by chance less than 5% of the

Table 21

Percentage of Students Scoring Better than Chance by Treatment Condition on the Orthographic Choice Task

	Performed Better Than Chance	
Condition	Yes	No
Segmentation	6	10
% within segmentation	37.5%	62.5%
Word Reading	3	14
% within word reading	17.6%	82.4%
Minimal Control	1	8
% within minimal control	11.1%	88.9%
Total	10	32
% within total	23.8%	76.2%

Note. $\chi^2 = 2.81$, 2*df*, p=.245.

time (P |X >12| = .048). As can be seen in Table 21, the segmentation condition had the greatest proportion of students whose scores were better than chance though the difference was not statistically significant. In order to explore what factors may have contributed to success on the orthographic choice task, a regression analysis was performed using the raw score (0-18). Reading was the only variable that made a significant contribution to the orthographic choice score (model $F = 21.54$, $p < .01$, $R^2 = .35$, $b = 2.10$, $t = 4.64$, $p < .01$).

An additional analysis was done to investigate whether different spelling patterns yielded different scoring patterns. To do this, the three scores for each spelling pattern were combined

Table 22

Number of times the correct spelling pattern was chosen during the orthographic choice posttest

Condition	DR	TR	MP	SS	CK	I_E	RR	KH	W
Total Correct max = 126	61	77*	62	82*	80*	63	59	53	59

*The probability that this number of selections occurred by chance > .05, two tailed.

and totaled for each student and then totaled again for all students, producing a score for each spelling pattern that could range from 0-126 (42 students x 3 questions for each spelling pattern). Since these scores are the product of a choice task with two choices, a binomial distribution was used to determine whether the results were likely to be the product of chance (if 53 < score <73, then there is less than a .05 percent chance that the results were due to chance). Table 22 contains the breakdown for each spelling pattern. As can be seen, only three of the spelling patterns have scores that represent a significant departure from chance—TR, SS and CK.

Error Analysis.

The initial error analysis was done on a word-by-word basis. It consisted of two analyses—first, changes in the spellings of the targeted features over the course of the intervention and second, the analysis of spelling improvement from pretest to posttest.

The first analysis examined initial errors on the pretest and final errors on the spelling test administered before the fifth training session to determine whether and how spelling changed as a result of training. Representations of the targeted spelling pattern were tallied for the two time periods and cross tabulated by training condition. In some instances the student's writing was idiosyncratic. Rather than listing a lot of spellings that only occurred once, these spelling

Table 23

Percentage of students who produced the particular type of spelling pattern either correctly with both letters or only one of the required letters on the spelling test prior to the fifth training session

		Spelling	
Different Letter Blend	Group	Both Letters	Single Letter
TR, DR, KH, MP, CK	Segmentation	63.2%	36.8%
	Word Reading	35%	65%
Same Letter			
SS, RR	Segmentation	48.5%	51.5%
	Word Reading	82.4%	17.6%

attempts were analyzed and categorized as being either an unmarked/random attempt or a pattern from another word on the list. The unmarked/random category was for spellings where either students did not represent the targeted spelling pattern or they represented it with either a random letter string or with a familiar but unrelated word. The list pattern category was for the times students misrepresented the targeted spelling pattern but used a pattern from a different taught word…as in the student who would consistently write VINE for DRAG. Details of this analysis are contained in Appendix J.

In analyzing these data in finer detail, some qualitative differences in the response patterns between the two treatment conditions emerge. These involved how students responded differently to two letter patterns at either the beginning or end of the word depending on the treatment condition they were in and the type of spelling pattern. Some of the letter spelling patterns contained two different letters (DR, TR, KH at the beginning and MP and CK at the end) and others were double letters (RR at the beginning and SS at the end). Table 23 shows the percentage of the responses for the spelling patterns separated by treatment. For the patterns that

had two different consonants a much higher proportion of students in the segmentation group correctly wrote both letters than only the single letter at the beginning or end of the word compared to students in the word reading group who showed the opposite pattern. However, in the case of double letters, the reverse was evident. Students in the word reading condition correctly wrote both letters more frequently than those in the segmentation condition. In both cases, χ^2 tests reveal that the differences in response patterns were significant (both χ^2's > 8.5, $p < .01$).

The second analysis examined whether children's spelling improved as measured by whether their performance on the spelling posttest of untaught words reverted to their initial pretest spelling level of development, or improved to a higher level. To be regarded as an improvement, the final spelling had to be closer phonologically or orthographically to the correct spelling than the initial spelling. For example a student who spelled DRAG on the pretest by writing JRAG, and who spelled DROP on the posttest by writing GROP would be judged no change. However, spelling it with a D would be considered an improvement. In most cases it was very clear whether or not a change constituted an improvement. The only difficult area was around the vowel sounds in VINE and NWG. If the student went from not marking the vowel to marking it, even if the vowel letter itself was wrong it was marked as an improvement. However, many students went from one wrong vowel to another, for example spelling NWG as NOG on the pretest and FWT as FAT on the posttest. Transitions from one wrong vowel to another were considered no improvement even if the incorrect vowel used was marginally closer to the correct vowel sound. Any final spelling that was further from the correct phonological or orthographic representation than the original was considered a regression. For example, a student who wrote DRAG as JRAG on the pretest and wrote DROP as JOP on the posttest would

Table 24

Percentage of student' spellings of the targeted spelling patterns that either regressed, remained consistent or improved from the initial spelling pretest to the spelling posttest of untaught words

Condition	Regressed	Consistant	Improved
Segmentation	14.3%	38.1%	47.6%
Word-Reading	16.7%	47.9%	35.4%
Minimal Control	6.7%	56.7%	36.7%

Notes: $\chi^2_4 = 3.69$, $p > .05$.

be scored as having regressed because of the omission of the R. (See Appendix J for full details of the analysis). Table 24 shows the results the results aggregated by condition. It can be seen that the segmentation condition was slightly though not significantly superior to the other conditions ($\chi^2_4 = 3.69$, p = .45).

Chapter VI Discussion

How do young children who use inventive spelling strategies acquire conventional spelling patterns? To isolate important factors in the transition from inventive to conventional spelling patterns, the study utilized three treatment conditions—segmentation with letters, word reading, and invented spelling—to teach students three types of spelling patterns—phonetic, orthographic, and non-word—in a three-week intensive intervention study. A micro-genetic analysis was used to compare the rate of acquisition and transfer produced by these different methods and to assess the contribution of prior word reading skill to the rate of acquisition.

Treatment Effects for Learning to Spell

The first research question was whether students would learn the new spelling patterns after exposure to them. It was hypothesized that those in the treatment conditions would demonstrate learning whereas those in the control group would not. As hypothesized, the students in the two treatment conditions learned more spelling patterns than those in the control group who only practiced inventing spellings of the words with no corrective feedback. While this was not statistically testable due to lack of variance in the control group's scores, both of the treatment groups learned, on average, more than three of the spelling patterns by the beginning of the 5th training session, whereas the control group had no appreciable gain (i.e. only two students produced one correct spelling pattern each). Gains were still present, though slightly decreased, at the one-week follow-up. While the finding that learning to segment the words with letters or repeatedly reading them on flashcards is better than just inventing spellings with no corrective feedback is not surprising, it does confirm the efficacy of word reading and phoneme segmentation with letters for learning spellings. These findings are not unexpected given the support for both training programs from prior research; Ehri (1980), Ehri and Roberts (1979),

Ehri and Wilce (1986), and Share (2004) for the word reading training and Ehri and Wilce (1987), Ouellette and Senechal (2008b), and Uhry and Shepherd (1993) for the segmentation training. This is in fact why the treatments were designed as they were particularly when compared to the less effective exercise of just practicing invented spellings (Rieben et al., 2005). In previous studies the act of inventing spelling was found to be effective in learning correct spellings (Callaway et al, 1972; Clarke, 1988; Kleisus et al, 1998). However, these studies all had much longer time frames for the interventions and were looking at general growth in spelling rather than growth in the use of particular patterns or words. While their findings demonstrate that an instructional framework utilizing invented spelling is effective for general spelling development, present findings suggest it is not as effective for teaching specific difficult spelling patterns as were the two training methods employed herein.

While present findings clearly answered the first research question, findings did not reveal any differences between word reading and segmentation forms of training, which was the second research question. It was hypothesized that students receiving segmentation training would learn more of the spelling patterns than those in the word reading training; however, this was not the case. In looking at the between-session and within-session learning (see Figures 1 and 2), it was evident that there was very little difference between the two groups. This was borne out in the statistical tests as well, with no significant difference between the two training conditions. In addition, both treatment groups were similar in that they did not learn many of the spelling patterns. At best both groups peaked in learning a little over one-third of the nine spelling patterns. This is similar to Share's (1999) finding where 1st grade students did not demonstrate orthographic learning after decoding the words repeatedly in text. However, it was not the case that these students had no ability to spell. The scores on the invented spelling

pretest indicate that on average they were producing almost half of the phonological information for each word. Additionally, for the initial consonants of the training words whose sounds are found in their letter name (*P, B, V, L, N,* and *K*) 73% of them were used correctly on the pretest and 87% on the test before the final training session. They knew the basic phoneme to grapheme patterns but could not learn the new grapheme to phoneme patterns of these new more complex spelling patterns. As Ehri (1997, 2005) argues, without the understanding of the specific grapheme to phoneme regularities, recall for specific spelling patterns will be difficult. As is evident by the lack of learning, these interventions did not effectively teach these patterns.

There was concern that since a majority of the students were Hispanic this could confound the findings. However, the responses of Hispanic students compared to non-Hispanic students during training gave little indication that language skill had any effect on the training. Moreover, the PPVT was used to eliminate students with limited English skills, so this minimized any differential of language background. Additionally, Hispanic students were evenly distributed among the conditions so any language effects should not have affected performance of the groups. Although it is considered unlikely that students' Hispanic background caused them to respond differently from other non-Hispanic students, this matter awaits further research.

Treatment Effects in Learning Different Types of Spelling Patterns

The third research question was whether acquisition of the particular spelling patterns was influenced by spelling features of the words (i.e. phonetic, orthographic or non-word features). It was hypothesized that words with phonetic spelling features would be easier to learn than orthographic features, which in turn would be faster than non-words. The score from the spelling test administered before the fifth session (the peak learning test) shows that, without considering treatment condition, the orthographic words were slightly easier to learn than the

phonetic words followed by the non-words (*m* = 1.00, 0.85, and 0.80 respectively). However, if the training is taken into consideration, the students who practiced segmentation and spelling the words learned more orthographic words than phonetic words, whereas the students who practiced reading the words learned more of the non-words than the other types of words (see Table 8, pretest fifth session), with only two students in the control group learning one word each—one phonetic and one orthographic.

To explore these training by spelling pattern interactions three measures of learning were analyzed: (a) the number of correct patterns on the spelling test given at the end of each training session which measure the amount of learning immediately after training, (b) the number of correct spelling patterns on the spelling test given at the beginning of each session which measured how much they remembered from the previous session, and (c) the delayed learning task which measured how well they remembered the targeted spelling patterns one week after the final training session. The analysis involved the use of multi-level Bernoulli, with spelling pattern as the second level variable. This allowed for the analysis to be broken down by the type of spelling pattern— orthographic, phonetic or non-word.

When learning the orthographic patterns, the treatment condition made no significant contribution as expected since the learning of orthographic patterns was fairly close between groups. When learning phonetic spelling patterns, receiving the segmentation training increased the odds of acquiring the phonetic spelling patterns on the between-session learning. In learning to spell the non-word spelling patterns, receiving the segmentation training decreased the odds of learning the spelling patterns (or conversely being in the word reading condition increased the odds). It is this unexpected finding that confounded, in a way, the second research questions hypothesis that the segmentation training would lead to more learning. As was mentioned

previously for phonetic words, the students who learned segmentation were significantly better at learning the phonetic patterns on the between-session learning, there was no significant difference between the groups for the orthographic words, and for non-words the word-reading group was significantly better. Meaning that those in the word reading group learned around the same number of spelling patterns as those in the segmentation group, those in the segmentation group learned more real spelling patterns.

However, it may not have been purely the nature of the spelling patterns that explains this difference. In the error analysis it was highlighted how the word reading treatment group learned the double letter spelling patterns significantly better than the segmentation treatment group. In looking at Table 16, it can also be seen that the only words where the word reading treatment group outperformed the segmentation group were PASS, RRET, and NWG. So instead of it being the nature of the spelling pattern it may be that the visually distinctive nature of the double letters made them easier to learn for the word-reading group. The double letters were so distinctive that students often commented on them. During the training, one student in the segmentation group repeatedly put the silent letter marker over the second R in *rret,* saying "it's silent since the first R already makes the /r/ sound." Another student upon seeing the word *boss* in the transfer task said "it has two S's just like pass." Other research has pointed out that double letters are an orthographic pattern that is learned early in the course of literacy development (Cassar & Trieman, 1997, Wright & Ehri, 2007). These findings, however, differ in that in the previous research it was only doublets in legal positions that were learned easier, whereas in this study, for the students in the word reading condition, it was in both legal and illegal positions that they learned these double letters better. It is important to note that this finding only pertains to the spelling task and for participants in the word reading condition, as

will be discussed below. In the orthographic choice task, the selection of the initial double R was no better than chance. There is also the possibility, that while it was visually easy for the students in the word reading condition to remember the double R, the fact that the segmentation group scored so much lower on this particular word suggests that, in line with the previous findings, the full analysis of the word activated the background knowledge that this is an illegal or non-word spelling pattern and suppressed the learning in the segmentation condition. While this does not account for the higher performance in spelling NWG, it does account for about two-thirds of the better performance over the segmentation group.

Treatment and Literacy Skills as Predictors of Learning Spelling Patterns

The fourth research question looked at the effects of prior literacy knowledge on the acquisition of the target spelling patterns. It was hypothesized that word reading skill would be the best predictor of acquisition. In the multi-level Bernoulli models described above there was an additional second level variable for the rate of growth in both the within and between-session learning. As hypothesized, reading was the best predictor for rate of learning and, as it turned out, the only predictor for rate of learning.

However, different skills predicted learning of the different word patterns. For learning orthographic patterns, timed letter naming contributed to all three learning situations, and reading contributed to the between session learning and the delayed learning task. For learning phonetic spelling patterns, scores on the phonological tasks contributed to better success at learning these spelling patterns. Additionally, in the between- session learning, having better letter knowledge increased the odds of remembering the phonetic spelling patterns from one session to the next. In learning to spell the non-word spelling patterns, on both the within and

between-session learning measures, analyses showed that having a higher score on the PPVT decreased the odds of learning these illegal spelling patterns.

This finding on non-words is very interesting if looked at in conjunction with the finding that students in the segmentation group did not learn the non-words as well as those in the word reading group. If vocabulary knowledge as measured by the PPVT is taken as a proxy for language experience, it is possible that those with more experience are more likely to recognize and possibly reject what they know is not orthographically legal. The full analysis of the words that was undertaken by those in the segmentation group might have further highlighted this orthographic illegality. This possibility is consistent with the theory that novice spellers have an understanding of orthographic conventions beyond their ability to produce those conventions.

It is also important to note that while these literacy skills were all highly related— even though the reading and phonological factor scores were correlated, with r = .67 ($p < .05$)—both factors consistently predicted the learning of different types of spelling patterns. Reading predicted orthographic patterns and rate of growth while phonological skills predicted phonetic patterns. It is also interesting that none of the literacy skills predicted the learning for the non-words. Reading was the best and only predictor for rate of learning across trials for both within and between-session learning of the patterns. So while other literacy skills may have predicted particular spelling patterns, when looking at overall growth over time, reading was the best predictor. While this makes sense in that reading is the culmination of all the other literacy skills and has a strong relationship with spelling (Ehri, 1997).

Transfer of Learning to the Spelling of Untaught Words

The final research question dealt with the analysis of transfer. Analysis of the transfer to new words with the same targeted spelling features involved three measures: (a) the initial

transfer task that was the same as the initial training trial but with new words, (b) a spelling posttest (administered one week after the final training session) of untaught words that involved trying to spell new words with the same targeted spelling patterns, and (c) the orthographic choice task in which the student had to choose between two plausible spellings of words, one that represented the correct orthographic convention taught in the training and the other representing a common "invented" spelling.

The first hypothesis predicted that there would be faster growth on the three tests in the transfer task than on the three tests in the first training session. However, this was not the case. For both the overall word total and for individual spelling pattern types there was no evidence of faster learning in the transfer task. Perhaps these scores come close to representing a current ceiling for learning with these students. Most of the gain in the between-session spelling test scores occurred in the first session (see Figure 2). Additionally, looking at the scores at the end of three important sessions, the final tests in session 1 and the transfer session and the final spelling test given at the end of session 5, the correlations were quite high—.75 to.83 (all *p*'s < .05). Additionally, scores did not improve much after the second training session (see figures 1 and 2). Taken together these findings suggest that what the children could remember after three exposures to the words was about the same as what they remembered after 11 exposures and that this was consistent within students. This demonstrated that immediate recall was not a very effective measure for learning; gains were relatively quick but did not stick since students forgot on average one word between the first and second training session. Once again this is similar to Share's (1999) finding that orthographic learning is very difficult for beginning readers.

In the delayed spelling posttest for untaught words, as well as the orthographic choice test, the scores were unsurprisingly low given the low level of learning in the original training—

to transfer as knowledge it must first be learned. This suggests that an increased dosage of exposure to the spelling patterns is required. This will be taken up further in the section on future research.

The results for the spelling posttest for untaught words followed the same pattern as in the taught words—reading skills contributed to the orthographic words and phonological skills contributed to the phonetic words. No effects of treatment, however, were evident although it was hypothesized that the segmentation condition would lead to better transfer. This could mean that while the treatment may have helped or hindered learning certain spelling patterns during training, when it came time to apply that knowledge to a new word it was the student's underlying skill, not the mode of treatment that enabled transfer.

The treatment, likewise, did not affect the orthographic choice task. In this case only reading skill predicted who would perform better than chance. Additionally, when looking at results for spelling patterns across all students, only three spelling patterns were above chance (76 out of 126 comparisons nearly—60% with a .05 two tailed probability cut off). Interestingly, the pattern with highest percent correct was the SS pattern (65%), which was also the most learned during the training (54%). However, the RR pattern, which was the second most learned during the training (39%), was only chosen in the orthographic choice test 46% of the time (still in the random range). While it was easy to learn as a particular instance during the training this did not translate to success in the orthographic choice test. Perhaps, children's understanding of the illegality of initial doublets in English orthography from an early age (Cassar & Trieman, 1997, Wright & Ehri, 2007) kept them from transferring the knowledge they demonstrated during the training to the orthographic choice task.

These results, taken together, support both a connectionist theory of learning and the

overlapping wave theory put forth by Siegler (1986). For transfer to be successful it needed to be supported by stronger underlying literacy skills. The difficulty that students had on the orthographic choice task, however, indicates that even in a recognition task—presumably easier than the production task of spelling untaught words—the competing patterns still had a strong influence on student choice. This would indicate that, in overlapping waves theory language, most of these students, though learning a new strategy, were still very much employing their old strategy when confronted with new words.

To apply the language of connectionist learning theory, the connection weights between the old way of spelling and the new way were still in flux for most of the students except for those with stronger literacy skills. These students presumably had the most literacy exposure, and had already begun the process of shifting the weights towards the correct spelling. They also had better strategies for engaging the spellings as evidenced by some of the overt behaviors during the training.

Use of various strategies was evidenced by students' comments. The previously mentioned students who commented on the double letters were exhibiting use of an orthographic strategy. Another student indicated use of both orthographic and phonological strategies when she orally segmented the word *pass* by pronouncing two separate /s/'s but then reported that it only had three sounds. Also, when the same student segmented the nonword *nwg* she pronounced /w/ instead of /ʌ/ for the middle sound, indicating that she was pronouncing the sound of the letter rather than the sound in the nonword. These students performed well on learning the spelling patterns. However, not all the strategies evidenced by students were useful. One student, on the word reading task, misread drag as *vine* and then spelled it as *rret* indicating that he was memorizing and guessing, but not using the alphabetic principal. Another student

sub-vocalized initial sounds as she looked for words in the word identification part of the word reading training, indicating that she was using initial sound cues but not analyzing and remembering all the letters in the word. The latter students, unsurprisingly given their strategy use, performed poorly on learning the new spelling patterns.

Students' lack of experience and lack of knowledge about effective strategies may explain why the learning results for this study were not as strong as previous studies with older students (Cunningham, Perry, Stanovich, & Share, 2002; Ricketts, Bishop, Pimperton, & Nation, 2011; Share, 1999, 2004). The older students with more literacy knowledge were able to form stronger connections in learning new spelling patterns due to the additional years of literacy experience. The contribution of experience is a particularly important issue, given that in the four previously mentioned studies the amount of exposure to the words was far less than in this study yet the learning results far stronger.

Implications for Instruction

The present study carries two main instructional implications. First, literacy skills play an important role in the acquisition of conventional spelling patterns. Regardless of training condition, word reading and phonological skills were key predictors for the odds of learning one or another spelling pattern. This suggests that conventional spelling instruction should follow reading instruction, a claim supported by Frith's (1985, 1986) argument that at this stage reading will drive conventional spelling acquisition. The findings also indicate that while the segmentation condition was statistically better for learning phonetic-based spelling patterns and trending towards being better for the orthographic patterns (with the exception of the double S) learning did take place through just reading the words as supported by the research of Ehri (1980), Ehri & Roberts (1979), Ehri & Wilce (1986), and Share (2004). This is crucial in that

word exposure is a byproduct of reading instruction—students see words as they learn to read—as opposed to the segmentation activity, which is a time consuming instructional activity in its own right. Teachers should be strategic and ensure that students have opportunity for repeated exposure to a broad base of spelling patterns to ease the acquisition of spelling. However, as this research points out some spelling patterns, like the phonetic ones, would benefit from explicit analysis of the word to make the phonetic ambiguities transparent.

Strengths and Limitations

The spelling pattern findings are particularly strong due to the particular design of this study. The multilevel longitudinal model employed in the study allowed for spelling patterns to be analyzed individually. This allowed for reliable estimates of the odds of acquisition for each spelling pattern by the predictors of training and literacy skills. This methodology allowed for spelling to be analyzed at a finer grain within one experiment and analysis. Additionally, the fact that the multiple follow-up and transfer tasks showed similar patterns in the results makes these findings particularly robust.

While the study was methodologically strong there were two issues that ultimately limited the utility of the findings. The first was that the exclusionary requirement was too severe. By disallowing any student who knew even one of the spelling patterns the resultant sample was truncated at the upper end of the distribution. While it was easy to find students with poor literacy skills to be in the study, most of the disqualifications were for knowing one or more of the spelling patterns. These were the students with higher literacy skills and those presumably most ready to learn the other patterns. While there was information to be learned from the lack of growth among the students with lower literacy skills, to have more students with higher skills would have been more informative. Furthermore, this limited the generalizability of the

findings. The second issue was the lack of any growth from the control group, which, while not surprising given the short time frame of the study, made it difficult to make comparisons.

Future Research

In addition to these limitations there are unanswered questions for future research. First, though students made gains, it is unclear whether the gains are sustainable given that the time frame of the study was short and transfer was weak. Second, does learning a limited set of orthographic and phonetic patterns generalize to a broader range of orthographic and phonetic patterns? Finally, is there a way to boost transfer? To clarify these issues and deal with the limitations of the design, future research needs to focus on a larger and broader set of words to be learned. Also students with a broader set of literacy skills, including some that would already know some of the target words, need to be sampled. In addition, a longer time frame both for learning and for the follow-up is necessary so that meaningful comparisons can be made with the control group. The optimal design would be similar to the current study with the following modifications:

- The intervention would occur at the beginning of the year.
- Training would be done on a larger set of words containing more orthographic and phonetic patterns. The list would be segmented so that as students learned words, more words would be added.
- Two different word lists for each type of training, segmentation and word-reading would be taught. One group, for each type of training, would train on only one instance of each spelling pattern e.g., their only exposure to DR would be with *drag*. The other group, for each type of training, would train on three instances of each spelling pattern (e.g. *drag, drop* and *drip*) for the same amount of training time. There would also be a business-as-

usual control group that would get periodic spelling tests on the target spelling patterns to be used as a comparison.

- The retention and transfer posttests would continue throughout the school year.

These modifications would allow for a deep analysis of spelling development with a broader range of words so that instruction by training and literacy ability interactions could be explored more fully. The two different types of training and the single exemplar versus multiple exemplar manipulation would shed more light on transferability and on the mechanism of acquisition specifically related to connectionist learning theories. The longer time frame for the follow-up would allow for a more meaningful comparison to the control group in order to explore how the treatment groups' gains compare to natural development within the classroom and the long term retention and transfer of the trained words. Undertaking this line of research will help develop new understandings of how children acquire unknown spelling patterns and the instructional practices to best support their learning.

Appendix A

Informed Consent Letter

To the Parents at _____,

My name is Mark Lauterbach and I am a doctoral student in Educational Psychology at the Graduate Center of The City University of New York working on my dissertation, *The Acquisition of Conventional Spelling Patterns by Pre-Conventional Spellers: A Developmental Analysis*. I am interested in conducting research at your child's school. The project will be done under the advisement of Dr. Linnea Ehri, Distinguished Professor of Educational Psychology at the Graduate Center of the City University of New York.

The project involves working with about 60 children to teach them to read, segment or write words to see how this affects their ability to spell these words. Since this project is looking at a very narrow phase of spelling development an initial literacy assessment will be given to determine your child's level of spelling development. If your child's spelling ability is in what is known as the phonetic spelling phase he or she will be asked if they would be willing to participate in the project. If they agree they will receive one of three spelling instruction programs—one that teaches children to read the words, one that teaches them how to segment the word into its sounds and one that gives practice in writing the words. Your child's involvement in the project will require two 20-30 minute sessions at the beginning and end of the project and six 5-15 minute sessions over the course of three weeks.

Participation in this project holds promise of benefiting both students and teachers. Students usually enjoy the individual attention received and the opportunity to show their knowledge about reading and writing. Students will also gain knowledge about how to read and analyze words. Results of this study should advance our knowledge about how children learn to spell and in turn improve literacy instruction in our schools.

In order for your child to participate in this project, your written permission is required. If you are agreeable, please sign the attached permission form and return it to your child's teacher as soon as possible.

You should know that participation in this project is completely voluntary. Any child who participates is free to withdraw from the study at any time without consequence. Your child's performance will be kept confidential. The information will be kept in a locked filing cabinet at the Graduate Center. However, if you choose, information about your child's literacy development can be shared with your child's teacher.

Results of the study may be published in a professional educational journal. However, I will not use names of children in these publications. If you are interested in the final copy of this research, please give me your name and address so that I can send you a copy.

If you would like to talk to me about the study feel free to call me at (718) 853-0970. You may also direct questions to Dr. Linnea Ehri at (212) 817-8294. If you have questions about your child's rights as a participant in this study, you can contact Kay Powell, IRB Administrator, The Graduate Center/City University of New York, (212) 817-7525, kpowell@gc.cuny.edu.

Thank you for considering this request. If you agree to have your child participate, please sign below.

I grant permission for my child named _____ to participate.

_____ _____
(Signature of parent or guardian) (Date)

_____ _____
(Signature of investigator) (Date)

You may share information about my child's literacy development with my child's teacher.

(Please check one) YES_____ NO_____

Appendix B

Spelling test instructions

I am going to say some words to you and I want you to try to spell them as best you can. Most of the words are real words but some of them are words that I have made up. I don't expect you to know how to spell all of the words but I want you to write as many of the sounds you hear in the words as you can. Let me show you…lets pretend that I do not know how to spell the word *beaver* and I was taking the test. The first sound I hear is the /b/ sound, so I will write a B (test administrator writes an B on the paper). The next sound I hear is an /i/ so I will write an E (test administrator writes an E on the paper). The next sound I hear is a /v/ so I will write a V (test administrator writes an V on the paper). The last sound I hear is /r/ so I will write an R (test administrator writes an R on the paper). I made a good guess because I wrote the sounds I heard in *beaver*. However, I missed a few letters I didn't hear. This is the correct way to spell *beaver* (test administrator writes BEAVER on the paper while naming the letters). My guess is ok for this test, but next time I will remember to write the correct spelling.

Now I am going to say some more words. I would like you to write the correct spelling. If you don't know it, that is ok. Just write the sounds that you hear like I did.

Lets Begin.

Number one: Pass. Pass the ball to me. Pass.

Number two: Trot. The horse likes to trot. Trot.

Number three: Bump. There was a Bump on my head after the ball hit me. Bump.

Number four: drag. Can you drag the trashcans out tonight? Drag.

Number five: Luck. I keep this penny for good Luck. Luck..

Number six: Rret. Rret is a word that I made up. Rret.

Number seven Khib. Khib is a word that I made up. Khib.

Number eight: Vine. A Vine is a type of plant. Vine.

Number nine: Nwg. Nwg is a word that I made up. Nwg.

Appendix C

Scoring rubric for correct spelling patterns

DR, TR, KH, and RR had to appear at beginning of the word with the no intervening letters.

MP, CK, and SS had to appear at the end of the word with no intervening letters.

The I_E in vine needed to have the I followed by a consonant followed by the E at the end of the word.

The W had to be placed after the initial consonant but was scored correct if the final consonant was left off or was marked with more than one letter.

Scoring Rubric for invented spelling (Modified from Oldrieve 2003)

Rules:

- 4 points for exact correct letter.
- 3 points for phonemically equivalent letter(s).
- 3 points for double letters that are not necessary to be doubled.
- 2 points for Similar sound letter.
- 2 points for long representation of short vowel
- 2 points for reversed letter
- 2 points for inverted letter
- 2 points for similar letter form
- 2 points for partially represented phoneme
- 0 points for wrong or missing phoneme

1 point deduction:

- From the letter if that given letter, or partially correct letter, or grapheme combination is placed by the student in the wrong location.

Additional Rules:

- Vowel diagraphs and V+ silent e are considered as on position and only awarded 4 points
- CK gets 2 points as C or K, 3 points as KC.
- CH is scored as one position.
- 3 points for a letter name equivalent e.g. C for see would receive 3 points out of a possible 8.

Appendix D

Word Reading

"I am going to show you some cards. On some of the cards are words and some of the cards have pictures. For the picture cards tell me what you see in the picture. For cards with words on them, I want you to do your best to read the word. Even if your not sure but think you might know, take your best guess". (If the student does not answer in 7 seconds the experimenter will say) "lets try the next one" (and move to the next card).

1. The___*
2. glass___
3. To ___*
4. Find_____
5. and___*
6. train___
7. he____*
8. draw____
9. you___*
10. try____
11. it____*
12. Think___
13. of____*
14. grass____
15. in_____*
16. back____
17. was___*
18. bike____
19. said____*
20. class____
21. his_____*
22. duck____
23. that____*
24. like_____
25. she____*
26. for____*
27. drove____
28. truck____
29. game____
30. jump____
31. drink____
32. rock____

*Boder words

Appendix E

Word Reading Condition

First Session

Reasearcher: I am going to teach you how to read some words (*R lays out all of the flash cards on the table*). I am going to point to a word and read it and then I want you to point to the word and read it to me.

Researcher points to the 1st card: "Drag. If you drag your coat along the floor, it will get dirty. Can you point to the word and say drag."

Researcher points to the next card: "Trot. Horses like to trot. Can you point to the word and say trot."

Researcher points to the next card: "Bump. He got a bump on his head when he banged into the door. Can you point to the word and say Bump."

Researcher points to the next card: "Pass. Football players like to pass the ball. Can you point to the word and say pass."

Researcher points to the next card: "Luck. I think this penny brings me good luck. Can you point to the word and say luck."

Researcher points to the next card: "Vine. A vine is a plant with a long, thin stem. Grapes grow on a vine. Can you point to the word and say vine."

Researcher points to the next card: "Khib. Khib is a silly word that I made up. It doesn't have any meaning. Let's pretend it came from Mars. Can you point to the word and say khib."

Researcher points to the next card: "Rret. Rret is a silly word that I made up. It doesn't have any meaning. It lets pretend it came from Mars. Can you point to the word and say Rret."

Researcher points to the next card: "Nwg. Nwg is a silly word that I made up. It doesn't have any meaning. Let's pretend it came from Mars. Can you point to the word and say nwg."

Now I am going to say a word and I want you to point to the word I say. *If the student points to the wrong word the researcher will say "good try but it is actually this word" and point to the correct word "now try it again" and the researcher will repeat the word. If the student responds incorrectly a second time the researcher will respond "good try but it is actually this word" and point to the correct response. The researcher will then say "let's go to the next word" and continue the process. If the student has not responded after 7 seconds the researcher will point to the correct response and say "this word says _____, can you point to _____." If the student still does not respond or responds incorrectly the researcher will say "good try but it is actually this word" and point to the correct response and then say "lets go to the next word".*

Researcher says: Luck. Can you point to the word that says luck.

Researcher says: trot. Can you point to the word that says trot.

Researcher says: Nwg. Can you point to the word that says nwg.

Researcher says: Pass. Can you point to the word that says pass.

Researcher says: Drag. Can you point to the word that says drag.

Researcher says: Vine. Can you point to the word that says vine.

Researcher says: Khib. Can you point to the word that says khib.

Researcher says: Rret. Can you point to the word that says Rret.

Researcher says: Bump. Can you point to the word that says Bump.

The researcher will pick up all the cards and stack them for individual presentation.

R: Now I am going to show you the words one at a time. Try to read them as best as you can. If you can't or you make a mistake I will tell you the right answer. Just try to do the best you can. Lets' begin.
The researcher will shuffle the cards then go through all the words once. If an incorrect answer is given the researcher will respond with "good try" and then give the correct answer. If the student does not respond the researcher will give the correct answer and say, "I know this is hard but keep trying". If the student gives the correct response the researcher will say "good Job".

Now that we have practiced reading these words I want you to try to write them. This is just like the test I gave you in class the other day. Just like you did before I would like you to write the correct spelling. If you don't know it, then write the word as best as you can. Since you just

read these words you will have a better idea about how to spell the word than you did the last time you took the test. If that happens it is ok to spell the word differently than you did last time you took the test. Lets' Begin.

Number one: Nwg. Nwg is a word that I made up. Nwg.

Number two: Vine. A Vine is a type of plant. Vine.

Number three: Khib. Khib is a word that I made up. Khib.

Number four: Pass. Pass the ball to me. Pass.

Number five: Luck. The penny is good luck. luck.

Number six: Trot. The horse likes to trot. trot.

Number seven Bump. There was a Bump on my head after the ball hit me. Bump.

Number eight: Rret. Rret is a word that I made up. Rret.

Number nine: drag. Can you drag the trashcans out tonight? Drag.

R: We are going to practice reading the words again, first I will have you point to the word after I say them then I will have you read them.
Researcher lays cards out in a column.
Now I am going to say a word and I want you to point to the word I say. *If the student points to the wrong word the researcher will say "good try but it is actually this word" and point to the correct word "now try it again" and the researcher will repeat the word. If the student responds incorrectly a second time the researcher will respond "good try but it is actually this word" and point to the correct response. The researcher will then say "let's go to the next word" and continue the process. If the student has not responded after 7 seconds the researcher will point to the correct response and say "this word says _____, can you point to _____." If the student still does not respond or responds incorrectly the researcher will say "good try but it is actually this word" and point to the correct response and then say "lets go to the next word".*

Researcher says: Luck. Can you point to the word that says luck.

Researcher says: trot. Can you point to the word that says trot.

Researcher says: Nwg. Can you point to the word that says nwg.

Researcher says: Pass. Can you point to the word that says pass.

Researcher says: Drag. Can you point to the word that says drag.

Researcher says: Vine. Can you point to the word that says vine.

Researcher says: Khib. Can you point to the word that says khib.

Researcher says: Rret. Can you point to the word that says Rret.

Researcher says: Bump. Can you point to the word that says Bump.

R: Now we are going to practice reading the words again. I am going to show them to you one at a time. Try to read them as best as you can. If you can't or you make a mistake I will tell you the right answer. Just do the best you can. Lets begin.
The researcher will shuffle the cards then go through all the wordsonce. If an incorrect answer is given the researcher will respond with "good try" and then give the correct answer. If the student does not respond the researcher will give the correct answer and say, "I know this is hard but keep trying". If the student gives the correct response the researcher will say "good Job".

Now that we have practiced reading these words I want you to try to write them. Just like you did before I would like you to write the correct spelling. If you don't know it, then write the word as best as you can. Since you just read these words you will have a better idea about how to spell the word than you did the last time you took the test. If that happens it is ok to spell the word differently than you did last time you took the test. Lets Begin.

Number one: Nwg. Nwg is a word that I made up. Nwg.

Number two: Vine. A Vine is a type of plant. Vine.

Number three: Khib. Khib is a word that I made up. Khib.

Number four: Pass. Pass the ball to me. Pass.

Number five: Luck. The penny is good luck. luck.

Number six: Trot. The horse likes to trot. trot.

Number seven Bump. There was a Bump on my head after the ball hit me. Bump.

Number eight: Rret. Rret is a word that I made up. Rret.

Number nine: drag. Can you drag the trashcans out tonight? Drag.

This will be repeated one more time for a total of three read/spell sessions.

Sessions 2-5
All stimuli will be randomly ordered for session 2-5. This particular presentation serves as a template from which the particular sessions will be derived.
Researcher: Today we are going to practice reading those words again, but before we do I am going to give you a spelling test to see how much you remember. Just like on the other tests I want you to write as many of the sounds you hear in the words as you can. Let begin.
Number one: Nwg. Nwg is a word that I made up. Nwg.

Number two: Vine. A Vine is a type of plant. Vine.

Number three: Khib. Khib is a word that I made up. Khib.

Number four: Pass. Pass the ball to me. Pass.

Number five: Luck. The penny is good luck. luck.

Number six: Trot. The horse likes to trot. trot.

Number seven Bump. There was a Bump on my head after the ball hit me. Bump.

Number eight: Rret. Rret is a word that I made up. Rret.

Number nine: drag. Can you drag the trashcans out tonight? Drag.

R: We are going to practice reading the words again first I will have you point to the word after I say them then I will have you read them.
Researcher lays cards out in a column.
Now I am going to say a word and I want you to point to the word I say. *If the student points to the wrong word the researcher will say "good try but it is actually this word" and point to the correct word "now try it again" and the researcher will repeat the word. If the student responds incorrectly a second time the researcher will respond "good try but it is actually this word" and point to the correct response. The researcher will then say "let's go to the next word" and continue the process. If the student has not responded after 7 seconds the researcher will point to the correct response and say "this word says _____, can you point to _____." If the student still does not respond or responds incorrectly the researcher will say "good try but it is actually this word" and point to the correct response and then say "lets go to the next word".*

Researcher says: Drag. Can you point to the word that says drag.

Researcher says: Metal. Can you point to the word that says metal.

Researcher says: Bump. Can you point to the word that says Bump.

Researcher says: Pass. Can you point to the word that says pass.

Researcher says: Sack. Can you point to the word that says sack.

Researcher says: Vine. Can you point to the word that says vine.

Researcher says: Khib. Can you point to the word that says khib.

Researcher says: Rret. Can you point to the word that says Rret.

Researcher says: Nwg. Can you point to the word that says nwg.

Now we are going to practice reading the words again. I am going to show them to you one at a time. Try to read them as best as you can. If you can't or you make a mistake I will tell you the right answer. Just do the best you can. Lets begin.
The researcher will shuffle the cards then go through all the words twice. If an incorrect answer is given the researcher will respond with "good try" and then give the correct answer. If the student does not respond the researcher will give the correct answer and say, "I know this is hard but keep trying". If the student gives the correct response the researcher will say "good Job".

This identify then read process will be repeated three times before the final spelling test.

Now that we have practiced reading these words I want you to try to write them. Just like you did before I would like you to write the correct spelling. If you don't know it, then write the word as best as you can. Since you just read these words you will have a better idea about how to spell the word than you did the last time you took the test. If that happens it is ok to spell the word differently than you did last time you took the test. Lets Begin.

Number one: drag. Can you drag the trashcans out tonight? Drag.

Number two: Metal. The car is made out of metal. Metal.

Number three: Bump. There was a Bump on my head after the ball hit me. Bump.

Number four: Pass. Pass the ball to me. Pass.

Number five: Sack. Put the clothes in the Sack. Sack.

Number six: Vine. A Vine is a type of plant. Vine.

Number seven Khib. Khib is a word that I made up. Khib.

Number eight: Rret. Rret is a word that I made up. Rret.

Number nine: Nwg. Nwg is a word that I made up. Nwg.

Transfer Session 6

We are going to learn how to read some new words today. We are going to do it just like we learned the other words. However before we begin I want to give you a spelling test to see how well you can write them before you read them. Just like the other tests I want you to write the correct spelling. If you do not know how to spell the word write as many of the sounds you hear in the words as you can. Lets begin.

Number one: Trim. The barber gave the boy a little trim. trim.

Number two: Rrog. Rrog is a silly word that I made up. Let's pretend it is from Mars. Rrog.

Number three: drip. The faucet has a drip. Drip.

Number four: Khep. Khep is a silly word that I made up. Lets' pretend it is from Mars. Khep.

Number five: Pack. We need to pack the bags for the trip. Pack.

Number six: Hive. Bees live in a hive. Hive.

Number seven: The boss is the person in charge at work. Boss.

Number eight: fwt. Fwt is a silly word that I made up. Lets pretend it is from Mars. fwt.

Number nine: limp. After I hurt my foot I walked with a limp. limp.

Researcher: I am going to teach you how to read these words (*R lays out all of the flash cards on the table*). I am going to point to a word and read it and then I want you to point to the word and read it to me.

Researcher points to the 1st card: Boss. Can you point to the word and say boss.

Researcher points to the next card: Khep. Can you point to the word and say khep.

Researcher points to the next card: limp. Can you point to the word and say limp. *Researcher points to the next card*: Fwt. Can you point to the word and say Fwt.

Researcher points to the next card: Drip. Can you point to the word and say drip.

Researcher points to the next card: Hive. Can you point to the word and say Hive.

Researcher points to the next card: trim. Can you point to the word and say trim.

Researcher points to the next card: Rrog. Can you point to the word and say Rrog.

Researcher points to the next card: Pack. Can you point to the word and say Pack.

Now I am going to say a word and I want you to point to the word I say. *If the student points to the wrong word the researcher will say "good try but it is actually this word" and point to the correct word "now try it again" and the researcher will repeat the word. If the student responds incorrectly a second time the researcher will respond "good try but it is actually this word" and point to the correct response. The researcher will then say "let's go to the next word" and continue the process. If the student has not responded after 7 seconds the researcher will point to the correct response and say "this word says _____, can you point to _____." If the student still does not respond or responds incorrectly the researcher will say "good try but it is actually this word" and point to the correct response and then say "lets go to the next word".*

Researcher says: Hive. Can you point to the word that says Hive.

Researcher says: Drip. Can you point to the word that says drip.

Researcher says: Limp. Can you point to the word that says Limp.

Researcher says: Boss. Can you point to the word that says Boss.

Researcher says: Pack. Can you point to the word that says Pack.

Researcher says: Fwt. Can you point to the word that says Fwt.

Researcher says: Trim. Can you point to the word that says trim.

Researcher says: Rrog. Can you point to the word that says Rrog.

Researcher says: Khep. Can you point to the word that says khip.

The researcher will pick up all the cards and stack them for individual presentation.

R: Now I am going to show you the words one at a time. Try to read them as best as you can. If you can't or you make a mistake I will tell you the right answer. Just try to do the best you can. Lets begin.
The researcher will shuffle the cards then go through all the words twice. If an incorrect answer is given the researcher will respond with "good try" and then give the correct answer. If the student does not respond the researcher will give the correct answer and say, "I know this is hard but keep trying". If the student gives the correct response the researcher will say "good Job".

Now that we have practiced reading these words I want you to try to write them. Just like you did before I would like you to write the correct spelling. If you don't know it, then write the word as best as you can. Since you just read these words you will have a better idea about how to spell the word than you did the last time you took the test. If that happens it is ok to spell the word differently than you did last time you took the test. Lets Begin.

Number one: drip. The faucet has a drip. Drip.

Number two: Khep. Khep is a word that I made up. Khep.

Number three: Trim. The barber gave the boy a little trim. trim.

Number four: Boss. The boss told him to get to work. Boss.

Number five: Rrog. Rrog is a word that I made up. Lets pretend its from Mars. Rrog.

Number six: Hive. Bees live in a hive. Hive

Number seven: Pack . We need to pack the bags for the trip. Pack.

Number eight: : fwt. Fwt is a silly word that I made up. Lets pretend it is from Mars. fwt..

Number nine: limp. After I hurt my foot I walked with a limp. limp

The flash card reading/spelling practice sessions will be done two more times for a total of three sessions.

Appendix F

Segmentation with letters Condition

First Session

Introduction:
"I am going to show you how some words are written. I will teach you how to break up the words into their sounds and then match up letters to the sounds so you will see why the word is spelled that way. We will use these plastic letters and these boxes."

Procedures for Teaching Each Word:

1. The first word is "drag."
Here's what it means: "If you drag your coat along the floor, it will get dirty."
Now I will break "drag" into separate sounds and mouth movements.
I will say the separate sounds in "drag" and count them on my fingers.
Listen to the sounds and watch my mouth move.
/d/ - /r/ - /a/ - /g/ - (*lift a finger as you say each sound).*
"Drag" has 4 sounds so I need 4 boxes for those sounds.
(*Select row of 4 boxes)*

Now I will figure out how to fill the boxes with letters.
(Place the letters D R A G below the Elkonin box in random order.)
Here are the letters that spell "drag" in mixed up order.
I will say each sound, find that letter, and move it into its box.
(Say "drag," *then say each sound* /d/ - /r/ - /a/ - /g/ *as you move each letter into a box.)*
(*Then run your finger underneath the word as you say "*drag*.")*
Each letter matches a sound in the word, so each letter goes into one of the boxes.

(*Remove letters from boxes, mix them up and cover them.)*

Now you do it just like I did.
First say "drag," then say its separate sounds as you lift your fingers.
(Child responds. Record response.)
(*If correct*) Good. How many sounds do your fingers show? (*Child R.*) *(If # wrong, correct.)*

(If wrong) Watch me do it.
I will say and count the sounds in "drag" on my fingers.
Listen to the sounds and watch my mouth move.

/d/ - /r/ - /a/ - /g/ - *(lift a finger as you say each sound).*
"Drag" has four sounds.

Here are four boxes for those sounds. You need to figure out how to fill them with letters.
Here are the letters that spell "drag" in mixed up order. (*present letters*)

Say each sound in "drag" as you move that letter into its box.
(Child responds. Record response)

(If correct) Now run your finger underneath the word as you say "drag." *(Child R)*
Good job.

(If wrong, remove letters from box, mix them up, place below boxes in random order.)
Watch how I do it.
I say each sound in drag, find its letter, and put it in its box.
(Say "drag," *then say each sound* /d/ - /r/ - /a/ - /g/ *as you move each letter into a box.)*
(*Then run your finger underneath the word as you say "drag.")*
Each letter matches a sound in the word, so each letter goes into one of the boxes.

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2. The next word is "pass."
Here's what it means: "Football players like to pass the ball."
Now I will break "pass" into separate sounds and mouth movements.
I will say the separate sounds in "pass" and count them on my fingers.
Listen to the sounds and watch my mouth move.
/p/ - /a/ - /s/ - (*lift a finger as you say each sound).*
"Pass" has 3 sounds so I need 3 boxes for those sounds.
(*Select row of 3 boxes)*

Now I will figure out how to fill the boxes with letters.
(Place the letters P A S S below the Elkonin box in random order.)
Here are the letters that spell "pass" in mixed up order.
I will say each sound, find that letter, and move it into its box.
(Say "pass," *then say each sound* /p/ - /a/ - /s/ *as you move each letter into a box.)*
Oh, Oh. There is another letter to put somewhere.
I know. Sometimes it takes 2 letters to spell one sound.
In the word "pass," it takes 2 letters to spell the /s/ sound so I need to put 2 Ss together in one box. *(Move letter into box.)*
(*Then run your finger underneath the word as you say "*pass*.")*

(*Remove letters from boxes, mix them up and cover them.)*

Now you do it just like I did.
First say "pass," then say its separate sounds as you lift your fingers.
(Child responds. Record response.)
(If correct) Good. How many sounds do your fingers show? (*Child R.*) *(If # wrong, correct.)*

(If wrong) Watch me do it.
I will say and count the sounds in "pass" on my fingers.
Listen to the sounds and watch my mouth move.
/p/ - /a/ - /s/ - *(lift a finger as you say each sound).*
"Pass" has 3 sounds.

Here are 3 boxes for those sounds. You need to figure out how to fill them with letters.
Here are the letters that spell "pass" in mixed up order. (*present letters*)
Say each sound in "pass" as you move the letters into their boxes.
Don't forget the tricky letter.
(Child responds. Record response)

(If correct) Now run your finger underneath the word as you say "pass." *(Child R)*
Good job.

(If wrong, remove letters from box, mix them up, place below boxes in random order.)
Watch how I do it.
I will say each sound, find that letter, and move it into its box.
(Say "pass," *then say each sound* /p/ - /a/ - /s/ *as you move each letter into a box.)*
I remember. Sometimes it takes 2 letters to spell one sound.
In the word "pass," it takes 2 letters to spell the /s/ sound so I will put 2 Ss together in one box. *(Move letter into box.)*
(*Then run your finger underneath the word as you say "*pass*.")*

---

3. The next word is "Rret."
"Rret" is a silly word that I made up. It doesn't have any meaning. It lets pretend it came from Mars.
Now I will break "rret" into separate sounds and mouth movements.
I will say the separate sounds in "rret" and count them on my fingers.
Listen to the sounds and watch my mouth move.
/r/ - /e/ - /t/ - (*lift a finger as you say each sound).*
"Rret" has 3 sounds so I need 3 boxes for those sounds.
(*Select row of 3 boxes)*

Now I will figure out how to fill the boxes with letters.
(Place the letters R R E T below the Elkonin box in random order.)
Here are the letters that spell "rret" in mixed up order.
I will say each sound, find that letter, and move it into its box.
(Say "rret," *then say each sound* /r/ - /e/ - /t/ *as you move each letter into a box.)*
Oh, Oh. There is another letter to put somewhere.
I know. Sometimes it takes 2 letters to spell one sound.
In the word "rret," it takes 2 letters to spell the /r/ sound so I need to put 2 Rs together in one box. *(Move letter into box.)*
(*Then run your finger underneath the word as you say "*rret*.")*

(*Remove letters from boxes, mix them up and cover them.)*

Now you do it just like I did.
First say "rret," then say its separate sounds as you lift your fingers.
(Child responds. Record response.)

(If correct) Good. How many sounds do your fingers show? (*Child R.*) *(If # wrong, correct.)*

(If wrong) Watch me do it.
I will say and count the sounds in "rret" on my fingers.
Listen to the sounds and watch my mouth move.
/r/ - /e/ - /t/ - *(lift a finger as you say each sound).*
"Rret" has 3 sounds.

Here are 3 boxes for those sounds. You need to figure out how to fill them with letters.
Here are the letters that spell "rret" in mixed up order. (*present letters*)
Say each sound in "rret" as you move the letters into their boxes.
Don't forget the tricky letter.
(Child responds. Record response)

(If correct) Now run your finger underneath the word as you say "rret." *(Child R)*
Good job.

(If wrong, remove letters from box, mix them up, place below boxes in random order.)
Watch how I do it.
I will say each sound, find that letter, and move it into its box.
(Say "rret," *then say each sound* /r/ - /e/ - /t/ *as you move each letter into a box.)*
I remember. Sometimes it takes 2 letters to spell one sound.

In the word "rret," it takes 2 letters to spell the /r/ sound so I will put 2 Rs together in one box. *(Move letter into box.)*
(*Then run your finger underneath the word as you say "*rret*.")*

---

4. The next word is "bump."
Here's what it means: "He got a <u>bump</u> on his head when he banged into the door."
Now I will break "bump" into separate sounds and mouth movements, and I will count them on my
fingers.
Listen to the sounds and watch my mouth move.
/b/ - /u/ - /m/ - /p/ - (*lift a finger as you say each sound).*
"Bump" has 4 sounds so I need 4 boxes for those sounds.
(*Select row of 4 boxes)*

Now I will figure out how to fill the boxes with letters.
(Place the letters B U M P below the Elkonin box in random order.)
Here are the letters that spell "bump" in mixed up order.
I will say each sound, find that letter, and move it into its box.
(Say "bump" *then say each sound* /b/ - /u/ - /m/ - /p/ *as you move each letter into a box.)*
(*Then run your finger underneath the word as you say "*bump*."*
Each letter matches a sound in the word, so each letter goes into one of the boxes.

(*Remove letters from boxes, mix them up and cover them.)*

Now you do it just like I did.
First say "bump," then say its separate sounds as you lift your fingers.
(Child responds. Record response.)
(If correct) Good. How many sounds do your fingers show? (*Child R.*) *(If # wrong, correct.)*

(If wrong) Watch me do it.
I will say and count the sounds in "bump" on my fingers.
Listen to the sounds and watch my mouth move.

/b/ - /u/ - /m/ - /p/ - *(lift a finger as you say each sound).*
"Bump" has four sounds.

Here are four boxes for those sounds. You need to figure out how to fill them with letters.
Here are the letters that spell "bump" in mixed up order. (*present letters*)
Say each sound in "bump" as you move that letter into its box.
(Child responds. Record response)

(If correct) Now run your finger underneath the word as you say "bump." *(Child R)*
Good job.

(If wrong, remove letters from box, mix them up, place below boxes in random order.)
Watch how I do it.
I say each sound in "bump", find its letter, and put it in its box.
(Say "bump," *then say each sound* /b/ - /u/ - /m/ - /p/ *as you move each letter into a box.)*
(*Then run your finger underneath the word as you say "*bump*.")*
Each letter matches a sound in the word, so each letter goes into one of the boxes.
---

5. The next word is "luck."
Here's what it means: "When everything goes great some people say you have good <u>luck.</u>"
Now I will break "luck" into separate sounds and mouth movements.
I will say the separate sounds in "luck" and count them on my fingers.
Listen to the sounds and watch my mouth move.
/l/ - /u/ - /k/ - (*lift a finger as you say each sound).*
"luck" has 3 sounds so I need 3 boxes for those sounds.
(*Select row of 3 boxes)*

Now I will figure out how to fill the boxes with letters.
(Place the letters L U C K below the Elkonin box in random order.)
Here are the letters that spell "luck" in mixed up order.
I will say each sound, find that letter, and move it into its box.
(Say "luck," *then say each sound* /l/ - /u/ - /k/ *as you move each letter L U K into a box.)*
Oh, Oh. There is another letter to put somewhere.
I know. Sometimes it takes 2 letters to spell one sound.

In the word “luck,” the C and the K go together to spell the /k/ sound, so I need to put C and K together in one box. The C comes before the K. *(Move letter into box.)*
(*Then run your finger underneath the word as you say “*luck*.”*

(*Remove letters from boxes, mix them up and cover them.)*

Now you do it just like I did.
First say “luck,” then say its separate sounds as you lift your fingers.
(Child responds. Record response.)
(If correct) Good. How many sounds do your fingers show? (*Child R.*) *(If # wrong, correct.)*

(If wrong) Watch me do it.
I will say and count the sounds in “luck” on my fingers.
Listen to the sounds and watch my mouth move.
/l / - /u/ - /k/ - *(lift a finger as you say each sound).*
“luck” has 3 sounds.

Here are 3 boxes for those sounds. You need to figure out how to fill them with letters.
Here are the letters that spell “luck” in mixed up order. (*present letters*)
Say each sound in “luck” as you move the letters into their boxes.
Don’t forget the tricky letter.
(Child responds. Record response)

(If correct) Now run your finger underneath the word as you say “luck.” *(Child R)*
Good job.

(If wrong, remove letters from box, mix them up, place below boxes in random order.)
Watch how I do it.
I will say each sound, find that letter, and move it into its box.
(Say “sack,” *then say each sound* /l/ - /u/ - /k/ *as you move each letter into a box.)*
I remember. Sometimes it takes 2 letters to spell one sound in some words.
In the word “luck,” it takes both C and K to spell the /k/ sound so I will put C and K together in one box. The C comes before the K. *(Move letter into box.)*
(*Then run your finger underneath the word as you say “*luck*.”)*

---

6. The next word is “nwg.”
“Nwg” is a silly word that I made up. It doesn’t have any meaning. Let’s pretend it came from Mars. Now I will break “nwg” into separate sounds and mouth movements.
I will say the separate sounds in “nwg” and count them on my fingers.
Listen to the sounds and watch my mouth move.
/n/ - /u - /g/ - (*lift a finger as you say each sound).*
“nwg” has 3 sounds so I need 3 boxes for those sounds.
(*Select row of 3 boxes)*

Now I will figure out how to fill the boxes with letters.

(Place the letters N W G below the Elkonin box in random order.)
Here are the letters that spell "nwg" in mixed up order.
I will say each sound, find that letter, and move it into its box.
(Say "nwg," *then say each sound* /n/ - /u/ - /g/ *as you move each letter into a box.)*
(*Then run your finger underneath the word as you say "*nwg*."*
Each letter matches a sound in the word, so each letter goes into one of the boxes.

(*Remove letters from boxes, mix them up and cover them.)*

Now you do it just like I did.
First say "nwg," then say its separate sounds as you lift your fingers.
(Child responds. Record response.)
(If correct) Good. How many sounds do your fingers show? (*Child R.*) *(If # wrong, correct.)*

(If segmentation wrong) Watch me do it.
I will say and count the sounds in "nwg" on my fingers.
Listen to the sounds and watch my mouth move.
/n/ - /u/ - /g/ - *(lift a finger as you say each sound).*
"nwg" has 3 sounds.

Here are 3 boxes for those sounds. You need to figure out how to fill them with letters.
Here are the letters that spell "nwg" in mixed up order. (*present letters*)
Say each sound in "nwg" as you move that letter into its box.
(Child responds. Record response)

(If correct) Now run your finger underneath the word as you say "nwg." *(Child R)*
Good job.

(If wrong, remove letters from box, mix them up, place below boxes in random order.)
Watch how I do it.
I say each sound in nwg, find its letter, and put it in its box.
(Say "nwg," *then say each sound* /n/ - /u/ - /g/ *as you move each letter into a box.)*
(*Then run your finger underneath the word as you say "*nwg*.")*
Each letter matches a sound in the word, so each letter goes into one of the boxes.
---

7. The next word is "trot."
Here's what it means: "When horses walk fast it is called a <u>trot</u>."
Now I will break "trot" into separate sounds and mouth movements.
I will say the separate sounds in "trot" and count them on my fingers.
Listen to the sounds and watch my mouth move.
/t/ - /r/ - /o/ - /t/ - (*lift a finger as you say each sound).*
"trot" has 4 sounds so I need 4 boxes for those sounds.
(*Select row of 4 boxes)*

Now I will figure out how to fill the boxes with letters.

(Place the letters T R O T below the Elkonin box in random order.)
Here are the letters that spell "trot" in mixed up order.
I will say each sound, find that letter, and move it into its box.
(Say "trot," *then say each sound* /t/ - /r/ - /o/ - /t/ *as you move each letter into a box.)*
(*Then run your finger underneath the word as you say "*trot*."*
Each letter matches a sound in the word, so each letter goes into one of the boxes.

(*Remove letters from boxes, mix them up and cover them.)*

Now you do it just like I did.
First say "trot," then say its separate sounds as you lift your fingers.
(Child responds. Record response.)
(If correct) Good. How many sounds do your fingers show? (*Child R.*) *(If # wrong, correct.)*

(If wrong) Watch me do it.
I will say and count the sounds in "trot" on my fingers.
Listen to the sounds and watch my mouth move.
/t/ - /r/ - /o/ - /t/ - *(lift a finger as you say each sound).*
"trot" has 4 sounds.

Here are 4 boxes for those sounds. You need to figure out how to fill them with letters.
Here are the letters that spell "trot" in mixed up order. (*present letters*)
Say each sound in "trot" as you move that letter into its box.
(Child responds. Record response)

(If correct) Now run your finger underneath the word as you say "trot." *(Child R)*
Good job.

(If wrong, remove letters from box, mix them up, place below boxes in random order.)
Watch how I do it.
I say each sound in trot, find its letter, and put it in its box.
(Say "trot," *then say each sound* /t/ - /r/ - /o/ - /t/ *as you move each letter into a box.)*
(*Then run your finger underneath the word as you say "*trot*.")*
Each letter matches a sound in the word, so each letter goes into one of the boxes.

---

8. The next word is "vine."
Here's what it means: "A vine is a plant with a long, thin stem. Grapes grow on a vine."
Now I will break "vine" into separate sounds and mouth movements.
I will say the separate sounds in "vine" and count them on my fingers.
Listen to the sounds and watch my mouth move.
/v/ - /i/ - /n/ - (*lift a finger as you say each sound).*
"vine" has 3 sounds so I need 3 boxes for those sounds.
(*Select row of 3 boxes)*

Now I will figure out how to fill the boxes with letters.
(Place the letters V I N E below the Elkonin box in random order.)

Here are the letters that spell "vine" in mixed up order.
I will say each sound, find that letter, and move it into its box.
(Say "vine," *then say each sound* /v/ - /i/ - /n/ *as you move each letter V I N into a box.)*
Oh, Oh. There is another letter to put somewhere.
I know. Sometimes words have letters that don't make any sound.
In the word "vine," the letter E comes at the very end and is silent.
I will place it at the end and then put a black cover over it to show that you can seen the letter E in the written word but you can't hear its sound when you say "vine." *(Move letter to final position, then cover it.)*
(*Then run your finger underneath the word as you say "*vine*")*

(*Remove letters from boxes, mix them up and cover them.)*

Now you do it just like I did.
First say "vine," then say its separate sounds as you lift your fingers.
(Child responds. Record response.)
(*If correct*) Good. How many sounds do your fingers show? (*Child R.*) *(If # wrong, correct.)*

(If wrong) Watch me do it.
I will say and count the sounds in "vine" on my fingers.
Listen to the sounds and watch my mouth move.
/v/ - /i/ - /n/ - *(lift a finger as you say each sound).*
"vine" has 3 sounds.

Here are 3 boxes for those sounds. You need to figure out how to fill them with letters.
Here are the letters that spell "vine" in mixed up order. (*present letters*)
Say each sound in "vine" as you move the letters into their boxes.
Don't forget the tricky letter.
(Child responds. Record response)

(If correct) Now run your finger underneath the word as you say "vine." *(Child R)*
Good job.

(If wrong, remove letters from box, mix them up, place below boxes in random order.)
Watch how I do it.
I will say each sound, find that letter, and move it into its box.
(Say "vine," *then say each sound* /v/ - /i/ - /n/ *as you move each letter into a box.)*
I remember. Sometimes words have letters that don't make any sound.
In the word "vine," the letter E comes at the very end and is silent.
I will place it at the end and then put a black cover over it to show that you can see it in the written word but you can't hear its sound when you say "vine."
(Move letter to final position, then cover it.)
(*Then run your finger underneath the word as you say "*vine*")*

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9. The next word is "khib."

"Khib" is a silly word that I made up. It doesn't have any meaning. Let's pretend it came from Mars.
Now I will break "khib" into separate sounds and mouth movements.
I will say the separate sounds in "khib" and count them on my fingers.
Listen to the sounds and watch my mouth move.
/k/ - /i/ - /b/ - (*lift a finger as you say each sound).*
"khib" has 3 sounds so I need 3 boxes for those sounds.
(*Select row of 3 boxes)*

Now I will figure out how to fill the boxes with letters.
(Place the letters K H I B below the Elkonin box in random order.)
Here are the letters that spell "khib" in mixed up order.
I will say each sound, find that letter, and move it into its box.
(Say "khib," *then say each sound* /k/ - /i/ - /b/ *as you move each letter K I B into a box.)*
Oh, Oh. There is another letter to put somewhere.
I know. Sometimes words have letters that don't make any sound.
In the word "khib," the letter H comes after the K and is silent.
I will move the letters to make a place for the H. *(Move letters, insert K.)*
It comes right after the K.
Then I will put the black cover over it *(place cover)* to show that you can seen H in the written word but you can't hear its sound when you say "khib." *(Move letter to final position, then cover it.)*
(*Then run your finger underneath the word as you say "*khib*.")*

(*Remove letters from boxes, mix them up and cover them.)*

Now you do it just like I did.
First say "khib," then say its separate sounds as you lift your fingers.
(Child responds. Record response.)
(*If correct*) Good. How many sounds do your fingers show? (*Child R.*) *(If # wrong, correct.)*

(If wrong) Watch me do it.
I will say and count the sounds in "khib" on my fingers.
Listen to the sounds and watch my mouth move.
/k/ - /i/ - /b/ - *(lift a finger as you say each sound).*
"khib" has 3 sounds.

Here are 3 boxes for those sounds. You need to figure out how to fill them with letters.
Here are the letters that spell "khib" in mixed up order. (*present letters*)
Say each sound in "khib" as you move the letters into their boxes.
Don't forget the tricky letter.
(Child responds. Record response)

(If correct) Now run your finger underneath the word as you say "khib." *(Child R)*
Good job.

(If wrong, remove letters from box, mix them up, place below boxes in random order.)

Watch how I do it.
I will say each sound, find that letter, and move it into its box.
(Say "khib," *then say each sound* /k/ - /i/ - /b/ *as you move each letter K I B into a box.)*
I remember. Sometimes words have letters that don't make any sound.
In the word "khib," the letter H comes after the K and is silent.
I will move the letters to make a place for the H. *(Move letters, insert K.)*
It comes right after the K.
Then I will put the black cover over it *(place cover)* to show that you can seen H in the written word but you can't hear its sound when you say "khib."
(Move letter to final position, then cover it.)
(*Then run your finger underneath the word as you say "*khib*."*

Now that we have practiced breaking these words into their sounds I want you to try to write them. Just like you did before I would like you to write the correct spelling. If you don't know it, then write the word as best as you can. Since you just worked with these words you will have a better idea about how to spell the words than you did the last time you took the test. If that happens it is ok to spell the word differently than you did last time you took the test. Lets Begin.

Number one: Vine. A Vine is a type of plant. Vine.

Number two: Nwg. Nwg is a word that I made up. Nwg.

Number three: Khib. Khib is a word that I made up. Khib.

Number four: Bump. There was a Bump on my head after the ball hit me. Bump.

Number five: Luck. Put the clothes in the Luck. Luck.

Number six: Drag. Did you drag the trashcans out tonight? Drag.

Number seven Pass. Pass the ball to me. Pass.

Number eight: Rret. Rret is a word that I made up. Rret.

Number nine: Trot. Horses like to trot. Trot.

Very good work. Now we are going to practice breaking these words up into their sounds again. This time instead of me doing it first I will tell you the word and have you break the word up into sounds and count them. Then you will put the letters into the boxes as you say the sounds.

The first word is "drag." Now say its separate sounds as you lift your fingers.
(Child responds. Record response.)
(If correct) Good. How many sounds do your fingers show? (*Child R.*) *(If # wrong, correct.)*

(If wrong) Watch me do it.
I will say and count the sounds in "drag" on my fingers.
Listen to the sounds and watch my mouth move.

/d/ - /r/ - /a/ - /g/ - *(lift a finger as you say each sound).*
"Drag" has four sounds.

Here are four boxes for those sounds. You need to figure out how to fill them with letters.
Here are the letters that spell "drag" in mixed up order. (*present letters*)
Say each sound in "drag" as you move that letter into its box.
(Child responds. Record response)

(If correct) Now run your finger underneath the word as you say "drag." *(Child R)*
Good job.

(If wrong, remove letters from box, mix them up, place below boxes in random order.)
Watch how I do it.
I say each sound in drag, find its letter, and put it in its box.
(Say "drag," *then say each sound* /d/ - /r/ - /a/ - /g/ *as you move each letter into a box.)*
(*Then run your finger underneath the word as you say "drag.")*
Each letter matches a sound in the word, so each letter goes into one of the boxes.

---

2. The next word is "pass." Now say its separate sounds as you lift your fingers.

(Child responds. Record response.)
(If correct) Good. How many sounds do your fingers show? (*Child R.*) *(If # wrong, correct.)*

(If wrong) Watch me do it.
I will say and count the sounds in "pass" on my fingers.
Listen to the sounds and watch my mouth move.
/p/ - /a/ - /s/ - *(lift a finger as you say each sound).*
"Pass" has 3 sounds.

Here are 3 boxes for those sounds. You need to figure out how to fill them with letters.
Here are the letters that spell "pass" in mixed up order. (*present letters*)
Say each sound in "pass" as you move the letters into their boxes.
Don't forget the tricky letter.

(Child responds. Record response)

(If correct) Now run your finger underneath the word as you say "pass." *(Child R)*
Good job.

(If wrong, remove letters from box, mix them up, place below boxes in random order.)
Watch how I do it.
I will say each sound, find that letter, and move it into its box.
(Say "pass," *then say each sound* /p/ - /a/ - /s/ *as you move each letter into a box.)*
I remember. Sometimes it takes 2 letters to spell one sound.
In the word "pass," it takes 2 letters to spell the /s/ sound so I will put 2 Ss together in one box. *(Move letter into box.)*
(*Then run your finger underneath the word as you say "*pass*."*

---

3. The next word is "Rret." Now say its separate sounds as you lift your fingers.
(Child responds. Record response.)
(If correct) Good. How many sounds do your fingers show? (*Child R.*) *(If # wrong, correct.)*

(If wrong) Watch me do it.
I will say and count the sounds in "rret" on my fingers.
Listen to the sounds and watch my mouth move.
/r/ - /e/ - /t/ - *(lift a finger as you say each sound).*
"Rret" has 3 sounds.

Here are 3 boxes for those sounds. You need to figure out how to fill them with letters.
Here are the letters that spell "rret" in mixed up order. (*present letters*)
Say each sound in "rret" as you move the letters into their boxes.
Don't forget the tricky letter.
(Child responds. Record response)

(If correct) Now run your finger underneath the word as you say "rret." *(Child R)*
Good job.

(If wrong, remove letters from box, mix them up, place below boxes in random order.)
Watch how I do it.
I will say each sound, find that letter, and move it into its box.
(Say "rret," *then say each sound* /r/ - /e/ - /t/ *as you move each letter into a box.)*
I remember. Sometimes it takes 2 letters to spell one sound.
In the word "rret," it takes 2 letters to spell the /r/ sound so I will put 2 Rs together in one box. *(Move letter into box.)*
(*Then run your finger underneath the word as you say "*rret*."*

---

4. The next word is "bump." Now say its separate sounds as you lift your fingers.
(Child responds. Record response.)

(If correct) Good. How many sounds do your fingers show? (*Child R.*) *(If # wrong, correct.)*

(If wrong) Watch me do it.
I will say and count the sounds in "bump" on my fingers.
Listen to the sounds and watch my mouth move.

/b/ - /u/ - /m/ - /p/ - *(lift a finger as you say each sound).*
"Bump" has four sounds.

Here are four boxes for those sounds. You need to figure out how to fill them with letters.
Here are the letters that spell "bump" in mixed up order. (*present letters*)
Say each sound in "bump" as you move that letter into its box.
(Child responds. Record response)

(If correct) Now run your finger underneath the word as you say "bump." *(Child R)*
Good job.

(If wrong, remove letters from box, mix them up, place below boxes in random order.)
Watch how I do it.
I say each sound in "bump", find its letter, and put it in its box.
(Say "bump," *then say each sound* /b/ - /u/ - /m/ - /p/ *as you move each letter into a box.)*
(*Then run your finger underneath the word as you say "*bump*.")*
Each letter matches a sound in the word, so each letter goes into one of the boxes.

---

5. The next word is "Luck." Now say its separate sounds as you lift your fingers.
(Child responds. Record response.)
(If correct) Good. How many sounds do your fingers show? (*Child R.*) *(If # wrong, correct.)*

(If wrong) Watch me do it.
I will say and count the sounds in "Luck" on my fingers.
Listen to the sounds and watch my mouth move.
/l / - /u/ - /k/ - *(lift a finger as you say each sound).*
"sack" has 3 sounds.

Here are 3 boxes for those sounds. You need to figure out how to fill them with letters.
Here are the letters that spell "luck" in mixed up order. (*present letters*)
Say each sound in "luck" as you move the letters into their boxes.
Don't forget the tricky letter.
(Child responds. Record response)

(If correct) Now run your finger underneath the word as you say "luck." *(Child R)*
Good job.

(If wrong, remove letters from box, mix them up, place below boxes in random order.)
Watch how I do it.

I will say each sound, find that letter, and move it into its box.
(Say "luck," *then say each sound* /l/ - /u/ - /k/ *as you move each letter into a box.)*
I remember. Sometimes it takes 2 letters to spell one sound in some words.
In the word "luck," it takes both C and K to spell the /k/ sound so I will put C and K together in one box. The C comes before the K. *(Move letter into box.)*
(*Then run your finger underneath the word as you say "*luck*."*

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6. The next word is "nwg." Now say its separate sounds as you lift your fingers.
(Child responds. Record response.)
(*If correct*) Good. How many sounds do your fingers show? (*Child R.*) *(If # wrong, correct.)*

(If segmentation wrong) Watch me do it.
I will say and count the sounds in "nwg" on my fingers.
Listen to the sounds and watch my mouth move.
/n/ - /u/ - /g/ - *(lift a finger as you say each sound).*
"nwg" has 3 sounds.

Here are 3 boxes for those sounds. You need to figure out how to fill them with letters.
Here are the letters that spell "nwg" in mixed up order. (*present letters*)
Say each sound in "nwg" as you move that letter into its box.
(Child responds. Record response)

(If correct) Now run your finger underneath the word as you say "nwg." *(Child R)*
Good job.

(If wrong, remove letters from box, mix them up, place below boxes in random order.)
Watch how I do it.
I say each sound in nwg, find its letter, and put it in its box.
(Say "nwg," *then say each sound* /n/ - /u/ - /g/ *as you move each letter into a box.)*
(*Then run your finger underneath the word as you say "*nwg*.")*
Each letter matches a sound in the word, so each letter goes into one of the boxes.

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7. The next word is "trot." Now say its separate sounds as you lift your fingers.
(Child responds. Record response.)
(*If correct*) Good. How many sounds do your fingers show? (*Child R.*) *(If # wrong, correct.)*

(If wrong) Watch me do it.
I will say and count the sounds in "trot" on my fingers.
Listen to the sounds and watch my mouth move.
/t/ - /r/ - /o/ - /t/ *(lift a finger as you say each sound).*
"trot" has 4 sounds.

Here are 4 boxes for those sounds. You need to figure out how to fill them with letters.
Here are the letters that spell "trot" in mixed up order. (*present letters*)

Say each sound in “trot” as you move that letter into its box.
(Child responds. Record response)

(If correct) Now run your finger underneath the word as you say “tro.” *(Child R)*
Good job.

(If wrong, remove letters from box, mix them up, place below boxes in random order.)
Watch how I do it.
I say each sound in drag, find its letter, and put it in its box.
(Say “trot,” *then say each sound* /t/ - /r/ - /o/ - /t/ *as you move each letter into a box.)*
(*Then run your finger underneath the word as you say “*trot*.”)*
Each letter matches a sound in the word, so each letter goes into one of the boxes.
---

8. The next word is “vine.” Now say its separate sounds as you lift your fingers.
(Child responds. Record response.)
(*If correct*) Good. How many sounds do your fingers show? (*Child R.*) *(If # wrong, correct.)*

(If wrong) Watch me do it.
I will say and count the sounds in “vine” on my fingers.
Listen to the sounds and watch my mouth move.
/v/ - /i/ - /n/ - *(lift a finger as you say each sound).*
“vine” has 3 sounds.

Here are 3 boxes for those sounds. You need to figure out how to fill them with letters.
Here are the letters that spell “vine” in mixed up order. (*present letters*)
Say each sound in “vine” as you move the letters into their boxes.
Don’t forget the tricky letter.
(Child responds. Record response)

(If correct) Now run your finger underneath the word as you say “vine.” *(Child R)*
Good job.

(If wrong, remove letters from box, mix them up, place below boxes in random order.)
Watch how I do it.
I will say each sound, find that letter, and move it into its box.
(Say “vine,” *then say each sound* /v/ - /i/ - /n/ *as you move each letter into a box.)*
I remember. Sometimes words have letters that don’t make any sound.
In the word “vine,” the letter E comes at the very end and is silent.
I will place it at the end and then put a black cover over it to show that you can seen it in the written word but you can’t hear its sound when you say “vine.”
(Move letter to final position, then cover it.)
(*Then run your finger underneath the word as you say “*vine*.”*
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9. The next word is “khib.” Now say its separate sounds as you lift your fingers.

(Child responds. Record response.)
(If correct) Good. How many sounds do your fingers show? (*Child R.*) *(If # wrong, correct.)*

(If wrong) Watch me do it.
I will say and count the sounds in "khib" on my fingers.
Listen to the sounds and watch my mouth move.
/k/ - /i/ - /b/ - *(lift a finger as you say each sound).*
"khib" has 3 sounds.

Here are 3 boxes for those sounds. You need to figure out how to fill them with letters.
Here are the letters that spell "khib" in mixed up order. (*present letters*)
Say each sound in "khib" as you move the letters into their boxes.
Don't forget the tricky letter.
(Child responds. Record response)

(If correct) Now run your finger underneath the word as you say "khib." *(Child R)*
Good job.

(If wrong, remove letters from box, mix them up, place below boxes in random order.)
Watch how I do it.
I will say each sound, find that letter, and move it into its box.
(Say "khib," *then say each sound* /k/ - /i/ - /b/ *as you move each letter K I B into a box.)*
I remember. Sometimes words have letters that don't make any sound.
In the word "khib," the letter H comes after the K and is silent.
I will move the letters to make a place for the H. *(Move letters, insert K.)*
It comes right after the K.
Then I will put the black cover over it *(place cover)* to show that you can seen H in the written word but you can't hear its sound when you say "khib."
(Move letter to final position, then cover it.)
(*Then run your finger underneath the word as you say "*khib*."*

This will be done for all the words and then followed by the spelling test. This whole process will be repeated one more time for a total of 3 practice spell sessions.

Sessions 2-6
The stimuli for sessions 2-6 will be presented in random order. This particular presentation will serve as the template from which the presentations will be derived.
Researcher: We are going to practice breaking the words up into sounds again. However, before we do that I want to give you the spelling test to see how much you remember. Just like on the other tests I want you to write as many of the sounds you hear in the words as you can. Let begin.

Number one: Vine. A Vine is a type of plant. Vine.

Number two: Nwg. Nwg is a word that I made up. Nwg.

Number three: Khib. Khib is a word that I made up. Khib.

Number four: Bump. There was a Bump on my head after the ball hit me. Bump.

Number five: Luck. Put the clothes in the Luck. Luck.

Number six: drag. Did you drag the trashcans out tonight? Drag.

Number seven Pass. Pass the ball to me. Pass.

Number eight: Rret. Rret is a word that I made up. Rret.

Number nine: Trot. Horses like to trot. Trot.

Very good work. Now we are going to practice breaking these words up into their sounds again. This time instead of me doing it first I will tell you the word and have you break the word up into sounds and count them. Then you will put the letters into the boxes as you say the sounds.

The first word is "drag." Now say its separate sounds as you lift your fingers.
(Child responds. Record response.)
(If correct) Good. How many sounds do your fingers show? (*Child R.*) *(If # wrong, correct.)*

(If wrong) Watch me do it.
I will say and count the sounds in "drag" on my fingers.
Listen to the sounds and watch my mouth move.

/d/ - /r/ - /a/ - /g/ - *(lift a finger as you say each sound).*
"Drag" has four sounds.

Here are four boxes for those sounds. You need to figure out how to fill them with letters.
Here are the letters that spell "drag" in mixed up order. (*present letters*)
Say each sound in "drag" as you move that letter into its box.
(Child responds. Record response)

(If correct) Now run your finger underneath the word as you say "drag." *(Child R)*
Good job.

(If wrong, remove letters from box, mix them up, place below boxes in random order.)
Watch how I do it.
I say each sound in drag, find its letter, and put it in its box.
(Say "drag," *then say each sound* /d/ - /r/ - /a/ - /g/ *as you move each letter into a box.)*
(*Then run your finger underneath the word as you say "drag.")*
Each letter matches a sound in the word, so each letter goes into one of the boxes.
This will be repeated for the whole word list three times.

Now that we have practiced breaking these words into their sounds I want you to try to write them. Just like you did before I would like you to write the correct spelling. If you don't know it, then write the word as best as you can. Since you just worked with these words you will have a better idea about how to spell the words than you did the last time you took the test. If that happens it is ok to spell the word differently than you did last time you took the test. Lets Begin.

Number one: Vine. A Vine is a type of plant. Vine.

Number two: Nwg. Nwg is a word that I made up. Nwg.

Number three: Khib. Khib is a word that I made up. Khib.

Number four: Bump. There was a Bump on my head after the ball hit me. Bump.

Number five: Luck. Put the clothes in the Luck. Luck.

Number six: drag. Did you drag the trashcans out tonight? Drag.

Number seven Pass. Pass the ball to me. Pass.

Number eight: Rret. Rret is a word that I made up. Rret.

Number nine: Trot. Horses like to trot. Trot.

Transfer task

Researcher: This session we are going to learn how to break up some new words into their sounds. We are going to do it the same way we have been practicing with the other words. But before we do it I want you to try to write the words. I would like you to write the correct spelling. If you don't know it, that is ok. Just write the sounds that you hear like you have done before.

Lets Begin.

Number one: Pack. Pack your bags before the trip. Pack.

Number two: Trim. Go to the barber to get a trim. Trim.

Number three: drip. The faucet has a drip. Drip.

Number four: Boss. The boss told him to get to work. Boss.

Number five: Khep. Khep is a word that I made up. Khep.

Number six: limp. I had a limp after I twisted my ankle. limp.

Number seven Rrog. Rrog is a word that I made up. Rrog.

Number eight: fwt. Fwt is a word that I made up. fwt.

Number nine: Hive. Bees live in a hive. Hive.

Now lets practice breaking the words up into their sounds. This first time I will do it first and then you repeat what I say. Lets begin.

Introduction:
"I am going to show you how some words are written. I will teach you how to break up the words into their sounds and then match up letters to the sounds so you will see why the word is spelled that way. We will use these plastic letters and these boxes."

Procedures for Teaching Each Word:

1. The first word is "drip."
Here's what it means: "Your ice cream will drip if it melts."
Now I will break "drip" into separate sounds and mouth movements.
I will say the separate sounds in "drip" and count them on my fingers.
Listen to the sounds and watch my mouth move.
/d/ - /r/ - /i/ - /p/ - (*lift a finger as you say each sound).*
"Drip" has 4 sounds so I need 4 boxes for those sounds.
(*Select row of 4 boxes)*

Now I will figure out how to fill the boxes with letters.
(Place the letters D R I P below the Elkonin box in random order.)
Here are the letters that spell "drip" in mixed up order.
I will say each sound, find that letter, and move it into its box.
(Say "drip," *then say each sound* /d/ - /r/ - /i/ - /p/ *as you move each letter into a box.)*
(*Then run your finger underneath the word as you say "*drip*."*
Each letter matches a sound in the word, so each letter goes into one of the boxes.

(*Remove letters from boxes, mix them up and cover them.)*

Now you do it just like I did.

First say "drip," then say its separate sounds as you lift your fingers.
(Child responds. Record response.)
(If correct) Good. How many sounds do your fingers show? (*Child R.*) *(If # wrong, correct.)*

(If wrong) Watch me do it.
I will say and count the sounds in "drip" on my fingers.
Listen to the sounds and watch my mouth move.

/d/ - /r/ - /i/ - /p/ - *(lift a finger as you say each sound).*
"Drip" has four sounds.

Here are four boxes for those sounds. You need to figure out how to fill them with letters.
Here are the letters that spell "drip" in mixed up order. (*present letters*)
Say each sound in "drip" as you move that letter into its box.
(Child responds. Record response)

(If correct) Now run your finger underneath the word as you say "drip." *(Child R)*
Good job.

(If wrong, remove letters from box, mix them up, place below boxes in random order.)
Watch how I do it.
I say each sound in drip, find its letter, and put it in its box.
(Say "drip," *then say each sound* /d/ - /r/ - /i / - /p/ *as you move each letter into a box.)*
(*Then run your finger underneath the word as you say "drip.")*
Each letter matches a sound in the word, so each letter goes into one of the boxes.
---

2. The next word is "boss."
Here's what it means: "The boss tells people what to do at work."
Now I will break "boss" into separate sounds and mouth movements.
I will say the separate sounds in "boss" and count them on my fingers.
Listen to the sounds and watch my mouth move.
/b/ - /o/ - /s/ - (*lift a finger as you say each sound).*
"Boss" has 3 sounds so I need 3 boxes for those sounds.
(*Select row of 3 boxes)*

Now I will figure out how to fill the boxes with letters.
(Place the letters B O S S below the Elkonin box in random order.)
Here are the letters that spell "boss" in mixed up order.
I will say each sound, find that letter, and move it into its box.
(Say "boss," *then say each sound* /b/ - /o/ - /s/ *as you move each letter into a box.)*
Oh, Oh. There is another letter to put somewhere.
I know. Sometimes it takes 2 letters to spell one sound.
In the word "boss," it takes 2 letters to spell the /s/ sound so I need to put 2 Ss together in one box. *(Move letter into box.)*
(*Then run your finger underneath the word as you say "*pass*."*

(*Remove letters from boxes, mix them up and cover them.)*

Now you do it just like I did.
First say "boss," then say its separate sounds as you lift your fingers.
(Child responds. Record response.)
(If correct) Good. How many sounds do your fingers show? (*Child R.*) *(If # wrong, correct.)*

(If wrong) Watch me do it.
I will say and count the sounds in "boss" on my fingers.
Listen to the sounds and watch my mouth move.
/b/ - /o/ - /s/ - *(lift a finger as you say each sound).*
"Boss" has 3 sounds.

Here are 3 boxes for those sounds. You need to figure out how to fill them with letters.
Here are the letters that spell "boss" in mixed up order. (*present letters*)
Say each sound in "boss" as you move the letters into their boxes.
Don't forget the tricky letter.
(Child responds. Record response)

(If correct) Now run your finger underneath the word as you say "boss." *(Child R)*
Good job.

(If wrong, remove letters from box, mix them up, place below boxes in random order.)
Watch how I do it.
I will say each sound, find that letter, and move it into its box.
(Say "boss," *then say each sound* /b/ - /o/ - /s/ *as you move each letter into a box.)*
I remember. Sometimes it takes 2 letters to spell one sound.
In the word "boss," it takes 2 letters to spell the /s/ sound so I will put 2 Ss together in one box. *(Move letter into box.)*
(*Then run your finger underneath the word as you say "*boss*."*
---

3. The next word is "Rrog."
"Rrog" is a silly word that I made up. It doesn't have any meaning. Lets pretend it came from Mars.
Now I will break "rrog" into separate sounds and mouth movements.
I will say the separate sounds in "rrog" and count them on my fingers.
Listen to the sounds and watch my mouth move.
/r/ - /o/ - /g/ - (*lift a finger as you say each sound).*
"Rrog" has 3 sounds so I need 3 boxes for those sounds.
(*Select row of 3 boxes)*

Now I will figure out how to fill the boxes with letters.
(Place the letters R R O G below the Elkonin box in random order.)
Here are the letters that spell "rrog" in mixed up order.

I will say each sound, find that letter, and move it into its box.
(Say "rrog," *then say each sound* /r/ - /o/ - /g/ *as you move each letter into a box.)*
Oh, Oh. There is another letter to put somewhere.
I know. Sometimes it takes 2 letters to spell one sound.
In the word "rrog," it takes 2 letters to spell the /r/ sound so I need to put 2 Rs together in one box. *(Move letter into box.)*
(*Then run your finger underneath the word as you say "*rrog*.")*

(*Remove letters from boxes, mix them up and cover them.)*

Now you do it just like I did.
First say "rrog," then say its separate sounds as you lift your fingers.
(Child responds. Record response.)
(*If correct*) Good. How many sounds do your fingers show? (*Child R.*) *(If # wrong, correct.)*

(If wrong) Watch me do it.
I will say and count the sounds in "rrog" on my fingers.
Listen to the sounds and watch my mouth move.
/r/ - /o/ - /t/ - *(lift a finger as you say each sound).*
"Rrog" has 3 sounds.

Here are 3 boxes for those sounds. You need to figure out how to fill them with letters.
Here are the letters that spell "rrog" in mixed up order. (*present letters*)
Say each sound in "rrog" as you move the letters into their boxes.
Don't forget the tricky letter.
(Child responds. Record response)

(If correct) Now run your finger underneath the word as you say "rrog." *(Child R)*
Good job.

(If wrong, remove letters from box, mix them up, place below boxes in random order.)
Watch how I do it.
I will say each sound, find that letter, and move it into its box.
(Say "rrog," *then say each sound* /r/ - /o/ - /g/ *as you move each letter into a box.)*
I remember. Sometimes it takes 2 letters to spell one sound.
In the word "rrog," it takes 2 letters to spell the /r/ sound so I will put 2 Rs together in one box. *(Move letter into box.)*
(*Then run your finger underneath the word as you say "*rrog*."*
---

4. The next word is "limp."
Here's what it means: "I limp when my foot hurts."
Now I will break "limp" into separate sounds and mouth movements, and I will count them on my fingers.
Listen to the sounds and watch my mouth move.
/l/ - /i/ - /m/ - /p/ - (*lift a finger as you say each sound).*

"limp" has 4 sounds so I need 4 boxes for those sounds.
(*Select row of 4 boxes)*

Now I will figure out how to fill the boxes with letters.
(Place the letters L I M P below the Elkonin box in random order.)
Here are the letters that spell "limp" in mixed up order.
I will say each sound, find that letter, and move it into its box.
(Say "lump" *then say each sound* /l/ - /i/ - /m/ - /p/ *as you move each letter into a box.)*
(*Then run your finger underneath the word as you say "*limp*."*
Each letter matches a sound in the word, so each letter goes into one of the boxes.

(*Remove letters from boxes, mix them up and cover them.)*

Now you do it just like I did.
First say "limp," then say its separate sounds as you lift your fingers.
(Child responds. Record response.)
(*If correct*) Good. How many sounds do your fingers show? (*Child R.*) *(If # wrong, correct.)*

(If wrong) Watch me do it.
I will say and count the sounds in "limp" on my fingers.
Listen to the sounds and watch my mouth move.

/l/ - /i/ - /m/ - /p/ - *(lift a finger as you say each sound).*
"Lump" has four sounds.

Here are four boxes for those sounds. You need to figure out how to fill them with letters.
Here are the letters that spell "limp" in mixed up order. (*present letters*)
Say each sound in "limp" as you move that letter into its box.
(Child responds. Record response)

(If correct) Now run your finger underneath the word as you say "limp." *(Child R)*
Good job.

(If wrong, remove letters from box, mix them up, place below boxes in random order.)
Watch how I do it.
I say each sound in "lump", find its letter, and put it in its box.
(Say "limp," *then say each sound* /l/ - /i/ - /m/ - /p/ *as you move each letter into a box.)*
(*Then run your finger underneath the word as you say "*limp*.")*
Each letter matches a sound in the word, so each letter goes into one of the boxes.

---

5. The next word is "Pack."
Here's what it means: "When you put all your stuff into a bag it means you pack the bag."
Now I will break "Pack" into separate sounds and mouth movements.
I will say the separate sounds in "pack" and count them on my fingers.
Listen to the sounds and watch my mouth move.

/p/ - /a/ - /k/ - (*lift a finger as you say each sound).*
"Pack" has 3 sounds so I need 3 boxes for those sounds.
(*Select row of 3 boxes)*

Now I will figure out how to fill the boxes with letters.
(Place the letters P A C K below the Elkonin box in random order.)
Here are the letters that spell "pack" in mixed up order.
I will say each sound, find that letter, and move it into its box.
(Say "pack," *then say each sound* /p/ - /a/ - /k/ *as you move each letter P A K into a box.)*
Oh, Oh. There is another letter to put somewhere.
I know. Sometimes it takes 2 letters to spell one sound.
In the word "pack," the C and the K go together to spell the /k/ sound, so I need to put C and K together in one box. The C comes before the K. *(Move letter into box.)*
(*Then run your finger underneath the word as you say "*pack*."*

(*Remove letters from boxes, mix them up and cover them.)*

Now you do it just like I did.
First say "pack," then say its separate sounds as you lift your fingers.
(Child responds. Record response.)
(If correct) Good. How many sounds do your fingers show? (*Child R.*) *(If # wrong, correct.)*

(If wrong) Watch me do it.
I will say and count the sounds in "pack" on my fingers.
Listen to the sounds and watch my mouth move.
/p / - /a/ - /k/ - *(lift a finger as you say each sound).*
"pack" has 3 sounds.

Here are 3 boxes for those sounds. You need to figure out how to fill them with letters.
Here are the letters that spell "pack" in mixed up order. (*present letters*)
Say each sound in "pack" as you move the letters into their boxes.
Don't forget the tricky letter.
(Child responds. Record response)

(If correct) Now run your finger underneath the word as you say "pack." *(Child R)*
Good job.

(If wrong, remove letters from box, mix them up, place below boxes in random order.)
Watch how I do it.
I will say each sound, find that letter, and move it into its box.
(Say "luck," *then say each sound* /p/ - /a/ - /k/ *as you move each letter into a box.)*
I remember. Sometimes it takes 2 letters to spell one sound in some words.
In the word "pack," it takes both C and K to spell the /k/ sound so I will put C and K together in one box. The C comes before the K. *(Move letter into box.)*
(*Then run your finger underneath the word as you say "*pack*."*

---

6. The next word is “fwt.”
“Fwt” is a silly word that I made up. It doesn’t have any meaning. Let’s pretend it came from Mars. Now I will break “fwt” into separate sounds and mouth movements.
I will say the separate sounds in “fwt” and count them on my fingers.
Listen to the sounds and watch my mouth move.
/f/ - /u - /t/ - (*lift a finger as you say each sound).*
“fwt” has 3 sounds so I need 3 boxes for those sounds.
(*Select row of 3 boxes)*

Now I will figure out how to fill the boxes with letters.
(Place the letters F W T below the Elkonin box in random order.)
Here are the letters that spell “fwt” in mixed up order.
I will say each sound, find that letter, and move it into its box.
(Say “fwt,” *then say each sound* /f/ - /u/ - /t/ *as you move each letter into a box.)*
(*Then run your finger underneath the word as you say “*fwt*.”*
Each letter matches a sound in the word, so each letter goes into one of the boxes.

(*Remove letters from boxes, mix them up and cover them.)*

Now you do it just like I did.
First say “fwt,” then say its separate sounds as you lift your fingers.
(Child responds. Record response.)
(If correct) Good. How many sounds do your fingers show? (*Child R.*) *(If # wrong, correct.)*

(If segmentation wrong) Watch me do it.
I will say and count the sounds in “fwt” on my fingers.
Listen to the sounds and watch my mouth move.
/f/ - /u/ - /t/ - *(lift a finger as you say each sound).*
“fwt” has 3 sounds.

Here are 3 boxes for those sounds. You need to figure out how to fill them with letters.
Here are the letters that spell “fwt” in mixed up order. (*present letters*)
Say each sound in “fwt” as you move that letter into its box.
(Child responds. Record response)

(If correct) Now run your finger underneath the word as you say “fwt.” *(Child R)*
Good job.

(If wrong, remove letters from box, mix them up, place below boxes in random order.)
Watch how I do it.
I say each sound in fwt, find its letter, and put it in its box.
(Say “fwt,” *then say each sound* /f/ - /u/ - /t/ *as you move each letter into a box.)*
(*Then run your finger underneath the word as you say “*fwt*.”)*
Each letter matches a sound in the word, so each letter goes into one of the boxes.
---

7. The next word is “trim.”
Here’s what it means: “A little haircut is called a trim.”
Now I will break “trim” into separate sounds and mouth movements.
I will say the separate sounds in “metal” and count them on my fingers.
Listen to the sounds and watch my mouth move.
/t/ - /r/ - /i/ - /m/ (*lift a finger as you say each sound).*
“trim” has 4 sounds so I need 4 boxes for those sounds.
(*Select row of 4 boxes)*

Now I will figure out how to fill the boxes with letters.
(Place the letters T R I M below the Elkonin box in random order.)
Here are the letters that spell “trim” in mixed up order.
I will say each sound, find that letter, and move it into its box.
(Say “trim,” *then say each sound* /t/ - /r/ - /i/ - /m/ *as you move each letter into a box.)*
(*Then run your finger underneath the word as you say “*trim*.”*
Each letter matches a sound in the word, so each letter goes into one of the boxes.

(*Remove letters from boxes, mix them up and cover them.)*

Now you do it just like I did.
First say “trim,” then say its separate sounds as you lift your fingers.
(Child responds. Record response.)
(If correct) Good. How many sounds do your fingers show? (*Child R.*) *(If # wrong, correct.)*

(If wrong) Watch me do it.
I will say and count the sounds in “trim” on my fingers.
Listen to the sounds and watch my mouth move.
/t/ - /r/ - /i/ - /m/ *(lift a finger as you say each sound).*
“trim” has 4 sounds.

Here are 4 boxes for those sounds. You need to figure out how to fill them with letters.
Here are the letters that spell “trim” in mixed up order. (*present letters*)
Say each sound in “trim” as you move that letter into its box.
(Child responds. Record response)

(If correct) Now run your finger underneath the word as you say “trim.” *(Child R)*
Good job.

(If wrong, remove letters from box, mix them up, place below boxes in random order.)
Watch how I do it.
I say each sound in drag, find its letter, and put it in its box.
(Say “trim,” *then say each sound* /t/ - /r/ - /i/ - /m/ *as you move each letter into a box.)*
(*Then run your finger underneath the word as you say “*trim*.”)*
Each letter matches a sound in the word, so each letter goes into one of the boxes.
---

8. The next word is “hive.”
Here’s what it means: “A hive is where bees live.”
Now I will break “hive” into separate sounds and mouth movements.
I will say the separate sounds in “hive” and count them on my fingers.
Listen to the sounds and watch my mouth move.
/h/ - /i/ - /v/ - (*lift a finger as you say each sound).*
“hive” has 3 sounds so I need 3 boxes for those sounds.
(*Select row of 3 boxes)*

Now I will figure out how to fill the boxes with letters.
(Place the letters H I V E below the Elkonin box in random order.)
Here are the letters that spell “hive” in mixed up order.
I will say each sound, find that letter, and move it into its box.
(Say “hive,” *then say each sound* /h/ - /i/ - /v/ *as you move each letter H I V into a box.)*
Oh, Oh. There is another letter to put somewhere.
I know. Sometimes words have letters that don’t make any sound.
In the word “hive,” the letter E comes at the very end and is silent.
I will place it at the end and then put a black cover over it to show that you can seen the letter E in the written word but you can’t hear its sound when you say “hive.”
(Move letter to final position, then cover it.)
(*Then run your finger underneath the word as you say “*hive*.”*

(*Remove letters from boxes, mix them up and cover them.)*

Now you do it just like I did.
First say “hive,” then say its separate sounds as you lift your fingers.
(Child responds. Record response.)
(*If correct*) Good. How many sounds do your fingers show? (*Child R.*) *(If # wrong, correct.)*

(If wrong) Watch me do it.
I will say and count the sounds in “hive” on my fingers.
Listen to the sounds and watch my mouth move.
/h/ - /i/ - /v/ - *(lift a finger as you say each sound).*
“hive” has 3 sounds.

Here are 3 boxes for those sounds. You need to figure out how to fill them with letters.
Here are the letters that spell “hive” in mixed up order. (*present letters*)
Say each sound in “hive” as you move the letters into their boxes.
Don’t forget the tricky letter.
(Child responds. Record response)

(If correct) Now run your finger underneath the word as you say “hive.” *(Child R)*
Good job.

(If wrong, remove letters from box, mix them up, place below boxes in random order.)
Watch how I do it.

I will say each sound, find that letter, and move it into its box.
(Say "hive," *then say each sound* /h/ - /i/ - /v/ *as you move each letter into a box.)*
I remember. Sometimes words have letters that don't make any sound.
In the word "hive," the letter E comes at the very end and is silent.
I will place it at the end and then put a black cover over it to show that you can see it in the written word but you can't hear its sound when you say "hive."
(Move letter to final position, then cover it.)
(*Then run your finger underneath the word as you say "*hive*."*

---

9. The next word is "khep."
"Khep" is a silly word that I made up. It doesn't have any meaning. Let's pretend it came from Mars.
Now I will break "khep" into separate sounds and mouth movements.
I will say the separate sounds in "khep" and count them on my fingers.
Listen to the sounds and watch my mouth move.
/k/ - /e/ - /p/ - (*lift a finger as you say each sound).*
"khep" has 3 sounds so I need 3 boxes for those sounds.
(*Select row of 3 boxes)*

Now I will figure out how to fill the boxes with letters.
(Place the letters K H E P below the Elkonin box in random order.)
Here are the letters that spell "khep" in mixed up order.
I will say each sound, find that letter, and move it into its box.
(Say "khep," *then say each sound* /k/ - /e/ - /p/ *as you move each letter K E P into a box.)*
Oh, Oh. There is another letter to put somewhere.
I know. Sometimes words have letters that don't make any sound.
In the word "khep," the letter H comes after the K and is silent.
I will move the letters to make a place for the H. *(Move letters, insert K.)*
It comes right after the K.
Then I will put the black cover over it *(place cover)* to show that you can seen H in the written word but you can't hear its sound when you say "khep." *(Move letter to final position, then cover it.)*
(*Then run your finger underneath the word as you say "*khep*."*

(*Remove letters from boxes, mix them up and cover them.)*

Now you do it just like I did.
First say "khep," then say its separate sounds as you lift your fingers.
(Child responds. Record response.)
(*If correct*) Good. How many sounds do your fingers show? (*Child R.*) *(If # wrong, correct.)*

(If wrong) Watch me do it.
I will say and count the sounds in "khep" on my fingers.
Listen to the sounds and watch my mouth move.
/k/ - /e/ - /p/ - *(lift a finger as you say each sound).*

"khep" has 3 sounds.

Here are 3 boxes for those sounds. You need to figure out how to fill them with letters.
Here are the letters that spell "khep" in mixed up order. (*present letters*)
Say each sound in "khep" as you move the letters into their boxes.
Don't forget the tricky letter.
(Child responds. Record response)

(If correct) Now run your finger underneath the word as you say "khep." *(Child R)*
Good job.

(If wrong, remove letters from box, mix them up, place below boxes in random order.)
Watch how I do it.
I will say each sound, find that letter, and move it into its box.
(Say "khep," *then say each sound* /k/ - /i/ - /p/ *as you move each letter K I B into a box.)*
I remember. Sometimes words have letters that don't make any sound.
In the word "khep," the letter H comes after the K and is silent.
I will move the letters to make a place for the H. *(Move letters, insert K.)*
It comes right after the K.
Then I will put the black cover over it *(place cover)* to show that you can seen H in the written word but you can't hear its sound when you say "khep."
(Move letter to final position, then cover it.)
(*Then run your finger underneath the word as you say "*khep*."*

Now that we have practiced breaking these words into their sounds I want you to try to write them. Since you just worked with these words you will have a better idea about how to spell the words than you did the last time you took the test. If that happens it is ok to spell the word differently than you did last time you took the test. Lets Begin.

Number one: Pack. Pack your bags before the trip. Pack.

Number two: Trim. Go to the barber to get a trim. Trim.

Number three: drip. The faucet has a drip. Drip.

Number four: Boss. The boss told him to get to work. Boss.

Number five: Khep. Khep is a word that I made up. Khep.

Number six: limp. I had a limp after I twisted my ankle. limp.

Number seven Rrog. Rrog is a word that I made up. Rrog.

Number eight: fwt. Fwt is a word that I made up. fwt.

Number nine: Hive. Bees live in a hive. Hive.

Very good work. Now we are going to practice breaking these words up into their sounds again. This time instead of me doing it first I will tell you the word and have you break the word up into sounds and count them. Then you will put the letters into the boxes as you say the sounds.

The first word is "drip." Now say its separate sounds as you lift your fingers.
(Child responds. Record response.)
(If correct) Good. How many sounds do your fingers show? (*Child R.*) *(If # wrong, correct.)*

(If wrong) Watch me do it.
I will say and count the sounds in "drip" on my fingers.
Listen to the sounds and watch my mouth move.

/d/ - /r/ - /i/ - /p/ - *(lift a finger as you say each sound).*
"Drip" has four sounds.

Here are four boxes for those sounds. You need to figure out how to fill them with letters.
Here are the letters that spell "drip" in mixed up order. (*present letters*)
Say each sound in "drip" as you move that letter into its box.
(Child responds. Record response)

(If correct) Now run your finger underneath the word as you say "drip." *(Child R)*
Good job.

(If wrong, remove letters from box, mix them up, place below boxes in random order.)
Watch how I do it.
I say each sound in drip, find its letter, and put it in its box.
(Say "drip," *then say each sound* /d/ - /r/ - /i/ - /p/ *as you move each letter into a box.)*
(*Then run your finger underneath the word as you say "drip.")*
Each letter matches a sound in the word, so each letter goes into one of the boxes.

This will be done for all the words and then followed by the spelling test. This whole process will be repeated one more time for a total of 3 practice spell sessions. Stimuli will be presented in random order.

Appendix G

Invented spelling condition

1st session

I am going to be giving you a spelling test every other day for the next three weeks. It is just like the on I gave you in class the other day that had some real words and some made up words on it. Just like on that test I want you to write the correct spelling if you know it. If you do not know it try to spell as many of the sounds as you hear in the word. Since you will be spelling these words so many times, sometimes you might hear more sounds than you did the last time we took the test. If that happens it is ok to spell the word differently than you did last time you took the test. Lets Begin.

Number one: Nwg. Nwg is a word that I made up. Nwg.

Number two: Vine. A Vine is a type of plant. Vine.

Number three: Khib. Khib is a word that I made up. Khib.

Number four: Pass. Pass the ball to me. Pass.

Number five: Luck. The penny is good luck. luck.

Number six: Trot. The horse likes to trot. trot.

Number seven Bump. There was a Bump on my head after the ball hit me. Bump.

Number eight: Rret. Rret is a word that I made up. Rret.

Number nine: drag. Can you drag the trashcans out tonight? Drag.

Following sessions

We are going to take the spelling test again. Just like before I want you to write the correct spelling if you know it. If you do not know it try to spell as many of the sounds as you hear in

the word. Since you will be spelling these words so many times, sometimes you will hear more sounds than you did the last time we took the test. If that happens it is ok to spell the word differently than you did last time you took the test. Let's Begin.

See previous list presented in random order.

Transfer task

We are going to take the spelling test again except this time there are new words. Just like the other test there are some real words and some words that I made up. Just like on the other tests I want you to write the correct spelling if you know it. If you do not know it try to spell as many of the sounds as you here in the word.

Lets Begin.

.

Number one: drip. The faucet has a drip. Drip.

Number two: Khep. Khep is a word that I made up. Khep.

Number three: Trim. The barber gave the boy a little trim. trim.

Number four: Boss. The boss told him to get to work. Boss.

Number five: Rrog. Rrog is a word that I made up. Lets pretend its from Mars. Rrog.

Number six: Hive. Bees live in a hive. Hive

Number seven: Pack . We need to pack the bags for the trip. Pack.

Number eight: fwt. Fwt is a silly word that I made up. Lets pretend it is from Mars. fwt..

Appendix H

Delayed Spelling Test

I am going to give you another spelling test. This one has some words that I have worked with you on already and some are new words. Most of the words are real words but some of them are words that I have made up. I would like you to write the correct spelling. If you don't know it, that is ok. Just write the sounds that you hear like we have done on other tests.

Lets Begin.

Number one: Trap. The animal got stuck in a trap. trap.

Number two: Sock. My sock has a hole in it Sock.

Number three: Rrab. Rrab is a word that I made up. Rrab.

Number four: Ripe. When the banana is yellow it is ripe. Ripe.

Number five: drop. Don't drop the ball. Drop.

Number six: Lwd. Lwd is a word that I made up. Lwd.

Number seven: Khag. Khag is a word that I made up. Khag.

Number eight: Hiss. Snakes Hiss when they stick out their tongue. Hiss.

Number nine: Lamp. Turn on the Lamp it is dark in here. Lamp.

Number ten: Nwg. Nwg is a word that I made up. Nwg.

Number eleven: Vine. A Vine is a type of plant. Vine.

Number twelve: Khib. Khib is a word that I made up. Khib.

Number thirteen: Pass. Pass the ball to me. Pass.

Number fourteen: Luck. The penny is good luck. luck.

Number fifteen: Trot. The horse likes to trot. trot.

Number sixteen: Bump. There was a Bump on my head after the ball hit me. Bump.

Number seventeen: Rret. Rret is a word that I made up. Rret.

Number eighteen: drag. Can you drag the trashcans out tonight? Drag.

Appendix I

Orthographic Choice Posttest

I am going to show you some words that other children have written for me. Each page will have one word but you will see two *different* ways that children wrote that word. For example, let me show you. The word here is fr*og*. One child wrote it this way (point to FROG), and another child wrote it this way (point FRG). See. Some of the letters are the same and some letters are different. Your job will be to look at the two spellings and decide which way you think is the best way to write the word. One more thing you need to know. Some of the words will be real words you have heard before, and some will be words I made up. Your job is to listen to the words and decide which spelling is best. Okay? Let's begin:

Experimenter opens the test booklet to the next page and says the following directions. If the student hesitates for too long (over 10 seconds) or says something to the effect of "I don't know" he experimenter will ask the student to make their best guess so that we can move on to the next question.

1. Here are two ways that children have written the word *dragon*. Say "dragon" as you look at each word and then after you look at both, point to the best way to spell the word *dragon* and draw a circle around it?

Test stimuli: Dragon Jragon

2. Here are two ways that children have written the word *bwv* /bʌv/. Can you circle the best way to spell the word *bwv* /bʌv/?

Test stimuli: Bwv Byv

3. Here are two ways that children have written the word *khub* /kʌb/. Can you circle the best way to spell the word *khub* /kʌb/?

Test stimuli: kub khub

4. Here are two ways that children have written the word *dry*. Can you circle the best way to spell the word *dry*?

Test stimuli: Jri Dri

5. Here are two ways that children have written the word *true*. Can you circle the best way to spell the word *true*?

Test stimuli: tru chru

6 Here are two ways that children have written the word *bass*. Can you circle the best way to spell the word *bass*?

Test stimuli: Bas Bass

7. Here are two ways that children have written the word *bike*. Can you circle the best way to spell the word *bike*?

Test stimuli: bike bik

8. Here are two ways that children have written the word *Khon*. Can you circle the best way to spell the word *Khon*?

Test Stimuli kon khon

9. Here are two ways that children have written the word *trail*. Can you circle the best way to spell the word *trail*?

Test stimuli: tral chral

10. Here are two ways that children have written the word *fut*. Can you circle the best way to spell the word *fut*?

Test stimuli: fyt fwt

11. Here are two ways that children have written the word *moss*. Can you circle the best way to spell the word *moss*?

Test stimuli: mos moss

12. Here are two ways that children have written the word *drank*. Can you circle the best way to spell the word *drank*?

Test stimuli: drank jrank

13. Here are two ways that children have written the word *clock*. Can you circle the best way to spell the word *clock*?

Test stimuli: clock cloc

14. Here are two ways that children have written the word *rab*. Can you circle the best way to spell the word *rab*?

Test stimuli: rrab rab

15. Here are two ways that children have written the word *thump*. Can you circle the best way to spell the word *thump*?

Test stimuli: thup thump

16. Here are two ways that children have written the word *rom*. Can you circle the best way to spell the word *rom*?

Test stimuli: rrom rom

17. Here are two ways that children have written the word *dup*. Can you circle the best way to spell the word *dup*?

Test stimuli: dwp dyp

18. Here are two ways that children have written the word *loss*. Can you circle the best way to spell the word *loss*?

Test stimuli: loss los

19. Here are two ways that children have written the word *dump*. Can you circle the best way to spell the word *dump*?

Test stimuli: dump dup

20. Here are two ways that children have written the word *treat*. Can you circle the best way to spell the word *treat*?

Test stimuli: chreat treat

21. Here are two ways that children have written the word *temp*. Can you circle the best way to spell the word *temp*?

Test stimuli: temp tep

22. Here are two ways that children have written the word *dive*. Can you circle the best way to spell the word *dive*?

Test stimuli: dive div

23. Here are two ways that children have written the word *kham*. Can you circle the best way to spell the word *kham*?

Test stimuli: kam kham

24. Here are two ways that children have written the word *rep*. Can you circle the best way to spell the word *rep*?

Test stimuli: rrep rep

25. Here are two ways that children have written the word *pipe.* Can you circle the best way to spell the word *pipe*?

Test stimuli: pip pipe

26. Here are two ways that children have written the word *pack*. Can you circle the best way to spell the word *pack*?

Test stimuli: Pack Pak

27. Here are two ways that children have written the word *trick*. Can you circle the best way to spell the word *trick*?

Test stimuli: Trik Trick

Appendix J

Error Analysis

Drag

	Condition					
	Segmentation		Word Reading		Minimal Control	
Spelling	Pretest	Session 5	Pretest	Session 5	Pretest	Session 5
DR	0	8	0	6	0	1
D_R	1	1	0	1	0	1
D	0	4	1	6	0	1
JR	4	0	2	1	1	2
GR	1	3	3	0	0	0
J	5	1	4	0	1	2
G	6	0	7	2	7	3
R	0	0	0	2	0	0
Random/Unmarked	1	1	3	1	2	1
List Pattern	0	0	0	2	0	0

	Condition		
	Segmentation	Word Reading	Minimal Control
	%	%	%
Regressed	7.1	6.3	10
Stayed the Same	50.0	62.5	70
Improved	42.9	31.2	20

Trot

	Condition					
	Segmentation		Word Reading		Minimal Control	
Spelling	Pretest	Session 5	Pretest	Session 5	Pretest	Session 5
TR	0	6	0	4	0	0
T_R	1	0	0	0	1	1
T	3	1	4	6	3	2
CHR	1	1	0	0	0	0
CH	1	0	1	0	0	0
HR	1	2	1	0	0	1
H	1	0	3	1	3	0
THR	1	0	0	2	0	0
TH	2	1	2	0	0	2
JR/GR	3	3	3	0	2	3
R	1	0	0	1	1	
Random/Unmarked	3	3	6	2	1	2
List Pattern	0	1	0	4	0	0

	Condition		
	Segmentation	Word Reading	Minimal Control
	%	%	%
Regressed	21.4	18.8	10
Stayed the Same	28.6	37.5	40
Improved	50	43.8	50

Bump

	Condition					
	Segmentation		Word Reading		Minimal Control	
Spelling	Pretest	Session 5	Pretest	Session 5	Pretest	Session 5
MP	0	10	0	5	0	0
M_P	0	0	2	0	0	1
P	9	2	11	7	4	8
M	0	0	0	2	0	0
N	1	0	0	4	0	0
MB	1	0	0	0	0	0
M	0	0	0	2	0	0
B	3	2	1	0	2	1
Random/Unmarked	4	2	6	2	5	1
List Pattern	0	0	0	2	0	0

	Condition		
	Segmentation	Word Reading	Minimal Control
	%	%	%
Regressed	14.3	25	0
Stayed the Same	35.3	48.8	60
Improved	50	31.2	40

Pass

	Condition					
	Segmentation		Word Reading		Minimal Control	
Spelling	Pretest	Session 5	Pretest	Session 5	Pretest	Session 5
SS	0	11	0	15	0	0
S	14	5	13	1	6	8
ST	0	1	0	0	0	0
C	1	0	2	0	2	1
Random/Unmarked	3	1	5	3	3	2
List Pattern	0	0	0	1	0	0

	Condition		
	Segmentation	Word Reading	Minimal Control
	%	%	%
Regressed	7.1	25	10
Stayed the Same	64.3	68.8	50
Improved	28.6	6.2	40

Luck

	Condition					
	Segmentation		Word Reading		Minimal Control	
Spelling	Pretest	Session 5	Pretest	Session 5	Pretest	Session 5
CK	0	9	0	4	0	0
KC	0	1	0	0	0	0
K	11	4	8	8	6	5
C	4	1	5	1	2	1
G	0	1	1	0	0	1
Random/Unmarked	3	2	6	6	3	4
List Pattern	0	0	0	1	0	0

	Condition		
	Segmentation	Word Reading	Minimal Control
	%	%	%
Regressed	14.3	12.5	20
Stayed the Same	50	62.5	40
Improved	35.7	25	40

Vine

	Condition					
	Segmentation		Word Reading		Minimal Control	
Spelling	Pretest	Session 5	Pretest	Session 5	Pretest	Session 5
I_E	0	6	0	3	0	1
IE	0	1	0	7	0	0
I	7	6	9	4	4	3
A	5	3	0	0	3	2
E	1	0	1	0	1	1
O	1	0	2	1	0	1
U	0	0	1	0	0	0
Y	0	0	1	0	0	0
IA/OI	0	0	0	2	0	0
Random/Unmarked	4	2	6	2	3	3
List Pattern	0	0	0	1	0	0

	Condition		
	Segmentation	Word Reading	Minimal Control
	%	%	%
Regressed	14.3	6.3	10
Stayed the Same	57.1	31.2	60
Improved	28.6	62.5	30

Khib

	Condition					
	Segmentation		Word Reading		Minimal Control	
Spelling	Pretest	Session 5	Pretest	Session 5	Pretest	Session 5
KH	0	3	0	3	0	0
K_H	0	0	0	1	0	0
K	10	10	11	12	8	7
H	0	0	0	0	0	0
C	5	4	5	1	3	4
Q	1	0	0	0	0	0
Random/Unmarked	2	1	4	2	0	0
List Pattern	0	0	0	1	0	0

	Condition		
	Segmentation	Word Reading	Minimal Control
	%	%	%
Regressed	7.1	5.9	10
Stayed the Same	71.4	88.2	90
Improved	21.5	5.9	0

Rret

	Condition					
	Segmentation		Word Reading		Minimal Control	
Spelling	Pretest	Session 5	Pretest	Session 5	Pretest	Session 5
RR	0	5	0	13	0	0
R	14	12	15	5	10	10
W	2	0	1	0	0	0
Random/Unmarked	2	1	4	2	1	1
List Pattern	0	0	0	0	0	0

	Condition		
	Segmentation	Word Reading	Minimal Control
	%	%	%
Regressed	0	0	0
Stayed the Same	78.6	81.3	100
Improved	21.4	18.7	0

Nwg

	Condition					
	Segmentation		Word Reading		Minimal Control	
Spelling	Pretest	Session 5	Pretest	Session 5	Pretest	Session 5
W	0	4	0	11	0	0
U	3	4	4	1	1	1
A	2	2	3	1	2	5
E	2	2	2	1	1	1
I	2	1	2	1	2	1
O	4	2	2	3	2	0
Random/Unmarked	5	3	7	2	3	2
List Pattern	0	0	0	1	0	0

	Condition		
	Segmentation	Word Reading	Minimal Control
	%	%	%
Regressed	7.1	25	10
Stayed the Same	64.3	68.8	50
Improved	28.6	6.2	40

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