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Evaluating Teaching Efficiency in Reading and Spelling Instruction

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EVALUATING TEACHING EFFICIENCY IN READING AND SPELLING INSTRUCTION

A Dissertation

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

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by

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Abstract

Reading and spelling are essential skills for a student's educational success. The current literature on spelling instruction has examined a variety of spelling modalities, but has never directly compared written versus oral spelling. There are theoretical and empirical indications that either method may be superior to the other. Thus, study one directly compared written and oral spelling instruction for their rates of spelling acquisition as well as generalization to reading. The results of study 1 indicated that written spelling was superior to oral spelling in rates of acquisition of both spelling and reading accuracy. Previous research has also indicated that spontaneous generalization can occur between reading and spelling, however, the investigations have been limited by methodological issues. Study 2 was designed to address these limitations through a comparison of reading instruction alone, spelling instruction alone, and combined reading and spelling instruction. The results of study 2 indicated that combining instruction in reading and spelling led to the most rapid rates of acquisition of spelling and reading accuracy. These findings are discussed in light of behavioral concepts such as stimulus control, complete learning trials, and generalization.

Introduction

Over the past 20 years, educational and school psychological research has experienced a progressive shift from a focus on identifying individuals who are eligible for special education to an emphasis on preventing and remediating academic difficulties in students. In other words, the question in research has shifted its primary focus from “how can we identify if this student has a disability” to “how can we deliver services to this student to help them succeed academically?” This shift has occurred for a host of reasons, including the publishing of a report on reading instruction and achievement from a presidentially-commissioned study group and the passage of laws which highlight the importance of early instructional intervention to prevent academic difficulties (Individuals with Disabilities Education Improvement Act, 2004; NICHD, 2000). One additional major source of evidence supporting the importance of early intervention is a series of studies that demonstrated that students who experience significant reading difficulties can often be remediated to the point of normalized reading achievement through intensive instruction (Vellutino, Scanlon, & Tanzman, 1998; Torgeson, Alexander, Wagner, Rashotte, Voelker, & Conway, 2001; Vaughn, Linan-Thompson, & Hickman, 2003). Three studies that demonstrate this effect are summarized below.

The first of these studies was conducted by Vellutino, Scanlon, and Tanzman (1998). The authors conducted a longitudinal study of kindergarten students, half of whom were identified as poor readers and half of whom were identified as normal readers. Students were considered poor readers if they scored in the bottom 15th percentile on standardized measures of word identification and letter-sound correspondence, two important early literacy skills. The poor readers were given intensive reading instruction in the form of daily 30-minute one-to-one tutoring sessions for 15 weeks in addition to their regular reading instruction. The normal readers

received regular reading instruction in the classroom and were considered the control group. At the end of the 15 weeks, 74% of students who received intervention had improved their reading skills, as indicated by scoring above the 15th percentile on the standardized measures administered as inclusion criteria. In fact, 67% of students who received intervention scored above the 30th percentile, falling within the normal range of performance.

Torgeson et al. (2001) conducted a similar study in which they compared two intensive reading interventions for students who had previously been identified as learning-disabled. Both interventions consisted of one-to-one intensive tutoring five days per week but utilized different teaching methods. At the end of 8 weeks, Torgeson et al. found that not only had a majority of students in both conditions improved their reading skills, but also that 40% of students no longer met the IQ-achievement discrepancy criterion required for a diagnosis of a learning disability and thus were able to return to general education.

Vaughn, Linan-Thompson, and Hickman (2003) used a multiple-gating exit strategy to deliver increasingly intensive levels of intervention to 2nd grade students who had been identified as at-risk for reading problems. They delivered daily tutoring sessions and evaluated student progress after 10 weeks of intervention. Students who performed within the average range on several measures of reading achievement after receiving the intervention were removed from the program, while the rest of the students received an additional ten weeks of intervention and were again tested for improvements in reading achievement. Students who failed to meet the exit criteria were given ten more weeks of intervention and tested at the end of the ten weeks. By the end of the third testing, Vaughn et al. found that 76% of students had met the exit criteria of normalized reading achievement at some point throughout the three testing periods.

These three studies provide evidence that a majority of the reading difficulties previously used to classify students having a learning disability can be remediated through intervention. This is particularly important because learning disabilities have often been considered a long-lasting disability frequently seen as a deficit of the individual. These results also indicate that students will require varying intensities of intervention to successfully remediate these problems. Vaughn et al.'s (2003) study demonstrated the success of systematically applying increasing intensities of intervention to students based on the level of improvement seen after intervention. This approach has been termed the response to intervention (RTI) approach and has become increasingly popular for the prevention and remediation of academic and behavioral difficulties in schools. RTI generally works within a three tier framework, and it can be used to make decisions about the intensity of students' academic and behavioral needs and whether the current level of services are sufficient to meet the student's needs (Fuchs & Fuchs, 2007; Gresham, 2004; McMaster, Fuchs, Fuchs, & Compton, 2005; Walker & Shinn, 2010).

In general, whether it is being used to address academic or behavioral concerns, RTI begins with a strong universal program that is administered to all students; this program is referred to as tier 1. A tier 1 approach should use a research-based curriculum that has been demonstrated to be effective for a majority of students, defined as a curriculum that results in 80% of the targeted population experiencing a positive outcome after exposure to the universal program. Tier 1 is referred to as the preventative tier as it is intended to result in preventing this 80% of students from experiencing a negative outcome (e.g., reading problems). Tier 1 typically screens all students in a population three times per year in an effort to identify students who are not meeting expected benchmarks of performance. In reading, a tier 1 approach would consist of the use of an

evidence-based reading curriculum that is delivered to all students and screening all students three times per year on measures of reading achievement.

Students who have been identified in tier 1 screenings as performing below the expected benchmark are considered “at-risk” for a negative outcome and are generally placed into tier 2, which provides more targeted support. The goal in tier 2 is to reverse the negative outcome the student has begun to experience (e.g., to remediate their current reading difficulties). Tier 2 attempts to accomplish this goal by providing short-term, intensive intervention. In reading, this may be accomplished by providing 30 minutes of supplemental reading instruction in a small group format three to four times per week in addition to the regular education program. Tier 2 generally monitors student progress every two weeks.

Students who are not making adequate progress in tier 2 are then placed into tier 3 for intensive support. Tier 3 is designed for students who will require more individualized and longer-lasting intervention than students in tier 2, and the goal in tier 3 is to reduce the amount of harm the student is experiencing. Typically, students in tier 3 will require supports for at least a year and they may require placement in special education in order to access services that are sufficiently intensive and individualized. Tier 3 interventions are normally provided at least once per day, in addition to regular education initiatives and are often delivered in a one-to-one format in order to maximize the amount of practice and feedback the student receives.

Vellutino, Scanlon, Zhang, & Schatschneider (2008) found that an RTI model identifies and remediates students with reading difficulties better than traditional identification methods (e.g., a teacher referral and psychological testing approach). Vellutino et al.’s results also indicated that the source of most early reading difficulties is inadequate educational experiences rather than biological deficits. This finding indicates that an RTI approach would be a more appropriate

approach for reading problems as it is designed to prevent and remediate those reading difficulties that are the result of inadequate educational opportunity. RTI has particular importance for reading difficulties, as longitudinal research has repeatedly shown that students who start out as poor readers are likely to remain poor readers (Juel, 1988; Stanovich, 1986; Stuart & Coltheart, 1988). In their longitudinal studies of reading achievement, Juel (1988) and Stuart and Coltheart (1988) demonstrated that, without intervention, students who are poor readers in kindergarten or first grade are likely to continue to be poor readers. Juel found this likelihood to be a probability of 0.88; in other words, there is nearly a 90% chance that a poor reader in kindergarten or first grade will remain a poor reader throughout their lifetime. However, Vellutino et al. (1998), Torgeson et al. (2001), and Vaughn et al. (2003) also demonstrated that students who start out as poor readers can become good readers through intensive intervention. Thus, the identification of effective remedial interventions for reading has received increased focus in educational literature, and many effective interventions have been identified such as repeated readings, drill practice, phonics, etc. (Fuchs & Fuchs, 2007).

Intervention Efficiency within an RTI Approach

While research has identified interventions that are efficacious in that they result in improved academic skills, less focus has been devoted to the identification of the most efficient interventions, that is, interventions that require the least amount of instructional time to develop mastery of a skill. Efficiency is a particularly important dimension of interventions that are delivered in schools, as only a finite amount of time exists during the day to deliver instruction to students. Kameenui (1993) advocated that if two methods are effective to teach a skill and one method is more efficient, educators and interventionists should use the more efficient method. Kameenui argued that this principle is necessary to apply if struggling readers are to ever catch

up with normal readers, as they must improve their reading skills at a faster rate than their peers are learning new skills. Daly and Kupzyk (2013) echoed this call for efficient instruction, noting that methods of teaching that lead to the most rapid rates of learning will have the greatest benefit to beginning readers. The importance of this benefit to beginning readers is demonstrated by Juel (1988) and Stuart & Coltheart (1988)'s findings that success in early reading is a strong predictor of long-term academic success. The efficiency of an intervention is very important in the implementation of RTI, as students are, by definition, evaluated based on their responsiveness to an intervention, that is, their rate of improvement during the intervention. Thus, if various interventions result in differing rates of mastery by design; this would be an important factor to take into consideration when evaluating whether a student has demonstrated an adequate response to an intervention or whether they require additional supports. More importantly, knowing which intervention leads to the most rapid rates of mastery can allow educators and interventionists to utilize interventions that will remediate struggling readers in the least amount of time.

Much of the early RTI research stems from reading intervention research. Thus, close examination of reading research can be informative for the overall RTI process of identifying the most efficient interventions. Theoretical and empirical accounts of learning to read and spell that can inform this process are described below.

Theoretical Accounts of the Process of Learning to Read and Spell

Much research on reading and spelling has utilized a cognitive approach to describing the process of learning to read and spell, which typically places the causal events for acquiring the skill within the reader, referring to things such as “mental representations” or “mental images” of words to describe how a child learns to read. Barron (1980), Frith (1980), and Ehri (1980) all

hypothesized that students “match” the written word they see with the mental representation of the word they have “stored” in their memory. Frith (1980) proposed this as the primary cause of differences between good and poor spellers, stating that good spellers were able to compare their spelling of a word to their mentally-stored image in order to ensure they spelled the word correctly while poor spellers had not established this mental image and thus could not use it to aid their spelling.

Daly and Kupzyk (2013) argued that these constructs, while they may be intuitively appealing, do not allow for a stringent empirical evaluation of their proposed role as they are by definition unobservable events that occur within the individual. Daly and Kupzyk (2013) also proposed that these internal constructs are not necessary to describe the process of learning to read. Rather, the process can be described behaviorally using the concepts of stimulus control and differential reinforcement to describe the development of reading and spelling behavior.

Stimulus control is the alteration in one or more aspects of a response such as the rate, latency, duration, or strength of the response as a result of the presence or absence of a stimulus (Dinsmoor, 1995a, b). For example, people generally do not attempt to answer a telephone when it is not ringing, however they will attempt if the telephone is ringing. Thus, the ringing of a telephone has stimulus control over the answering behavior. In reading, stimulus control would be demonstrated by correctly reading the word “bug” aloud and not pronouncing another word such as “tug.” Baron, Trieman, Wilf, and Kellman (1980) described reading as the result of learning to produce specific sounds in response to letters as stimuli. Similarly, spelling is described as the result of learning to produce specific letters in response to sounds as stimuli. Thus each letter has stimulus control over the production of a given sound and vice versa.

Stimulus control is an operant behavior (Skinner, 1957) and is established through differential reinforcement.

Differential reinforcement is the systematic delivery of a reinforcer following certain responses but not following other responses (e.g., one would deliver a reinforcer following the emission of the sound that corresponds to the letter 'b' if it was emitted in the presence of the written letter 'b' but not if it was emitted in the presence of the written letter 'a'). A reinforcer is a stimulus that, when delivered following the occurrence of a behavior, results in an increase in the likelihood of that behavior in the future (Catania, 1998). Differential reinforcement works through a three-term contingency which involves an antecedent event, the occurrence of a behavior, and a consequence that follows the behavior. Through the use of differential reinforcement, the antecedent acquires the ability to reliably elicit a behavior in its presence when the consequences that follow that behavior are reinforcing. A three-term contingency occurs frequently during academic instruction when an instruction or prompt is delivered (antecedent), the student makes a response (behavior), and praise or corrective feedback is delivered (consequence). In academics, this is referred to as a complete learning trial, as it gives the student the opportunity to make an academic response and receive feedback regarding the accuracy of their response (Belfiore, Skinner, & Ferkis, 1995). Daly and Kupzyk (2013)'s proposal that the process of learning to read and spell occurs through differential reinforcement of correct responding implemented within a three-term contingency in order to develop appropriate stimulus control is an account that is clearly within the realm of experimental evaluation and manipulation.

Contrary to cognitive accounts of the creation of mental representations or images, Baron et al. (1980) and Daly and Kupzyk's (2013) accounts describe processes that are within the teacher

or tutor's control to manipulate, increasing the ability of learning researchers to identify the causal and instructional events necessary to develop proficiency in reading and spelling. Directly assessing the presence or absence of a mental image and whether that mental image is accurate for the given word is impossible. Assessing whether an intervention can change that mental image would be even more difficult. In contrast, the processes described by Baron et al. and Daly and Kupzyk are questions that can clearly be empirically evaluated by research: assessing how providing differential reinforcement across various responses to certain stimuli, varying the number of complete learning trials, and manipulating aspects of the stimuli used in training affect a student's accuracy of responding.

One example of the utility of this proposed account in extending the literature on effective teaching methods comes from Kupzyk, Daly, and Anderson (2011). The authors compared two sight-word reading interventions and found that the number of complete learning trials was an important factor influencing the effectiveness of an intervention. Other studies have also demonstrated that increasing the number of complete learning trials in a session can lead to reduced off-task behavior, increased academic compliance, and increased learning rates (Belfiore et al., 1995; Heward, 1994). These findings are consistent with Baron et al. (1980) and Daly and Kupzyk's (2013) proposed theory of how learning occurs, as increasing the number of complete learning trials (i.e., increasing a student's exposure to a specific three-term contingency) would be expected to develop stimulus control more rapidly and completely since it leads to higher opportunities for reinforcement for the individual. Such findings point toward modifications that can be directly applied to instruction within a classroom.

Explicit versus Implicit Approaches to Reading and Spelling Instruction

Similar to the various theoretical accounts of the processes of learning to read and spell, approaches to teaching reading and spelling have varied as well. These approaches can be broadly classified into two categories: a meaning emphasis approach and a code emphasis approach (Chall, 1967). Meaning emphasis approaches focus much attention upon the meaning of words and looking at words as wholes rather than by their components (i.e., the letters that make up the word). Word instruction is typically “embedded” within other activities such as reading books aloud. By contrast, code emphasis approaches focus much attention upon explicitly teaching letter-sound correspondence in isolation prior to attempting to teach students to read connected text. In current educational practice, the meaning emphasis approach is commonly referred to as “whole-language” instruction while the code emphasis approach is often referred to as “phonics” instruction. Advocates of a meaning emphasis approach believe that incorporating reading instruction while reading connected text preserves the connection between the processes of reading and comprehension while code emphasis approaches artificially divide these processes and disrupt comprehension. In contrast, advocates of a code emphasis approach believe that meaning emphasis approaches do not provide instruction that is explicit enough to develop mastery of the rules that govern reading and that it is necessary for students to first master these rules in order to allow for fluent reading of text, a skill that has been demonstrated to significantly influence comprehension (Chall, 1967).

Research comparing the two approaches has continually supported code emphasis (phonics) instruction as a more effective approach to teaching reading and its prerequisite skills. Chall (1967) found that phonics instruction, when compared to meaning emphasis instruction, produced more rapid reading and increased comprehension, contrary to the claims of meaning

emphasis advocates. Adams (1990), Linan-Thompson and Vaughn (2010), and the NICHD (2000) have all concluded that explicit methods of instruction are superior to indirect methods of instruction such as whole-language instruction because they lead to more rapid rates of learning, particularly for beginning readers. Similarly, Linan-Thompson and Vaughn (2010) concluded that the use of direct instruction is the most effective approach to providing reading instruction at all three levels of an RTI model. Linan-Thompson and Vaughn described direct instruction as the use of overt explanations, models, and prompts to teach specific skills and the provision of multiple opportunities for students to practice their newly learned skills. Direct instruction also includes frequent feedback regarding the accuracy of a student's responses during practice.

Roberts and Meiring (2006) conducted an experimental study in which they randomly assigned children to receive either phonics instruction embedded within a literature context or phonics instruction taught explicitly in a spelling context. Immediate measures of phonological achievement as well as measures of reading comprehension at a four-year follow-up indicated that explicit phonics instruction resulted in greater improvement than embedded phonics instruction. The superiority of explicit phonics instruction was even greater for students who were classified as low ability readers at the onset of the study, indicating that an interaction was present between a student's initial reading skills and the impact the type of instruction had upon them. This interaction again highlights the need for experimental identification of interventions that may have differential efficacy and efficiency for students who are struggling to acquire early literacy skills as compared to the general student population. Identification of such interventions would lead to improved tier 2 performance.

Best Practices in Reading Instruction

The Report of the National Reading Panel (NICHHD, 2000), in a summary of the reading research literature, identified five core components of reading as necessary for students to become competent readers. Each of the components, while identified as necessary, were also shown to be insufficient on their own to develop proficient readers because each component interacts with the other four components. Therefore students must develop proficiency in all five areas to be competent readers. The five core components consist of phonemic awareness, phonics, fluency, vocabulary, and comprehension.

Phonemic awareness refers to the ability of an individual to manipulate the individual phonemes in a word. A phoneme is the smallest unit of speech. Thus, phonemic awareness is demonstrated by a student's ability to break a spoken word into its individual phonemes (e.g., "What are the sounds in 'cat'?" "/c/ /ae/ /t/"). Phonemic awareness can also be demonstrated by deleting or manipulating phonemes within a word (e.g., "if you take the 'c' out of 'cat' and replace it with 'b,' what word do you have?" "Bat."). Stuart and Coltheart (1988) found correlations ranging from .67 - .86 between two early literacy skills, phonemic awareness and letter-sound knowledge, prior to entering school and a student's reading ability during each of the first three years of school. Foorman, Breier, and Fletcher (2003) also found that a student's level of phonemic awareness is a strong predictor of how well they will later learn to read.

The second component, phonics, or the alphabetic principle, refers to knowledge of letter-sound relationships and the ability of a student to blend sounds together to form a word (e.g., c/ae/t/... "cat") or segment a word into its component sounds (e.g. "cat"... "c/ae/t"). The National Reading Panel's (NRP) meta-analysis on phonics instruction found that multiple studies demonstrated improvement not only in students' ability to segment and blend words but also in

their overall reading and spelling ability following receipt of instruction, demonstrating phonics is an important step in developing fluent reading.

The third component of reading is fluency, defined as a student's ability to read text accurately, quickly, and with proper expression. Fluency is best measured using oral rather than silent reading, as it allows for an external evaluation of the accuracy with which the student is reading the text. A student's fluency is calculated by combining their rate of word reading and the accuracy with which they read the words. The NRP identified fluency as a critical component in developing reading comprehension. Phonemic awareness and phonics instruction contribute to, and are necessary for, developing fluency but alone they are insufficient. Direct instruction on phonetically-irregular sight words is also necessary to develop reading fluency as phonemic awareness and phonics instruction are, by definition, not applicable to sight words. Developing sight-word reading is also important in developing the fourth component of reading, vocabulary, and will be further discussed below.

Vocabulary refers to a student's knowledge of the meaning of a word. Obviously if a student does not know the meaning of a word in a sentence this could impair their ability to understand the meaning of the sentence, particularly depending upon the importance of that word in the sentence. Thus vocabulary has often been viewed as an important factor in developing comprehension of text. The NRP identified a number of direct and indirect methods of providing vocabulary instruction that appear to be effective. They also distinguished between different types of vocabulary: reading and oral vocabulary. Reading vocabulary refers to words an individual is able to understand when reading a text while oral vocabulary refers to words an individual is able to understand when they are spoken aloud. Within reading vocabulary, the NRP also distinguished between vocabulary for which the words are decoded in order for the

reader to understand them and “sight vocabulary.” Sight vocabulary can refer either to words the reader encounters so often they do not have to continue to decode them or words for which the rules of phonics do not apply and thus cannot be decoded at all. Hanna, Hanna, Hohes, and Rudorc (1966) identified 13 percent of words in the English language as phonetically-irregular sight words. Thus, in order for students to master reading, they must develop a strong sight word vocabulary in addition to mastering phonics. Research has demonstrated that sight word mastery is a skill that can be efficiently taught using a three-term contingency and differential reinforcement to establish stimulus control, with trials requiring as little as 5 seconds or less when using a constant-time delay instructional method (Daly et al., 2004; Kupzyk et al., 2011; Noell, Connell & Duhon, 2006). The importance of sight-word mastery in overall reading fluency and the documented poor performance of students with reading difficulties on measures of word recognition (Fletcher, 2007) indicate that identifying interventions at the tier 2 or 3 level for improving sight-word mastery may be necessary in order to fully remediate reading difficulties and develop proficiency in vocabulary and fluency skills.

Finally, the fifth component, comprehension, is the understanding of the meaning of the text read. Comprehending text is the purpose and intent of reading (Durkin, 1993); this can be for educational, recreational, or instructional purposes. A number of instructional strategies were found to be effective for improving comprehension, including increasing vocabulary, asking the student questions about the material read, or asking the student to create their own questions about the reading.

Altogether, the NRP’s review of reading research found that explicit instruction in each of the five components of reading is important for developing basic reading skills and overall comprehension of the text read. The studies summarized indicated the connections between the

five components and the necessity of mastering each component in order to avoid difficulties in the ultimate end of reading, comprehension.

Best Practices in Spelling Instruction

Relative to reading, spelling instruction has received less attention in education and educational research. Rice (1893, 1897), in an evaluation of spelling instruction as it occurred in schools, found that spelling instruction was generally poor and varied greatly throughout the country. Rice noted that spelling was often taught in isolation from the rest of the curriculum and typically consisted merely of worksheets the student was asked to complete. As a result of his research, he identified eight recommendations for effective spelling instruction. These recommendations were: use a variety of methods to teach the skill, separate regular and irregular words, stress rules for adding suffixes (e.g., when to retain or drop a final *e* in a word), spend only 15 minutes per day on spelling, give priority to common words, omit instruction for words that can be easily spelled phonetically, and begin instruction as soon as possible on small but difficult words. Many of these recommendations continue to be upheld by most current educational research, particularly stressing rules for adding suffixes, beginning instruction early, and separating regular and irregular words (Foorman, 1999). Unfortunately, these recommendations often are not implemented in classrooms. This seems to be a result of educational philosophies, such as whole-language approaches, that believe sufficient exposure to reading and writing text will improve spelling ability, without the need for explicit instruction (Marsh, Friedman, Welch, & Desberg, 1980).

However, Baron et al. (1980), Ehri and Wilce (1987), and Perfetti, Rieben, and Fayol (1997), along with many others, identified spelling as a more difficult skill to master than reading due to the increased variability for spelling a given sound in English compared to the

number of ways to pronounce print. The English language contains approximately 40 sounds but has approximately 70 letters or letter combinations to spell those sounds. For example, when reading ‘f’ or ‘ph,’ the reader has only one sound option to produce, but in writing the sound /f/, the speller must decide which of the two options is appropriate for the given word. Many researchers view this increased variability and potential for error as one reason students typically perform better on reading tasks than on spelling tasks and thus view spelling as a more complex skill to master (Baron et al., 1980; Frith, 1980; Ehri & Wilce, 1987; Marsh et al., 1980).

Foorman (1995) advocated that early spelling instruction (first through third grade) should first focus on the one-to-one correspondence of letters to their sounds, developing strong phonemic awareness. Similar to reading, it appears that a student must be able to segment words and have good letter-sound knowledge in order to master spelling. Both of these skills have been found to be strong predictors of early reading and spelling ability (Stuart & Coltheart, 1988; Juel, 1988). After mastering simple letter-sound relationships, the student should then be instructed in more complex sound-symbol correspondences, that is, letter combinations that result in a given sound (e.g., ‘ph’ or ‘igh’). Along with letter combinations, rules for certain written patterns should be directly instructed as well (e.g., ‘qu’), and phonetically-irregular sight word instruction should be included throughout this process. Foorman argued that such a sequence provides the appropriate scaffolding for a student to gain the required skills for spelling mastery; the similarity between Foorman’s recommendations and Rice’s (1897) recommendations can be clearly seen.

Different Modalities of Spelling: Oral versus Written

There are two primary methods by which spelling can be evaluated: oral (stating the letters aloud) or written (using a physical method to spell the word such as a pencil and paper,

blocks with letters on them, or a keyboard and computer). Both methods of instruction are used in education, although written spelling is by far a more common method. Spelling research has also utilized both methods of spelling, although again there has been a much greater emphasis on written spelling. The methods by which written spelling have been operationalized have utilized all of the above methods (Conrad, 2008; Davidson & Jenkins, 1994; Ehri & Wilce, 1987; DiVeta & Speece, 1990; Graham, Harris, & Chorzemp, 2002; Noell et al. 2006).

Some comparative research has found that, as early as first grade, individuals demonstrate better written spelling than oral spelling, even for the same word (Treiman & Bourassa, 2000). This has been hypothesized to occur because of the ability to “read” a word to check it for accuracy after writing it (Weiser & Mathes, 2011) and the reduction of the necessity for an individual to “keep track” mentally of where they are in spelling a word (Brooks, 1968). Tenney (1979) asked participants to identify which of two spelling alternatives was correct. Tenney varied the modality in which spelling alternatives were presented to participants, presenting the spelling alternatives orally in one condition and written in the other. Participants identified the correct spelling significantly more often in the written condition than in the oral condition. Tenney proposed that the increased accuracy in the written condition was accounted for by the participants’ ability to determine whether the word “looks right,” a method that is not readily available when the spellings are orally presented. It remains unknown whether this superiority exists with beginning spellers who are acquiring the skill, however, as this study was conducted with college students. It is also unknown whether this superiority maintains when the participants are asked to produce the spelling themselves, as Tenney’s participants were asked to identify which of the presented spellings was correct. It is plausible that identifying which of two

orally-presented spelling options is correct is a more difficult task than producing the oral spelling of a word.

It is also possible that written spelling may provide more salient stimuli to acquire control over the spelling response. Dinsmoor (1995) indicated that the acquisition of stimulus control is influenced by the salience of the stimulus. Written spelling leaves a visual stimulus as well as incorporates a motor response. Each written letter may also serve as a textual prompt for the next letter in the word. In contrast, oral spelling incorporates motor (vocal) responses and gives auditory stimuli during spelling but does not leave a permanent, visual stimulus with the entirety of the word after spelling. If written spelling does indeed contain more salient stimuli than oral spelling, one would expect faster acquisition of stimulus control for words written down relative to those orally spelled. The ability to see the written word may also facilitate generalization from spelling to reading by increasing the individual's exposure to the written word.

Oral spelling, on the other hand, has been hypothesized to require less response effort than written spelling, particularly for young children for whom writing may be a difficult motor task (Noell et al., 2006). The response effort associated with a task is a variable that can influence a participant's willingness to complete the task, with tasks that require less response effort necessitating less potent reinforcers and having lower overall aversive effects (Fisher & Mazur, 1997). Young children who are not yet fluent in handwriting often require extended time to write an individual letter compared to older, more experienced writers. This extended time can reduce the number of complete learning trials that can be accomplished during a given instructional time, which could result in slower acquisition of spelling accuracy. Oral spelling eliminates the response effort associated with handwriting, and thus may allow for more complete learning trials during a given period of time as well as reduce any potentially aversive

aspects of the task that handwriting may introduce. Given that the number of opportunities to respond can be an important factor in the acquisition of academic skills (Kupzyk et al., 2011), it is possible that oral spelling may result in faster acquisition of stimulus control relative to written spelling, despite the absence of a permanent written product after completing the task. Noell et al. (2006) demonstrated that oral spelling can be sufficient to establish a spelling response and can result in generalization to reading the instructed word. While research has demonstrated that both written and oral spelling are effective methods of instruction, the current literature review indicates that no research to date has experimentally compared the two methods for any differential benefit when instructing a new skill.

Connections between reading and spelling

Reading and spelling have long been researched as existing in some relationship to one another. Various proposals describing this relationship have been put forward, such as hypotheses that reading must precede spelling, that spelling must precede reading, that they are the same skill, that they share some relationship but also each contain unique aspects, and even that they are entirely separate skills with no relationship with each other (Bryant & Bradley, 1980; Chomsky, 1971; Ehri, 1992; Frith, 1980; Gill, 1992; Henderson & Chard, 1980; Stuart & Coltheart, 1980; Gibson & Levin, 1975). Frith (1980) demonstrated that good readers who are poor spellers as well as good spellers who are poor readers both exist in the student population. This observation is contrary to the first two hypotheses which propose that one skill necessarily precedes the other in acquisition, for example, that one must learn how to read a word before they can learn to spell it or vice versa. Stuart and Coltheart (1980) and Ehri (1992) advocated for the existence of a reciprocal relationship between reading and spelling. Ehri hypothesized that words are stored as mental images that can then be utilized both for reading and spelling and thus

the knowledge needed to spell is the same as the knowledge needed to read. Frith (1980), Henderson and Chard (1980), and Bryant and Bradley (1980) all claimed that reading and spelling were separate skills based on the observation that people can read words they cannot spell and can spell words they cannot read. They also proposed that the two skills are fundamentally different in that reading is more receptive in nature while spelling is more productive in nature.

Each of the above hypotheses would lead to a different conclusion as to the optimal method of reading and spelling instruction, that is, whether they should be instructed together or separately. If a relationship exists between reading and spelling, it would be logical to instruct reading and spelling in relation to one another. However, if no relationship exists, the curricula could be successfully instructed separately. Thus, the question of the relationship between reading and spelling is an important one for educational research. There now appears to be strong correlational and experimental support that reading and spelling share a relationship but that they also each contain unique components that may not be present in the other skill; a portion of research that indicates this connection will now be summarized.

Correlational Evaluations of Reading and Spelling

As previously described, Stuart and Coltheart (1988) and Foorman et al. (2003) found that phonemic awareness and the ability to segment and blend words are strong predictors of future reading and spelling proficiency. The NRP (2000) report similarly found an overall effect size of .86 for outcomes in phonemic segmentation and blending skills for students that received instruction in these skills. This is considered a large effect (Cohen, 1988). While an intervention that leads to improved outcomes in the skill that was directly taught may not be particularly surprising, the authors also found an effect size of .53 for reading outcomes and .59 for spelling

outcomes as well; an effect size of .50 is considered a medium effect. Students were able to generalize the skills learned in phonemic segmentation and blending to assist their reading and spelling as well. This indicates that the same foundational skills are important for developing reading and spelling. Foorman and Petscher (2010), in a correlational evaluation of reading and spelling abilities as they exist in the student population, found correlations between reading and spelling abilities ranging from .68 - .86. This is considered a strong relationship in psychological research (Cohen, 1988). While these high correlations reflect that reading and spelling abilities are highly related amongst students, they also indicate that it is not a perfect relationship (as would be demonstrated by a correlation of 1.0), meaning that some differences do exist between reading and spelling abilities. In other words, the lack of a perfect correlation provides support for the existence of certain aspects of reading and spelling that are unique to each.

Barron (1980) selected good and poor readers and asked them to spell a list of regular and irregular words. He found that the good readers spelled more words correctly than the poor readers. In addition to the number of errors made, the types of errors were systematically different between the two groups. The poor readers had more phonological (sound-related) errors in their spellings than the good readers. He proposed that this occurred as a result of the poor readers using a phonological approach to spell the words. A phonological approach refers to attending to individual sounds in a word and writing the letter or letter combinations that make up those sounds. While this method works fairly well for regular words, it results in spelling errors for irregular words (e.g., one does not hear the 'w' in *sword* and thus would misspell the word if using phonological cues alone). Barron proposed that the good readers, who spelled more words correctly, used a visual-orthographic approach in addition to a phonological approach. Barron described the visual-orthographic approach as the process of examining the visual aspects

of the word to see if it “looks right” (i.e., does it visually match with other times the student has seen the word written?). Based on his findings, he concluded that both phonological and visual-orthographic approaches are necessary in order to master spelling and encouraged including explicit instruction in how to use both approaches. It is noteworthy that Barron selected his groups based on reading ability alone but also found consistent differences in their spelling ability and the types of errors the groups made, again providing support for the existence of some shared relationship between reading and spelling.

Using the Relationship between Reading and Spelling

To date, most research has focused on identification of the presence of a relationship between reading and spelling abilities or how the acquisition of each skill occurs in isolation rather than evaluating the emergence of generalization between the two skills and the process by which that occurs. However, now that there is strong correlational support for the hypothesis that reading and spelling have a strong shared relationship but that they are not the same skill, experimental studies have begun to evaluate various methods of instructional design in an attempt to further explain and capitalize upon that relationship. Some of these studies have examined the emergence of generalized responding following acquisition of reading or spelling. The goal of such research is to identify instruction that would facilitate the generalization of a skill learned in spelling to reading and vice versa.

Generalization is the emergence of a trained response in an untrained context, and it can occur across stimuli, responses, or time (Cooper, Heron, & Heward, 2007; Stokes & Baer, 1977). Generalization across stimuli occurs when a trained response occurs in the presence of a stimulus for which no training was ever delivered (e.g., a toddler who was taught that a golden retriever is a dog also calls a Labrador a dog without any additional teaching). Generalization across

responses occurs when an untrained response occurs in the presence of a trained stimulus to accomplish a functionally-equivalent end (e.g., a student taught to say “excuse me” to gain a teacher’s attention one day says “pardon me” in an attempt to gain the teacher’s attention).

Generalization across time is described as a trained response that continues to occur despite the passage of time from training, and it is also referred to as response maintenance. In relationship to reading and spelling, generalization would be demonstrated by the emergence of responding in one skill after instruction in another skill. For example, if a student was taught to read a word and was subsequently able to spell it, this would be an instance of generalization across responses (from a reading to spelling response) and stimuli (from printed to verbal stimuli). Stokes and Baer (1977) stated that generalization also occurs when the amount of instruction needed to acquire a skill is significantly reduced by prior instruction. For example, if a student, after learning to read a word, learns to spell a word twice as quickly than if they had not learned how to read that word, this would be considered an instance of generalization because of the reduced instruction required to learn to spell. The emergence of generalization is often used to demonstrate that a student has learned a skill (Sidman, Willson-Morris & Kirk, 1986).

Generalization of learned skills is desired in educational settings, as no teacher could feasibly instruct every possible condition under which a student must emit an instructed response. Rather, good teachers, whether knowingly or unknowingly, use techniques such as training sufficient exemplars or utilizing stimuli that are commonly present when a student must emit a response to develop generalization of responding (Stokes & Bear, 1977). Generalization can only reasonably be expected if there are shared underlying principles, and there appears to be strong support that this is the case for reading and spelling. A selection of experimental research demonstrating the ability for instruction in one skill to generalize to the other skill is presented below.

Experimental Evaluations of Generalization between Reading and Spelling

Ehri (1980) conducted a study evaluating the impact of reading instruction on spelling achievement. Participants were taught to read nonsense words until they performed at 100% accuracy. At post-test, they were then asked to write down the words they had learned to read, without receiving any explicit spelling instruction. Ehri found that participants correctly spelled 69% of the instructed nonsense words. When they separated the instructed words into phonetically-regular and phonetically-irregular words, the results indicated that participants made more spelling errors for words that did not follow phonetic rules than for those that did follow phonetic rules (they spelled only 59% of phonetically-irregular words correctly while they spelled 80% of phonetically-regular words correctly). This finding provides support for the occurrence of spontaneous but incomplete generalization from reading to spelling, indicating that reading instruction can generalize to improve spelling but that its impact may be reduced for phonetically-irregular sight words for which phonetic cues cannot be used to aid in spelling. This also indicates there may be a need for some direct instruction in the spelling of irregular words.

Similarly, in a summary of numerous studies evaluating the impact of reading instruction on spelling skills, Perfetti, Rieben, and Fayol (1997) noted that children who had received reading instruction for a given word spelled a higher proportion of the letters in that word correctly than those who had not received reading instruction. Perfetti et al. found that while the participants demonstrated some generalization to accurately spell the entire word (30-40% of targets), they showed even greater generalization if each letter in the word was scored for accuracy based on its presence and placement in the child's spelling of the words (70-80% of letters correct). This again demonstrates that, while there may not be complete generalization from reading to spelling, it does occur to some degree without explicit programming.

In a study evaluating the effects of spelling instruction on reading achievement, Ehri and Wilce (1987) provided an experimental group with instruction on how to spell nonsense words using letter tiles, requiring them to pronounce the word and say each sound aloud as they selected each letter for the word. The control group received training in matching letters to sounds but did not use the letters to spell any words. Following training, the authors asked all participants to attempt to read novel words. The authors provided corrective feedback during this test but capped the number of trials participants could experience. The experimental group outperformed the control group both in total words mastered and in their rate of learning to read these novel words. Ehri and Wilce concluded that, despite not receiving any explicit reading instruction, the spelling instruction provided to the experimental group had generalized to improve their reading skills as well.

In a synthesis of studies that included both reading and spelling instruction, Weiser and Mathes (2011) found that when struggling readers and spellers in kindergarten through 3rd grade received instruction that incorporated both spelling and reading instruction, the students made significant gains in phonemic awareness, word reading, spelling, reading fluency, and reading comprehension compared to students who received reading instruction alone. They concluded that explicit spelling instruction appears to be the “missing link” in most classroom instruction for struggling readers and spellers. They highlighted that there is an inherent connection between reading and spelling in the task of written spelling, as most students are instructed to “read” the word to check for correctness. This has been proposed to be a unique added benefit of written spelling as compared to oral spelling. While continually discussed in the literature, no experimental evaluations have confirmed the presence of this proposed benefit of written spelling. Weiser and Mathes also stated that, while it was clear that some combination of reading

and spelling instruction was best, it was impossible to determine from the literature an optimal balance of time to spend between spelling and reading instruction.

Daly, Chafouleas, Persampieri, Bonfiglio, and LaFleur (2004) conducted an experiment in which they systematically manipulated the size of the “textual unit” they targeted to develop stimulus control in their participants. The textual units were either an entire word or individual phonemes, depending on the condition to which the participant was assigned. A phoneme is the smallest unit of speech in a language (Perfetti, Rieben, & Fayol, 1997). Students in the word condition received whole-word instruction on nonsense words, which consisted of simply telling the student how to pronounce the word and did not incorporate any phonics instruction such as sounding out the word. Phonemes by definition cannot be sounded out, as they are the smallest sounds in a language, so instruction in the phoneme condition also involved simply telling the student how to pronounce the phoneme. After each instructional session, Daly et al. asked the participants to read novel words which contained the same phonemes that had been present in both conditions, however the phonemes were presented in different orders (e.g., a participant may have received instruction on the nonsense word “tib” and was then asked to read the novel word “bit”). The authors screened both the nonsense and real versions of the words used in this study prior to instruction to ensure they were unknown by the participants. Daly et al. found that participants who received the individual phoneme instruction were more likely to correctly decipher the novel words than students who received whole word instruction. They proposed this resulted from the development of stimulus control of a smaller textual unit over a participants’ reading behavior in the phoneme condition than in the whole word condition, which resulted in a greater ability to generalize across stimuli in the phoneme condition. This generalization was demonstrated when participants in the phoneme condition sounded out the words, responding to

the individual phonemes that had been previously instructed, while the participants in the whole-word condition did not sound out any words. This would be expected under a stimulus control account, as instruction targeting phonemes developed stimulus control for a stimulus that was also present in the novel word (e.g., the ‘t’ in “tib” and in “bit” and thus the participant’s learned response to the ‘t’ was accurately elicited). In contrast, instruction targeting a whole word as a stimulus developed stimulus control for a stimulus that was not present in the novel word (e.g., the word “tib” is not present in “bit,” thus the participant’s learned response was not elicited here and would not be accurate even if it was). This study gives some indication that generalization from spelling to reading may occur through the use of stimuli present in both modalities. It also gives indication that spelling instruction may result in more complete generalization to reading than reading instruction generalizes to spelling because of the smaller unit for which stimulus control is developed.

Noell and colleagues (2006) conducted a single-subject study using an alternating-treatments design with three elementary school students in which they compared whole-word reading instruction to oral spelling instruction for efficiency in acquisition of the instructed skill. They also evaluated whether generalization occurred from one skill to another (reading to spelling and vice versa). Each participant received whole-word reading instruction on 10 unknown words and oral spelling instruction on a separate set of 10 unknown words. All words were phonetically-irregular sight words that the participant was unable to read during a screening procedure. Following each instructional session, the authors evaluated the participants’ ability to both read and orally spell each word. Thus, every participant received an opportunity to respond to each word using both response modalities, even though for any given word they had only received instruction in one modality. For example, a participant who was instructed how to read

the word “was” would be probed for their ability to both read and spell that word. Probes that tested the uninstructed skill (spelling for reading instruction and reading for spelling instruction) were designed to assess for generalization. The authors equated instructional time across conditions, noting this is an important variable to control for when evaluating instructional efficiency because the amount of time in a school day is a variable that often cannot be manipulated in the real world.

Noell et al. found inconsistent results across their participants regarding the method of instruction that resulted in the most rapid acquisition of the instructed skill. One participant, Mario, clearly acquired targets in the reading condition more rapidly than the spelling condition. However the other two participants, Darren and Sharon, demonstrated fairly similar rates of acquisition between the reading and spelling conditions. In the generalization probes, all three participants demonstrated some degree of generalization from the instructed skill to the uninstructed skill, but again only one participant’s results clearly indicated more generalization from one condition to another. For this participant, Darren, he was able to correctly read 80% of words that he had been taught to spell while he could spell only 60% of words that he had been taught to read. The remaining two participants did not consistently demonstrate differential rates of generalization from spelling to reading or from reading to spelling (Mario generalized approximately 60% of words from both conditions and Sharon generalized approximately 80% of words from both conditions).

These results indicate that both whole-word instruction and oral spelling instruction may be viable options for remediating students who are struggling to master sight words. They also give some indication that providing spelling instruction may lead to more generalization than reading instruction. If interventions are evaluated based on their efficiency in leading to the

mastery of new skills, providing oral spelling instruction to students may prove to be a more efficient method of intervention than providing whole-word reading instruction. Students would then gain skills in both spelling and reading rather than just reading, as was indicated by Darren's results. However, the lack of consistency between participants as to which method of instruction was most efficient in mastery of the instructed skill and generalization across skills indicates a need for further research to identify the most effective and efficient method of instruction. Noell et al. also noted that while all participants demonstrated some degree of generalization, it was less than 100% of the words mastered in the instructed skill for all participants. This indicates that while generalization may occur spontaneously, it is likely to be incomplete. The authors suggested that it may be necessary to provide some direct instruction in the generalization skill in order to facilitate the generalization of skills a participant has already gained in the instructed skill. Noell et al. also noted that it is possible there may be an added benefit to simultaneously receiving instruction in both reading and spelling, as it may allow the skills to reciprocally strengthen each other and facilitate generalization. They suggested this could be evaluated through the use of a 'balanced' condition in which participants receive instruction that incorporates both reading and spelling. This balanced condition could be compared against the two conditions used in Noell et al.'s study to evaluate if there is indeed an added benefit.

Noell et al. noted two particularly surprising findings of their study. The first was the degree to which oral spelling instruction resulted in generalization to reading. This occurred despite the fact that the participants never saw the words written down. The experimenter orally presented the word to the participant and they spelled the word aloud. The only times participants saw the oral spelling targets written down were during generalization probes.

Written spelling is often considered to have the added benefit of the speller being able to read the word to check it for accuracy after spelling. The participants in this study acquired and generalized their responses without this supposedly added benefit. Second, the reading and spelling conditions resulted in similar rates of acquisition for two of the three participants. This equivalency between reading and spelling instruction for acquisition of the instructed skill occurred despite the potential for more complete learning trials in the reading condition due to the shorter nature of the response and instructional trial. This is surprising in light of findings that the number of opportunities to respond is often an important factor in the acquisition of a new academic skill (Belfiore et al., 1995; Heward, 1994; Kupzyk et al., 2011).

Conrad (2008) evaluated the reading versus spelling instruction question using a between-groups design. Participants were assigned either to a reading condition or a spelling condition, thus no participant received both methods of instruction. Conrad's study differed from Noell et al. (2006) in three important ways: there was no pre-test for prior reading ability, rather each participant received the same predetermined list of 40 words while Noell et al. screened the students prior to instruction and provided instruction on only unknown words; conditions were equated for the number of practice trials and instructional time was allowed to vary whereas Noell et al. equated instructional time but allowed the number of practice trials to vary; and participants received written spelling instruction rather than oral spelling instruction. Following sixteen instructional trials, all participants were tested on their response accuracy in their instructed condition (e.g., for students in the reading condition, whether they were able to accurately read the word aloud) as well as their response accuracy in their uninstructed condition (e.g., for students who received reading instruction, whether they were able to accurately write

the word). This second measure of accurate responding in the uninstructed skill was referred to as a generalized response as the participants never received instruction in that skill.

Conrad's results indicated that participants generalized from the instructed skill to the uninstructed skill in both conditions. However, the spelling condition was clearly superior to the reading condition, with participants demonstrating the ability to accurately read all words on which they received spelling instruction (100% generalization from spelling to reading) whereas generalization from reading to spelling occurred only on a portion of the words on which they received reading instruction (60% generalization from reading to spelling).

These findings would seem to indicate that one should provide spelling instruction to struggling readers and thus simultaneously improve their reading and spelling skills, but there are three important factors for which future research must control before such a conclusion could be made. The first factor is to ensure that the words targeted for instruction are unknown by the participants at the beginning of the study. The participants in Conrad's study accurately responded to approximately 75% of words during the first trial of instruction, indicating that prior to the study they likely had some degree of mastery or experience with the stimuli on which they were to receive instruction. This is a large and very important confound when evaluating the efficacy and efficiency of instruction as these aspects can only truly be evaluated with stimuli that have been demonstrated to be unknown prior to instruction. Such a high rate of accurate responding during the first trial of "instruction" undermines any evaluation of the efficacy of the instruction provided. The second important factor to evaluate is to equate instructional time rather than trials. Conrad did not report the average difference in time between instructional conditions, though she did note that spelling sessions generally took longer than reading sessions and that sessions ranged from 10-30 minutes per day. A threefold increase in the amount of time

needed to implement an intervention is not an inconsequential variable. The amount of time in a school day that can be devoted to remedial instruction is limited, and thus research that intends to identify the most efficient and effective interventions should evaluate interventions when the amount of time spent in instruction is equated. At the very least, research should give clear indications of what trade-offs would be associated with implementing a more time-consuming intervention (e.g., clear descriptions of the differences in time needed to implement the two interventions and the rates of learning in each). The third factor is both a methodological and conceptual confound: the error correction procedure used by Conrad. If participants erred in the spelling condition, they were handed a card with the word printed on it and told to make their written word match what was written on the card. Conrad acknowledged that this introduced a reading component to the spelling condition and proposed that the condition may be more aptly named “spelling plus reading.” In order to truly identify the most effective and efficient methods of instruction, particularly if one desires to explain the causal mechanisms contributing to the superiority of a given method of instruction, it is necessary to clearly identify what processes are being instructed (e.g., reading, spelling, or reading and spelling).

The Current Studies

The first study directly evaluated oral and written spelling when instructional time was equated, comparing the two methods for their rates of acquisition of accuracy in spelling as well as testing for the emergence of generalization to accuracy in reading. The method that led to the highest rates of total mastered words was considered the most efficient, with a total mastered word defined as a previously unknown word the participant was able to both read and spell after spelling instruction. This study extended the literature by directly comparing whether the proposed benefit in written spelling of being able to read a word to check for accuracy after writing it is superior to the proposed benefit in oral spelling of reduced response effort and the

ability to include more complete learning trials (Kupzyk et al., 2011; Noell et al., 2006; Tenney, 1979; Weiser & Mathes, 2011). It also contributed to the literature by evaluating whether the method identified as most efficient varies if the desired outcome is to strengthen spelling accuracy alone or both reading and spelling accuracy. Both conditions used in this study were designed to be potential tier 2 interventions, thus, this study also served to extend the literature on tier 2 interventions for students struggling to read and spell sight words.

The second study consisted of a comparison among three instructional conditions: reading instruction alone, spelling instruction alone, and combined reading and spelling instruction. As in the first study, conditions were compared to identify the method that led to the most rapid rates of total mastery when instructional time was equated. The spelling method that led to the highest rates of total mastered words in study 1 was utilized in study 2. This study extended the literature by controlling for confounds in previous studies of generalization between reading and spelling (e.g., not screening target words for prior reading and spelling ability, not equating instructional time across conditions) as well as compared various tier 2 interventions for instructional efficiency. This study also allowed for a comparison of the potential added benefit of instructing reading and spelling in tandem, as has been suggested by Noell and colleagues (2006) and Weiser and Mathes (2011), through the use of the third combined condition. Since the current literature does not provide guidance as to an optimal balance between reading and spelling instruction, the combined condition simply alternated between reading and spelling trials while holding instructional time constant across conditions.

Study 1 Method

Participants, Setting, and Design

Three second-grade students, one male and two females, from an urban school district in the Southern United States were recruited for participation in study 1. Participants were nominated by their teachers as in need of supplemental reading and/or spelling instruction but were not currently receiving, nor eligible for, special education services. Participants were also required to meet the screening criteria described below. We first obtained permission from the principal of the school to conduct the study in their school and then recruited teacher-nominated students via letters sent home from their class. Following parental informed consent and child assent, the intervention was delivered individually to each student at a table in a hallway. The effects of oral versus written spelling instruction were evaluated in an alternating treatments design.

Data Collection and Interobserver Agreement

Participant response data were collected by the experimenter during all probe trials. The experimenter recorded participant responses as correct or incorrect using paper and pen recording. A correct response for written spelling was defined as the participant writing the first letter within 3 seconds of oral presentation of the word, adding a new letter at least every 3 seconds, and writing the letters in the word in the correct order. An incorrect response for written spelling was defined as the participant giving no response within 3 seconds of oral presentation of the word, writing the letters in the incorrect order, or writing a word other than the one orally presented. A correct response for oral spelling was defined as the participant orally pronouncing the first letter of the word within 3 seconds of the experimenter orally stating the word, adding each subsequent letter in the word within 3 seconds of the previous letter, and naming the letters

in the correct order. An incorrect response for spelling was defined as the participant failing to orally pronounce the first letter of the word within 3 seconds of the experimenter orally stating the target word, failing to add each subsequent letter in the word within 3 seconds of the previous letter, or failing to name the letters in the correct order. A correct response for reading was defined as pronouncing the word written on the card within 3 seconds of presentation. An incorrect response for reading was defined as pronouncing a word other than that which was presented on the card, pronouncing an incorrect version of the word (e.g., “dogs” for “dog”), or giving no response within 3 s of card presentation.

Interobserver agreement (IOA) was collected for 38% of sessions. Data were compared on a word-by-word basis. An agreement was defined as both observers recording the same classification of the participant response for the same word (e.g., both observers scored the participant’s response as correct). A disagreement was defined as observers recording different classifications of the participant response for the same word (e.g., one observer recorded the participant’s response as correct while the other recorded the participant’s response as incorrect). IOA was calculated by summing the number of agreements, dividing that number by the total number of agreements plus disagreements, and multiplying it by 100 in order to yield a percent of total agreement. Average IOA for Jamie for reading was 94.6% (range 90-100%) and for spelling was 98% (range 90-100%). Average IOA for Margaret for reading was 91.5% (range 90-93%) and for spelling was 99.4% (range 96-100%). Average IOA for Julia for reading was 95% (no range) and for spelling was 98.1% (range 95-100%).

Procedures

Screening and Identifying Instructional Items. Following receipt of parental consent for the study, the experimenter conducted a screening using a standardized first-grade oral

reading fluency passage. Participants were included in the study if they accurately read aloud 40 words or more in one minute. The purpose of this screener was to ensure that participants had some rudimentary reading skills (e.g., phonemic awareness, letter sound knowledge) that are considered necessary foundational skills for reading. While phonemic awareness and letter-sound knowledge do not necessarily aid a student in spelling a phonetically-irregular word, a second-grade student who demonstrated such a severe deficit in reading skills would likely require more intensive intervention than the current study. One participant did not meet this screening criterion, and we notified the teacher of the student as well as the vice-principal of the school and encouraged her referral for intensive intervention.

For all participants, the experimenter then screened a predetermined list of phonetically-irregular words to identify unknown words. Margaret was screened with the same list of phonetically-irregular words, however, after the second session of instruction she correctly read 50% of control words. Such a spontaneous increase in accuracy indicates Margaret may have been exposed to these words through other avenues such as books she was reading in class, and thus the experimenter screened a new list of words. This new list came from a seventh-grade science vocabulary list, as it was hypothesized to be unlikely that she would come across these words (e.g., amplitude, meteorite) through other materials. This resulted in a list of instructional targets that were not phonetically-irregular, but it seemed to be more beneficial to attempt to control for extra-experimental exposure than to maintain phonetically-irregular words.

The screening for all three participants consisted of an oral reading, oral spelling, and written spelling screener. The accuracy criteria used were identical to the criteria described above in the data collection section. The reading screener consisted of presenting each word on an index card and asking the participant to read the word aloud, and any words the participant

was unable to read correctly were retained for the spelling screening. Any word a participant read correctly was removed from the list of potential targets. Following identification of words the participant was not able to read, the experimenter provided a two minute break in which the participant engaged in a leisure activity (e.g., coloring or playing a game with the experimenter). Following the break, the experimenter stated each word the participant was not able to read and asked the participant to spell the word aloud. Any words the participant orally spelled correctly were removed from the list of potential target items. Again a two minute break was provided to the student with a leisure activity. Following the break, the experimenter stated each word the participant was not able to read or orally spell and asked the participant to try to write the word. Undifferentiated praise was delivered to students following every two to five responses (e.g., “good job working”) to encourage performance. Only words the participant was neither able to read, spell aloud, or write were eligible as targets for the study. A minimum of 30 unknown words was necessary for inclusion in the study. These 30 words were then randomly divided into the instructional and control word lists. The only exception to this minimum of 30 was Julia, whose control list was expanded to contain 20 words, described below. The mean number of letters per word was equated across instructional conditions such that all instructional lists were within 0.5 letters of one another (see Appendix A for the exact words included). The only exception to this was Jamie’s second control list. This list contained words that were 1.7 to 2 letters shorter than his instructional lists. The experimenter allowed this difference due to a shortage of other phonetically-irregular words to include in his second control list. Given Jamie’s new control list contained shorter words, any differential impact of word length would have favored responding to the control list rather than inflating any appearance of responding to the

instructional lists, thus the internal validity of the study was maintained despite this variation in word length across lists.

Teaching Procedures

Oral Spelling Instruction. In the oral spelling (OS) instruction condition, the experimenter began the session by giving the participant the following instructions: “We are going to practice our spelling. Please tell me how to spell the word when I say it. Just say each letter in the word. If you get stuck I will help you. Do you have any questions?” The experimenter answered any questions the participant had, started the timer for 10 minutes, and stated the first word. The experimenter provided praise following a correct response or corrective feedback following an incorrect or no response 3 seconds after the prompt. If the participant did not begin to spell the word within 3 seconds of the prompt, the experimenter prompted the participant to spell the word by stating each letter in the word and requiring the participant to repeat each letter immediately after it was stated. If the participant began to correctly spell the word within 3 seconds of the prompt but paused for more than 3 seconds between any letters, the experimenter prompted the participant to spell the word by starting from the beginning of the word and stating each letter in the word, requiring the participant to repeat each letter immediately after it was stated. Verbal praise was delivered for correct oral spelling of the word (e.g., “great job”; “that’s right”). Following delivering praise or corrective feedback to the participant, the next word in the list was presented. Each word was presented once, then the entire instructional deck was shuffled and represented; this process continued for the remainder of the session time.

Written Spelling Instruction. In the written spelling (WS) instruction condition the experimenter began the session by giving the participant the following instructions: “We are

going to practice our spelling. Please write the word when I say it. Just write each letter in the word. If you get stuck I will help you. Do you have any questions?” The experimenter answered any questions the participant had, started the timer for 10 minutes, and stated the first word. The experimenter provided praise following a correct response or corrective feedback following an incorrect or no response 3 seconds after the prompt. If the participant did not begin to write the word within 3 seconds of the prompt, the experimenter prompted the participant to spell the word by stating each letter in the word and requiring the participant to write each letter immediately after it is stated. If the participant began to correctly write the word within 3 seconds of the prompt but paused for more than 3 seconds between adding any letter, the experimenter prompted the participant to spell the word by starting from the beginning of the word and stating each letter in the word, requiring the participant to write the letter immediately after it is stated. The experimenter continued this procedure until the participant had written all of letters in the word. Praise was delivered for correct written spelling of the word (e.g., “great job”; “that’s right”). Following delivering praise or corrective feedback to the participant, the next word in the list was presented. Each word was presented once, then the entire instructional deck was shuffled and represented for the remainder of the session time.

Within-Session Response Scoring. The first trial for each word in the session was recorded to assess for skill mastery. Half of the control list was probed during this first trial with each instructional list as well, but unlike the instructed words no feedback was provided to the participant regarding their accuracy. The exact control words probed each session randomly changed between the oral and written instruction lists in order to probe each control (CT) word in both modalities across sessions. This randomization was achieved by assigning each CT word a number one through ten. A random order of the numbers one through ten was derived for each

session, and the first five words were included in the oral spelling session while the latter five words were included in the written spelling session. A word was considered mastered when a participant correctly responded on the first trial of the word across three consecutive sessions. Sessions lasted for 10 minutes, and words were presented as many times as possible during the session. Instruction continued until participants had mastered all words in at least one condition or until differentiation between conditions was apparent.

Reading Probes

With the exception of the first two probes for Jamie and the first probe for Julia, reading probes were conducted every other session to assess whether generalization from spelling to reading was occurring. The first reading probe for Jamie and Julia occurred on the third session, but after observing higher rates of correct responding than expected, the interval between probes was shortened in hopes of observing more closely how generalization was occurring. Margaret began the study with reading probes conducted every other session.

Reading probes consisted of presenting the OS, WS, and CT words written on a 3 x 5 inch index card and asking the students to read the words aloud. A correct response was defined as correctly pronouncing the word within 3 s of presentation of the card on which the word was written. An incorrect response was defined as stating a word other than the word written on the card or giving no response within 3 s of card presentation. If a participant gave an acceptable version of a word but not the version targeted for spelling (e.g., saying ‘tear’ as in tearing a sheet of paper but ‘tear’ as in a tear in your eye was the study target), the experimenter asked, “Can you tell me another way to say it?” Aside from this question, which was only utilized with one participant, no praise or corrective feedback was provided during probes. Each probe was conducted immediately prior to the spelling instructional session and therefore followed the

random order of presentation of the WS and OS sessions. The control list was randomly distributed across the two lists as in the spelling probes.

Reverse Condition Probe

Following meeting criteria to terminate participation in the study, each participant participated in a reverse condition probe. During this probe, the experimenter presented each word from an instructional list and asked the participant to spell the word using the opposite modality from which they had received instruction. For example, the WS list was orally presented, and the participants were asked to orally spell the words. For the OS list, the participants were asked to write the words. This probe allowed for a direct assessment of any differential spelling ability across modalities.

Control List Modifications

As will be depicted in the graphs, all three participants demonstrated some degree of correct responding to the control list. In an attempt to identify why this unexpected responding was occurring, various modifications were used with each participant to attempt to identify the cause of this responding. These modifications will be described for each participant here.

Jamie. Jamie was the first participant to demonstrate accurate responding to the control list, correctly reading 80% of the control words on the first reading probe. To assess whether this was an artifact the specific words in his control list, a new set of 10 unknown words replaced his original control list beginning with session four. See Appendix A for the list of control words.

Julia. When Julia demonstrated accurate responding to the control list, her control list was lengthened from ten to 20 words beginning with session five. This was done in an effort to assess for whether the control list was simply short enough that participants were able to

correctly guess two or three of the words each time. The ten additional words included were also unknown based on the original screening criteria. See Appendix A for the list of control words.

Margaret. Margaret originally demonstrated the highest rates of accurate responding to the control list, and she began the study after the above modifications had been conducted with Jamie and Julia and had been unsuccessful at reducing their accurate responding. Thus, Margaret received instruction on a completely new set of words selected from a seventh-grade science program to decrease the likelihood that she would come in to contact with these words throughout her other academic activities. The data depicted in the graphs below represent her responding to those seventh-grade words. See Appendix A for the list of control words.

Study 1 Results

Each study 1 participant's data are presented in two ways. Figure 1 contains graphs depicting the number of words mastered by each participant in the instructed spelling modality.

Mastery was defined as spelling a word correctly on three consecutive sessions.

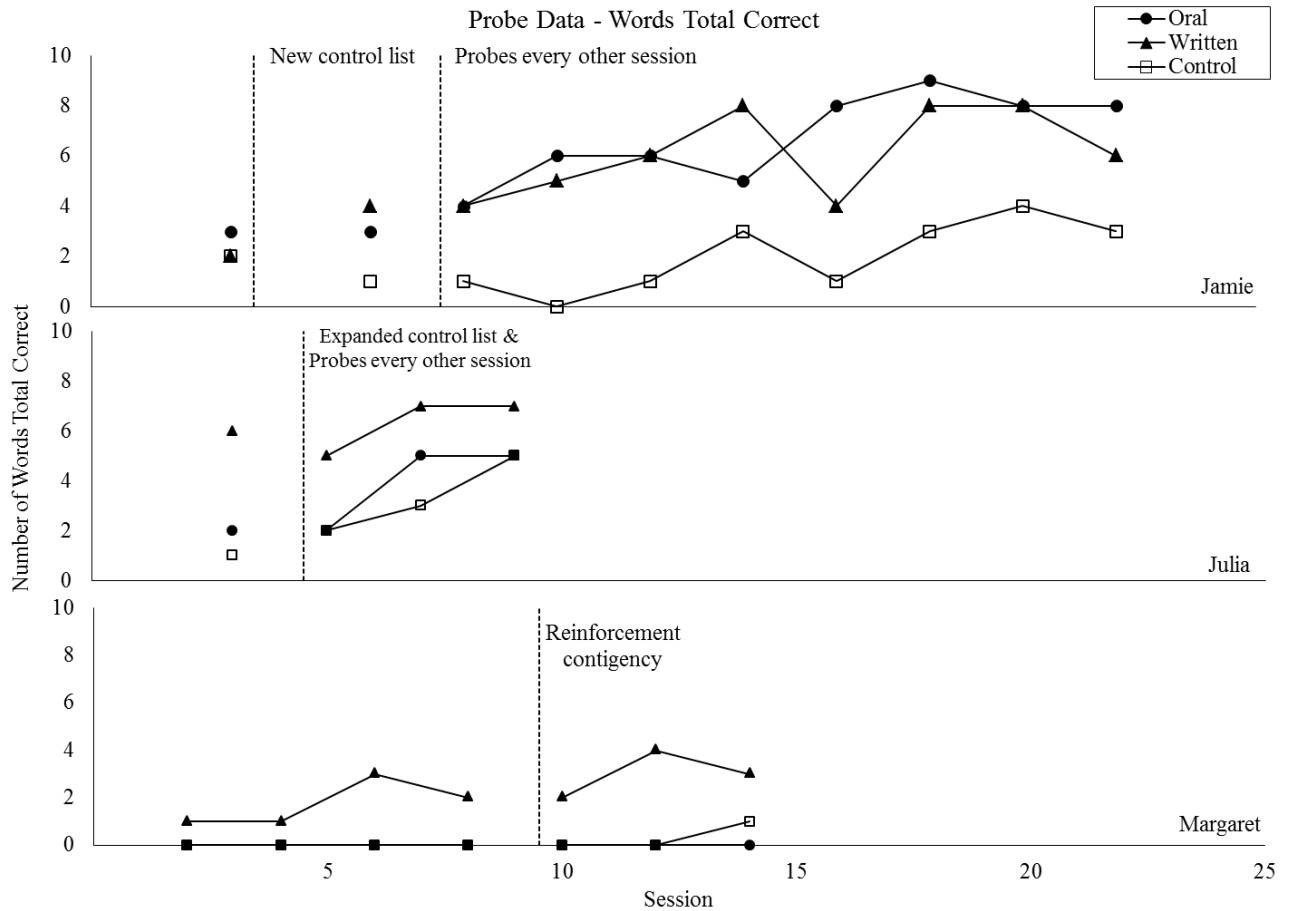


Figure 1. Cumulative number of words mastered by each participant in the instructed spelling modality. Mastery was defined as spelling a word correctly on three consecutive sessions.

Figure 2 contains graphs depicting the number of words the participant both read and spelled correctly during the reading and spelling probes for a given session, which we refer to as ‘total correct’.

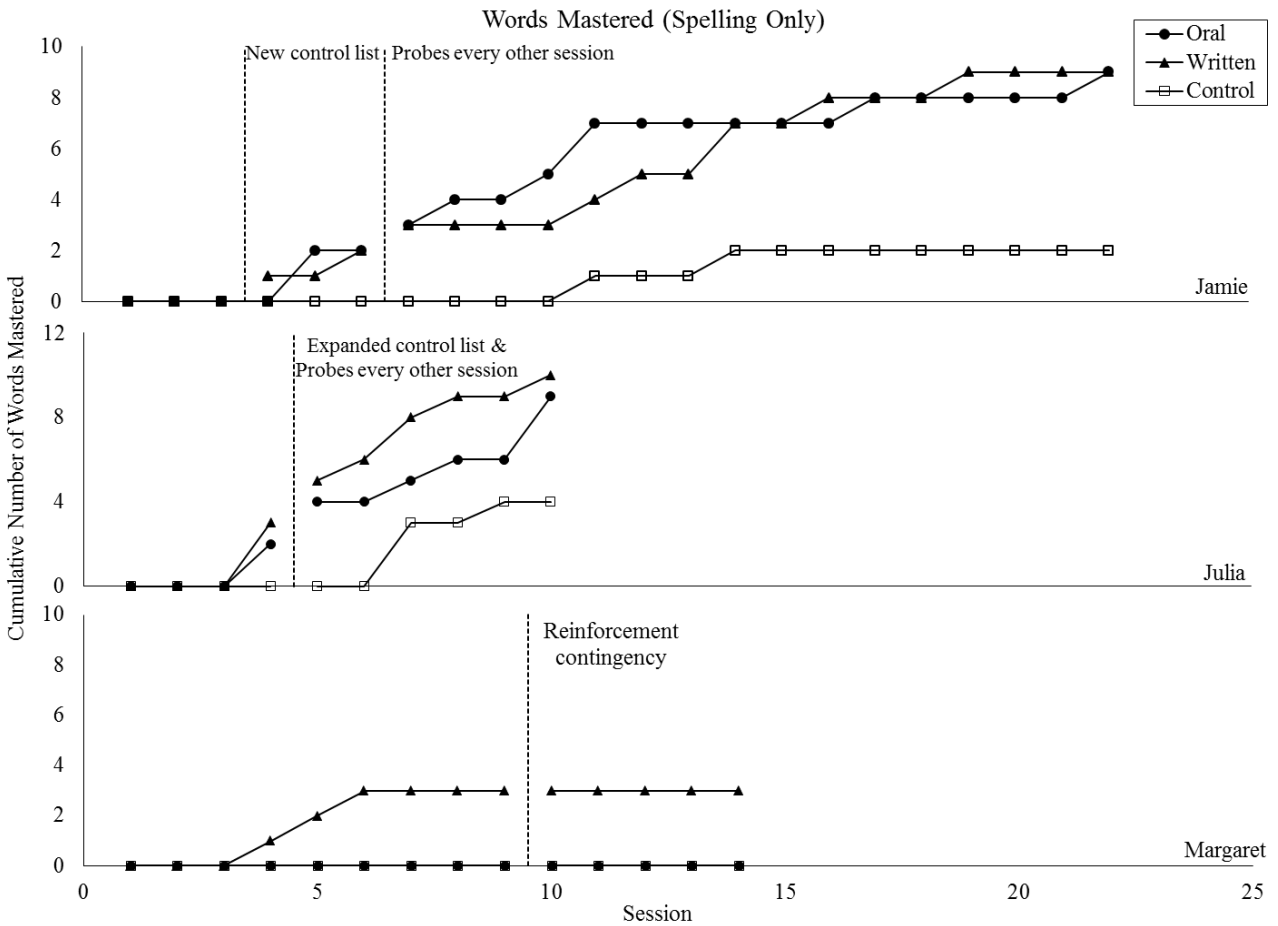


Figure 2. Number of words the participant both read and spelled correctly during the reading and spelling probes for a given session, termed ‘total correct’.

Since for the majority of the study, probes were only conducted every other session, the graphs depict the percent of correct responses per probe, rather than the percent of words mastered, due to the smaller data sample. Additionally, given that Julia had different numbers of words in her control and instructional lists, her data are presented using raw numbers rather than as a percent correct.

Julia's data reflect a clear superiority for the written spelling (WS) condition. Julia consistently mastered words more rapidly in the WS condition, as well as generalized reading of those words more rapidly in the WS condition. In contrast, her responding in the oral spelling (OS) condition was largely undifferentiated from her control list responding. This lack of differentiation was due to inaccurate reading responses to targets she correctly spelled aloud, indicating that learning to orally spell a word did not necessarily generalize to reading that same word. Conversely, for the written condition, she demonstrated nearly 100% accurate reading of words she spelled correctly. In the reverse condition probe, Julia correctly spelled 90% of OS words using the written method. She correctly spelled only 60% of WS words when asked to spell them aloud despite spelling 100% of WS words correctly in the three previous WS teaching sessions. This probe's data also supports the superiority of written methods of spelling over oral methods.

Margaret's data also reflected a clear superiority for the written spelling condition. Margaret never met mastery criteria for any of the words in the OS condition, while she mastered 30% of words in the WS condition. A reinforcement contingency was implemented after session 9 due to a decreasing trend in spelling accuracy; Margaret was beginning to err on words she had previously mastered and was not acquiring any new words. Thus, a contingency was implemented in which she was required to "beat her score" from the previous probe (i.e., read or spell a higher number of words correctly) in order to access coloring books in the array of leisure items that were available on her break. Prior to this contingency, Margaret had almost exclusively selected coloring as her break activity between sessions. Following implementation, Margaret performed at a slightly higher level of accuracy, however, due to restrictions in the school calendar her participation in the study ended after only five sessions with the contingency

and prior to reaching high levels of accuracy in any condition. In the reverse condition probe, Margaret correctly spelled 20% of OS words using the written method. In contrast, she did not correctly spell any WS words correctly when asked to spell them aloud. This again confirms the superiority of written methods of spelling over oral methods for Margaret as she was able to correctly write words that she was simultaneously unable to orally spell.

Jamie initially mastered words more quickly in the OS condition, but by the 14th instructional session, the data paths crossed and he began to master words more consistently in the WS condition. When evaluated for words read and spelled correctly (total correct), Jamie's data lack clear differentiation between the OS and WS conditions. A slight superiority of the OS condition appeared around session 16, after which the OS condition continued to have more accurate total correct responses across probes as compared to the WS or control conditions. This superiority was due to an increase in accurate responses for the OS condition as well as a simultaneous increase in spelling errors in the WS probes for words Jamie had previously mastered. Thus, while the number of words mastered in WS increased when graphed cumulatively, when session-by-session accuracy data are graphed, OS maintained consistently higher rates of responding. Thus, for Jamie, different methods are indicated as more efficient depending on the measure used (e.g., mastery in the spelling response alone versus accuracy in both reading and spelling). At the reverse condition probe, Jamie correctly spelled equal percentages of words from each list, again indicating a lack of differentiation between the two modalities.

All three participants demonstrated some degree of learning in the control condition, as reflected in the total correct graphs. However, despite this learning, the control condition

remained substantially lower than the WS condition for all three participants, indicating a superiority of the WS condition over the control condition.

Study 1 Discussion

The results of study 1 support a superiority for written spelling over oral spelling, both when evaluated for efficiency in teaching spelling as well as spontaneous generalization to reading the instructed words. This study extends the literature by comparing written and oral spelling modalities during skill acquisition. Previous research has typically compared the modalities across performance for previously mastered or likely mastered skills. For example, Treiman and Bourassa (2000) found superiority of written spelling over oral spelling for adults and children as young as second grade when participants were asked to spell words they were likely to have already been taught. The authors did not provide any instruction, but rather assessed whether participants were more likely to spell a given word correctly using written versus oral spelling (i.e., a snapshot of performance was utilized). Thus, it is possible that this phenomenon was observed simply because written spelling is the most common way participants learn to spell words, and individuals tend to perform better on a test that measures a response in the same way it was instructed (Mulligan & Osborn, 2009). The current study contributes to an evaluation of this question by providing instruction using both modalities and comparing relative rates of acquisition.

This superiority may be surprising since participants experienced less overall instructional trials in the WS condition, a variable often thought to be particularly important in skill acquisition (Belfiore, Skinnners, & Ferkis, 1995; Kupzyk, Daly, & Anderson, 2011). The more rapid rates of mastery in the WS condition indicate that this condition likely had a higher trial quality than the OS condition. It appears that the higher trial quality of the WS condition was a more important variable in skill acquisition than the larger trial quantities in the OS condition. It is possible that the superiority of written spelling observed here is a result of greater

experience with written spelling such that a general superiority of the modality itself has already been established by second grade. However, it is also possible that unique aspects of written spelling (e.g., the production of a permanent visual product on paper) facilitate the development of stimulus control over a participant's response (Dinsmoor, 1997). This possibility is somewhat supported here by participants' more rapid generalization to reading words in the WS condition relative to those in the OS condition.

Additionally, during the reverse condition probe at the end of the study, two of the three participants were more likely to spell words correctly when asked to write the words rather than orally spell them. This indicates that individuals may be able to spell words in one modality but not in another. Julia's responding is the best example of this, as she was able to correctly orally spell only 60% of the WS list but could correctly write 100% of the list. These results seem to support that there may be unique elements of written spelling that facilitate response accuracy.

All three participants demonstrated some degree of learning to read and spell CT words. This learning is concerning for establishing the internal validity of the current study, however, the rates at which participants learned CT words were notably slower than the rates at which they learned WS words. It is also worth noting that, for all participants, correct responding was much more likely to occur for reading CT words than for spelling them. When assessing spelling accuracy, an effect of our independent variable is clearly apparent despite the extra-experimental learning in the reading response. Jamie was the first participant to demonstrate this pattern of responding. To assess whether this was an artifact the specific words in his control list, a new set of 10 unknown words replaced his original control list beginning with session four. This resulted in an initial decrease in response accuracy but Jamie eventually began responding correctly to the control words again. This second increase will be discussed again below.

One hypothesized reason response accuracy was increasing was that since only five control words were presented with each instructional list, the participants were able to accurately guess some of the words by repeating words the experimenter had asked them to spell during previous probes (e.g., they were able to guess that this unknown word that starts with an ‘r’ may be the word ‘recipe’ that the experimenter has been asking them to try to spell). In an attempt to control for this, Julia’s control list was lengthened to contain 20 words total, resulting in ten control words probed with each instructional set (thus an equal number of instructional and control words were present in each probe). If participants were simply guessing the words, expanding the control list would reduce the likelihood that they would be able to correctly guess the word presented to them. This did not decrease the accuracy with which Julia responded to the control words, as she continued to correctly respond to the CT words she had previously answered correctly. Thus, it does not appear that guessing alone can explain the learning that occurred in the control set. Additionally, when Jamie and Julia’s graphs of total correct responding are visually inspected, their accurate responses to control words gradually increased in a way that is typically associated with learning, not merely guessing.

Another potential explanation of CT word accuracy is that the words utilized in this study were too close to the participants’ current instructional level and thus they were encountering these words through other academic activities (e.g., English Language Arts or library classes). This hypothesis is supported by the fact that for Jamie, who participated in the study for the longest amount of time, his study targets began to overlap with his classroom instructional targets. By happenstance, his second control list contained the majority of the words that overlapped. This explains the reemergence of correct responding to the CT list at the end of the study, as well as why his responding followed a pattern typically associated with learning.

Thus the last participant to begin the study, Margaret, received instruction on seventh-grade science words in an effort to control for this extra-experimental exposure. This required a forfeiture of phonetically-irregular words but allowed for the use of words she was unlikely to come across in her daily academic activities. When Margaret's instructional targets came from the same list of phonetically-irregular words used for Jamie and Julia, she correctly read 50% of control words after only one instructional session, despite having been unable to read any of the words during the screening session. When her instructional targets came from the seventh-grade curriculum, these high levels of accuracy were not observed.

Future research may benefit from selecting words at a higher difficulty level to control for such confounds. Alternatively, future research could also include a more stringent screening criteria, perhaps requiring two or three screening trials across a few days prior to identifying a word as unknown. It is possible that the screening criteria utilized in the current study was not sufficient to exclude all words the participants knew or were rapidly learning. Study 2 utilized sixth-grade spelling words in an effort to control for this overlap between study and school-based targets.

Study 2

The results of study 1 indicated that written spelling was more efficient for teaching spelling and obtaining the emergence of reading. Thus, study 2 was conducted to evaluate which of three instructional strategies were most efficient at obtaining accurate reading and spelling of novel words when utilizing this method of spelling. The three strategies compared were spelling instruction alone, reading instruction alone, or combined reading and spelling instruction. All sessions were equated for instructional time, allowing for an evaluation of instructional efficiency.

Study 2 Method

Participants, Setting, and Design

Participants for study 2 were recruited and screened using identical measures to those used for study 1. However, the instructional targets differed for participants in study 2 from those in study 1. Participants in study 2 were screened on a list of sixth grade spelling words from the same makers of their second-grade curriculum. These words (e.g., nocturnal, immigrate) were selected because they were thought to be likely to become useful to the participants after completion of the study but also were unlikely to be exposed to the participants during their current academic activities. Thus, similar to Margaret in study 1, these participants received instruction on phonetically-regular words. A minimum of 40 unknown words was required for participation in the study, and these 40 words were randomly distributed to create the three instructional lists and the control list. The mean number of letters in the words in each list varied no more than 0.1 letter across lists (see Appendix A for the exact words included per list). Sessions were conducted in the same settings as study 1. An alternating treatments design was also utilized for study 2.

Data Collection and Interobserver Agreement

Participant response data were collected by the experimenter during all probe sessions using the same recording method as study 1. The spelling method identified in study 1 as the more efficient method (written spelling) was utilized in study 2. Correct and incorrect scoring criteria for reading and spelling were as described in study 1.

Interobserver agreement (IOA) was collected for 40% of probe sessions with a range of 37.5 to 42.9% of session across participants. Data were compared on a word-by-word basis. An agreement was defined as both observers recording the same classification of the participant's

response for the same word (e.g., both observers scored the participant's response as correct). A disagreement was defined as observers recording different classifications of the participant's response for the same word (e.g., one observer recorded the participant's response as correct while the other recorded the participant's response as incorrect). IOA was calculated by summing the number of agreements, dividing that number by the total number of agreements plus disagreements, and multiplying it by 100 to yield a percent of total agreement. Average IOA for Brandon for reading was 97.8% (range 92 to 100%) and for spelling was 98.7% (range 95 to 100%). Average IOA for Hannah for reading was 94.2% (range 90 to 100%) and for spelling was 98.5% (range 92.5 to 100%). Average IOA for Sherry for reading was 99.2% (range 97.5 to 100%) and for spelling was 99.6% (range 97.5 to 100%).

Teaching and Probe Procedures

Spelling Instruction. In the spelling instruction condition, written spelling, the method identified in study 1 as most efficient, was provided to participants. Praise and corrective feedback were delivered as described in study 1. Prior to beginning the session, the experimenter gave the participant the following instructions: "We are going to practice our spelling. Please write the word when I say it. Just write each letter in the word in the order they go. If you get stuck, I will help you. Do you have any questions?" Sessions lasted for 5 minutes, and words were presented as many times as possible during the session. The experimenter shuffled the deck each time all ten cards were completed during instruction. Sessions continued until participants mastered all words in at least one condition or until differentiation between conditions was apparent.

Reading Instruction. In the reading instruction condition, the experimenter gave the participant the following instructions prior to beginning the session: "We are going to practice

our reading. Please tell me the word that is written on the card I hold up. If you get stuck, I will help you. Do you have any questions?” The experimenter answered any questions the participant had, started the timer for 5 minutes, and presented each of the 10 unknowns words one at a time on a 3 x 5 inch index card. The experimenter either provided praise following a correct response (e.g., “that’s right”) or whole-word corrective feedback following an incorrect response or no response 3 s after the prompt (e.g., “nocturnal”). Sessions lasted for 5 minutes, and words were presented as many times as possible during the session. The experimenter shuffled the deck each time all ten cards were completed during instruction. Sessions continued until participants mastered all words in at least one condition or until differentiation between conditions was apparent.

Combined Instruction. Prior to beginning the combined instruction session, the experimenter told the participant: “We are going to practice our reading and spelling. First I will ask you to read the word, and then I will ask you to spell it. If you get stuck on either of those, I will help you. Do you have any questions?” The experimenter answered any questions the participant had, started the timer for 5 minutes, and presented the first word on an index card, asking the participant to read the word. The same criteria as described in the reading instruction condition were used to deliver praise or corrective feedback. Immediately after delivering praise or corrective feedback for the participant’s reading response, the experimenter asked the participant to spell the same word. The experimenter again delivered praise or corrective feedback as described in the spelling instruction condition. Sessions lasted for 5 minutes, and words were presented as many times as possible during the session. The experimenter shuffled the deck each time all ten cards were completed during instruction. Sessions continued until

participants mastered all words in at least one condition or until differentiation between conditions was apparent.

Probes. Probes were conducted prior to each instructional session to assess for mastery of instructional targets in spelling and reading. The cards for each of the four lists (Spelling, Reading, Combined, and Control) were combined into one large deck of 40 cards and probed together. The order in which the response modalities (e.g., reading and spelling) were probed varied randomly across sessions with the restriction that the same skill could not be probed first for more than three consecutive sessions. Prior to beginning each probe, the experimenter said: “I would like you to try to read [or spell, depending on the probe] the words that I have written on these index cards. You might not know all of them, and that’s ok. I won’t be able to tell you whether you got it right or wrong, but just try your best. Do you have any questions?” The experimenter answered any questions the participant had and then began the probe. No praise or corrective feedback was provided during probes and accuracy criteria were identical to that used during instruction. A word was considered mastered when a participant correctly responded to a target across three consecutive probes in both response modalities.

A reinforcement contingency was implemented for Sherry after session 12 due to a decreasing trend in response accuracy. Prior to beginning the probe, Sherry was told her score from the previous session and that she needed to beat her score in order to have play-dough as an option for her break activities. Prior to implementing the contingency, she had previously selected play-dough for the majority of her break activities, thus the goal was to restrict access to a high-preferred item for higher performance.

Study 2 Results

The results of study 2 are presented using two graphs for each participant. Figure 3 reflects the percent of words answered correctly in both modalities (reading and spelling) during each probe.

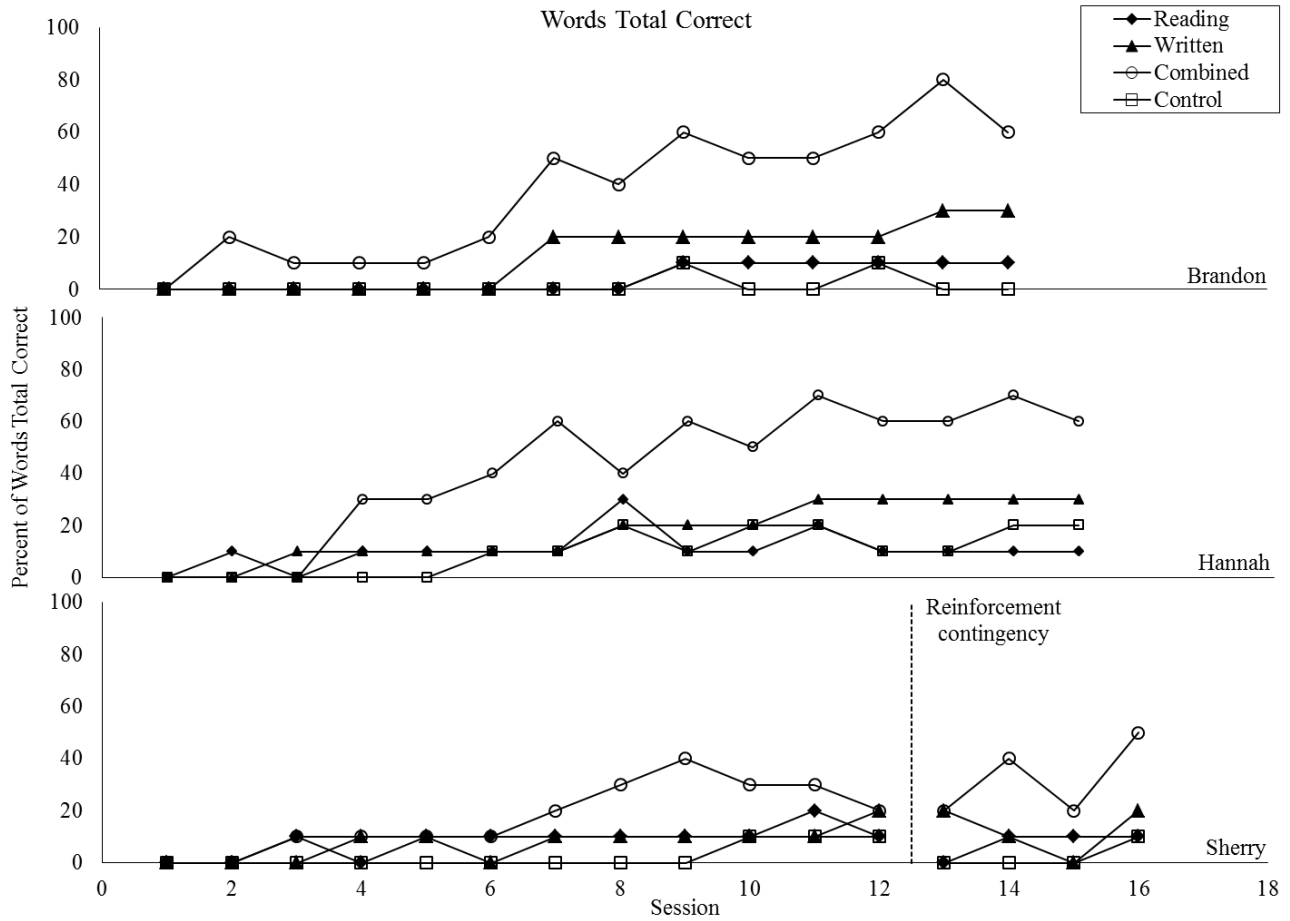


Figure 3. Percent of words answered correctly in both modalities (reading and spelling).

Figure 4 reflects the percent of words mastered in both modalities (i.e., the percent of words to which the participant correctly responded across three consecutive probes in both modalities).

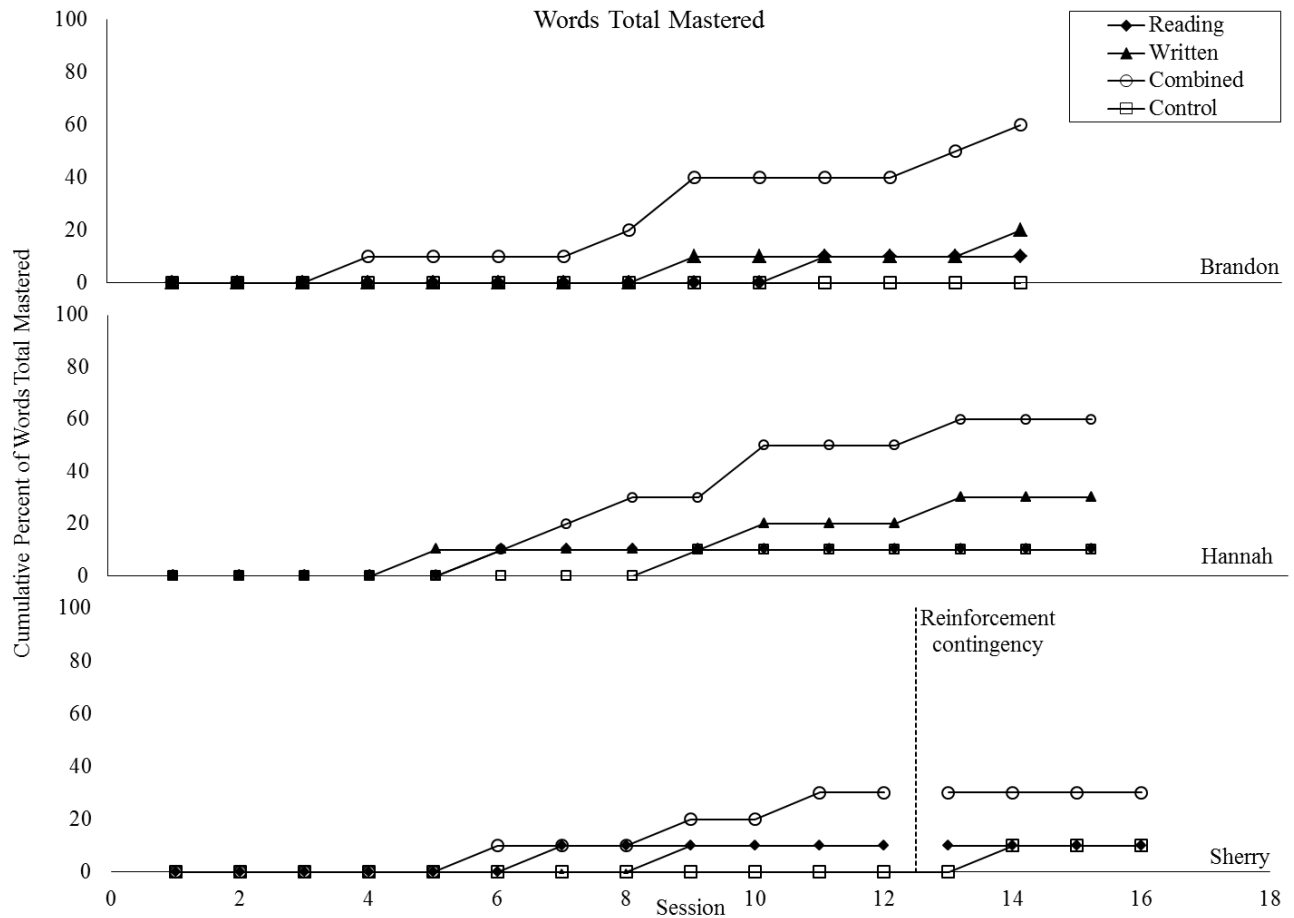


Figure 4. Percent of words mastered in both modalities (reading and spelling), termed ‘total mastered’. Mastery was defined as correctly responding across three consecutive probes in both modalities.

All three participants demonstrated the most rapid rates of learning in the combined condition. Brandon and Hannah’s data are very similar and thus will be discussed together. Both Brandon and Hannah’s probe data for the combined condition quickly differentiated from the other instructional conditions and the control condition and remained higher for the duration of the study. Both Brandon and Hannah mastered 60% of words in the combined condition prior to termination of the study. Experimental sessions were terminated prior to 100% mastery due to the end of the school year. Written spelling was the second most efficient method for both participants, although it was notably lower than the combined condition, with Brandon mastering

20% and Hannah mastering 30% of words in the spelling condition. Responding in the control and reading conditions were largely undifferentiated, indicating that the reading alone condition did not facilitate generalization to spelling. Brandon's response accuracy to control words remained near zero for the duration of the study, while Hannah actually responded accurately to 10% more control words than reading alone words at the end of the study.

Sherry's response accuracy was initially low and undifferentiated for the first six sessions of the study. Beginning with session seven, however, her response accuracy increased in the combined condition and differentiated from the other instructional conditions and control condition. Her data began to reflect a downward trend in response accuracy beginning with session 10, and thus a reinforcement contingency was implemented beginning with session 13. The reinforcement contingency required that Sherry correctly respond to more words in the current probe than in the previous session's probe in order to access a high-preferred leisure item (play-dough). This contingency increased her response accuracy for two of the four probes conducted after implementation. Due to the end of the school year, sessions terminated prior to reaching stable rates of high responding, although Sherry responded with the highest level of accuracy in the last session of the study.

Study 2 Discussion

The results of study 2, when evaluated based on the ability to correctly read and spell target words, indicate a clear superiority for a combined instructional approach in which instructional time is split between reading and spelling instruction. In the reading alone condition, participants made rapid progress in the instructed skill of reading, but progress was slow in the uninstructed skill of spelling. In the spelling alone condition, participants often read more words than they could correctly spell. These results indicate that learning was occurring in all three conditions, but that the combination of direct instruction in both response modalities increased the rate at which learning occurred for both skills.

While there was no “uninstructed skill” for the combined condition, the mastery rates here exhibit a type of generalization in which the amount of instructional time necessary to master a skill is significantly reduced by previous instruction (Stokes and Baer, 1977). Future research could further evaluate this by comparing the combined condition utilized in the current study with a condition that teaches one skill (e.g., reading) to mastery and then provides instruction in a second skill (e.g., spelling). These instructional approaches could be compared to assess which condition requires the least overall instructional time to develop mastery for reading and spelling a given word.

Due to the presentation of the word as a reading target prior to each request to spell the word, the combined condition seemed to prevent errors more than either of the other instructional conditions. Participants often spelled more letters in a word prior to erring in the combined condition than in the spelling alone condition. This reduced the degree to which participants practiced errors, a variable thought to be influential in skill acquisition (Warmington, 2014). Anecdotally, participants also responded more rapidly during the combined condition

relative to the spelling condition, both in initiating spelling a word and continuing to add letters to the word. Particularly for Brandon, this increased the likelihood of an independent response from him, as he often did not attempt to spell a word that he could not answer correctly. Thus, the combined instructional condition appeared to support more independent responding relative to the other conditions, at least for some participants.

Additionally, because instructional time was equated across conditions, participants received many more practice opportunities in the reading condition relative to the other two conditions. Sessions ranged from containing 2-16 trials on each word, depending on the accuracy with which the participant was responding. While these repeated response opportunities allowed for rapid learning of how to read the words, it also appeared to become tiresome for participants after many sessions of practice on the same ten words. Particularly for Sherry, she began erring on words she had previously read correctly as sessions continued. This increase in errors was associated with an increase in fidgeting and off-task comments or questions during the reading alone condition, indicating that Sherry's attention decreased in this condition over time. If the goal of an intervention is to develop reading accuracy alone, new instructional targets would be presented once participants can accurately read a word. However, if the goal is to develop both reading and spelling accuracy, the reading alone condition did not achieve this goal prior to evoking inattentive behaviors and incorrect responses. The dense repeated practice of previously learned words that occurred in this study has some procedural similarities to positive practice, an overcorrection procedure in which individuals are required to repeatedly engage in a target behavior. Positive practice is often used as a consequence for making an error or for the occurrence of inappropriate behaviors (Carey & Bucher, 2013), while in this case the repeated presentation of the words was simply a function of the study design. Despite this difference in

contingencies, it may have contained similar aversive elements to an overcorrection procedure, which may have contributed to the off-task behavior observed during these sessions.

Future research should improve upon several limitations of the current study. First, mastered words could be removed from the instructional deck, allowing more instructional time to be spent practicing words participants have not yet learned. This removal of words would more closely mimic what would occur in most educational settings. This modification would likely enhance the superiority of the combined condition, as participants would be able to receive more instructional trials on words they have not yet mastered. Similarly, new instructional targets could be folded in to the deck as words are mastered, allowing the potential to learn more than the ten targets presented in the current study.

Additionally, session time could be extended beyond the five-minute sessions utilized here. Due to the limited times students were available for study participation and the multi-element design utilized in the current study, five-minute sessions were necessary in order to conduct all probes and instructional sessions each day. However, if session time were extended, this would allow more practice trials on each word. This would likely have the largest impact on the spelling and combined conditions, as participants often received two or less practice trials on each word per session. However, an extension of session time would likely exacerbate the inattention problem observed during the reading condition. Thus, a study that extended session time may benefit from only comparing the spelling and combined conditions, as these were also the only conditions observed to facilitate spontaneous generalization between reading and spelling to more than one word.

General Discussion

The results of these studies extend the current literature in several important ways. First, study 1 directly compared two methods of spelling instruction used in previous research for their relative efficiency in teaching spelling and developing the emergence of reading. This study extended the literature by evaluating these modalities in the context of skill acquisition, rather than simply skill performance as Treiman & Bourassa (2000). The results affirm the current educational approach of using written methods to teach spelling. This affirmation comes from more rapid rates of acquisition of the instructed spelling response as well as greater generalization to the uninstructed reading response by two of the three participants. Similarly, the increased performance in the written modality by study 1 participants during the reverse condition probe also support a superiority of written spelling over oral spelling. One participant's (Jamie) data did not follow the same pattern of superiority of written spelling over oral spelling, rather his data were fairly similar between the two conditions. This indicates that there may be some individual differences in the degree to which written spelling is superior to oral spelling. Despite this potential individual difference, there is no indication in the current study that oral spelling is superior to written spelling as proposed by Noell et al. (2006).

Second, both study 1 and study 2 controlled for confounds in previous studies such as Conrad (2008) by ensuring instructional targets were unknown prior to teaching and equating instructional time across conditions. These variables are particularly important to control for when conducting efficiency research, as they allow for an assessment of interventions across aspects that are highly relevant in schools. Ensuring targets are unknown prior to teaching preserves the internal validity of the study to assess the impact of instruction as well as avoids spending instructional time on material students have already mastered. The amount of time

required out of a school day necessary to implement an intervention is often highlighted as an important aspect in intervention (Daly and Kupzyk, 2013; Noell et al., 2006), and thus time is a critical variable in intervention research. The method of instruction identified as most effective in study 2, combined instruction, resulted in mastery levels between 30-60% after ranges of instructional time of only one hour and 10 minutes to one hour and 20 minutes. This level of mastery was achieved with five-minute sessions per day. In implementation in a school, session time would likely be extended to 10-15 minutes which would allow for more trials per session. While future research should evaluate this hypothesis, this increase in trials in the combined condition would likely accelerate the rates at which participants master words. Anecdotally, participants seemed more likely to correctly spell a word on its second trial in the combined condition, thus it is likely that the inclusion of a third or fourth trial would result in fewer errors and more fluent responding.

Third, these studies provided a more thorough evaluation of the process of learning to spell than previously available in the literature. Spelling is thought to be a more complex skill due to the increased variability for correctly spelling a given sound as compared to the number of correct options for pronouncing print (Baron et al., 1980; Ehri & Wilce, 1987; Perfetti, Riehem, & Fayol, 1997). The slower rates of acquisition of spelling and slower generalization from mastery of reading to mastery of spelling appear to support spelling as a more difficult skill to master than reading. Participants in both studies were frequently able to correctly read a word prior to correctly spelling the same word.

Fourth, study 2 extends the literature through the inclusion of a combined reading and spelling instructional condition as suggested by Noell et al. (2006). The inclusion of this condition resulted in identification of a method of instruction superior to either reading or

spelling instruction in isolation. The mastery rates of study 2 indicate that teaching reading and spelling in tandem for the same words can maximize a student's learning, despite experiencing fewer complete learning trials relative to the conditions that teach skills in isolation. This suggests that the combined instruction learning trials have higher trial quality (i.e., the amount of learning that occurs in a trial is greater) compared to the other conditions in the current study.

The incomplete generalization between reading and spelling observed in studies 1 and 2 corresponds with evidence supporting the need for explicit instruction in both reading and spelling (Adams, 1990; Linan-Thompson & Vaughn, 2010; NICHD, 2000). However, the fact that generalization was observed to some degree also supports the theory that reading and spelling are skills with a shared relationship but also with unique individual aspects (Foorman & Petscher, 2010). In other words, the incomplete generalization between reading and spelling is evidence of some less than perfect correspondence between the two skills. Finally, the current findings contribute to the evidence supporting combining reading and spelling instruction to maximize students' learning (Perfetti, Rieben, & Fayol, 1997; Weiser & Mathes, 2011; Noell et al., 2006).

Limitations

There are several limitations of the current studies. First, some degree of learning of control words was observed for all participants. This is problematic for establishing the internal validity of the study. It was also surprising given that previous studies on sight-word acquisition that included a control list did not observe this type of responding to control words (Noell et al., 2006). However, the rates of acquisition were much lower than the most efficient instructional method for all participants, indicating that, despite the extra-experimental learning that was occurring, the instruction delivered in the current studies had a differential impact. The inclusion

of higher-level words with Margaret in study 1 and all participants in study 2 reduced the degree to which accurate responding to control words occurred. This gives support for the hypothesis that Jamie and Julia's study targets were too similar to their current classroom instruction and they were encountering these words in their other academic activities. Thus, future research may benefit from utilizing higher-level words.

A second limitation for both studies is that the most effective treatment was not implemented for the instructional targets in the other conditions. Ideally, combined instruction would have been implemented across the other instructional lists to demonstrate that learning systematically increased with the application of this method of instruction. While this did not occur, the experimenter did communicate the method of teaching identified as most effective to each participant's parents along with instructions for how this method could be utilized with homework and future skills.

Similarly, a third limitation is that instruction terminated for all participants except Julia prior to 100% mastery of any instructional list. While the data were clearly differentiated, answering the current research question, it would have been preferable to teach the targets to complete mastery. Due to schedule restrictions of the school year, this was unattainable.

Finally, the results of these studies should be replicated with a larger sample to evaluate whether the results obtained here will be obtained with a broader population. Larger group studies could evaluate individual characteristics that may differentially impact performance. The findings in the current studies indicate that there may be the impact of various types of instruction may vary across individuals, and educational research would benefit from identification of the variables that impact the response to intervention.

Conclusion

In summary, study 1 compared written and oral spelling instruction for their relative rates of mastery of the instructed skill of spelling as well as spontaneous generalization to reading. The results of study 1 indicate that written spelling resulted in the most rapid rates of mastery as well as the highest rates of generalization. Study 2 extended upon study 1 by comparing written spelling instruction alone, reading instruction alone, and combined reading and spelling instruction for their relative rates of mastery in both reading and spelling. Both studies equated instructional time rather than trials across conditions, allowing for an evaluation of instructional efficiency. The results of study 2 indicate that providing explicit instruction in both reading and spelling resulted in the most rapid rates of acquisition of the two skills. Future research can expand upon these studies by further investigating the accurate responding to control words observed here, extending session time between the spelling alone and combined instruction conditions, removing mastered words and folding in new targets, and comparing the combined instruction condition to a condition that teaches one skill to mastery (e.g., reading) followed by instruction in the second skill (e.g., spelling).

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Appendix A
Words Used in Instruction

Study 1

Participant	Jamie			
Condition	Oral	Written	Control 1*	Control 2
	Adjective	Bread	Any	Aisle
	Answer	Design	Brought	Ate
	Feather	Enough	Climbed	Bull
	Island	Mountain	Could	Buy
	Kind	Often	Heard	Debt
	Many	Science	Measure	Gnat
	Move	Should	Sign	Knit
	Subtle	Stretch	Would	Pint
	Thought	Though	Your	Recipe
	Where	Whose	Youth	Tear
Mean letters per word	5.8	6.1	5.2	4.1

*Prior to session 4, control 1 list was utilized. Beginning with session 4, Control 2 list was utilized for remainder of study.

Participant	Julia			
Condition	Oral	Written	Control*	
	Adjective	Although	Aisle	Bouquet
	Ballet	Could	Brought	Recognize
	Example	Doubt	Design	Brief
	Feather	Knit	Gnat	Fierce
	Guy	Measure	Heard	Psalm
	Island	Plumb	Mild	Guide
	Know	Stretch	Science	Debt
	Pint	Tear	Straight	Malady
	Recipe	Notch	Subtle	Contagious
	Sign	Usually	Whose	Ogre
Mean letters per word	5.6	5.8	5.9	

*Prior to session 5, the first column of Julia's control list was utilized alone. Beginning with session 5, the control list included all 20 words.

Participant	Margaret		
Condition	Oral	Written	Control
	Amplitude	Asteroid	Circuit
	Covalent	Electric	Element
	Endothermic	Entropy	Experiment
	Forensic	Fusion	Galaxy
	Insulator	Gravity	Hydrogen
	Isotope	Independent	Inhibitor
	Molecule	Induction	Meteorite
	Plasma	Neutral	Periodic
	Product	Precipitate	Radiation
	Solstice	Proton	Salinity
Mean letters per word	8.1	8	8.1

Study 2

Participant	Brandon			
Condition	Reading	Spelling	Combined	Control
	Accompany	Amnesia	Announce	Archeology
	Arrest	Arrive	Assembly	Bazaar
	Chaos	Democracy	Collect	Commission
	Cosmetics	Illogical	Geometry	Heroism
	Hygiene	Irregular	Illuminate	Interfere
	Immature	Nocturnal	Lethal	Mania
	Musician	Plateau	Phobia	Physician
	Proportion	Subscribe	Suffix	Suffocate
	Sympathy	Telepathy	Postpone	Tourist
	Transparent	Zoology	Transformation	Submarine
Mean letters per word	8.1	8.1	8.1	8.1

Participant	Sherry			
Condition	Reading	Spelling	Combined	Control
	Accompany	Amnesia	Announce	Archeology
	Arrest	Arrive	Assembly	Bazaar
	Chaos	Sympathy	Collect	Commission
	Companion	Cooperate	Copilot	Correspond
	Cosmetics	Phobia	Geometry	Heroism
	Hygiene	Illogical	Illuminate	Immature
	Immigrate	Irregular	Impractical	Interfere
	Interrupt	Nocturnal	Lethal	Mania
	Subscribe	Plateau	Proportion	Physician
	Submarine	Collaborate	Suffix	Romance
Mean letters per word	8.1	8.1	8.1	8.1

Participant	Hannah			
Condition	Reading	Spelling	Combined	Control
	Archeology	Announce	Assembly	Amnesia
	Chaos	Bazaar	Collect	Arrive
	Companion	Cosmetics	Copilot	Cooperate
	Democracy	Hygiene	Heroism	Geometry
	Impractical	Irregular	Illuminate	Illogical
	Lethal	Nocturnal	Musician	Immature
	Phobia	Plateau	Pianist	Mania
	Postpone	Submarine	Romance	Physician
	Subscribe	Telepathy	Sympathy	Proportion
	Terrain	Zoology	Transparent	Suppress
Mean letters per word	8	8	8	7.9

Appendix B
Institutional Review Board Approval



Institutional Review Board
Dr. Robert Mathews, Chair
130 David Boyd Hall
Baton Rouge, LA 70803
P: 225.578.8692
F: 225.578.5983
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ACTION ON PROTOCOL APPROVAL REQUEST

TO: George Noell
Psychology

FROM: Robert C. Mathews
Chair, Institutional Review Board

DATE: December 3, 2013
RE: IRB# 3442

TITLE: Evaluating Teaching Efficiency in Reading and Spelling Instruction

New Protocol/Modification/Continuation: New Protocol

Review type: Full Expedited **Review date:** 12/4/2013

Risk Factor: Minimal Uncertain Greater Than Minimal

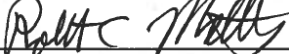
Approved **Disapproved**

Approval Date: 12/4/2013 **Approval Expiration Date:** 12/3/2014

Re-review frequency: (annual unless otherwise stated)

Number of subjects approved: 6

Protocol Matches Scope of Work in Grant proposal: (if applicable)

By: Robert C. Mathews, Chairman 

PRINCIPAL INVESTIGATOR: PLEASE READ THE FOLLOWING –
Continuing approval is CONDITIONAL on:

1. Adherence to the approved protocol, familiarity with, and adherence to the ethical standards of the Belmont Report, and LSU's Assurance of Compliance with DHHS regulations for the protection of human subjects*
2. Prior approval of a change in protocol, including revision of the consent documents or an increase in the number of subjects over that approved.
3. Obtaining renewed approval (or submittal of a termination report), prior to the approval expiration date, upon request by the IRB office (irrespective of when the project actually begins); notification of project termination.
4. Retention of documentation of informed consent and study records for at least 3 years after the study ends.
5. Continuing attention to the physical and psychological well-being and informed consent of the individual participants, including notification of new information that might affect consent.
6. A prompt report to the IRB of any adverse event affecting a participant potentially arising from the study.
7. Notification of the IRB of a serious compliance failure.
8. SPECIAL NOTE:

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

ACTION ON PROTOCOL CONTINUATION REQUEST



Institutional Review Board
Dr. Dennis Landin, Chair
130 David Boyd Hall
Baton Rouge, LA 70803
P: 225.578.8692
F: 225.578.5983
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TO: George Noell
Psychology

FROM: Dennis Landin
Chair, Institutional Review Board

DATE: October 7, 2014

RE: IRB# 3442

TITLE: Evaluating Teaching Efficiency in Reading and Spelling Instruction

New Protocol/Modification/Continuation: Continuation

Review type: Full Expedited Review date: 10/6/2014

Risk Factor: Minimal Uncertain Greater Than Minimal

Approved Disapproved

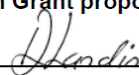
Approval Date: 10/6/2014 Approval Expiration Date: 10/5/2015

Re-review frequency: (annual unless otherwise stated)

Number of subjects approved: 6

LSU Proposal Number (if applicable): _____

Protocol Matches Scope of Work in Grant proposal: (if applicable) _____

By: Dennis Landin, Chairman 

PRINCIPAL INVESTIGATOR: PLEASE READ THE FOLLOWING –
Continuing approval is **CONDITIONAL** on:

1. Adherence to the approved protocol, familiarity with, and adherence to the ethical standards of the Belmont Report, and LSU's Assurance of Compliance with DHHS regulations for the protection of human subjects*
2. Prior approval of a change in protocol, including revision of the consent documents or an increase in the number of subjects over that approved.
3. Obtaining renewed approval (or submittal of a termination report), prior to the approval expiration date, upon request by the IRB office (irrespective of when the project actually begins); notification of project termination.
4. Retention of documentation of informed consent and study records for at least 3 years after the study ends.
5. Continuing attention to the physical and psychological well-being and informed consent of the individual participants, including notification of new information that might affect consent.
6. A prompt report to the IRB of any adverse event affecting a participant potentially arising from the study.
7. Notification of the IRB of a serious compliance failure.
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**All investigators and support staff have access to copies of the Belmont Report, LSU's Assurance with DHHS, DHHS (45 CFR 46) and FDA regulations governing use of human subjects, and other relevant documents in print in this office or on our World Wide Web site at <http://www.lsu.edu/irb>*

Vita

Sarah Joanne Miller, a Louisiana native, received her bachelor's in science degree at Louisiana State University in 2010. She continued her studies at Louisiana State University under the mentorship of Dr. George Noell and Dr. Jeffrey Tiger, earning her Master of Arts degree in psychology in 2012. She completed a doctoral psychology internship at the Marcus Autism Center in Atlanta, Georgia and will earn a Doctor of Philosophy degree in psychology in August 2015. Sarah plans to complete a Postdoctoral Fellowship at Emory University, where she will continue her clinical and research work as it relates to behavior analysis, learning, and behavioral treatments for children.