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A Synthesis of Reading and Spelling Interventions and Their Effects on Spelling Outcomes for Students With Learning Disabilities

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Abstract

Spelling is one of the most challenging areas for students with learning disabilities (LD), and improving spelling outcomes for these students is of high importance. In this synthesis, we examined the effects of spelling and reading interventions on spelling outcomes for students with LD in Grades K through 12. A systematic search of peer-reviewed literature published between 2004 and 2014 was conducted using electronic databases and hand searches of relevant journals. To be eligible for inclusion, studies had to meet the following criteria: (a) Participants were identified with LD and were in Grades K through 12, (b) designs were either treatment/comparison or single case, (c) a reading or spelling intervention was implemented, (d) at least one spelling outcome was measured, and (e) instruction was in English. Ten studies met criteria for inclusion in the synthesis, and effectiveness ranged from ineffective to highly effective. Findings demonstrated that spelling outcomes for taught words were improved for students with LD with the use of explicit instruction or self-correction strategies.

Keywords

spelling and reading interventions; synthesis; LD

Students with learning disabilities (LD) account for 37% of students receiving special education services in public schools (U.S. Department of Education, 2015). While these students struggle across many different content areas, acquisition and mastery of specific spelling skills can be especially difficult (Fletcher, Lyon, Fuchs, & Barnes, 2007; Vaughn, Bos, & Schumm, 2011). Spelling is a developmental process that involves a combination of code-based skills. For most students, spelling begins with phonemic awareness instruction where students develop the ability to hear and manipulate the sounds in spoken speech. The ability to segment words into phonemes is a predictor of spelling achievement (National

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Institute of Child Health and Human Development, 2000). Students need to know the names of the letters of the alphabet and need to recognize that those letters have direct associations to the sounds, which is known as the alphabetic principle (Vacca et al., 2006); this leads to phonological awareness and understanding that phonemes can be related to graphemes.

Thus, spelling instruction is more complex than teaching students one-to-one letter-sound correspondences. The English orthography consists of three layers that affect spelling development: alphabetic, pattern, and meaning (Bear, Invernizzi, Templeton, & Johnston, 2008). Students progress from the alphabetic layer, which involves the aforementioned letter-to-sound relationships, to the pattern layer where they learn to find patterns that identify groups of letters, to the meaning layer where groups of letters are related to word meanings (Bear et al., 2008; Invernizzi & Hayes, 2004). As students progress through these layers, spelling becomes an increasingly challenging task because students move from focusing on spelling sounds to spelling for meaning (Templeton & Morris, 2000).

Reading and spelling are closely related processes (Graham, Harris, & Chorzempa, 2002; Noell, Connell, & Duhon, 2006; Santoro, Coyne, & Simmons, 2006). Despite this connection, the actual process of spelling, or encoding, can be more challenging than reading, or decoding (Westwood, 2008). This is because encoding is a production task rather than a recognition task (McKenna & Stahl, 2009). When children decode new words, they recognize familiar patterns and apply their knowledge of the alphabetic principle to those patterns. This skill may not automatically transfer to spelling, where students have to spell these patterns from memory (Westwood, 2008). It has also been noted, however, that some students who have spelling deficits do not have comorbid word recognition deficits (Fletcher et al., 2007), indicating that other skills and processes are also involved when spelling words as compared to reading words.

Two recent syntheses (Wanzek et al., 2006; Weiser & Mathes, 2011) and one meta-analysis (Graham & Santangelo, 2014) have examined the reading-spelling connection. Weiser and Mathes (2011) examined the impact of encoding instruction on reading and spelling performance for at-risk elementary students and older students with LD who read at less than below a 3rd-grade level. Encoding instruction was defined as the teaching of phoneme-grapheme relationships and word work activities where students manipulated those relationships (Weiser & Mathes, 2011). Results from the synthesis suggest that instruction in encoding increases students' knowledge of the alphabetic principle, development of phonemic awareness, and growth of reading and spelling skills. More recently, Graham and Santangelo (2014) investigated whether spelling instruction in any language made students better spellers, readers, and writers. Their analysis included studies of spelling interventions for students with and without disabilities in kindergarten through 12th grade in regular school settings. Results from their meta-analysis highlight the effectiveness of formal spelling instruction for increasing spelling performance, phonological awareness, reading performance, and spelling while writing. The results from both Weiser and Mathes (2011) and Graham and Santangelo (2014) confirm that in order to improve spelling skills, students should have explicit and formal instruction in spelling strategies and multiple opportunities to practice with new words (Sayeski, 2011; Wanzek et al., 2006). However, despite the compelling evidence for the benefits of some type of formal spelling instruction, neither

specifically examined the impact of spelling or reading instruction on spelling outcomes for students diagnosed with LD.

In 2006, Wanzek and colleagues investigated the impact of reading and spelling interventions on spelling outcomes for students with LD. Their synthesis focused exclusively on participants with LD and included studies that investigated the impact of reading or spelling interventions on spelling outcomes. The researchers examined 19 studies from 1995 to 2003 and determined that interventions involving spelling strategies, extensive practice with spelling patterns, and word practice methods yielded the largest effect sizes on spelling outcomes (Wanzek et al., 2006). Additionally, results suggested that reading interventions with phonics or morphological components, immediate corrective feedback for misspelled words, and the use of computer-assisted instruction were beneficial and increased spelling outcomes for students with LD. The purpose of the current synthesis is to replicate and extend the work done by Wanzek et al. (2006) in order to better understand the effects of spelling and reading interventions on spelling outcomes for students with LD by systematically reviewing studies published from 2004 to 2014. This synthesis differs from the similar recently published work discussed earlier (Graham & Santangelo, 2014; Weiser & Mathes, 2011) in that it examines the impact of two types of interventions on spelling outcomes specifically for students identified with LD.

Research Question

What are the effects of reading and spelling interventions on spelling outcomes for students with LD in kindergarten through 12th grade?

Method

Data Collection

To locate all relevant research studies, a systematic search of the literature was conducted. Because the current synthesis is a replication and extension of the Wanzek et al. (2006) synthesis, the same search procedures and inclusion criteria were used to locate articles. First, a computer search was performed utilizing the databases of ERIC, Education Source, and PsychINFO to find studies published from January 2004 to the end of September 2014. Three primary search terms were used (“read*” or “spell*” or “writ*”) to capture all studies related to these three domains. Secondary or subsearch terms included “learning dis*” or “LD” or “mild handicaps” or “reading dis*” or “writing dis*” or “dyslex*.” Because language and terminology frequently change in special education (e.g., *learning disabled*, *learning disability*, *specific learning disability*, *dyslexia*, *reading disability*), it was felt that the combination of these terms would best identify all possible studies that might relate to students with LD. The search was further limited by including only peer-reviewed articles in academic journals published in English. The initial search yielded 6,263 articles after duplicates had been removed. From this list of studies, the titles and abstracts were read and sorted into three categories: yes, maybe, and no. Those studies in the yes and maybe categories were more closely scrutinized to ensure that they met the inclusion criteria and were reallocated to a different category as needed.

After completion of the computer search, a hand search was conducted of nine major journals that had been selected by Wanzek et al. (2006) as covering both publications in a range of cross-categorical special education research and those specific to LD and had been determined to be a representative sample of the field. The hand search examined studies published from September 2012 to September 2014 in each of the journals to confirm that all relevant studies had been identified in the computer search. (The hand search included the following journals: *Exceptional Children*, *Journal of Educational Psychology*, *Journal of Learning Disabilities*, *The Journal of Special Education*, *Learning Disability Quarterly*, *Learning Disabilities Research & Practice*, *Reading Research Quarterly*, *Remedial and Special Education*, and *Scientific Studies of Reading*.) No additional articles were found through this method. An ancestral search (Cooper, 2010) was also conducted using the reference lists of the syntheses by Weiser and Mathes (2011) and Graham and Santangelo (2014). No additional studies were located in these reference lists.

To be selected for our synthesis, studies had to meet the following criteria, which were modified from the original Wanzek et al. (2006) synthesis. Participants were identified with LD; if studies had participants without LD, the studies were included if disaggregated data were provided for those with LD. Participants were in kindergarten through 12th grade. The study's research design was treatment-comparison or single subject. The study employed an intervention that included spelling or reading (single component or multicomponent) instruction and was conducted in English. One of the dependent measures directly tested spelling words in isolation.

Studies were excluded if they were not published in English, did not disaggregate results for students with LD or for spelling-related outcomes, did not formally diagnose LD or state that participants were struggling readers or at-risk for LD, or utilized single-group or qualitative designs. The only difference from the Wanzek and colleagues (2006) criteria was that they had included single-group designs; however, in this synthesis single-group designs were excluded, as they do not have an adequate control or comparison group. Studies were also excluded if they were not published in a peer-reviewed or academic journal or if they included an intervention not directly related to reading or spelling instruction.

Data Analysis

Coding procedures—Extensive coding procedures were used to organize information from each of the studies, with coding sheets previously developed by researchers within The Meadows Center for Preventing Educational Risk and used for the 2006 synthesis by Wanzek and colleagues. These were used to record information about general study characteristics, participant information, type of design, treatment and comparison groups, clarity of causal inference, quality of study, general findings, precision of outcome, and measures and effect sizes. Participant information was coded using forced-choice items (e.g., socioeconomic status, risk type, criteria for classifying students with disabilities) and open-ended items (e.g., number of participants for each gender, age/grade of subjects, exceptionality of subjects) to obtain further clarification of information. Design information was also obtained using forced-choice and open-ended items; this included information regarding type of design, assignment/selection of participants for intervention, any reported

fidelity checks or pretest scores, and selection criteria for participants. Treatment and comparison information was coded using 11 open-ended items (e.g., role of implementer, session length, duration of intervention). A description of the treatment(s) was also included.

Clarity of causal inference was determined by coding each study using forced-choice and open-ended questions, which included information about differential attrition, equating procedures, evidence of local history events, and possibility of intervention contaminants. Studies were then coded for quality (e.g., low, medium, high), general findings, and outcomes. To code the findings, information was extracted from the measures, and forced-choice questions were answered about assumptions and adequacy of sample sizes. Single-subject studies' results were coded using an open-ended item where the results were described for each participant in detail.

The primary researcher was trained on the coding procedures by an experienced researcher, and then reliability was established by double coding sample studies prior to coding studies from the current search. The studies were coded by four researchers who established reliability of greater than 95% on all articles. When coding was complete, the studies were summarized in two tables. Table 1 provides a summary of the features of each intervention, while Table 2 provides descriptions of interventions and findings for each study. For the treatment/comparison study, effect sizes are provided. Findings for single-subject studies are descriptively reported, and percentage of nonoverlapping data (PND) was calculated for each.

Effect size calculation—Effect sizes were calculated from the statistical information in the original research studies. Cohen's d was computed by taking the difference between the posttest mean of the treatment group and the posttest mean of the comparison/control group and dividing by the pooled standard deviation. For the treatment studies, effect sizes of $d = 0.2$ are small, $d = 0.5$ are medium, and $d = 0.8$ are large (Cohen, 1992). For the single-case design studies, PND was calculated for each case as appropriate. PND is calculated by finding the highest point in the baseline and counting the number of data points in the intervention above this point, then dividing this number by the total number of intervention points (Scruggs & Mastropieri, 1998). PND scores of 90% or greater are considered highly effective, 70% to 90% are effective, 50% to 70% are questionable, and less than 50% are ineffective.

Results

Ten studies met criteria for inclusion in the synthesis. One used a treatment-comparison design, and 9 used single-case designs. Effect size as measured by Cohen's d is reported for the treatment-comparison study, and PND and descriptive results are reported for single-case design studies. Table 1 provides an overview of each of the studies, and Table 2 provides descriptions of treatments, measures used, and results. Results are summarized across studies by (a) participants' characteristics, (b) type of design, (c) intervention characteristics, (d) duration of intervention, and (e) intervention group size and implementer.

Participant Characteristics

Overall, the studies reported included a total of 71 participants (77% males, 23% females), all identified as students with LD. In most of the studies, school records were used to determine LD status (i.e., having an Individualized Education Program or receiving special education services), and four studies specifically stated that LD was identified through the IQ discrepancy model (Darch, Eaves, Crowe, Simmons, & Conniff, 2006; Nies & Belfiore, 2006; Viel-Ruma, Houchins, & Fredrick, 2007; Zielinski, McLaughlin, & Derby, 2012). Two studies did not report how students were identified with LD (Alber & Walshe, 2004; Kubina, Young, & Kilwein, 2004). In general, socioeconomic status was not reported, although four of the studies indicated that participants were from low- or middle-class backgrounds (Hochstetler, McLaughlin, Derby, & Kinney, 2013; Jitendra et al., 2004; Kubina et al., 2004; Owens, Fredrick, & Shippen, 2004).

The participants in the studies were in Grades 2 through 12, and ages ranged from 7 to 18. The majority of studies were conducted in the elementary grades, with 66 total participants (Alber & Walshe, 2004; Burks, 2004; Darch et al., 2006; Jitendra et al., 2004; Kubina et al., 2004; Nies & Belfiore, 2006; Owens et al., 2004). Of the studies conducted with elementary schools students, the main focus was on Grades 2 through 5, with 16 participants in second grade, 27 participants in third grade, 12 in fourth grade, and 11 in fifth grade. Only three studies were conducted with secondary students. Hochstetler et al. (2013) investigated spelling outcomes for three middle school students, and Viel-Ruma et al. (2007) and Zielinski et al. (2012) studied six high school participants in 9th, 10th, and 12th grades.

Type of Design

The search and subsequent inclusion review identified one experimental study with a treatment-comparison design and nine single-case designs.

Treatment-comparison—Darch et al. (2006) compared the effectiveness of rule-based strategy spelling instruction utilizing Spelling Mastery Level D to traditional spelling instruction. Effect sizes were calculated for each of the measures in this study. Moderate to large effects were found in favor of the rule-based spelling strategy instruction group for the researcher-created unit tests and the researcher-created transfer test. Small to moderate effects favoring the rule-based strategy spelling instruction group were also found for the *Test of Written Spelling-3* ($d = .47$) (Larsen & Hammill, 1994) and the researcher-created maintenance test ($d = .55$); however, these differences were not statistically significant.

Single-case design—The remaining studies employed single-case designs to examine spelling outcomes for students with LD. Three studies used alternating treatment designs (Alber & Walshe, 2004; Nies & Belfiore, 2006; Viel-Ruma et al., 2007). Three studies used multiple-probe designs (Jitendra et al., 2004; Kubina et al., 2004; Owens et al., 2004). Two used multiple baseline (Hochstetler et al., 2013; Zielinski et al., 2012), one of which also used a brief reversal (Zielinski et al., 2012). One study used a brief ABA design (Burks, 2004).

PND calculations were attempted for all studies; however, it was possible to calculate PND for only 18 of the 29 individual cases. Among these, there was high variability in effectiveness, with some treatments ranging from ineffective to highly effective for different participants within a single study. For 10 cases, the treatment was highly effective or effective (Hochstetler et al., 2013; Kubina et al., 2004; Owens et al., 2004; Zielinski et al., 2012). For 2 cases, treatments were questionable, and for 6 cases, treatments were ineffective (Burks, 2004; Kubina et al., 2004; Owens et al., 2004; Zielinski et al., 2012). This group of studies reported mixed spelling outcomes for reading and spelling interventions when looking solely at PND; however, qualitatively all participants made gains using the strategies employed in the interventions. For the 2 questionable cases (Kubina et al., 2004; Owens et al., 2004), both participants increased their percentage of words spelled correctly but had some variability in baseline. Similar patterns were found for the studies rated as ineffective based on PND. In Burks (2004), students scored on average 10 to 20 percentage points higher in the treatment condition than baseline condition. In Kubina et al. (2004), the third participant increased his percentage of words spelled correctly from 55% to a range of 80% to 100%. Participant 2 in Zielinski et al. (2012) also demonstrated an increase in his mean percentage of words spelled correctly, from 55% in baseline to 90% during treatment. Owens et al. (2004) had varying levels of effectiveness, but duration of intervention differed for each set of participants. According to PND, the intervention was considered highly effective or effective for the four participants who received 12 weeks or 9 weeks of instruction, respectively; it was questionable or ineffective for the two participants who completed only 4 weeks of intervention.

PND was not calculated for four studies involving 11 participants due to design and data collection restrictions. Three of the studies used an alternating treatment design to compare the effectiveness of two different treatments for sets of spelling words and did not have actual baseline points. Of these, Alber and Walshe (2004) found that participants' mean number of words spelled correctly was higher for the self-correct after each word condition than for the self-correct after 10 words condition. In Nies and Belfiore's (2006) study, participants spelled more words correctly using the cover-copy-compare (CCC) strategy than the copy alone strategy. Viel-Ruma et al. (2007) compared traditional repeated practice to error self-correction and found that participants' mean percentage of words spelled correctly was higher for the error self-correction condition. Jitendra et al. (2004) reported one baseline and one intervention data point, but results indicated an increase in partial points on the *Tangel and Blachman* spelling measure (Tangel & Blachman, 1992).

Intervention Characteristics

To be included in the synthesis, studies had to have a spelling or reading intervention as the independent variable. Additionally, each study had to have a dependent measure that assessed spelling of words in isolation. Findings by type of intervention (spelling or reading) are described in the following sections.

Spelling interventions—Of the 10 studies, 9 employed spelling interventions (Alber & Walshe, 2004; Burks, 2004; Darch et al., 2006; Hochstetler et al., 2013; Kubina et al., 2004; Nies & Belfiore, 2006; Owens et al., 2004; Viel-Ruma et al., 2007; Zielinski et al., 2012).

Overall, participants were able to increase their spelling accuracy for taught words following the interventions. This group of spelling interventions included a variety of strategies and intervention components.

Two studies specifically examined the effects of the Spelling Mastery program (Levels A and D) when compared with traditional spelling instruction (Darch et al., 2006) or no spelling instruction (Owens et al., 2004). Spelling Mastery is a scripted direct instruction program that involves explicit instruction in sound-symbol correspondences and irregular word patterns. Darch et al. (2006) found that participants in the treatment condition outperformed controls with moderate to large effects on unit tests of taught words and on a transfer test that assessed untaught words. Participants in the treatment condition also demonstrated moderate gains on the *Test of Written Spelling-3* and maintenance test, although these were not statistically significant. In Owens et al. (2004), paraprofessionals were trained to implement Spelling Mastery in a multiple-probe design across participants. All participants were able to increase their percentages of correctly spelled words on CBM probes when compared to baseline. Additionally, Owens et al. (2004) administered the *Test of Written Spelling-4* at pre- and postintervention, and five of the six participants improved their percentage of correctly spelled words.

Five studies investigated the use of self-correction strategies to study spelling words (Alber & Walshe, 2004; Hochstetler et al., 2013; Nies & Belfiore, 2006; Viel-Ruma et al., 2007; Zielinski et al., 2012). The predominant self-correction strategy was CCC. In this strategy, students look at a spelling word, cover the word, write the word, and then compare the written word to the original word. If participants spell the word incorrectly, they usually have to copy the correct spelling (one to three times) immediately after checking the word. Hochstetler et al. (2013) and Zielinski et al. (2012) compared this procedure to a baseline condition with no spelling strategies or instruction with a sample of middle and high school students and found that all participants were able to increase spelling accuracy on dictation spelling tests following instruction. Nies and Belfiore (2006) compared the CCC strategy to a copy-only condition and found that both participants were able to spell more words correctly and maintain the spelling of those words the following week for the CCC condition. Two additional studies used self-correction procedures to study sets of spelling words. Alber and Walshe (2004) had participants study two sets of words, each under a different condition. In the self-correct after each word condition, participants listened to a dictated word on an audiotape, wrote the word, and then checked and corrected the word immediately after writing it while using a self-correction folder. In the self-correct after 10 words condition, participants followed the same procedures except they did not check and correct the words until after the whole list had been dictated. Participants were assessed on all 20 words for the week, and results indicated that students spelled more words correctly in the self-correct after each word condition and were able to maintain more of the words learned in this condition. Viel-Ruma et al. (2007) compared traditional repeated practice where students write each spelling word three times each to an error self-correction procedure where students listen to a dictated word, spell the word, and self-correct after each word as necessary. All participants had higher percentages of words spelled correctly in the self-correction condition than the traditional repeated practice condition.

The final two spelling interventions used different approaches from the aforementioned studies. Burks (2004) added classwide peer tutoring once a week to a traditional spelling program. The classwide peer tutoring involved a pair format with social and point reinforcements, distributed practice, and immediate error correction. When this component was added to traditional instruction, all three participants increased their percentages of correctly spelled words. Kubina et al. (2004) used application, which involves combining two or more behaviors, in this case letter-sound writing and oral word segmentation, to form a compound behavior such as spelling. Participants first practiced for accuracy and then to a fluency criterion for each of the two skills. After the second phase, students increased their percentage of words spelled correctly.

Reading intervention—One study examined the effects of a reading intervention on spelling outcomes (Jitendra et al., 2004). In this study, the Read Well (Sprick, Howard, & Fidanque, 1998) program was implemented, and reading and spelling outcomes were assessed. The Read Well program uses systematic, explicit reading instruction in phonological awareness, phonics, fluency, vocabulary, and comprehension. Spelling was measured prior to and at the completion of the program for two participants with LD, but spelling probes were not taken throughout the baseline and intervention phases. Both participants were able to increase their performance on the *Tangel and Blachman* spelling measure after the intervention.

Duration of Intervention

Duration of intervention (number of hours) was calculated by using the information about frequency and length (time) of sessions in the original studies. Most of the interventions were relatively short, and four of the studies provided intervention for 10 hours or less (Burks, 2004; Darch et al., 2006; Hochstetler et al., 2013; Nies & Belfiore, 2006). Alber and Walshe (2004) and Jitendra et al. (2004) both utilized interventions lasting longer than 11 hours but less than 40 hours. Intervention length moderated effectiveness for one study. Owens et al. (2004) reported that sets of participants received different intervention lengths and that this directly affected the effectiveness of the intervention. The greatest gains occurred for the participants who received 15 to 20 hours of the intervention, while small gains were recorded for the participants who received only 6.7 hours of intervention. The remaining three studies did not provide enough information to calculate duration, but session length ranged from 20 to 30 min (Kubina et al., 2004; Viel-Ruma et al., 2007; Zielinski et al., 2012). Regardless of intervention length (except for Owens et al., 2004), all studies demonstrated increased spelling performance.

Intervention Group Size and Implementer

Group sizes for all studies in this synthesis were relatively small. Four studies had interventionists work individually with participants (Hochstetler et al., 2013; Jitendra et al., 2004; Kubina et al., 2004; Zielinski et al., 2012). In the remainder of the studies, students were taught in small groups of two to six students, even though participants usually worked independently during the actual interventions. Additionally, in the majority of studies the classroom teacher was the interventionist, although three studies used researchers (Darch et al., 2006; Hochstetler et al., 2013; Kubina et al., 2004), and one group trained

paraprofessionals to implement the intervention (Owens et al., 2004). Spelling outcomes did not appear to be moderated by the group size or implementer, as all studies showed increased number and percentage of words spelled correctly following the interventions.

Discussion

What are the effects of reading and spelling interventions on spelling outcomes for students with LD in kindergarten through 12th grade?

This synthesis was conducted to provide updated information about spelling and reading interventions and their impact on spelling outcomes for students with LD in grades K through 12. A systematic search identified 10 studies for inclusion in the synthesis, and findings were described by (a) participants' characteristics, (b) type of design, (c) intervention characteristics, (d) duration of intervention, and (e) intervention group size and implementer. Where appropriate, Cohen's *d* and PND were calculated and reported to aid in the comparison of results across studies. Only one study used a treatment-comparison design with a control group (Darch et al., 2006), while the remainder of the studies used single-case designs to demonstrate experimental control. Participants in all studies increased their spelling accuracy for words directly taught and practiced in the interventions.

Two types of interventions emerged from the research. The first category included the most common strategy across the interventions, which was the use of self-correction procedures such as CCC. These strategies were utilized as individual self-study interventions where participants used the strategies to study a set of words that they would be tested on in the future. The other type of spelling intervention was explicit instruction such as letter sound writing, oral word segmentation, or the Spelling Mastery (Dixon, 2007) program. Explicit instruction, multiple opportunities for practice, and immediate corrective feedback were important components of these interventions. Despite these differences, participants in interventions with the all of the aforementioned features demonstrated increased spelling accuracy when compared to other conditions or baseline phases. Although many participants made improvements, they still did not improve spelling accuracy to clinically significant levels, as the total percentage of words spelled correctly was often less than 70%. The finding that students still incorrectly spell many words is consistent with the previous synthesis that was based on studies through 2003 (Wanzek et al., 2006).

In all studies, spelling outcomes were measured through oral dictation tests. Only two groups of researchers (Darch et al., 2006; Owens et al., 2004) used standardized measures of spelling and assessed the transfer of the spelling instruction to untaught words. The remainder utilized researcher-created measures, and neither reliability nor validity was reported for any of these measures. Furthermore, only half of the groups of researchers examined maintenance of the taught words at a later time (Alber & Walshe, 2004; Darch et al., 2006; Nies & Belfiore, 2006; Owens et al., 2004; Viel-Ruma et al., 2007). Wanzek et al. (2006) indicated that developing a foundational system of spelling or methods to attend to word spellings could potentially lead to improved spelling outcomes for students with LD. Results from the current synthesis suggest that more research is still needed to determine

how reading and spelling interventions can affect spelling performance and generalization to untaught words.

Because many of the studies had similar outcomes for students with LD, the potential moderator variables of grade, duration, group size, and implementer were difficult to discern. Most of the participants were in Grades 2 through 5, and all studies utilized small groups or individual instruction. While the studies conducted at the secondary level showed promising results, they included a total of only eight participants. None of the studies examined the use of these interventions with larger group implementation. Only one group (Owens et al., 2004) found different results for different lengths of treatments for a direct-instruction spelling program. This may indicate that direct instruction programs might require more hours to affect spelling outcomes.

Although previous syntheses indicate that spelling instruction can have an impact on reading outcomes (Weiser & Mathes, 2011) and reading instruction can improve spelling outcomes (Graham & Santangelo, 2014; Wanzek et al., 2006), in the current synthesis we did not find much evidence to support this for students with LD. In only one study did the researchers examine the impact of a reading program on spelling outcomes for students with LD (Jitendra et al., 2004). It is important to note that many studies have been conducted that examined spelling outcomes after reading interventions, but these studies did not include disaggregated findings for participants with LD. Moreover, in no studies of spelling interventions were reading outcomes measured. Instruction in spelling can positively affect decoding and reading performance (Graham & Santangelo, 2014; Weiser & Mathes, 2011); however, more research is necessary to fully explore this for students with LD.

Limitations and Directions for Future Research

The conclusions that can be drawn from this synthesis are limited by the research designs and methods in the primary studies. Only one study utilized a comparison group to determine the effectiveness of a spelling intervention, while the remainder used single-case designs. Single-case designs are not necessarily meant to be generalized to larger populations. Furthermore, metrics such as PND have limitations when comparing and synthesizing findings from these designs. To determine the effectiveness of spelling and reading interventions for students with LD, more high-quality randomized group design studies are needed, or results need to be disaggregated for this population of students in larger randomized design studies. Also, the majority of the participants were in Grades 2 through 5; more high-quality research is needed for students younger than Grade 2 and at the secondary levels. Students with LD at the secondary level still struggle with reading and spelling, and it is important to determine how interventions can affect their spelling performance. Future research in these areas will strengthen the body of evidence regarding the effectiveness of specific interventions for students with LD.

Furthermore, only one study addressed a reading intervention and its impact on spelling outcomes for students with LD. There is a known reciprocal relationship between reading and spelling (Graham et al., 2002; Graham & Santangelo, 2014; Noell et al., 2006; Santoro et al., 2006; Weiser & Mathes, 2011); however, this relationship has not been fully explored

for students with LD. Future research should address this relationship and examine how spelling interventions could affect reading outcomes (Weiser & Mathes, 2011).

All of the studies used some type of researcher-created measure of spelling. These measures tend to be proximal and evaluate specifically what students learned in the intervention, which often shows stronger effects. Although they provide valuable information about participants' knowledge of the words learned, they do not capture participants' relative performance compared to peers. Additionally, with the exception of two studies that also utilized a standardized measure in conjunction with researcher-developed measures (Darch et al., 2006; Owens et al., 2004), most of the studies did not examine the generalization or transfer of skills to untaught words. Future research should examine both relative performance and generalization of the skills taught in the intervention by using additional distal measures.

Although the previous synthesis (Wanzek et al., 2006) indicated that assistive technology could be beneficial for increasing spelling outcomes in written compositions, none of the studies in this synthesis employed any type of assistive technology or computerized instruction. Given the increases in technology and computer-assisted instruction during the past 10 years, it is interesting that no studies emerged that examined this for students with LD. A potential limitation could be that the search terms did not adequately identify assistive technology or computer-assisted instruction in the search, and therefore these studies may have been excluded from the synthesis. More research is needed to determine the potential effects of such technology on spelling outcomes for students with LD.

The purpose of this synthesis was to explore the effectiveness of spelling and reading interventions on spelling outcomes for students with LD in grades K through 12. Findings demonstrate that there are positive effects for reading and spelling interventions when students are assessed on taught words; however, there are still many gaps in this area of research. More information is needed to examine moderators of effectiveness, the reciprocal relation of reading and spelling interventions on spelling and reading outcomes, the relative importance of immediate versus later spelling feedback (as in the CCC condition), long-term effects, and generalizability of effects to new learning.

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Table 1

Summary of Intervention Studies Reviewed.

Study (design)	N, grade, age	Duration	Group size, implementer	Intervention type
Darch, Eaves, Crowe, Simmons, and Conniff (2006) (treatment-comparison)	N= 42 Grade: 2 to 4 Age: 8 to 12	Fq: daily/4 weeks Sessions: 20 Total hours: 10	Group size: 3 to 6 Implementer: researcher	Spelling
Alber and Walshe (2004) (single-subject: alternating treatment)	N= 4 Grade: 5 Age: 10 and 11	Fq: 4 × week/8 weeks Sessions: 32 Total hours: 13 to 16	Group size: 6 Implementer: teacher	Spelling
Burks (2004) (single subject: ABA)	N= 3 Grade: 5 Age: 10 and 11	Fq: 1 × week/7 weeks Sessions: 7 Total hours: 2.33	Group size: 4 to 6 Implementer: teacher	Spelling
Hochstetler, McLaughlin, Derby, and Kinney (2013) (single subject: multiple baseline)	N= 3 Grade: 8 Age: 14	Fq: 3 × week/NR Sessions: 17 Total hours: 2.83 to 4.25	Group size: 1 Implementer: researcher	Spelling
Jitendra et al. (2004) (single-subject: multiple probe)	N= 2 Grade: 2 Age: 7	Fq: 4 × week/13 to 16 weeks Sessions: 52 to 64 Total hours: 34 to 39	Group size: 1 Implementer: teacher, teacher's assistant, and graduate students	Reading
Kubina, Young, and Kilwein (2004) (single-subject: multiple probe)	N= 3 Grade: 2 Age: 7 and 8	Fq: NR Sessions: NR Total hours: NR	Group size: 1 Implementer: researcher	Spelling
Nies and Belfiore (2006) (single-subject: adaptive alternating treatment)	N= 2 Grade: 3 Age: NR	Fq: daily/3 weeks Sessions: 15 Total hours: 5	Group size: 2 Implementer: teacher	Spelling
Owens, Fredrick, and Shippen (2004) (single-subject: alternating treatment)	N= 6 Grade: 2 and 3 Age: 7 to 9	Fq: daily/4 weeks/9 weeks/12 weeks Sessions: 22/36/60 Total hours: 6.7/15/20	Group size: 2 Implementer: paraprofessional	Spelling
Viel-Ruma, Houchins, and Fredrick (2007) (single-subject: alternating treatment)	N= 3 Grade: 10 and 12 Age: 16 and 18	Fq: daily/6 weeks Sessions: 30 Total hours: NR	Group size: 3 Implementer: teacher	Spelling
Zielinski, McLaughlin, and Derby (2012) (single-subject: multiple baseline with brief reversal)	N= 3 Grade: 9, 10, and 12 Age: 14, 16, and 18	Fq: NR Sessions: 20 Total hours: NR	Group size: 1 Implementer: teacher	Spelling

Note. Fq = frequency / length of sessions; NR = not reported.

Table 2

Summary of Intervention Findings With Effect Sizes.

Study and intervention components	Measures	Findings	PND
Darch, Eaves, Crowe, Simmons, and Conniff (2006)	Unit tests		N/A
<ul style="list-style-type: none"> T1 (Spelling Mastery Level D): introduction of spelling rule and sample words; application of rule to other words; student independent practice and corrective feedback T2 (traditional spelling instruction): dictation pretest and student correction; discussion of common patterns and meanings of each word; completion of spelling worksheet; follow-up dictionary and handwriting skill training activities 	<p>$T1 > T2, p < .05^*$ $d = 1.13$</p> <p><i>Test of Written Spelling-3</i> $T1 > T2, p > .05$ $d = 0.47$</p> <p>Transfer test $T1 > T2, p < .05^*$ $d = 0.49$</p> <p>Maintenance test $T1 > T2, p > .50$ $d = 0.55$</p>		
Alber and Walshe (2004)	Weekly spelling tests (mean number of words correctly spelled out of 10)	T1 T2	N/A
<ul style="list-style-type: none"> B (dictation pretest): Words were selected for the two conditions that all students missed on the B dictation pretest T1 (self-correction after each word): Students wrote 10 words dictated via audio-tape then checked and self-corrected each word after dictation T2 (self-correction after whole list): Students wrote 10 words dictated via audio-tape then checked and self-corrected words after whole list was dictated 	<p>P1: 6.5 5.4</p> <p>P2: 3.8 1.8</p> <p>P3: 7.1 6.1</p> <p>P4: 7.1 6.8</p> <p>P1: 4.0 3.5</p> <p>P2: 2.3 1.8</p> <p>P3: 5.4 4.9</p> <p>P4: 6.4 5.0</p>		
Burks (2004)	1-week maintenance tests (mean number of words correctly spelled out of 10)	T1 T2	
<ul style="list-style-type: none"> B (traditional spelling instruction): writing words, shaving cream spelling, crossword puzzle, spelling tests T (classwide peer tutoring): pair format, social and point reinforcements, distributed practice, immediate error correction, and public posting 	<p>Weekly spelling tests (mean percentage for each phase)</p> <p>P1: 70 96</p> <p>P2: 74 86</p> <p>P3: 76 91</p>	<p>B T B</p> <p>93</p> <p>56</p> <p>70</p>	<p>P1: 0%</p> <p>P2: 0%</p> <p>P3: 0%</p>
Hochstetler, McLaughlin, Derby, and Kinney (2013)	Spelling tests (number of words correct)	P1 P2 P3	P1 P2 P3
<ul style="list-style-type: none"> B (dictation): Teacher dictated word lists while student wrote words on paper T (copy-cover-compare): copy-cover-compare sheet to study spelling words for three sets of words 	<p>B S1: 3.3 2.0</p> <p>T S1: 7.6 9.6</p> <p>B S2: 2.0 1.4</p> <p>T S2: 7.5 9.4</p> <p>B S3: 3.4 1.4</p> <p>T S3: 7.7 8.3</p>	<p>3.0</p> <p>13.0</p> <p>2.3</p> <p>10.8</p> <p>2.3</p> <p>N/A</p>	<p>S1: 100% 100%</p> <p>S2: 100% 100%</p> <p>S3: 100% 100%</p> <p>N/A</p>

Study and intervention components	Measures	Findings				PND
Jitendra et al. (2004)	<i>Tangel and Blachman</i> spelling measure (scored out of 64 possible partial points for 8 total words)	B	T			N/A
<ul style="list-style-type: none"> B (traditional classroom instruction): Students received normal classroom reading instruction T (Read Well program): systematic, explicit reading instruction in phonological awareness, phonics, fluency, vocabulary, and comprehension 	P1: P2:	56 21	59 42			
Kubina, Young, & Kilwein (2004)	Spelling tests (percentage of words spelled correctly)	B	T1	T2		PND
<ul style="list-style-type: none"> B (dictated spelling lists): Three different spelling lists were dictated to the participants T1 (letter sound writing): Participants learned targeted letter sounds and practiced to a fluency criterion with corrective feedback T2 (oral word segmentation): Participants segmented orally presented words using felt and practiced to a fluency criterion 	P1: P2: P3:	60–70 40–65 25–55	40–75 40–65 25–35	80–100 65–100 80–100		P1: 91% P2: 67% P3: 45%
Nies and Belfiore (2006)	Spelling tests (number of spelling words learned)	T1	T2			N/A
<ul style="list-style-type: none"> T1 (cover-copy-compare): Participants used copy-cover-compare strategy to study spelling words T2 (copy only): Participants copy spelling words to practice 	P1: P2:	13 9	5 6			
	Follow-up spelling tests (number of words retained on Monday after Friday spelling test)	T1FU	T2FU			
		P1: P2:	13 8	4 3		
Owens, Fredrick, and Shippen (2004)	CBM Spelling Probes (percentage of correct letter sequences)	B	T	M		P1: 100% P2: 86% P3: 80% P4: 80% P5: 50% P6: 25%
<ul style="list-style-type: none"> B: no spelling instruction provided T1 (Spelling Mastery): Participants received instruction from Spelling Mastery Level A; 13 sight words and 31 sound-symbol relationships were taught 	P1 (12 weeks): P2 (12 weeks): P3 (9 weeks): P4 (9 weeks): P5 (4 weeks):	52.0 55.0 52.5 51.0 25.3	81.8 75.2 73.2 75.3 58.2	91.0 80.5 77.5 80.5 63.0		
	CBM Spelling Probes (percentage of correct words)	B	T	M		
		P1 (12 weeks): P2 (12 weeks): P3 (9 weeks): P4 (9 weeks): P5 (4 weeks): P6 (4 weeks):	41.7 16.7 25.0 25.0 0 0	66.7 51.9 45.0 57.3 25.0 0	79.2 58.3 54.2 54.2 37.5 NR	

Study and intervention components		Measures	Findings		PND
		<i>Test of Written Spelling-4</i> (percentage of correct words)		Pte	Post
			P1 (12 weeks):	0	47
			P2 (12 weeks):	0	40
			P3 (9 weeks):	0	27
			P4 (9 weeks):	0	50
			P5 (4 weeks):	0	22
			P6 (4 weeks):	0	0
Viel-Ruma, Houchins, and Fredrick (2007)		Researcher-created spelling test (mean percentage of words spelled correctly)	T1	FU	M
•	T1 (traditional repeated practice): Write each word three times using a model of correct spelling		P1: 10	28	16
•	T2 (error self-correction): Listen to dictated word, spell word (without correct model), check spelling, and self-correct as necessary		P2: 72	82	97
			P3: 44	82	72
Zielinski, McLaughlin, and Derby (2012)		Spelling tests (mean percentage of correctly spelled words)	B	T	
•	B (no spelling strategy): Words were dictated, and students spelled on paper		P1: 10	83	
•	T (cover-copy-compare): worksheet with 10 words; participants said word aloud, covered word, wrote word, checked for accuracy, and rewrote incorrectly spelled words three times each		P2: 55	90	
			P3: 63	92	
					P1: 100%
					P2: 48%
					P3: 72%

Note. PND = percentage of nonoverlapping data; T = treatment; P = participant; B = baseline; S = set; FU = follow-up; N/A = not applicable;

CBM = curriculum based measure; NR = not reported; M = maintenance. Effect sizes are Cohen's d. All measures were researcher-created dictation tests except for the *Test of Written Spelling-3* and the *Test of Written Spelling-4*, which are standardized.

* Statistically significant.