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Using Encoding Instruction to Improve the Reading and Spelling Performances of Elementary Students At Risk for Literacy Difficulties: A Best-Evidence Synthesis

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*Although connectionist models provide a framework explaining how the decoding and encoding abilities work reciprocally to enhance reading and spelling ability, encoding instruction in today's schools is not a priority. Although a limited amount of high-quality experimental or control studies to date (*N *= 11) give empirical support to using direct, explicit encoding instruction to increase the reading and spelling abilities of those students at risk for literacy failure, the benefits of integrating this instruction into current reading curriculums warrant further consideration. Students receiving encoding instruction and guided practice that included using (a) manipulatives (e.g., letter tiles, plastic letters) to learn phoneme–grapheme relationships and words and (b) writing phoneme–grapheme relationships and words made from these correspondences significantly outperformed contrast groups not receiving encoding instruction. Robust Cohen's* d *effect sizes, favoring the treatment groups, were found in areas of phonemic awareness, spelling, decoding, fluency, comprehension, and writing. Educational implications of these findings suggest that there is support for using encoding instruction to increase the literacy performances of at-risk primary grade students and that encoding instruction can be successful in improving the reading and spelling performances of older students with learning disabilities. Importantly, there is also evidence to support the transfer effects of early encoding instruction on later reading, writing, and spelling performances.*

Keywords: encoding instruction, at-risk readers, reading, spelling, manipulatives.

The current focus on reading assessments associated with the 2002 No Child Left Behind legislation and the Reading First federal program has not resulted in a comparable focus on the benefits of spelling instruction in terms of enhancing reading performance (Ehri, 1997; Graham, 2000). In fact, the National Reading Panel (NRP; National Institute of Child Health and Human Development, 2000) found that spelling achievement was coincidentally increased by explicit and systematic phonics instruction and further implied that spelling would eventually develop in response to appropriate reading instruction, without the need to deliver explicit spelling instruction. As a result, discussions of spelling are limited to the impact of phonics instruction rather than the beneficial effects of using explicit spelling instruction to improve decoding performance (Cooke, Slee, & Young, 2008; Treiman, 1998).

A convergence of evidence links the development of decoding and encoding ability in students to their underlying phonological and phonemic awareness knowledge (Adams, 1990; Blachman, Ball, Black, & Tangel, 1994, 2000; Snow, Burns, & Griffin, 1998). Students practice acquired decoding skills when they blend sounds and recognize words, when they orally or silently read lists of words or pseudowords (i.e., decodable nonsense words), and when they read connected text (e.g., sentences, paragraphs, stories, and books). Students who are adept at encoding not only spell well but also have learned to use their knowledge of phonemic awareness and phoneme–grapheme (i.e., sound to letter) correspondences to turn speech into print (Moats, 1998, 2010). Encoding instruction is not limited to just teaching spelling patterns and memorization skills. Encoding instruction also includes explicitly teaching beginning readers and spellers to write words according to their phoneme–grapheme correspondences, to build words using manipulatives (e.g., letter tiles, plastic letters, etc.), and to learn to manipulate phoneme–grapheme relationships to make new words (e.g., *pat* and *tap*, *stop* and *pots*).

Many researchers have shown strong, significant correlations between spelling ability and reading performance, ranging from .68 to .93, and have demonstrated the predictive powers of decoding and spelling performance on future reading and spelling abilities (Christo & Davis, 2008; Mehta, Foorman, Branum-Martin, & Taylor, 2005; Ritchey, 2008). Thus, encoding instruction and practice may offer insight into the types of knowledge individuals use to read and write unfamiliar words, providing a window to what students know about how words work (He & Wang, 2009; Joshi, Treiman, Carreker, & Moats, 2008; Stone, Siliman, Ehren, & Apel, 2005).

Possibly because of an underappreciation of the linguistic basis of encoding instruction, the facilitative role encoding and spelling instruction may play in early reading development has not been leveraged in most reading curriculums (Berninger et al., 1998; Ehri, 1997; Moats, 2005; Treiman, 1998). Spelling in the early grades is usually treated as a separate subject, unrelated to reading curriculums, with little attention given to the structure of how words work beyond memorization of a common pattern found in words in a weekly word list (Ehri, 1997, 2000; Moats, 1998; 2005; Treiman, 1998; Uhry & Shepherd, 1993). Few state standards specify what students at each grade level should be able to spell, and most subsume spelling under broader topics such as composition. Recent time-sampling observational studies suggest that first and second grade teachers allocate only a small percentage of time (i.e., less than 4%) to activities in which any encoding or spelling instruction is integrated into the core reading curriculum (Cooke et al., 2008; Foorman et al., 2006). Not surprisingly, many students do not make the connections between their alphabetic knowledge and their ability to spell (Ehri, 2000).

Theoretical Links

Ehri (1998) and Treiman (1998) both theorized that young students create spellings for words based on their understanding of language and their knowledge of phoneme–grapheme correspondences and print (Ehri, 1998; Treiman, 1998). Students who create their own spellings using these relationships are considered to arrive at a deeper understanding of English phonology (Moats, 2005). As students develop phonemic awareness and begin to grasp the alphabetic principle, their spellings of words reflect their attempts to symbolize the phonological structure of spoken words, and as they become better spellers, this stimulates progress in their reading abilities (Bourassa & Treiman, 2001; Groff, 2001; Santoro, Coyne, & Simmons, 2006) and writing skills (Graham, Harris, & Fink-Chorzempa, 2003; Pinnell & Fountas, 1998). Thus, there is likely power in making apparent to children the reciprocity of phonemic awareness knowledge and using the alphabetic principle to decode and encode words.

Connectionist models provide a framework explaining how the decoding and encoding abilities work reciprocally, or even synergistically, to enhance reading and spelling ability (Adams, 1990; Ehri, 1997, 1998, 2000; Hatcher, Hulme, & Ellis, 1994). Adams's theory suggests that both phonological and orthographic skills are connectively involved in the processing of interpreting letters, letter patterns, word parts, and whole words. She suggests that word reading is influenced by both of these processors because letters or graphemes are associated with phonological representations or phonemes, just as spelling ability is enhanced by associating written symbols or graphemes for their spoken sounds. Ehri's connectionist theory suggests that spelling and reading, although independent skills, develop together reciprocally because of a logical symmetry relationship. Ehri and Adams both suggest that students who spell poorly demonstrate more problems with combining both phonological and orthographic processes together than students who spell well, and students learn about language through print because print provides students with a schema for conceptualizing and analyzing the structure of speech (Ehri, 1998).

Hatcher et al. (1994) have a similar linkage theory to that of Adams and Ehri concerning these connections and hypothesize that learning how to manipulate phoneme–grapheme relationships during phonemic awareness instruction is the key to ameliorating early reading failure. These researchers argue that phonemic awareness instruction needs explicit links to connected prereading activities, such as learning the names and sounds of letters, spelling sounds using manipulatives, spelling and writing words while paying attention to their grapheme–phoneme correspondences, and reading connected text using previously taught sounds and words. Hatcher et al. argue that interventions to boost phonological processing need to be integrated with the teaching of connected encoding and decoding manipulating skills during phonemic awareness instruction to be maximally effective in improving literacy skills.

Connectionist theories of literacy warrant further examination for several reasons. First, these models espouse that learning to spell words and learning to read words both rely on the same knowledge about the alphabetic system and memory for the spellings of specific words. Second, reading and spelling researchers support the linking and manipulation of speech sounds to alphabetic symbols as they hypothesize it strengthens phonological and phonemic awareness (Bourassa & Treiman, 2001; Moats, 2009a, 2009b), decoding skills (Perfetti, 1997; Simmons et al., 2008), and spelling ability (Cunningham & Cunningham, 1992; Grace, 2007; Graham, 2000; Tangel & Blachman, 1995). Third, researchers have suggested that explicit and systematic encoding instructions in how to manipulate the order of phoneme–grapheme correspondences into different real and pseudoword combinations allows struggling readers to become more proficient at reading, writing, and spelling (Foorman, Francis, Fletcher, Schatschneider, & Mehta, 1998; Snow et al., 1998). Even so, the exact contribution of providing encoding instruction to prevent or remediate reading and spelling difficulties has not been fully examined empirically.

Purpose of Synthesis

Given that students are rarely taught to link their knowledge of previously taught phoneme–grapheme relationships or syllable patterns to encode new words, it is important to examine if increased attention to encoding instruction helps students become more proficient in reading and spelling. It is intuitive that students who practice encoding words and decoding text that comprises previously taught phoneme–grapheme combinations are more likely to acquire the alphabetic principle and develop fully specified orthographic representations of words. Therefore, the purpose of this best-evidence synthesis is to locate the empirical evidence examining the role of increased encoding instruction on student's understanding of the alphabetic principle and their decoding, fluency, comprehension, and spelling performances. Specifically, we investigate if there is support in the research base for providing explicit encoding instruction to improve the performances of students who struggle with reading and spelling. We hypothesize that encoding instruction improves both the reading and spelling performances of students at risk for reading and spelling difficulties. We also hypothesize that providing encoding instruction, integrated with phonemic awareness and phonics activities, enhances the understanding of the alphabetic principle and phoneme–grapheme relationships and improves the overall reading and spelling performances of students at risk for reading problems.

Method

In this review we followed the procedure for best-evidence synthesis (Slavin, 1986; Slavin, Cheung, Groff, & Lake, 2008), which reflects a hybrid of meta-analysis and a more traditional review of the literature. Best-evidence syntheses "seek to apply consistent, well-justified standards to identify unbiased, meaningful information from experimental studies, discussing each study in some detail and pooling Cohen's *d* effect sizes across studies in substantively justified categories" (Slavin et al., 2008, p. 292). Best-evidence syntheses first clearly specify prior criteria for inclusion of studies. Included in these criteria are quality study indicators to represent the best evidence on a specific topic. Second, they include an exhaustive search of the extant literature to locate all studies meeting these prior criteria to allow for the detailed discussion of studies representing the best evidence on a given topic. Third, effect sizes are recalculated using a consistent, statistical formula (or formulas) and are presented in conjunction with, and in addition to, a more traditional review of the literature, thus enabling individual studies and methodological and substantive issues to be compared and discussed in detail.

Literature Search

To identify possible publications, online computer searches were conducted using Academic OneFile (Gale), World Cat (Online Computer Library Center), and EBSCOhost. The latter search was with Academic Search Complete, PsycINFO, Psychological and Behavioral Sciences Collection, PsycARTICLES, ERIC, Professional Development Collection, Education Research Complete, and Science & Technology Collection. Descriptors and key subject terms included (a) *alphabetic code*, (b) *grapheme–phoneme correspondences*, (c) *phoneme–grapheme correspondences*, (d) *letter–sound correspondences*, (e) *letter training*, (f) *phonics and reading*, (g) *phonics and encoding*, (h) *alphabetic phonics*, (i) *systematic phonics*, (j) *phonological processing*, (k) *word study and encoding*, (l) *beginning reading*, *instruction and reading*, (m) *beginning reading*, *instruction*, *and encoding*, (n) *intervention*, *reading*, *and encoding*, (o) *orthography*, (p) *orthographic processing and reading*, (q) *orthographic processing and encoding*, (r) *orthographic processing and literacy*, (s) *encoding*, *orthography*, *and encoding*, (t) *encoding and reading*, (u) *prediction models and reading*, (v) *prediction models and encoding*, (w) *reading*, *and encoding*, (x) *analysis*, *reading*, *and encoding*, (y) *encoding*, *reading and encoding*, (z) *grapheme and phoneme*, (aa) *grapheme*, *phoneme*, *and orthography*, (bb) *manipulative and phonics*, (cc) *manipulative and encoding*, and (dd) *manipulative and reading*. A search of these descriptors without any limitations resulted in the identification of thousands of items, including journal articles, book chapters, reports, and dissertations. To narrow the field to only relevant items, a new search, using the same descriptors, was performed to meet the following criteria: (a) item was published in a peer-reviewed journal, (b) item contained information about the use of manipulatives (i.e., counters, tiles, plastic letters, real letters, letter cards, or Elkonin boxes; Elkonin, 1973) during instruction on the alphabetic principle, and (c) item reported information about the results of interventions that included the manipulation and/or writing of letters during phonics, reading, or spelling instruction. The rationale for these restrictions was to find information that examined the use of adding encoding instruction to support decoding ability. A total of 138 items met these initial criteria. Reference sections of these items and two meta-analysis studies (i.e., Bus & Van IJzendoorn, 1999; Wanzek et al., 2006) were then examined to find other possible articles, producing another 47 relevant articles and resulting in a total of 185 publications to be furthered reviewed.

Study Inclusion Criteria

In keeping with Slavin's 1986 best-evidence standards, the 185 articles were then coded by the authors to determine if they met the following inclusionary criteria:

1. Researchers included an experimental or quasiexperimental treatment-contrast design. A total of 143 items did not meet this first criterion, as these were mostly practitioner articles, single-group designs, or single-case studies. Eight additional studies that had been mined from the previously mentioned meta-analyses studies also were excluded because they did not include a contrast group.
2. Interventions needed to focus on students in grades kindergarten through third grade or on older students with learning disabilities reading below a third-grade level. One study was eliminated because its participants were older than third grade.
3. At least one condition of the study had to implement an intervention of using encoding activities (manipulating and/or writing of letters and/or sounds

and/or words) during phonemic awareness, phonics, spelling, reading, and/or word study instruction. All six of the treatment–control studies in the Wanzek et al. (2006) meta-analysis were eliminated as the intervention groups did not receive this type of encoding instruction.

4. To examine the effects of encoding instruction as part of reading instruction, interventions needed to be part of school programming. Five studies did not meet this criterion as they were done in after-school programs.
5. Interventions needed to be done with English-speaking students to minimize confounds from students learning in other languages or learning English as a second language. Six studies were eliminated as the purpose of the research was specifically examining English language learners.
6. To see the effects of including encoding instruction on decoding ability, one or more measure had to assess reading ability (e.g., letter–sound identification, reading real or pseudowords, fluency, and/or comprehension). Three spelling studies did not have a reading assessment at posttest and were not included in this synthesis.
7. To see the effects of encoding instruction on spelling ability, one or more measure had to assess spelling ability (e.g., dictated words, circling the correct spelling, etc.). One study was excluded because it did not include a spelling measure during the first 2 years of the intervention.
8. Researchers needed to use untrained items for assessment. Four studies reported using trained items only on spelling posttests and were not included in this synthesis.
9. Information allowing the calculation or estimation of effect sizes had to be reported to gauge the practical significance of the treatment group or groups over any contrast group or groups. Two studies were eliminated as the authors did not give enough information to independently compute effect sizes (e.g., mean scores, standard deviations, number of participants in each group, etc.)
10. Last, the study had to meet the criteria as being of acceptable quality using quality indicators for evidence-based research specified by Gersten et al. (2005; i.e., having at least 10 essential methodological quality indictors). Out of the remaining 17 studies, 6 of these did not meet this final criterion because they did not have enough essential indicators. These articles did not provide enough information about their interventions (i.e., time, frequency, description of instruction), their participants, the fidelity of the implementation, and/or the reliability of the data collection procedures, all of which are essential for evidence-based research.

Intercoder Reliability

Two education graduate students independently recoded 30% of the 185 studies ($n = 56$) to establish intercoder reliability. These coders went through the above list of criteria starting with the first one and then working down the list. Once a study did not meet one of the criteria listed, it was coded as unusable and the reason was given for the elimination. In cases of disagreement, discussions were held until there was 100% agreement.

Methodology for Analyzing Studies

After meeting the above criteria, a total of 11 studies were included in the synthesis. Studies were then coded using a form developed to identify substantive and methodological features of each study. Beyond the initial inclusion criteria, studies were coded for type of experimental design, type of encoding intervention (i.e., reading and encoding, phonemic awareness and encoding, or encoding only), size and type of instructional group, number of participants, instruction time and duration, amount of instructional lessons, and reading and spelling dependent measure types. Reliability of this coding process was checked by having another graduate research assistant recode the 11 studies. Agreement was determined using the following formula (Gall, Gall, & Borg, 2005): percentage agreement = agreements / (agreements + disagreements). Average agreement across criteria coding was 98%.

Computation of Effect Size

Cohen's *d* effect sizes were computed to determine the benefit of adding encoding instruction for each of specific intervention treatment groups in comparison to contrast groups not receiving additional encoding instruction. The specific formula used to determine each sample's effect size was based on the information given for each study. Effect sizes reported by the journal articles were not used to ensure that all effect sizes reported in this synthesis were calibrated using the same formulas. Cohen's *d* effect sizes were computed to measure how much the mean of the treatment group(s) exceeded the mean of the contrast group at posttest in standard deviation units by using procedures explicated for meta-analysis by Glass, McGaw, and Smith (1981). In some of the included studies, the effect size had to be mined from ANOVA tables producing an *F* statistic. In these cases, the effect size formula produced an eta-squared value (η^2), which was calculated by dividing the sum of squares between values by the sum of squares total amount (Huck, 2008). These measures provide an index of the proportion of variability in the study's dependent variable that is associated or explained by the study's grouping variable (i.e., treatment vs. contrast). When appropriate measures (i.e., numbers of participants, mean scores, and standard deviations) were given, Cohen's *d* effect sizes could then be calculated. If these measures were not given, η^2 was used to represent the comparisons. Effect size calculations were then rechecked by a graduate research assistant for correctness.

Results

As previously mentioned, 11 experimental intervention studies met the criteria to be included in this synthesis. Table 1 provides a summary of the included intervention studies, complete with participants' information, intervention and contrast group descriptions, measures used, and quantitative results.

Studies That Included Encoding Instruction With Reading Interventions

Four experimental studies were identified that presented interventions that included explicit and direct instruction of strategies reinforcing both decoding and encoding skills. The goal of these supplemental interventions was to support grapheme–phoneme recognition, decoding, fluency, and comprehension through a combination of decoding and encoding instruction. For example, Blachman et al.

(Text continues on p. 185)

TABLE 1

Summary of experimental studies

Intervention and duration	Dependent measures	Findings and results
Blachman et al. (1994) 159 at-risk kindergarteners T: Phonemic awareness with letter–sound correspondences, manipulation and sounds and letters, encoding; $n = 84$ C: Typical basal instruction; $n = 75$ Teacher–student ratio: 1:4–1:5 Implemented by: Classroom teachers Duration: 41 fifteen-minute lessons from March to May for a total of 10.25 hours	Researcher developed Phonemic Segmentation Test (PST: Ball & Blachman, 1988) Woodcock Reading Mastery Test–Revised (WRMT), Letter Name Fluency subtest (LNF; Woodcock, 1987) WRMT, Letter Sound Fluency subtest (LSF) Researcher developed Phonetically Regular Word Test using only letters taught (PRW) Researcher developed Phonetically Regular Nonword test using only letters taught (PRN) Researcher developed Developmental Spelling Test (DSPT; Tangel & Blachman, 1995)	Either ANCOVAs with pretest as covariate or independent *t*-tests were used; all results favored the T group: PST: $F(1, 156) = 126.50$, $p < .0001$, $d = 1.26$ LNF: $F(1, 156) = 5.51$, $p = .0201$, $d = 0.29$ LSF: $F(1, 156) = 23.43$, $p < .0001$, $d = 0.62$ PRW: $t(157) = 6.1$, $p < .0001$, $d = 0.94$ PRN: $t(157) = 5.9$, $p < .0001$, $d = 0.88$ DSPT: $t(157) = 5.8$, $p < .0001$, $d = 0.87$ Overall pooled effect size at posttest: $d = 0.81$
Blachman et al. (2004) 69 at-risk second and third graders T: Phonemic awareness with letter–sound correspondences, manipulation and writing of letters, encoding; $n = 37$ C: Typical resource instruction; $n = 32$ Teacher–student ratio: 1:1 Implemented by: Certified reading or special ed teachers Duration: 126 average 50-minute lessons, 5 days/week for a total of 8 months and an average of 105 hours; no intervention during the 2nd follow-up year	WRMT, Word Attack subtest (WA; Woodcock, 1987) and Letter–Word Identification subtest (LWID), Basic Skills Cluster (BSC) Spelling subtest of the Wide Range Achievement Test (3rd ed.; WRAT3–S; Wilkinson, 1993) Gray Oral Reading Tests (3rd ed.; GORT-3, Form A; Wiederholt & Bryant, 1992) subtests: Quotient (Q), Accuracy (A), Rate (R), Comprehension (C) Comprehensive Test of Phonological Processing CTOPP-PA; (Wagner, Torgesen, & Rashotte, 1999). Rapid Naming of Letters (RNL); in this measure, the student was asked to name rapidly five lowercase letters (o, a, s, d, p) Word Reading (WR; modified by B. Foorman and C. Schatschneider from a task used in Foorman, Francis, Fletcher, Schatschneider, & Mehta, 1998). Test of Word Reading Efficiency (TOWRE; Torgesen, Wagner, & Rashotte, 1999).	Posttest results favored the T group: WRMT-WA $F(1, 68) = 30.58$, $p = .0001$, $d = 0.75$ WRMT-LWID $F(1, 68) = 13.10$, $p = .0006$, $d = 0.88$ WRMT-BSC $F(1, 68) = 33.64$, $p = .0001$, $d = 0.89$ WRAT3–S $F(1, 68) = 21.62$, $p = .0001$, $d = 0.99$ GORT-3–Q $F(1, 68) = 10.24$, $p = .0021$, $d = 0.71$ GORT-3–A $F(1, 68) = 8.82$, $p = .0041$, $d = 0.67$ GORT-3–R $F(1, 68) = 15.84$, $p = .0001$, $d = 0.84$ GORT-3–C $F(1, 68) = 5.06$, $p = .0001$, $d = 0.53$ CTOPP-PA $t(416) = 2.22$, $p = .0268$, $d = 0.46$ RNL $t(416) = 2.15$, $p = .0322$, **d** $= 0.21$ WR $t(416) = 3.70$, $p = .0002$, $d = 0.71$ TOWRE $t(416) = 4.87$, $p = .0001$, $d = 0.74$ SD $t(416) = 3.79$, $p = .0002$, $d = 0.78$ Overall pooled effect size at posttest: $d = 0.72$ Growth curve analysis with differential growth rates favoring the T group at posttest: CTOPP-PA $t(416) = 3.70$, $p = .0002$[a] RNL $t(416) = 3.70$, $p = .002$[a]

(continued)

TABLE 1 (continued)

Intervention and duration	Dependent measures	Findings and results
	Spelling Dictation (SD; modified by B. Foorman and C. Schatschneider from a measure used in Foorman, Francis, Fletcher, and Lynn (1996).	WR $t(416) = 2.69$, $p = .0074$[a] TOWRE $t(416) = 2.67$, $p = .0079$[a] SD $t(416) = 2.55$, $p = .0110$[a] Follow-up results favored the T group: WRMT-WA $F(1, 68) = 18.75$, $p = .0001$, $d = 0.48$ WRMT-LWID $F(1, 68) = 5.34$, $p = .0001$, $d = 0.81$ WRMT-BSC $F(1, 68) = 16.24$, $p = .0001$, $d = 0.74$ WRAT3–S $F(1, 68) = 11.02$, $p = .0001$, $d = 0.67$ GORT-3–Q $F(1, 68) = 5.52$, $p = .0001$, $d = 0.48$ GORT-3–R $F(1, 68) = 11.09$, $p = .0001$, $d = 0.71$ CTOPP-PA $t(416) = 2.37$, $p = .02$, $d = 0.34$ RNL $t(416) = 2.27$, $p = .0235$, $d = 0.30$ WR $t(416) = 2.72$, $p = .0069$, $d = 0.75$ TOWRE $t(416) = 4.24$, $p = .0001$, $d = 0.73$ SD $t(416) = 2.75$, $p = .0063$, $d = 0.53$ Significant differences in growth analysis after the follow-up year: only RNL $t(416) = 2.27$, $p = .0235$[a]
Blachman et al. (1999) 128 first-grade students T: Phonemic awareness with letter/sound instruction in kindergarten; $n = 84$; Alphabetic code instruction in 1st grade + classroom encoding instruction; $n = 66$ (at the end of first grade) C: Traditional basal reading program + classroom encoding instruction in 1st grade; $n = 75$ in kindergarten; $n = 62$ (at the end of first grade) Teacher–student ratio: 1:4 in kindergarten and 1:6–1:9 in 1st grade Implemented by: Classroom teachers during language arts block	PST (Ball & Blachman, 1988) Researcher developed Letter Names and Letter Sounds Assessment—RDLN; RDLS WRMT, LWID (Woodcock, 1987) Researcher developed Phonetically Regular List (RDPR; 54 closed syllable, final e, variant vowels, and –r vowels) Decoding Skills Test (DST; Richardson & DiBenedetto, 1985) DSPT (Tangel & Blachman, 1995) Spelling subtest of the Wide Range Achievement Test–Revised, Level I (WRAT1–R-S; Jastak & Wilkinson, 1984)	At the end of first grade: All Results Favored the T group PST: $F(1, 125) = 31.84$, $p = .019$, $\eta^2 = .20$, $d = 0.95$ RDLN: $F(1, 125) = 5.64$, $p < .0001$, $\eta^2 = .04$, $d = 0.46$ RDLS: $F(1, 125) = 26.49$, $p < .0001$, $\eta^2 = .18$, $d = 0.90$ LWID: $t(126) = 1.92$, $p = .0001$, $d = 0.87$ RDPR: $t(126) = 4.106$, $p = .0001$, $d = 0.82$ DST: $t(126) = 4.877$, $p = .0001$, $d = 0.99$ DSPT: $t(126) = 43.66$, $p = .0004$, $d = 1.23$ WRAT1–R-S: $t(126) = 2.24$, $p = .0264$, $d = 0.93$ WRAT1–R-SM: $t(126) = 3.66$, $p = .001$, $d = 1.07$

(continued)

TABLE 1 (continued)

Intervention and duration	Dependent measures	Findings and results
Duration: 41 twenty-minute lessons for 11 weeks for a total of about 12 hours in spring term of kindergarten and then daily 30 = minute lessons for about 7 months for a total of about 70 hours in first grade → total of 171 lessons and 82 hours of intervention	WRAT1–R-S (Jastak & Wilkinson, 1984); researchers used a modified scoring system to measure encoding sophistication (see Tangel & Blachman, 1995; WRAT1–R-SM)	Overall pooled effect size at posttest: $d = 0.89$ Follow-up testing at the end of second grade: All results of measures given favored the T group except on WRAT spelling measures LWID: $t(104) = 2.22$, $p = .029$, $d = 1.17$ RDPR: $t(104) = 2.310$, $p = .028$, $d = 1.04$ DST: $t(104) = 2.358$, $p = .02$, $d = 0.89$ DSPT: $t(104) = 3.316$, $p = .0024$, $d = 1.29$ WRAT1–R-S: $t(104) = 0.000$, $p = ns$, $d = 0.00$ WRAT1–R-SM: $t(104) = 1.106$, $p = ns$, $d = 0.22$
Christensen and Bowey (2005) 116 first graders T1: Grapheme–phoneme condition; $n = 38$ T2: Onset rime condition; $n = 39$ C: Implicit phonics condition; $n = 39$ Teacher–student ratio: 1:6 to 1:8 Implemented by: Trained research assistants Duration: 70 twenty-minute lessons 5 days/week for 14 weeks for a total of about 23.3 hours	Researcher made Decoding Tests (DT) of 55 transfer words Researcher made Spelling Test (ST) with 20 CVe words and 20 words with vowel digraphs Salford Sentence Reading Test (SSRT; Bookbinder, 2002) Reading Comprehension subtest "Kicking Stones" from the Basic Academic Skills Samples (BASS-C; Deno, Espin, & Maruyama, 1985)	ANOVA results at posttest favoring T1 group DT of transfer words accuracy; T1 > T2 > C; $F(2, 102) = 16.86$, $p < .001$, $\eta^2 = .23$, $d = 1.44$ DT of transfer words speed; T1 > C; T2 > C; $F(2, 102) = 6.69$, $p < .01$, $\eta^2 = .11$, $d = 0.62$ ST of transfer words silent e; T1 > C: T2 > C; $F(2, 102) = 19.11$, $p < .001$, $\eta^2 = .25$, $d = 1.4$ ST of transfer words vowel digraphs; T1 > C; T2 > C; $F(2, 102) = 9.90$, $p < .001$, $\eta^2 = .15$, $d = 1.0$ SSRT: T1 > C; T2 > C; $F(2, 102) = 10.86$, $p < .001$, $\eta^2 = .38$, $d = 1.36$ BASS-C: T1 > T2 > C; $F(2, 102) = 19.72$, $p < .001$, $\eta^2 = .26$, $d = 1.53$ Overall pooled effect size at posttest: $d = 1.23$
Denton et al. (2006) 27 students with severe reading difficulties (Grades 1–3, mean age 7.9 years) T: Phono-Graphix program as a tertiary level intervention; $n = 16$ C: Typical special education instruction; $n = 11$ Teacher–student ratio: 1:1 to 1:2 Implemented by: 6 experienced, qualified teachers	Woodcock–Johnson Psychoeducational Battery–Revised (WJ-R) WA (Woodcock & Johnson, 1990) WJ-R LWID WJ-R Passage Comprehension subtest (WJ-R-PC) WJ-R Spelling subtest (WJ-R-S) TOWRE, Sight Word Efficiency (SWE; Torgesen et al., 1999)TOWRE, Phonemic Decoding (PD)	Posttests favored the treatment group on all measures: WJ-R-WA: $F(1, 25) = 72.64$, $p < .0001$, $d = 1.77$ WJ-R-LWID: $F(1, 25) = 46.63$, $p < .0001$, $d = 0.89$ WJ-R-PC: $F(1, 25) = 25.98$, $p < .0001$, $d = 0.37$ WJ-R-S: $F(1, 25) = 14.48$, $p < .008$, $d = 0.36$ TOWRE-SWE: $F(1, 25) = 19.16$, $p < .0001$, $d = 0.39$ TOWRE-PD: $F(1, 25) = 53.86$, $p < .0001$, $d = 0.70$

(continued)

TABLE 1 (continued)

Intervention and duration	Dependent measures	Findings and results
Duration: 2 fifty-minute sessions, 2 times/day for 8 weeks for a total of about 80 lessons and 66 hours; follow-up 8 weeks later	Fluency subtest (F) of the Gray Oral Reading Tests (4th ed.; GORT-4; (Wiederholt & Bryant, 2002) Comprehension subtest (C) of GORT-4	GORT-4–F: $F(1, 25) = 33.00$, $p < .0001$, $d = 0.29$ GORT-4–C: $F(1, 25) = 17.84$, $p < .0003$, $d = 0.63$ Overall pooled effect size at posttest: $d = 0.73$ Assessments at an 8–week follow-up favored the treatment group on all measures: WJ-R-WA: $F(1, 25) = 1.18$, $p = ns$, $d = 0.06$ WJ-R-LWID: $F(1, 25) = 5.51$, $p < .03$, $d = 0.36$ WJ-R-PC: $F(1, 25) = 10.24$, $p < .004$ $d = 0.28$ WJ-R-S: $F(1, 25) = 7.71$, $p < .02$, $d = 0.21$ TOWRE-SWE: $F(1, 25) = 34.43$, $p < .001$, $d = 0.69$ TOWRE-PD: $F(1, 25) = 16.20$, $p < .0001$, $d = 0.43$ GORT-4–F: $F(1, 25) = 43.45$, $p < .0001$, $d = 0.72$ GORT-4–C: $F(1, 25) = 1.42$, $p = ns$, $d = 0.10$
Graham et al. (2002) 54 second graders T: Supplemental encoding intervention, $n = 25$ C: Supplemental math intervention, $n = 29$ Teacher–student ratio: Most 1:2 Implemented by: Education graduate students Duration: 48 twenty-minute lessons 3 times/week for 16 weeks for a total of 16 hours	Spelling subtest of the Wechsler Individual Achievement Test (3rd ed.; WIAT-3; Wechsler, 1992) Predictable Words subtest (P) of the Test of Written Spelling (TWS-3; Larsen & Hammill, 1994) Non-Predictable Words subtest (NP) of TWS-3 WRMT, WA (Woodcock, 1987) WJ-R Writing Fluency subtest (WJ-R-WRF; Woodcock & Johnson, 1990)	ANCOVA analyses with pretest as the covariate favored the T group on all measures at posttest: WIAT-3–S: $F(1, 27) = 5.35$, $MSE = 41.06$, $p = .03$, $d = 0.81$ TWS-3–P: $F(1, 27) = 16.25$, $MSE = 20.91$, $p = .00$, $d = 0.91$ TWS-3–NP: $F(1, 27) = 4.26$, $MSE = 35.24$, $p = .05$, $d = 0.63$ WA: $F(1, 27) = 9.99$, $MSE = 63.96$, $p < .01$, $d = 0.99$ WJ-R-WRF: $F(1, 27) = 5.31$, $MSE = 68.66$, $p < .03$, $d = 0.62$ Overall pooled effect size at posttest: $d = 0.79$ ANCOVA analyses with pretest as the covariate favored the T group on all measures at maintenance: WIAT-3–S: $F(1, 24) = 6.41$, $MSE = 63.53$, $p = .02$, $d = 0.90$

(continued)

TABLE 1 (continued)

Intervention and duration	Dependent measures	Findings and results
		TWS-3–P: $F(1, 24) = 10.43$, $MSE = 10.50$, $p = .01$, $d = 0.99$ TWS-3–NP: $F(1, 24) = 4.38$, $MSE = 55.44$, $p = .05$, $d = 0.70$ WA: $p > .05$; $d = 0.47$[b] WJ-R-WRF: $p > .05$; $d = 0.60$[b]
Mathes et al. (2005) 252 at-risk first graders T1: Early interventions in reading + enhanced classroom instruction (EIR); $n = 80$ T2: Responsive reading + enhanced classroom instruction (RR); $n = 83$ C: Enhanced classroom instruction with teachers that used progress-monitoring to plan for differentiated instruction (EC); $n = 82$ Teacher–student ratio: 1:3 Implemented by: Certified teachers Duration: 175 forty-minute lessons 5 days/week for a total of 117 hours over 9 months	CTOPP (Wagner et al., 1999)—subtests included in single scaled score for phonological awareness: First Sound Comparison, Blending Onset Rime, Blending Words, Blending Nonwords, and Phoneme Elision TOWRE, SWE (Torgesen et al., 1999) TOWRE, PD WJ-R WA (Woodcock & Johnson, 1990) WJ-R Word Identification subtest (WJ-R-WID) WJ-R PC WJ-R Word Fluency subtest (WF; Woodcock & Johnson, 1990) WJ-R S Comprehensive Assessment of Reading Battery Revised for First Grade (CRAB-R-C; Mathes et al., 1998); administered only to students with a raw score of 5 or more on the WJ-R-PC subtest Fluency Assessment (CRAB-R-F); administered only to students with a raw score of 5 or more on the WJ-R-PC subtest	EIR vs. EC (CRAB-R-C) $t(304) = 0.79$, $d = 0.13$ *ns* EIR vs. EC (CRAB-R-F) $t(269) = 1.66$, $d = 0.26$ *ns* EIR vs. EC (WJ-R-PC) $t(305) = 1.36$, $d = 0.21$ *ns* EIR vs. EC (WJ-R-S) $t(305) = 3.31$, $d = 0.53$, $p < .01$ EIR vs. EC (WJ-R-WF) $t(262) = 0.00$, $d = 0.00$ *ns* EIR vs. EC (WJ-R-WA) $t(303) = 4.01$, $d = 0.63$, $p < .001$ EIR vs. EC (WJ-R-WID) $t(305) = 3.31$, $d = 0.52$, $p < .001$ RR vs. EC (CRAB-R-C) $t(304) = 1.62$, $d = 0.26$ *ns* RR vs. EC (CRAB-R-F) $t(269) = 1.76$, $d = 0.28$ *ns* RR vs. EC (WJ-R-PC) $t(305) = 1.95$, $d = 0.30$ *ns* RR vs. EC (WJ-R-S) $t(305) = 2.36$, $d = 0.53$, $p < .05$ RR vs. EC (WJ-R-WF) $t(262) = 1.29$, $d = 0.22$ *ns* RR vs. EC (WJ-R-WA) $t(303) = 1.53$, $d = 0.24$ *ns* RR vs. EC (WJ-R-WID) $t(305) = 2.36$, $d = 0.37$ $p < .05$ EIR vs. RR (CRAB-R-C) $t(304) = -0.79$, $d = 0.12$ EIR vs. RR (CRAB-R-F) $t(269) = -0.09$, $d = 0.01$ EIR vs. RR (WJ-R-PC) $t(305) = -0.54$, $d = 0.08$ *ns* EIR vs. RR (WJ-R-S) $t(305) = 0.97$, $d = 0.01$ *ns* EIR vs. RR (WJ-R-WF) $t(262) = -1.29$, $d = 0.22$ EIR vs. RR (WJ-R-WA) $t(303) = 2.45$, $d = 0.38$, $p < .05$ EIR vs. RR (WJ-R-WID) $t(305) = 0.97$, $d = 0.15$ *ns* Overall pooled effect size at posttest: $d = 0.34$ Growth curve analysis for all groups:

(continued)

TABLE 1 (continued)

Intervention and duration	Dependent measures	Findings and results
		CTOPP intercept $F(3, 85) = 15.71$, $p < .001$ CTOPP slope $F(3, 1431) = 29.25$, $p < .001$ TOWRE-SWE intercept $F(3, 85) = 36.08$, $p < .001$ TOWRE-SWE slope $F(3, 1431) = 4.53$, $p < .05$ TOWRE-PD intercept $F(3, 85) = 18.11$, $p < .001$ TOWRE-PD slope $F(3, 1431) = 2.14$, $p = .09$ *ns*
Roberts and Meiring (2006) 55 first graders in two classrooms S1: (first year) phonics instruction embedded in encoding; $n = 27$ S2: (follow-up 4 years later) $n = 16$ L1: (first year) phonics instruction embedded in literature: $n = 28$ L2: (follow-up 4 years later) $n = 23$ Teacher–student ratio: 1:27; 1:28 Implemented by: Classroom teachers Duration: 83 twenty-minute lessons from September to February of 1st grade year for a total of 27.7 hours Time I: October of 1st grade Time II: February of 1st GradeTime III: Maintenance May of 1st grade Time IV: 5th grade year–follow-up	Reading Comprehension subtest of Metropolitan Achievement Test (MAT; Prescott, Balow, Hogan, & Farr, 1978) Researcher developed spelling tasks: Phonetically Regular Real Words (SPRRW) Phonetically Regular Pseudowords (SPRP) High Frequency Sight Words From Basal (SHFS) Researcher developed reading tasks: Reading Phonetically Regular Pseudowords (RPRP) Reading Words in a Familiar Story (RWFS) Reading Words Out of Context (RWOC) Reading Words in an Unfamiliar Story (RWUS) Researcher developed untimed tasks:Writing Fluency (WF)	At initial posttest: results favored the S_1 group SPRRW–Time II $d = 1.10$[b] Time III $d = 0.51$[b] SPRP–Time II $d = 1.11$[b] Time III $d = 0.81$[b] RPRP–Time II $d = 0.68$[b] Time III $d = 0.64$[b] WF–Time III $d = 0.45$[b] At initial posttest: No statistically significant differences between groups with SHFS, MAT, RWFS, RWOC, or RWUS Overall pooled effect size at posttest: $d = 0.74$ Follow-up results at Time IV favored the S2 group over the L2 group: MAT $F(1, 38) = 5.53$, $p = .02$, $d = 0.73$

(continued)

TABLE 1 (continued)

Intervention and duration	Dependent measures	Findings and results
Santa and Hoien (1999) 49 at-risk first graders T: Early Steps—included word study and writing; $n = 23$ C: Guided reading instruction; $n = 26$ Teacher–student ratio: 1:1 Implemented by: Classroom teachers and Title I tutors Duration: 175 thirty-minute lessons; 5 days/week for 35 weeks for a total of 87.5 hours over 9 months Follow-up: Assessments were in September of 2nd Grade	WRMT, WA (Woodcock, 1987), given only at follow-up WRMT, LWID WRMT, PC Spelling assessment: Researcher made list with rubric modified to account for both phonemic and orthographic properties of the students' spelling (internal reliability $r = .94$ [Cronbach's α] and interrater reliability $r = .99$, $p < .001$)	Posttest: assessments results favoring T group: Spelling: $t(47) = 2.067$, $p < .05$, $d = 0.60$ LWID: $t(47) = 3.233$, $p < .005$, $d = 0.92$ PC: $t(47) = 2.523$, $p = .05$, $d = 0.74$ Overall pooled effect size at posttest: $d = 0.65$ Follow-up: assessments favoring the T group LWID: $t(36) = 6.29$, $p < .05$, $d = 0.58$ WA: $F(1, 36) = 14.757$, $p < .001$, $d = 1.17$ PC: $F(1, 36) = 5.678$, $p < .005$, $d = 0.89$
Uhry and Shepherd (1993) 22 first graders T: Encoding intervention, $n = 11$C: Math intervention, $n = 11$ Teacher–student ratio: 1:6 or 1:5 Implemented by: The first author (Uhry) and a trained graduate student Duration: 52 twenty-minute lessons/2 times per week for 6.5 months for a total of about 17.3 hours	WRMT, WA (Woodcock, 1987) WRMT, Nonsense Word Fluency subtest (NWF) WRMT, LWID GORT (Gray & Robinson, 1967) Spellmaster Diagnostic Tests (Greebaum, 1987)	Treatment groups pre–post gains over contrast group: WA: $t(20) = 3.237$, $p = .0041$, $d = 2.15$ NWF: $t(20) = 4.366$, $p = .0003$, $d = 1.86$ LWID: $t(20) = 2.866$, $p = .0095$, $d = 1.22$ GORT: $t(20) = 1.691$, $p > .05$, $d = 0.72$ For Spellmaster Tests: using pretest score as a covariate Test I: CVC Words:$F(1, 19) = 2.27$, $p = .149$, $\eta^2 = \mathbf{.11}$, $d = 0.62$ Test II: CCVC/CVCC Words:$F(1, 19) = 4.50$, $p = .047$, $\eta^2 = \mathbf{.19}$, $d = 0.92$ Tests III and IV: Word Lists:$F(1, 19) = 6.14$, $p = .02$, $\eta^2 = .24$, $d = 1.54$ Overall pooled effect size at posttest: $d = 1.15$ Repeated measures ANOVAs (× 4 times) WA: $F(1, 20) = 5.80$, $p = .026$, $\eta^2 = .22$ NWF: $F(1, 20) = 5.26$, $p = .033$, $\eta^2 = .21$ LWID: $F(1, 20) = 1.08$, $p = .312$, $\eta^2 = .05$ GORT: $F(1, 20) = 0.42$, $p = .523$, $\eta^2 = .02$, $\eta^2 = .24$

(continued)

TABLE 1 (continued)

Intervention and duration	Dependent measures	Findings and results
Vandervelden and Siegel (1997) 29 kindergarteners T: Letter–sound and encoding intervention; $n = 14$ at posttest C: Typical classroom instruction; $n = 15$ Teacher–student ratio: 1:1 (3 lowest scoring—30-minute sessions); 1:2 (8 next lowest s coring—45-minute sessions), 1:4 (4 highest scoring—30-minute sessions) Implemented by: A certified teacher (not the class-room teacher)	Researcher developed phonological recording tasks—alternate forms given at pre- and posttest: Speech-to-Print Matching (SPM) Speech-to-Print Pseudoword Matching (SPPM)—posttest only Spelling (Spell) Pseudoword Reading (PR) Researcher developed phonemic awareness and letter knowledge tasks—alternate forms given at pre- and posttest: Initial Phoneme Recognition (IPR) Final Phoneme Recognition (FPR)	Results favored the T group in all measures: Phonological recording tasks: SPM $F(1, 27) = 2.97$, $p < .006$, $d = 1.10$ SPPM $F(1, 27) = 3.97$, $p < .001$, $d = 1.80$ Spell $F(1, 27) = 3.07$, $p < .005$, $d = 1.14$ PR $F(1, 27) = 2.17$, $p = ns$, $d = 0.58$ Phonemic awareness and letter knowledge: IPR $F(1, 27) = 9.5$, $p < .005$, $d = 0.81$ FPR $F(1, 27) = 12.87$, $p < .001$, $d = 0.93$ CPR $F(1, 27) = 11.15$, $p < .001$, $d = 0.92$ LSR $F(1, 27) = 9.28$, $p < .005$, $d = 1.04$
Duration: 24 lessons/2 times per week for 12 weeks for a total of 12–18 hours	Complex Phoneme Recognition (CPR) Letter–Sound Recognition (LSR) Researcher developed reading tasks—alternate forms given at pre- and posttest: WR Naming Letter Task (NLT) Text Fingerpoint Reading (TFR) Key Words Fingerpoint Reading (KWFR)	Reading tasks:WR $F(1, 27) = 0.37$, $p = ns$, $d = 0.05$ NLT $F(1, 27) = 2.85$, $p < .05$, $d = 1.01$ TFR $F(1, 27) < 1$, $p = ns$, $d = 0.14$ KWFR $F(1, 27) < 1$, $p = ns$, $d = 0.57$ Overall pooled effect size at posttest: $d = 0.81$

Note. C = contrast group; T = treatment group; T1 = treatment group 1; T2 = treatment group 2; G = group; d = Cohen's d effect size based on pre- and posttest mean differences; *ns* = not statistically significant.

a. No effect size reported—not enough information to calculate effect size.

b. F values were not reported.

(2004) conducted a randomized intervention study where treatment students received tutoring sessions that included explicit and systematic instruction that was intended to help students develop an understanding of the phonologic and orthographic connections in words. Lessons included the following steps: (a) the introduction and review of letter–sound correspondences; (b) manipulating and building words using sound boards, tiles, and letter cards; (c) fluency exercises of reading the words that were built on flash cards and in connected text; and (d) the writing of practiced sounds and words in dictation activities. The contrast group received typical reading resource supplemental instruction. After 8 months, the treatment group had outperformed the contrast group in all areas of reading and encoding, with Cohen's *d* effect sizes ranging from 0.55 to 0.99. Differential growth curve analyses (Bryk & Raudenbush, 1992) during the treatment year also favored the treatment group in all areas. In addition, and without any continued intervention, the treatment group still outperformed the contrast group at a follow-up assessment, with Cohen's *d* effect sizes ranging from 0.23 to 0.81 and thus suggesting that the treatment from the previous year still gave these students an advantage over their peers who did not receive the intervention.

Denton, Fletcher, Anthony, and Francis (2006) examined the effects of providing an intensive Tier III reading intervention to special education students who did not make adequate progress during the first grade. During the first year of this study, the treatment group received the Phono-Graphix intervention (McGuiness, McGuiness, & McGuiness, 1996) that focuses on the nature of the English phoneme–grapheme system, allocating approximately 75% of the instructional time on encoding instruction. The contrast group continued to receive the typical special education reading program. Posttest analyses showed that students in the intervention group outperformed the contrast group on measures of word attack, letter–word identification, word reading fluency, phonemic decoding fluency, sight word efficiency, encoding, and comprehension, with Cohen's *d* effect sizes ranging from 0.29 to 1.77.

During the second phase of the study, students in the treatment group received a fluency intervention (i.e., Read Naturally; Ihnot, Mastoff, Gavin, & Hendrickson, 2001) which focused on improving oral reading fluency with a model. The contrast group received a Phono-Graphix intervention identical to the treatment group's initial treatment. At the end of this intervention phase, the original intervention group still demonstrated better performance in most areas except in word attack and reading comprehension. Cohen's *d* effect sizes ranged of 0.06 to 0.72, with measures of sight word reading fluency and passage fluency rates demonstrating larger Cohen's *d* effect sizes after the Read Naturally intervention (0.69 and 0.72, respectively).

Mathes et al. (2005) set out to determine if enhanced classroom reading instruction in combination with a small-group intervention would be more effective for at-risk first grade struggling readers than enhanced classroom instruction. They compared two intervention programs—one with a predetermined scope and sequence and fully specified lesson plans (i.e., Proactive Early Interventions in Reading [PEIR]; Mathes, 2005) and one in which teachers responded to the observed needs of each child (i.e., Responsive Reading Instruction [RRI]; Denton & Hocker, 2006) to enhanced classroom instruction. Students were randomly assigned within their schools to receive enhanced classroom instruction only or enhanced instruction with the addition of either PEIR or RRI. Enhanced classroom teachers received continuous monitoring data and workshops on interpreting these results to inform instruction.

Both interventions included manipulating and writing letters to help students understand the relationship of the alphabetic principle. An analysis of PEIR lessons determined that teachers spent approximately 36% of their instructional time teaching letter–sound correspondences by manipulating printed letters, letter–sound dictation, encoding dictation, and writing activities. These skills were then applied to the reading of words in isolation and decodable text. In all, 30% to 35% of RRI time focused on the application of phoneme–grapheme correspondences to the alphabetic principle by using encoding strategies to "build words" with magnetic letters, as well as other writing sentences as they received instruction in applying the alphabetic principle to write phoneme–grapheme correspondences.

On assessments of reading-related skills administered every 2 months during the intervention, both PEIR and RRI groups grew more rapidly than the enhanced classroom. The PEIR group also grew more rapidly than the RRI group in phonological awareness and more rapidly than the enhanced classroom group on word reading fluency and nonword reading fluency. In the analysis of end-of-year outcomes, both intervention groups scored significantly higher than the enhanced classroom group on word reading accuracy and encoding. Cohen's *d* effect sizes for the PEIR treatment compared to the enhanced classroom group ranged from 0.00 to 0.63 ($M = 0.34$, $SE = 0.06$). Cohen's *d* effect sizes for RRI compared to the enhanced classroom group ranged from 0.17 to 0.53 ($M = 0.30$, $SE = 0.06$).

Santa and Hoien (1999) evaluated Early Steps (Morris, Shaw, & Perney, 1990), an early intervention program that provides one-to-one intensive intervention for struggling readers. Two classrooms received decoding and encoding instruction that included the following activities: word study aimed at remediating deficits in phonological processing, developing sight-word reading skills, teaching metacognitive strategies for reading and encoding new words, and applying these skills through word study, guided reading, and writing. Students in the two comparison classrooms also received traditional daily intervention in small groups of students with a similar ability. The contrast intervention provided only incidental instruction in the alphabetic principle and no explicit encoding instruction. The intervention consisted of guided reading of a level-appropriate text followed by repeated reading of the text in pairs and then independently. After 35 weeks of intervention, the treatment group scored significantly higher than did the comparison group on all posttest measures, with Cohen's *d* effect sizes ranging between 0.60 and 0.92. Of students in the treatment group, 52% were reading at or above grade level at posttest, compared to 24% of students in the comparison group. Regression analyses showed that encoding performance contributed significantly to explaining the variance in the dependent variables (i.e., word reading accuracy, passage comprehension, and encoding). On the follow-up assessment at the beginning of the next school year, using encoding pretest scores as a covariate, the intervention group again scored significantly higher than the comparison group on all measures. Effect sizes ranged from 0.59 to 0.91 at posttest and from 0.57 to 1.15 on standardized measures at follow-up.

Studies Including Specific Encoding Interventions

Four intervention studies focused on the implementation of instructional encoding techniques to improve the spelling performances of struggling students.

Although the encoding programs were different in implementation, they all included direct, explicit encoding instruction and guided practice of applying the alphabetic principle through writing. First, Christensen and Bowey (2005) researched the efficacy of two encoding interventions to an implicit phonics approach with increasing first graders' word recognition, decoding speed, encoding, and comprehension skills. One of the treatment groups received tutoring sessions that included direct, explicit encoding instruction involving learning and writing phoneme–grapheme correspondences and guided practice in encoding words with these correspondences to enhance their phonemic awareness and alphabetic understanding. The second treatment group received an explicit encoding intervention that focused on onset rime patterns. A contrast group was provided implicit phonics instruction that did not include encoding instruction. At posttest, students in both treatment groups outperformed the contrast condition on all measures, with moderate to very large effect sizes ranging from 0.62 to 1.56. The phoneme–grapheme group, however, was superior to the onset rime condition on reading accuracy and text comprehension, with effect sizes of 1.44 and 1.53, respectively.

Graham, Harris, and Chorzempa (2002) also examined the effects of supplemental encoding instruction on the spelling and reading performances of second graders (40% of which were identified as having a learning, speech, or behavioral disability). This study included a treatment group that received supplemental lessons that concentrated on syllable pattern skills, grapheme–phoneme correspondences, word sorting, word building, and word dictation activities. Results were compared to a contrast group that received supplemental math instruction. All students received their normal language arts core instruction.

Students with and without disabilities in the supplemental encoding condition made greater improvements than the contrast group on norm-referenced spelling and reading measures and with a sentence writing fluency test. Students in the encoding condition improved their normative standing on several subtests, with significant differences favoring the treatment group and with effect sizes ranging from 0.62 to 0.99. Students in the treatment condition also outperformed the contrast group on a researcher developed spelling progress monitoring assessment of untaught words composed of patterns and phoneme–grapheme correspondences taught during the intervention, $t(53) = 8.136$, $p < .0001$, $d = 2.20$. Outcome differences were maintained 6 months following treatment on measures of spelling and word recognition, with mean differences and Cohen's d effect sizes ranging from 0.70 to 0.99 over the remaining contrast students. Statistical significance was not reached at maintenance for measures of writing fluency and the word attack, although Cohen's d effect sizes were still respectable (0.60 and 0.48, respectively).

Roberts and Meiring (2006) conducted a quasiexperimental study comparing two conditions of first grade phonics instruction. In the first condition, students were taught explicit phonics through letter–sound correspondences and explicit encoding instruction, with an emphasis on phonological processing while encoding. The second condition taught phonics embedded in literature with no explicit encoding instruction. At posttest, the explicit phonics and encoding group had considerably greater outcomes than the contrast group in measures of spelling phonetically real and phonetically regular pseudowords, reading of phonetically regular pseudowords, and writing fluency with moderate to large Cohen's d effect sizes, ranging from 0.45 to over 1.0. Although there were no significant differences between groups in comprehension, a follow-up assessment 4 years later indicated that students in the explicit phonics and encoding condition had an early advantage in applying letter–sound correspondence knowledge to word reading and encoding that had migrated to facilitating comprehension processes in fifth grade ($d = 0.64$) even though students received no further explicit phonics and encoding instruction. Regression analysis showed that encoding phonetically regular words and encoding sight words in first grade were the two independent predictors of fifth-grade comprehension, accounting for between 6% and 8% of the variance when intercorrelations between phonics and other variables were removed.

Uhry and Shepherd (1993) investigated whether supplemental instruction in isolating sounds in words (i.e., phoneme segmenting) and representing these sounds with letters (i.e., encoding) would have positive effects on struggling first graders' reading performance. Experimental participants received supplemental encoding instruction and guided practice on how to segment, blend, and spell phonetically regular words using phoneme–grapheme combinations. The contrast group received more of their classrooms' traditional approach that placed more emphasis on using letter names as cues to assist with decoding connected text. Students in the treatment groups made significantly greater gains than did the contrast group in posttest assessments, including reading nonsense words, reading real words, oral reading fluency, and encoding, with Cohen's *d* effect sizes ranging from 0.65 to 2.15. Repeated measures ANOVAs of word attack and nonsense word fluency also showed strong effects favoring the treatment group, with η^2 values ranging from .21 to .22. Although not all of the spelling measures achieved statistical significance, Cohen's *d* effect sizes favoring the encoding group were robust, ranging from 0.65 to 0.83.

Studies That Included Encoding Strategies With Phonemic Awareness Instruction

Three experimental–control studies using encoding instruction to supplement phonological processing and phonemic awareness instruction were found. These interventions used letters to support phonological processing, phonemic awareness, decoding, and encoding performance that were mainly focused on the manipulating and/or mapping of phoneme–grapheme correspondences. These studies also included explicit encoding instruction and guided practice to spell and write words using their sound–letter relationships to supplement and improve students' phonological processing and phonemic awareness knowledge.

Blachman et al. (1994) tested an intervention delivered by classroom teachers in small groups during their normal reading language arts block. The treatment condition received about 10 hours of small-group explicit instruction in (a) manipulating tiles (and later actual letters) during a say-it and move-it phonemic awareness activity, (b) direct phonemic instruction that included segmentation-related skills (as designed by Elkonin, 1973), and (c) grapheme–phoneme instruction involving eight letters that could be used to encode various words and nonwords (i.e., *a*, *m*, *t*, *i*, *s*, *r*, *f*, *b*). Treatment students also participated in occasional Bingo games where students matched the dictated sounds to their corresponding letters. All of these activities used tiles and/or letters to supplement the phonemic awareness instruction for the treatment students. The contrast group received supplemental small-group instruction using their school's typical basal reading instruction that did not incorporate either the manipulation of sounds and letters or any encoding practice. After this short intervention, students in the treatment condition, on average, outperformed the contrast students on measures of phonemic awareness, letter name and letter sound fluency, word reading of real and nonwords, and spelling, with mean differences favoring the treatment group and Cohen's *d* effects ranging from 0.29 to 1.26.

Blachman, Tangel, Ball, Black, and McGraw's (1999) study involved a 2-year intervention delivered to low-income, inner-city kindergarten students in regular classrooms by their classroom teachers. Treatment students' supplemental small-group phonological and phonemic awareness instruction connected to the alphabetic principle and included manipulation of letters to map sounds to print. Contrast group students received small-group supplemental instruction using the district's traditional basal program in which all phonemic awareness activities were done orally, without any manipulatives or letters. During the following year, all participants were exposed to their district's phonetically based spelling program that focused on phonetically regular short and long vowels, initial blends, and digraphs. Treatment students, however, received additional daily instruction in a reading program that emphasized explicit, systematic instruction in the alphabetic principle and encoding (i.e., Road to the Code; Blachman et al., 2000). This program included encoding practice in connecting letters to sounds, letter-by-letter blending strategies, manipulating letters to make words on a sound board, reading text that was phonetically decodable, and daily writing of words through dictation. Treatment participants were also introduced to the six syllable types (see Moats, 2010) to develop accurate and automatic word recognition skills. Contrast first graders received additional implicit phonics instruction using the district's basal reading program. At the end of first grade, posttest results indicated that the treatment group had statistically significantly outperformed contrast students, with Cohen's *d* effect sizes ranging from 0.46 to 1.23 on measures of spelling, decoding, phonemic awareness, and letter–word identification.

Last, Vandervelden and Siegel (1997) evaluated a kindergarten intervention designed to facilitate the use of grapheme–phoneme relationships and application of the alphabetic principle. The intervention included using plastic letters during phoneme awareness instruction activities, guided encoding activities that included grapheme–phoneme correspondences instruction, and encoding frames similar to those used in the Elkonin program (Elkonin, 1973). Students in the contrast group received oral phonemic awareness instruction. After the short intervention, results favored the treatment group on measures of phoneme awareness, letter naming, speech-to-print word matching speech-to-print pseudoword matching, and spelling, with Cohen's *d* effect sizes ranging from 0.83 to 1.80. A measure of pseudoword reading did not reach statistical significance, but the resulting 0.58 effect size was still respectable.

Discussion

Theoretical Implications of the Research Findings

This synthesis was initiated on the basis of interrelated connectionist theories of reading: Adams's (1990) connectivity theory, Ehri's (1997, 1998, 2000) connectionist theory of the reciprocal nature of reading and encoding, and Hatcher et al.'s (1994) phonological linkage theory. Together, these theories suggest that the processes involved in encoding and decoding are synergistic in nature. If this is true, then incorporating encoding instruction during phonemic awareness and decoding activities should support students' literacy performances.

The practical intent was to examine if benefits were attained from encoding instruction that made phoneme–grapheme relationships and patterns within words more concrete for students and whether there was growth in developing students' fully specified orthographic representations of words, both of which are necessary in learning to read and spell. Results from studies that met inclusion standards for best-evidence standards did indicate that struggling readers and spellers receiving encoding instruction integrated with decoding instruction were indeed able to make significant gains in phoneme awareness, alphabetic decoding, word reading, spelling, fluency, and comprehension. These experimental intervention studies included the guided practice of manipulating phonemes within words and direct encoding instruction of encoding words with these phoneme–grapheme combinations. Adding encoding instruction and activities to early reading interventions allowed students to use previously taught phonemes to practice letter–sound correspondences, blending, segmenting, encoding, and writing skills to improve reading and spelling performance. Also, explicit encoding instruction, which requires close attention to detail, enabled students to develop more detailed orthographic representations of words.

Educational Implications

Several instructional implications grow from this best-evidence synthesis. Encoding instruction not only improves students' understanding of the alphabetic principle but also assists in developing phonemic awareness, reading, and spelling skills. Evidence from this synthesis also answers the previously proposed questions concerning the theorized synergy between integrating encoding and decoding instruction to enhance the reading and spelling performances of struggling elementary students.

Encoding instruction to enhance the understanding of the alphabetic principle. Adams (1990) and Moats (1998) suggest that programs that emphasize explicit encoding and decoding instruction in learning grapheme–phoneme relationships have advantages over other early reading programs that do not. In the majority of the included experimental studies, students in the most effective conditions were given guided practice in writing phoneme–grapheme correspondences and encoding instruction to apply these pairings into words blended together with other previously taught sound–letter relationships. Adams claims this encoding and decoding instruction, which allows students to practice the alphabetic principle by including the sequencing of phoneme–grapheme correspondences, is what enables "skillful readers to process the letters of text so quickly and easily" (Adams, 1990, p. 410). Moats also agrees that word recognition develops from pathways from print to meaning and that the improvement of fluency and comprehension depends integrally on the knowledge of sound–spelling correspondences.

The research presented here supports these suppositions. First, instruction from all the included studies using encoding strategies as a context for teaching phoneme–grapheme correspondences, blending, and segmenting had significantly positive practical effects for struggling readers and spellers. It can also be deduced that the awareness of and ability to process the phonological information these students received orally was enhanced by the orthographic form that represents the sounds they were writing (i.e., encoding practice), and this instruction improved their acquisition of the alphabetic principle. In other words, students' ability to process the structure of these orthographic representations was activated by computing encoding and decoding connections between the phoneme–grapheme pairings used in the encodings and pronunciation of printed words. In the 28 subtests given to assess alphabetic understanding (i.e., letter name fluency, letter sound fluency, phonological processing), Cohen's average d effect size was 0.84 (SE = 0.07), favoring treatment students receiving supplemental encoding instruction and thus supporting the necessity of adding encoding instruction to help struggling students better understand the alphabetic principle.

Using encoding instruction to increase phonemic awareness. Current research in this synthesis confirms that encoding and writing experiences enhance phonological processing and phonemic awareness and in turn supports students' reading, writing, and spelling abilities. Three studies in this synthesis examined the role of instruction in mediating the links of adding encoding strategies to phonemic awareness instruction of at-risk and struggling readers to improve reading and spelling performance (Blachman et al., 1994, 1999; Vandervelden & Siegel, 1997). These researchers argue that instruction in phonological and phonemic awareness is most effective in enhancing reading acquisition when explicit links are made with mapping phonemes onto graphemes and that early instruction in the alphabetic principle is essential to all forms of literacy development. They also collectively concluded that struggling readers profit from phonemic awareness instruction that encompasses instruction in phoneme–grapheme relationships, manipulation activities using these correspondences, and practice making and reading words with learned phoneme–grapheme pairs. Perhaps the most convincing evidence for this type of instruction, however, is the strong practical effects that three groups of researchers found when encoding strategies were linked to phoneme awareness instruction. Averaged transfer effects from the integrated phonemic awareness and encoding instruction to improved reading and spelling measures was d = 0.87 (SE = 0.08), thus giving empirical evidence to incorporate encoding instruction during phoneme awareness instruction to boost literacy skills.

Manipulating phoneme–grapheme correspondences to enhance literacy performance. There is a strong association between early instruction in the manipulation, writing, and encoding of phoneme–grapheme correspondences and reading attainment. All of the interventions included in this synthesis used manipulatives in some fashion (e.g., tiles, counters, plastic letters, real letters, and Elkonin boxes), and students were explicitly and systematically taught to manipulate phoneme–grapheme correspondences, which in turn significantly improved their reading and spelling abilities. Posttests of reading and spelling were given in all studies (N = 82 subtests); a total of 69 (84%) had significant effects favoring the treatment group. The average pooled Cohen's d effect size was 0.81 (SE = 0.07), and the average pooled η^2 was .12 (SE = .05), demonstrating that the difference between the groups was large across studies.

Evidence to support the synergistic relationship of using encoding and decoding instruction. Results from this synthesis support the theory that there is a synergy between simultaneous encoding and decoding that helps students make the connections necessary to read and spell. Four supplemental reading intervention studies investigated the benefits of integrating both encoding and decoding instruction to help the reading performances of students at risk for reading difficulties (i.e., Blachman et al., 2004; Denton et al., 2006; Mathes et al., 2005; Santa & Hoien, 1999). For example, the Mathes et al. (2005) study compared two reading interventions that leveraged encoding to improve decoding through explicit integrated encoding and decoding instruction. Students in both treatment groups outscored contrast students at posttest and improved in reading to the point where they were on average reading above average on norm-referenced measures, giving evidence of the benefits of using decoding and encoding together. Likewise, in the Santa and Hoien (1999) study, encoding performances explained significant amounts of the variance in reading, suggesting a reciprocal relationship between reading and encoding. Furthermore, both the Blachman et al. and the Denton et al. studies demonstrated that treatment students maintained their advantage over contrast students a year later. The practical effects of integrating both decoding and encoding instruction to enhance reading and spelling were evident in the magnitude of differences between treatment and contrast groups across the studies. The average Cohen's d effect size for measures of reading was 0.84 (SE = 0.10) and 0.60 (SE = 0.10) for spelling.

The synergistic effect of encoding and decoding instruction was also observed in studies that focused solely on encoding instruction but found simultaneously impacts on decoding (Christensen & Bowey, 2005; Graham et al., 2002; Roberts & Meiring, 2006; Uhry & Shepherd, 1993). These researchers found that encoding instruction helped struggling spellers improve not only their spelling abilities but also their word recognition, alphabetic decoding, fluency, and comprehension performances with an average Cohen's d effect size of 0.84 (SE = 0.12).

The theory that there is synergy between encoding and decoding instruction was also supported by studies focusing exclusively on phonemic awareness (Blachman et al., 1994; Blachman et al., 1999; Vandervelden & Siegel, 1997). Although the main goal of these studies was to improve students' phonological processing skills, these researchers investigated interventions that gave students explicit instruction and practice in encoding words using manipulatives during phonemic awareness activities combined with opportunities to practice decoding these words. Results across these studies showed not only that encoding instruction during phonemic awareness boosted students' phonological processing skills but also that effects were seen in posttest assessments of decoding real and nonwords (mean Cohen's d = 0.70).

Long-term benefits of early encoding instruction. Several studies demonstrated the long-term impact of early encoding instruction and practice (i.e., Blachman et al., 1999, 2004; Graham et al., 2002; Roberts & Meiring, 2006; Santa & Hoien, 1999). When treatment students received early encoding interventions that included the manipulation and/or writing of grapheme–phoneme correspondences, they outperformed contrast students at follow-up assessments, even though these students did not receive any further encoding or decoding intervention. Table 2 contains a summary of these follow-up assessments that, in total, had a pooled Cohen's *d* effect size of 0.63 (*SE* = 0.06). The greatest results were seen in the transfer effects in the constructs of reading words, reading fluency, and the end goal of reading, reading comprehension (with pooled effect sizes of 0.70, 0.70, and 0.66, respectively). Educational implications of these findings further support early encoding instruction to help students at risk for reading difficulties and also the long-term transfer benefits to students' later reading, writing, and spelling performance.

High quality research to support encoding instruction to enhance literacy skills. A total of 11 studies were included in this synthesis because they met best-evidence standards espoused by Gersten et al. (2005), Slavin (1986), and Slavin et al. (2008). Each of these investigations had at least 10 of the recommended 11 essential quality indicators for group experimental and quasiexperimental research, giving evidence that there was sufficient information on the participants, the intervention, the data analyses, and reported effect sizes over the recommended 0.40 for educational research (Gersten et al., 2005). This is important to keep in mind because the studies represent trustworthy sources of evidence, allowing the field to make meaningful decisions about the importance of integrating encoding and decoding when working with struggling readers.

In conclusion, there appears to be quality empirical evidence supporting the integration of encoding instruction to primary grade reading instruction. Explicit encoding instruction appears to be a missing link for students struggling with reading and spelling. Students taught to manipulate and/or map grapheme–phoneme correspondences in these studies made greater improvements in word reading, fluency, comprehension, and spelling over contrast groups, with robust and meaningful effect sizes. This clearly supports the theory of synergy between encoding and decoding instruction and reading and spelling ability in the early grades and with students with learning disabilities. Given the evidence as to the power of providing integrated, explicit encoding and decoding instructions to students who are struggling readers, the question that now needs to be addressed is how to ensure this type of instruction makes its way into today's classrooms.

Limitations

Several known limitations of this synthesis should be reported. First, although an attempt was made to include all current research, we recognize that it is likely some studies could have been overlooked. In addition, including only 11 studies has its limitations and benefits as well. In most cases of educational research, ample investigative research has been conducted to be placed in meta-analyses or in best-evidence syntheses. Prior to this synthesis, the practice of adding encoding instruction to elementary reading programs had not been thoroughly introduced or examined, thus limiting the amount of high-quality research to support using encoding instruction to support students struggling with reading and spelling difficulties. The benefits seen here in these 11 included studies, however, warrant further consideration and future research. Second, issues concerning the amount of time allotted to encoding instruction could not be addressed in the current

TABLE 2

Summary of Cohen's d *effect sizes and pooled effect sizes favoring treatment groups at follow-up*

Intervention	Type	Time of follow-up testing	Letter names, letter sounds	Reading real words	Reading nonwords	Phono-logical awareness	Reading fluency	Comprehension	Spelling	Writing	Total subtests	Pooled effect size (d_p)
Blachman et al. (2004)	Reading	1 year	Yes**	Yes**	Yes**	Yes**	Yes**	Yes**	Yes**		11	0.58
Denton et al. (2006)	Reading	8 weeks		Yes**	Yes**		Yes**	Yes**	Yes**		7	0.33
Santa and Hoien (1999)	Reading	3 months		Yes**	Yes**			Yes**	Yes**		4	0.71
Graham et al. (2002)	Spelling	6 months			Yes**				Yes**	Yes**	5	0.73
Roberts and Meiring (2006)	Spelling	4 years			Yes**			Yes**	*ns*	*ns*	4	0.33
Blachman et al. (1999)	Phone-mic	1 year	*ns*	*ns*	Yes**	*ns*			Yes**		8	0.60
Total no. of subtests			2	8	8	2	3	4	10	2		
Pooled effect size (d_p)			0.25	0.70	0.56	0.27	0.70	0.66	0.52	0.40		

Note. Yes** = statistically significant; yes* = test was not significant, but effect size > 0.30; *ns* = test was not significant and effect size < 0.30; d_p = Cohen's *d* pooled effect sizes. Results include having at least one assessment in each of the measurement categories that reached statistical significance. Some studies gave more than one assessment in some of the categories.

synthesis. Thus, we are unable to discern if there is a preferred balance between time spent with decoding versus encoding instruction. Because of the integrated connectivity between encoding and decoding, it was also impossible to completely separate encoding instruction from decoding instruction, seeing how individuals who write words often read them to check for correctness. Although it may be unclear exactly how much of each intervention session was spent on the manipulation of phoneme–grapheme correspondences and how much time was given to students to practice reading and writing words made of these correspondences, it is clear that any combination was better than no combination.

Although there were a total of 119 posttest and follow-up tests given with the included studies, 41 of these subtests were researcher made (34%), meaning that they possibly had not been used enough to establish reliability and validity. Only one of these subtests (i.e., the Spelling Assessment given by Santa & Hoien, 1999) reported the internal reliability of the researcher made test, and one study solely relied on using researcher made assessments (i.e., Vandervelden & Siegel, 1997). Future research may want to consider using standard, norm-based assessments to give more credibility to the findings, and future meta-analyses and best-evidence syntheses should consider adding this as an essential criterion when reviewing and evaluating studies.

Last, the effect sizes reported in this article provide information about the effectiveness of the experimental encoding interventions in comparison to the instruction, or lack of instruction, provided to contrast groups. Since some students in the experimental groups were taught individually or in small groups, it may not be possible to completely determine whether the impacts were the result of more instruction or a specific type of encoding intervention. Likewise, some of the treatment students were taught by trained implementers, whereas contrast students received the school's traditional intervention or classroom instruction. Again, it is impossible to conclude if results can be solely related to the encoding instruction these students received or to the experience and knowledge of the intervention implementers.

Conclusion

Although there appears to be several ways to enhance phoneme–grapheme relationships and to implement encoding instruction, it should be noted that all of the effective interventions examined in this synthesis share a number of essential elements: early identification of students in need of intervention; explicit and direct instruction in phoneme–grapheme correspondences with actual manipulation of tiles, plastic letters, or real letters; encoding and writing activities of these phoneme–grapheme relationships; word study; and guided practice of manipulating and writing of specifically taught sounds and word patterns. Most importantly, for any intervention or educational program to be effective, phonemic awareness, letter recognition, encoding patterns, phoneme–grapheme correspondences, and individual words must be developed in connection with reading, spelling, and writing experiences that give meaning to print (Adams, 1990; He & Wang, 2009).

The direct and explicit encoding instructional strategies employed in each of these studies produced positive gains for students in both reading and spelling, thus confirming the theorized synergy between encoding and decoding ability. Currently though, most reading curriculums include little or no encoding instruction, and spelling instruction rarely makes any linkage to decoding skills. It appears necessary to include direct and explicit encoding instruction with decoding instruction. Linking the manipulation, writing, and encoding of grapheme–phoneme correspondences with phonemic awareness and word study instruction looks promising for the amelioration of early literacy problems as well as for struggling students experiencing phonological processing, reading, and spelling difficulties.

References

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

Ball, E. W., & Blachman, B. A. (1988). Phonemic segmentation training: Effect on reading readiness. *Annals of Dyslexia, 38*, 208–225.

Berninger, V., Vaughn, K., Abbott, R., Brooks, A., Abbott, S., Rogan, L., . . . Graham, S. (1998). Early intervention for spelling problems: Teaching functional spelling units of varying size with a multiple-connections framework. *Journal of Educational Psychology, 90*, 587–605.

Blachman, B. A., Ball, E. W., Black, R., & Tangel, D. M. (1994). Kindergarten teachers develop phoneme awareness in low-income, inner-city classrooms. *Reading and Writing: An Interdisciplinary Journal, 6*, 1–18.

Blachman, B. A., Ball, E. W., Black, R., & Tangel, D. M. (2000). *Road to the Code: A phonological awareness program for young students*. Baltimore, MD: Brookes.

Blachman, B. A., Schatschneider, C., Fletcher, J. M., Francis, D. J., Clonan, S. M., Shaywitz, B. A., & Shaywitz, S. E. (2004). Effects of intensive reading remediation for second and third graders and a one-year follow up. *Journal of Educational Psychology, 96*, 444–461.

Blachman, B. A., Tangel, D. M., Ball, E. W., Black, R., & McGraw, C. K. (1999). Developing phonological awareness and word recognition skills: A two-year intervention with low-income, inner-city students. *Reading and Writing: An Interdisciplinary Journal, 11*, 239–273.

Bookbinder, G. E. (2002). *Salford Sentence Reading Test*. London, England: Hodder and Soughton.

Bourassa, D. C., & Treiman, R. (2001). Spelling development and disabilities: The importance of linguistic factors. *Language, Speech, and Hearing Services in Schools, 32*, 172–181.

Bryk, A. S., & Raudenbush, S. W. (1992). *Hierarchical linear models: Applications and data analysis methods*. Newbury Park, CA: Sage.

Bus, A., & Van IJzendoorn, M. (1999). Phonological awareness and early reading: A meta-analysis of experimental training studies. *Journal of Educational Psychology, 91*, 403–414.

Christensen, C., & Bowey, J. (2005). The efficacy of orthographic rime, grapheme–phoneme correspondence, and implicit phonics approaches to teaching decoding skills. *Scientific Studies of Reading, 9*, 327–349.

Christo, C., & Davis, J. (2008). Rapid naming and phonological processing as predictors of reading and spelling. *The California School Psychologist, 13*, 7–18.

Cooke, N. L., Slee, J. M., & Young, C. A. (2008). How is contextualized spelling used to support reading in first-grade core reading programs? *Reading Improvement, 45* (1), 26–45.

Cunningham, P., & Cunningham, J. (1992). Making words: Enhancing the invented spelling-decoding connection. *Reading Teacher, 46*, 106–115.

Deno, S., Espin, C., & Maruyama, G. (1985). *Basic Academic Skills Samples (BASS)*. Minneapolis, MN: CES.

Denton, C. A., Fletcher, J. M., Anthony, J. L., & Francis, D. J. (2006). An evaluation of intensive intervention for students with persistent reading difficulties. *Journal of Learning Disabilities, 39*, 447–466.

Denton, C. A., & Hocker, J. L. (2006). *Responsive Reading Instruction: Flexible intervention for struggling readers in the early grades*. Longmont, CO: Sopris West.

Ehri, L. C. (1997). Learning to read and learning to spell are one and the same, almost. In C. A. Perfetti, L. Rieben, & M. Fayol (Eds.), *Learning to spell* (pp. 237–269). Hillsdale, NJ: Erlbaum.

Ehri, L. C. (1998). Grapheme–phoneme knowledge is essential for learning to read words in English. In J. L. Metsala & L. C. Ehri (Eds.), *Word recognition in beginning literacy* (pp. 3–40). Mahwah, NJ: Erlbaum.

Ehri, L. C. (2000). Learning to read and learning to spell: Two sides of a coin. *Topics of Language Disorders, 20*(3), 19–36.

Elkonin, D. B. (1973). Methods of teaching reading. In J. Downing (Ed.), *Comparative reading* (pp. 551–579). New York, NY: Macmillan.

Foorman, B. R., Francis, D. J., Fletcher, J. M., & Lynn, A. (1996). Relation of phonological and orthographic processing to early reading: Comparing two approaches to regression-based, reading-level match designs. *Journal of Educational Psychology, 88*, 639–652.

Foorman, B. R., Francis, D. J., Fletcher, J. M., Schatschneider, C., & Mehta, P. (1998). The role of instruction in learning to read: Preventing reading failure in at-risk students. *Journal of Educational Psychology, 90*, 37–55.

Foorman, B. R., Schatschneider, C., Eakin, M. N., Fletcher, J. M., Moats, L. C., & Francis, D. J. (2006). The impact of instructional practices in grades one and two on reading and spelling achievement in high poverty schools. *Contemporary Educational Psychology, 31*, 1–29.

Gall, J. P., Gall, M. D., & Borg, W. R. (2005). *Applying education research: A practical guide* (5th ed.). Boston, MA: Pearson.

Gersten, R., Fuchs, L. S., Compton, D., Coyne, M., Greenwood, C., & Innocenti, M. (2005). Quality indicators for group experimental and quasi-experimental research in special education. *Exceptional Students, 71*, 149–164.

Glass, G. V., McGaw, B., & Smith, M. L. (1981). *Meta-analysis in social research*. Beverly Hills, CA: Sage.

Grace, K. E. (2007). *Phonics and spelling through phoneme–grapheme mapping*. Longmont, CO: Sopris West.

Graham, S. (2000). Should the natural learning approach replace spelling instruction? *Journal of Educational Psychology, 92*, 235–247.

Graham, S., Harris, K. R., & Chorzempa, B. F. (2002). Contribution of spelling instruction to the spelling, writing, and reading of poor spellers. *Journal of Educational Psychology, 94*, 669–686.

Graham, S., Harris, K. R., & Fink-Chorzempa, B. R. (2003). Extra spelling instruction: Promoting better spelling, writing, and reading performance right from the start. *Teaching Exceptional Students, 35*(6), 66–68.

Gray, W. S., & Robinson, H. M. (1967). *GORT: Gray Oral Reading Test*. Indianapolis, IN: Bobbs-Merrill.

Greebaum, C. R. (1987). *Spellmaster Diagnostic Tests*. Austin, TX: Pro-Ed.

Groff, P. (2001). Teaching phonics: Letter-to-phoneme, phoneme-to-letter, or both? *Reading & Writing Quarterly, 17*, 291–306.

Hatcher, P. J., Hulme, C., & Ellis, A. W. (1994). Ameliorating early reading failure by integrating the teaching of reading and phonological skills: The phonological linkage hypothesis. *Student Development, 65*, 41–57.

He, T., & Wang, W. (2009). Invented spelling of EFL young beginning writers and its relation with phonological awareness and grapheme–phoneme principles. *Journal of Second Language Writing, 18*, 44–56.

Huck, S. W. (2008). *Reading statistics and research*. Boston, MA: Pearson.

Ihnot, C., Mastoff, J., Gavin, J., & Hendrickson, L. (2001). *Read Naturally*. St. Paul, MN: Read Naturally.

Jastak, S., & Wilkinson, G. S. (1984). *Wide range achievement test—Revised*. Wilmington, DE: Jastak Associates Inc.

Joshi, R. M., Treiman, R., Carreker, S., & Moats, L. C. (2008). How words cast their spell: Spelling is an integral part of learning the language, not a matter of memorization. *American Educator, 32*(4), 6–16, 42–43.

Larsen, S. C., & Hammill, D. D. (1994). *Test of Written Spelling–3*. Austin, TX: Pro-Ed.

Mathes, P. G. (2005). *Proactive Early Interventions in Reading*. Columbus, OH: SRA/McGraw-Hill.

Mathes, P. G., Denton, C. A., Fletcher, J. M., Anthony, J. L., Francis, D. J., & Schatschneider, C. (2005). The effects of theoretically different instruction and student characteristics on skills of struggling readers. *Reading Research Quarterly, 40*, 148–182.

Mathes, P. G., Howard, J. K., Allen, S., & Fuchs, D. (1998). Peer-assisted learning strategies for first-grade readers: Making early reading instruction more responsive to the needs of diverse learners. *Reading Research Quarterly, 33*, 62–94.

McGuiness, C., McGuiness, D., & McGuiness, G. (1996). Phono-Graphix: A new method for remediation of reading difficulties. *Annals of Dyslexia, 46*, 73–96.

Mehta, P., Foorman, B. R., Branum-Martin, L., & Taylor, P. W. (2005). Literacy as an unidimensional construct: Validation, sources of influence, and implications in a longitudinal study in grades 1 to 4. *Scientific Studies of Reading, 9*, 85–116.

Moats, L. C. (1998). Teaching decoding. *American Educator, 22*(1), 42–49.

Moats, L. C. (2005). How spelling supports reading and why it is more regular and predictable than you may think. *American Educator, 29*(4), 12–22, 42–43.

Moats, L. C. (2009a). *LETRS Module 2—The speech sounds of English: Phonetics, phonology, and phoneme awareness* (2nd ed.). Longmont, CO: Sopris West.

Moats, L. C. (2009b). *LETRS Module 3—Spellography for teachers: How English spelling works* (2nd ed.). Longmont, CO: Sopris West.

Moats, L. C. (2010). *Speech to print: Language essentials for teachers*. Baltimore, MD: Brookes.

Morris, D., Shaw, B., & Perney, J. (1990). Helping low readers in grades 2 and 3: An after-school volunteer tutoring program. *Elementary School Journal, 91*, 133–150.

National Institute of Child Health and Human Development. (2000). *Report of the National Reading Panel: Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction* (NIH Pub. No. 00–4754). Washington, DC: Government Printing Office.

Perfetti, C. A. (1997). The psycholinguistics of spelling and reading. In C. A. Perfetti, L. Rieben, & M. Royol (Eds.), *Learning to spell* (pp. 21–38). Hillsdale, NJ: Erlbaum.

Pinnell, G. S., & Fountas, I. C. (1998). *Word matters: Teaching phonics and spelling in the reading and writing classroom*. Portsmouth, NH: Heinemann.

Prescott, G., Balow, I., Hogan, T, & Farr, R. (1978). *Metropolitan achievement tests: Basic survey battery*. San Antonio, TX: The Psychological Corporation.

Richardson, E., & DiBenedetto, B. (1985). *Decoding Skills Test*. Parkton, MD: York Press.

Ritchey, K. (2008). The building blocks of writing: Learning to write letters and spell words. *Reading and Writing: An Interdisciplinary Journal, 21*, 27–47.

Roberts, T. A., & Meiring, A. (2006). Teaching phonics in the context of students' literature or spelling: Influences on first-grade reading, spelling, and writing and fifth grade comprehension. *Journal of Educational Psychology, 98*, 690–713.

Santa, C. M., & Hoien, T. (1999). An assessment of Early Steps: A program for early intervention of reading problems. *Reading Research Quarterly, 34*, 54–79.

Santoro, L. E., Coyne, M. D., & Simmons, D. C. (2006). The reading–spelling connection: Developing and evaluating a beginning spelling intervention for students at risk of reading disability. *Learning Disabilities Practice, 21*, 122–133.

Simmons, D. C., Coyne, M. D., Kwok, O., McDonagh, S., Harn, B. A., & Kame'enui, E. J. (2008). Indexing response to intervention: A longitudinal study of reading risk from kindergarten through third grade. *Journal of Learning Disabilities, 41*, 158–173.

Slavin, R. E. (1986). Best-evidence synthesis: An alternative to meta-analytic and traditional reviews. *Educational Researcher, 15*, 5–11.

Slavin, R. E., Cheung, A., Groff, C., & Lake, C. (2008). Effective reading programs for middle and high schools: A best-evidence synthesis. *Reading Research Quarterly, 43*, 290–322.

Snow, C. E., Burns, M. S., & Griffin, P. (Eds.). (1998). *Preventing reading difficulties in young students*. Washington, DC: National Academy Press. Retrieved from http://books.nap.edu/openbook.php?record_id=6023

Stone, C. A., Siliman, E. R., Ehren, B. J., & Apel, K. (Eds.). (2005). *Handbook of language and literacy: Development and disorders*. New York, NY: Guilford.

Tangel, D. M., & Blachman, B. A. (1995). Effect of phoneme awareness instruction on the invented spelling of first-graders: A one-year follow-up. *Journal of Reading Behavior, 27*, 153–187.

Torgesen, J. K., Wagner, R. K., & Rashotte, C. A. (1999). *The test of word reading efficiency*. Austin, TX: PRO-Ed.

Treiman, R. (1998). Why spelling? The benefits of incorporating spelling into beginning reading instruction. In J. L. Metsala & L. C. Ehri (Eds.), *Word recognition in beginning literacy* (pp. 289–313). Mahwah, NJ: Erlbaum.

Uhry, J. K., & Shepherd, M. J. (1993). Segmentation and spelling instruction as part of a first-grade reading program: Effects on several measures of reading. *Reading Research Quarterly, 28*, 219–233.

Vandervelden, M. C., & Siegel, L. S. (1997). Teaching phonological processing skills in early literacy: A developmental approach. *Learning Disability Quarterly, 20*(2), 63–81.

Wagner, R. K., Torgesen, J. K., & Rashotte, C. A. (1999). *Comprehensive Test of Phonological Processing*. Austin, TX: Pro-Ed.

Wanzek, J., Vaughn, S., Wexler, J., Swanson, E. A., Edmonds, M., & Kim, A. (2006). A synthesis of spelling and reading interventions and their effects on the spelling outcomes of students with LD. *Journal of Learning Disabilities, 39*, 528–543.

Wechsler, D. (1992). *Wechsler Individual Achievement Test*. San Antonio, TX: Psychological Corporation.

Wiederholt, J. L., & Bryant, B. R. (1992). *Gray Oral Reading Tests* (3rd ed.). Austin, TX: Pro-Ed.

Wiederholt, J. L., & Bryant, B. R. (2002). *Gray Oral Reading Tests* (4th ed.). Austin, TX: Pro-Ed.

Wilkinson, G. S. (1993). *Wide Range Achievement Test* (3rd ed.). Wilmington, DE: Wide Range.

Woodcock, R. W. (1987). *Woodcock Reading Mastery Test–Revised*. Circle Pines, MN: American Guidance Service.

Woodcock, R. W., & Johnson, M. (1990). *Woodcock–Johnson Psychoeducational Battery–Revised*. Chicago, IL: Riverside.

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