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Effectiveness of Early Phonological Awareness Interventions for Students with Speech or Language Impairments

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Abstract

This article reviews research examining the efficacy of early phonological interventions for young students identified with Speech or Language impairments. Eighteen studies are included, providing results for nearly 500 students in preschool through third grade. Although findings were generally positive, there were large individual differences in response to intervention. Further, there was little evidence that interventions enabled students to catch up in phonological or reading skills to typically developing peers. Methodological issues are described and implications for practice and future research are discussed.

Keywords

phonological awareness; reading; intervention; response to intervention; defining and diagnosing disabilities; children at risk

There is widespread agreement that phonological skills such as perceiving sounds in speech, identifying rhymes, and blending and segmenting words are the foundation for learning to read and write. Over a decade ago Share and Stanovich (1995) proposed that the early mastery of phonological and alphabetic skills lays the foundation for successful reading development. There is now converging evidence that the more sensitive a child is to the component sounds (e.g. syllables, rhymes, phonemes), the better a reader he or she is capable of becoming, regardless of factors such as intelligence, receptive vocabulary, memory skill, and social class (Adams, 1990; Bryant, MacLean, Bradley, & Crossland, 1990; Elbro, Borstrom, & Petersen, 1998; Lewis et al., 2006; Wagner & Torgesen, 1987). There is also unequivocal agreement that deficits in oral language, including vocabulary and syntax, have a detrimental effect on reading achievement (Aram, Ekelman, & Nation, 1984;

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Aram & Nation, 1975; Bishop & Adams, 1990; Bishop & Edmundson, 1987; Catts, 1993; Catts, Fey, Zhang, & Tomblin, 1999; Scarborough & Dobrich, 1990). Additionally, because researchers have shown that early language and phonological skills are strong predictors of later reading ability (Bird, Bishop, & Freeman, 1995; Lonigan, 2004; National Reading Panel, 2000; Scarborough, 1990; Snow, Burns, & Griffin, 1998; Storch & Whitehurst, 2002; Wagner & Torgesen, 1987), there is increasing concern about young children with speech or language deficits who appear to be at considerable risk for future reading difficulties. Nearly 18.7% of the school-age children who receive special education services are identified with Speech Impairments (SI) or Language Impairments (LI) (U.S. Department of Education, 2004).

Specifically, researchers have cautioned that preschool children with SI or LI appear slower to develop phonological and phonemic awareness compared to their typically developing peers (Bird et al., 1995; Boudreau & Hedberg, 1999; Nathan, Stackhouse, Goulandris, & Snowling, 2004; Webster & Plante, 1992), elevating their risk for reading difficulties (Aram & Hall, 1989; Bishop & Adams, 1990; Beitchman, Wilson, Brownlie, Walters, & Lancee, 1996; Catts, 1991, 1993; Scarborough & Dobrich, 1990; Rescorla; 2002). While both children with SI or LI are at risk, the risk appears substantially higher for children with LI. For example, in a large longitudinal study of children with LI, Catts and colleagues (2002) found that roughly half of kindergarteners with LI developed reading disabilities by second grade. According to the American Speech-Language-Hearing Association (2001), young children with LI are four to five times more likely than their peers to have reading problems later in elementary school and beyond.

In the case of children with SI, especially severe and persistent disorders of articulation and phonology have also been associated with later reading difficulties (Bird et al., 1995; Catts, 1993, 1997; Larivee & Catts, 1997; Webster, Plante, & Couvillion, 1997). Not surprisingly, researchers have shown that when LI and SI present concomitantly, the risk for developing reading difficulties increases substantially (Bishop, 2001; Bishop & Adams, 1990; Catts, 1993; Pennington, 2006; Raitano, Pennington, Tunick, Boada, & Shriberg, 2004). Thus, the long-term literacy outcomes for students with SI or LI are generally poor (e.g., Leitão & Fletcher, 2004; Snowling, Bishop, & Stothard, 2000; Stothard, Snowling, Bishop, Chipchase, & Kaplan, 1998).

Over twenty years of research has demonstrated that phonological training programs that provide early explicit and systematic teaching prevent reading difficulties for most children (Ball & Blachman, 1991; Ehri et al., 2001; Foorman, Fletcher, Francis, Schatschneider, & Mehta, 1998; National Reading Panel, 2000; Tunmer, Herriman, & Nesdale, 1988; Torgesen, Morgan, & Davis, 1992). This convincing body of evidence has led to a push for preventative models of early literacy instruction intervention that include explicit phonological training that are now embodied in policy initiatives such as No Child Left Behind (2001) (PL 107–110) and the recent amendments to the Individuals with Disabilities Education Improvement Act (2004) (PL 108–466); however, this research base does not include participants with SI or LI, who might be expected to have the most severe phonological deficits.

An important question, therefore, remains: Is there sufficient empirical evidence to substantiate phonological awareness training as an effective early intervention approach for increasing phonological awareness and emergent literacy abilities in children with SI or LI? Thus, the purpose of this article is to provide a thorough narrative review of the effects of early phonological intervention for this population by synthesizing the findings from published empirical research in the domains of speech-language as well as education. This has important implications for educators and speech-language pathologists working with children from this population and for future research in response to early literacy intervention.

Method

Literature Search

The literature search included four steps. We searched electronic databases to locate studies from 1990–2006, including the following: ERIC, FirstSearch, eLibrary, Infotrac, Science Direct, and Psychinfo. The following search terms were used: *phonological awareness, phonemic awareness, phonological disorder, communication disorder, communication impairment, articulation disorder, language disorder, language delay, speech disorder, emergent literacy, literacy, reading, reading disorder, reading difficulties, preschool*. We conducted a manual search of the following speech-language journals from January, 1990 to December, 2006: (a) *Journal of Speech, Language, and Hearing Research*, (b) *Speech, Language and Hearing Services in the Schools*, (c) *American Journal of Speech-Language Pathology*, (d) *Seminars in Speech and Language;* and the following education and special education journals for the same time period: *Annals of Dyslexia*, *Reading Research Quarterly*, *Journal of Learning Disabilities*, *The Reading Teacher*, *Journal of Special Education*, *Learning Disabilities Research and Practice*, *Intervention in School and Clinic*, *The Reading Teacher*, *Exceptional Children*, *Elementary School Journal*, *Learning Disabilities Quarterly*, *Reading and Writing Quarterly*, *Phi Delta Kappa*, and *Scientific Studies in Reading*. We also consulted prior reviews of early literacy or early phonological interventions: Al Otaiba and Fuchs (2002), Ehri et al. (2001), National Reading Panel (2000), and a meta-analysis from Troia (1999). Finally, an archival review was performed of all studies located in the prior steps.

Inclusion Criteria

To ensure that articles were appropriate for our review of the efficacy of phonological awareness training for students with SI or LI, we used five criteria to evaluate studies for inclusion. First, we selected studies that addressed phonological awareness interventions. Consequently, we excluded intervention research that focused solely on other speech, language, or emergent literacy skills, such as storybook reading (e.g., Justice & Ezell, 2000; Justice, Meier, & Walpole, 2005). Second, study outcomes included at least one measure of phonological awareness or reading.

Third, participating students included children with diagnosed SI or LI who ranged from preschool to third grade due to our interest in early intervention. To determine participants had SI or LI, we considered whether (a) researchers documented impairment by showing

performance of at least one standard deviation (SD) below the mean on measures of receptive and expressive language or speech or (b) researchers described that children had been diagnosed by speech-language pathologists in a school or clinical setting as having one or both impairments. We excluded one study that included participants with SI or LI but did not provide disaggregated findings for students with SI or LI; subsequently, we could not determine the efficacy of the programs (e.g., Hadley, Simmerman, Long, & Luna, 2000).

Fourth, because we were interested in the best available studies representing current practice, we selected only studies published in peer-reviewed journals from 1990 to 2006. 1990 was selected as a starting point because of our interest in evaluating studies that were published after the Individuals with Disabilities Education Act (PL 100–476), after which time services to preschool-age children had been lowered to three years of age and had also been expanded to include transition to school. Finally, only studies of English speakers were included. Our search procedures did include an examination of international sources, but did not yield any studies conducted in other languages.

Coding Features of Studies

A total of 18 intervention studies were obtained that met the inclusion criteria for our review. All three authors participated in coding the studies according to the following features: participant description (i.e., sample size, age, mental age or IQ, gender), intervention (i.e., description of the intervention; setting; intensity and duration; and training components and techniques), measures, research design, and effectiveness of intervention. Inter-rater agreement was calculated on a random selection of eight (40%) of the studies; 97% inter-rater agreement was found.

Results

In the 18 reviewed studies, participants included (a) students with LI (Fazio, 1997a; Fazio, 1997b; Pokorni, Worthington, & Jamison, 2004; Segers & Verhoeven, 2004; Warrick, Rubin, & Rowe-Walsh, 1993), (b) students with SI (Bernhardt & Major, 2005; Constantine, 2001; Denne, Langdown, Pring, & Roy, 2005; Gillon, 2000, 2002, 2005; Hesketh, Adams, Nightingale, & Hall, 2000; Major & Bernhardt, 1998; Moriarty & Gillon, 2006), or (c) students with undifferentiated SI or LI (Fuchs et al., 2002; Laing & Espeland, 2005; Roth, Troia, Worthington, & Handy, 2006; van Kleeck, Gillam, & McFadden, 1998). Additionally, this last set of studies differed from the prior two in that the interventions were delivered in school rather than primarily clinical settings. We used these three subtypes as a framework for organizing our findings. Table 1 provides a description of the (1) research design and participants, (2) features of each intervention, (3) the outcome measures utilized to assess intervention outcome, and (4) reported effectiveness of each intervention.

Students with Language Impairments

In the following five quasi-experimental and experimental studies, phonological awareness intervention was delivered to children with LI in clinical or pull-out settings. The briefer studies with relatively simpler interventions are presented first, followed by studies increasing in intensity (i.e., frequency of treatment and student-interventionist ratio) and

complexity. Fazio conducted two similar studies and, in the first (1997a), compared the effectiveness of brief, simple nursery rhyme training for preschool children with LI versus their typically developing peers. The children had been diagnosed with LI prior to the study by a speech-language pathologist and were given additional testing by research staff. From the children with LI, 8 participants were selected who scored below the mean on at least two of five subtests on the *Test of Language Development–Primary (Revised)* (TOLD-P; Newcomer & Hammill, 1988). Results indicated that both language comprehension and language production were impaired. In addition, nonverbal IQ was assessed to be within the average range (i.e., 85 to 115).

Each child participated in one-to-one rhyming instruction held in the Head Start preschool classroom. Five nursery rhymes: “Hickory, Dickory, Dock,” “Little Miss Muffet,” “Humpty Dumpty,” and “Little Boy Blue” were recited daily for 6 weeks. Fazio’s findings (1997a) suggest that children with LI improved their rhyming ability as measured by a rhyming cloze task and by their ability to recite the taught rhymes. However, they did not catch up to a peer group of children from the same classroom matched on gender and mental age.

Fazio (1997b) conducted a second brief study involving nursery rhymes, this time targeting preschoolers with LI and their typically developing peers who attended the same Head Start classroom. Fazio hypothesized that (a) using hand motions or (b) singing poems could function as a mnemonic or memory-enhancing device for increased recall of poems. Therefore, the purpose of the second study was to examine whether teaching children to use hand motions or to sing while learning poems had differential training effects for preschool children with LI versus their typically developing peers.

As in Fazio’s prior study (1997a), children who had been diagnosed as LI by speech-language pathologists were selected and subsequently assessed by research staff using three expressive subtests from the TOLD-P (Newcomer & Hammill, 1988). Children were included if they received a score of at least one SD below the mean on two of the three subtests presented. Nonverbal IQ was assessed in all participants and was determined to be in the normal range (i.e., 85–115).

The 16 children with LI were seen individually for four brief (15 minute) sessions after being placed in one of the four treatment conditions: (a) reciting the rhyme with hand motions, (b) reciting the rhyme without hand motions or a melody, (c) reciting the rhyme with a melody, or (d) reciting the rhyme with hand motions and a melody. The children with LI trained to use hand motions scored significantly better on post-testing than those children with LI who did not. Melody accompaniment did not appear to provide additional aid for learning or retrieval. However, the children with LI had more difficulty in learning rhymes than did their typically developing peers. Due to the small sample sizes and brief intervention, the results from both of Fazio’s small-scale intervention studies (1997a,b) should be considered exploratory and should be interpreted to suggest that some children with LI may benefit from even brief rhyming training.

Warrick et al. (1993) conducted an eight week study to determine whether small group phonemic awareness training for kindergarten children with LI increased their sensitivity to

the phonological structure of words. Additionally, the researchers evaluated the effects of training on the participants' reading and spelling development one year after intervention. Warrick et al. screened an unspecified number of kindergarten children using the *Kindergarten Language Screening Test* (KLST; Gauthier & Madison, 1978). Forty-two children who did not pass the screening measure were given additional tests of receptive and expressive language. None of the participating children scored above the twenty-fifth percentile on any of the tests of oral language comprehension or grammatical understanding. All participants scored within the average range on at least one subtest of nonverbal IQ as measured by the *Wechsler Preschool and Primary Scale of Intelligence* (WPPSI; Wechsler, 1967).

While both Fazio studies (1997a,b) focused exclusively on rhyme, Warrick et al. (1993) investigated the effects of a phonological awareness training comprised of four phonemic-based components used in prior intervention research (Lundberg, Frost, & Petersen, 1988). These components, delivered in a developmental hierarchy, or sequence, included (a) a syllable awareness training that taught the children to clap, count, and categorize the syllables of target words, (b) initial sound segmentation that used sound repetition or stretching initial sounds to create awareness of the first sound in words, (c) rime and rhyme recognition, taught in a similar fashion, and (d) phoneme segmentation that first focused on one sound in words, then expanded to create consonant/vowel real and nonsense words (e.g. Ma) and eventually consonant/vowel/consonant names and rhymes (e.g. Mat and Mat-Rat).

Children with LI were randomly assigned to treatment (n = 14) or control conditions (n = 14). Warrick et al. (1993) found that children with LI who received the phonological awareness training scored significantly better on post-treatment measures of phonological awareness than the control children with LI. Furthermore, at post-treatment and at the one-year follow-up testing, there were no longer any statistically significant differences between children with LI and their typically developing peers on measures of phonological awareness (except for one phoneme subtest: Repairs) and reading (Word Attack or Word Identification).

The next study involved investigating computer-assisted phonological training. Segers & Verhoeven (2004) randomly assigned matched triads of 36 children with LI to one of three treatments. Subjects had a mean age of 5.9 years and were matched on chronological age and their scores on a measure of nonverbal intelligence and phonological tasks. The first treatment group, Experimental group 1 (n = 12), was provided with a computer-supported phonological awareness program that included training in word, syllable, and phoneme segmentation; rhyme; and syllable and phoneme blending. The second treatment group, Experimental group 2 (n = 12), was provided the same phonological awareness training as Experimental group 1, but speech was slowed down (similar to the commercially available Fast ForWord program; Scientific Learning Corporation, 1999). The control group (n =12) was allowed to play computer vocabulary games for a similar amount of time as the other groups receiving training.

Participants were seen in a computer lab two or three times a week for 15 minutes over a 5-week period for a total of 3.5 hours. There were no significant pre-test differences among

the groups, nor were there significant differences at post-test. However, the authors reported small positive effects for students in the Experimental group 1, who received training delivered at the speed of typical speech on the phonological tasks. Although it is promising that computer-assisted training was feasible for this age group, given the lack of significant results, in conjunction with no fidelity of treatment data, it is unclear whether young children with LI would benefit from computer-assisted phonological awareness instruction.

In the final study looking at children with LI, Pokorni et al. (2004) directly compared the effectiveness of three commercially available explicit interventions (two of which were computer-assisted) for relatively older children with LI who had reading scores one or more years below grade level. Interventions were more intense than in the prior studies just reviewed. Children ranged in age from 7.5–9 years, had current Individualized Education Programs (IEPs), and were enrolled in speech or language therapy. In addition, participants scored more than one SD below the mean on at least one of three subtests of the *Clinical Evaluation of Language Fundamentals-Third Edition* (CELF-3; Semel, Wiig, & Secord, 1995). The researchers randomly assigned 20 children each to Fast ForWord (FFW; Scientific Learning Corporation, 1999), Earobics Step 2 (Cognitive Concepts, Inc., 1998), and Lindamood Phonemic Sequencing Program (LiPS; Lindamood & Lindamood, 1998).

Children received training three times per week for one-hour sessions during the 20-day summer program. For the FFW (Scientific Learning Corporation, 1999) and Earobics (Cognitive Concepts, Inc., 1998) programs, 4–6 students were assigned to a computer station with stereo headphones in a computer lab. Children in the LiPS (Lindamood & Lindamood, 1998) program were seen in groups of 4. FFW treatment included phoneme discrimination, listening comprehension, working memory, syntax and processing speed. The Earobics program involved following directions, sound recognition, auditory memory, segmentation, blending, and sound discrimination. Both the FFW and Earobics training are limited to phonological awareness training and contain no direct application to decoding letters, phonemes, or words. However, the LiPS training focuses on training oral-motor features of sounds, tracking letters, reading, and spelling. Outcome measures included two subtests of the *Phonological Awareness Test* (PAT; Robertson & Salter, 1997). Pre-test measures were administered 4–6 weeks before intervention while post-test measures were administered 6–8 weeks after intervention. No treatment fidelity was reported.

Results showed that for phonemic awareness, significant increases were noted for LiPS (Lindamood & Lindamood, 1998) (on blending) and for Earobics (Cognitive Concepts, Inc., 1998) (on phoneme segmentation). However, no statistically significant group differences were found on any of the reading-related skills. Moreover, the percentage of students with standard scores on phonological and reading measures below 90 remained high after intervention, indicating that the majority of students did not benefit from 60 hours of relatively intensive intervention and continued to experience deficits relative to national norms. Such disappointing findings align with other research regarding the difficulty of remediation in older children (Donovan & Cross, 2002) and emphasize the need for earlier interventions that train children with LI more intensely before and during formal reading instruction.

To summarize, across the five studies reviewed, researchers reported that students with LI improved on the phonological skills they were taught during the interventions, but gave no measures of transfer to more distal or global measures of phonological processing. Preschool and kindergarten children learned to rhyme (Fazio, 1997a,b; Warrick et al., 1993), to identify initial sounds (Fazio, 1997b), and to manipulate and segment phonemes (Warrick et al.); older children (7.5–9), who were already a year behind in reading, also improved in the segmenting and blending skills they were taught, as well as their word reading skills (notably, however, their standard scores indicated they fell further behind relative to national norms) (Pokorni et al., 2004). Only Warrick et al. followed children longitudinally and reported that students with LI who received training performed similarly to peers on all phoneme tasks they had been taught in the prior year and also on two measures of word reading. None of the studies examined whether phonological training led to improved reading fluency or comprehension. Several methodological issues constrain interpretations of these findings, and since many of these issues also exist in the literature on children with speech impairments, these issues will be explicated in the discussion.

Children with Speech Impairments

The following eight studies that examined the efficacy of phonological awareness training for children with SI are arranged from lower to relatively higher intensity, similar to those in the prior section. Constantine (2001) used a single subject multiple baseline design to determine if children with SI could increase their phonological awareness abilities by participating in an intervention that combined thematic-fantasy play and phonological awareness instruction. Four children with diagnosed SI (e.g. phonological disorders) participated in this study; however, neither the severity of their SI nor their nonverbal IQ were reported.

Phonological awareness training focused on rhyme discrimination and production using four stories: *Three Little Pigs*, *Jack and the Beanstalk*, *Goldilocks and the Three Bears*, and *The Big Pumpkin* during 20 hours of play-based therapy. A visual examination of the graphical data indicated that all four children with SI demonstrated improvement in rhyme discrimination and production over the intervention period.

Hesketh et al. (2000) directly compared the effectiveness of combining phonological awareness training with speech training over just speech training on speech production and phonological awareness outcomes of children with SI. Speech and language therapists were asked to refer children diagnosed with phonological disorder. The resulting 61 preschool participants presented with standard scores that were 85 or below on the *Edinburgh Articulation Test* (EAT; Anthony, Bogle, Ingram, & McIsaac, 1971). Additionally, their speech severity was rated based on the percent of consonants correctly produced; two scored in the moderate range, 20 were rated as moderate-severe, and 39 were rated as severe. Measures on nonverbal intelligence were not reported but language was assessed. To be included, participants had to receive a score of 7 or greater on the Sentence Structure subtest from the *Clinical Evaluation of Language Fundamentals-Preschool* (CELF-P; Wiig, Secord, & Semel, 1992) and a score of 70 or above on the *British Picture Vocabulary Scale* (BPVS; Dunn, Dunn, Whetton, & Pintilie, 1982). Hesketh et al. (2000) stated that 54 of the study

participants scored at or above the normal range on the BPVS (Dunn et al., 1982), while seven scored within the 84–70 range or at least 1.5 SDs below the mean. Thus, it appears that roughly 12% of the study participants may have also had LI. Unfortunately, scores were not disaggregated for this population with co-morbid SI and LI.

Children in the group that received the phonological awareness intervention, termed metaphonlogical therapy by Hesketh and colleagues (2000), were provided with four treatment sessions that included rhyming, syllable clapping, alliteration, blending and segmenting and then three additional sessions that emphasized speech production targets within the context of phonological awareness tasks. By contrast, the comparison group received traditional articulation therapy (i.e., completed tasks that focused on correct phoneme production of a target error sound and classes in the context of sound isolation; CV and VC patterns; words; and eventually sentences).

The results indicated both treatment groups significantly increased their phonological awareness skills more than the typically developing control group. There were no significant differences in outcomes of these two treatment groups; however, both treatment groups received explicit training in phoneme production. Although the goal of the articulation group was to provide articulation drill training in a traditional fashion, explicit training to the target sound was required.

Three of the remaining studies were conducted by Gillon (2000; 2002; 2005); a fourth study was conducted by Denne et al. (2005), who also used Gillon's phonological awareness training program. In her first study, Gillon (2000) hypothesized that children with SI would show greater improvement in phonological awareness skills and speech production abilities concurrently when provided with phonological awareness intervention in contrast to a traditional speech intervention or a collaborative consultation/minimal treatment condition.

Six-year-old children who demonstrated expressive phonological skills below the performance range expected for their age were referred by their school speech-language pathologists. Then, all children were further assessed and determined to have nonverbal IQs in the range of 82–123 as measured by the *Test of Nonverbal Intelligence-2* (TONI-2; Brown, Sherbenou, & Johnsen, 1990). Gillon (2000) reported that nearly 80% of her 61 participants scored within or above the normal range on two widely-used language measures: the Word Structure subtest from the CELF-3 (Semel et al., 1995) and the *Peabody Picture Vocabulary Test-Revised* (PPVT-R; Dunn & Dunn, 1981). However, as in the Hesketh et al. study (2000), although the range of reported scores indicate that roughly 20% of participants may have also had LI, scores for this population with co-morbid impairments were not disaggregated.

The phonological awareness intervention focused on improving the children's phonological awareness and speech production abilities through 20 hours of individual treatment that explicitly and systematically targeted skills including rhyme; manipulation of phonemes; identification of phonemes in initial, medial, and final word positions; phoneme segmenting; phoneme blending; and phoneme-grapheme correspondence. Additional individualized sound targets were based on the child's specific sound errors. The second group, traditional

intervention, also received 20 hours of individual instruction; however, the treatment approach of this group focused on correct speech production (i.e. ability to correctly articulate the treatment target sounds) and on remediation of severe phonological impairments. The third group, minimal intervention, did not receive any direct treatment; rather, the treatment design involved consultation with students' teachers. A fourth typical comparison group included 30 chronological age-matched peers. Children with SI were matched on age, severity of their speech problem, and on clinician judgment before they were assigned to condition. At pre-test, the three treatment groups of children with SI were equivalent on phonological and reading measures, and they scored significantly below their age-matched peers on these measures.

Results indicated that children with SI in the phonological awareness instruction group achieved significantly greater growth in phonological awareness abilities and reading skill compared to children with SI in either the traditional articulation intervention or the consultation/minimal intervention groups. In a follow-up study, Gillon (2002) assessed phonological awareness and reading scores to compare gains of students with SI who had been in the phonological awareness intervention group to students with SI who had received either the typical or consultation/minimal intervention, and to a typical peer group. Results showed continued superior phonological and reading performance for students who had received phonological awareness training. Importantly, the majority of this intervention group read comparably to the typically developing peers, which was at or above grade level.

To examine the longer term effects of phonological awareness intervention, Gillon (2005) conducted another quasi-experimental longitudinal three-year study. In phase 1, preschool children with moderate or severe SI (Group1-treatment, $n = 12$, age range−3.0 to 3.11 years) were compared to 19 typically developing peers (Group 2-control-normals). Group 1 received a total of 25.5 intervention sessions. Treatment was divided into 3 blocks; each block lasted 4–6 weeks. Participants were seen 2 times per week for 45 minutes each in one group session and one individual session. Intervention focused on improvement of speech intelligibility and on facilitation of phonological awareness, letter-name, and letter-sound knowledge. The control group consisted of typically developing peers. As measured by the PPVT-III (Dunn & Dunn, 1997), there were no statistically significant differences between these two treatment groups on receptive vocabulary. Gillon randomly selected about 12% of the sessions for video analysis and reported adequate fidelity of treatment implementation.

Three years later, when both groups of participants reached 6 years of age, their performance on phonological awareness, reading, and spelling measures was compared to a third convenience sample of 19 children with SI who had not received preschool specialized training (Group 3). Children with SI that had received preschool phonological training (Group 1) performed comparably to the typically developing peers (Group 2) on phoneme awareness tasks after treatment and again at the three year follow-up. Additionally, improvements were noted in speech intelligibility for Group 1. Furthermore, there were statistically significant differences favoring Group 1 over the untreated Group 3 on reading and spelling measures. Gillon (2005) concluded that children with SI were at risk for reading difficulties, but they benefited from early phonological training starting as early as 3 years of

age. Further, Gillon suggested that integrating the phonological awareness and speech production therapy may have been essential for improving both skill sets concurrently.

More recently, Moriarty & Gillon (2006) used a single subject multiple baseline design study to examine the effects of the same phonological awareness treatment for three children with apraxia of speech ranging in age from 6.3 to 7.3 years. Participants were concurrently enrolled in speech and language therapy. Participants were provided one-to-one phonological training three times per week for 3 weeks for a total of only 6.75 hours. Assessments were conducted three times: at baseline, pre-test, and post-test. Point-by-point analyses on 20% of baseline and intervention probes was undertaken to obtain reliability. Four sessions were randomly chosen for evaluation of treatment fidelity. Two (out of three) subjects showed improved speech and phonological awareness skills during intervention. Encouragingly, the phonological skills generalized from trained to untrained items and both students also showed improved performance on non-word reading tasks.

Denne et al. (2005) also tested the effects of Gilllon's phonological awareness training intervention. Researchers randomly assigned matched pairs of 20 children with expressive phonological problems to treated and untreated groups. Participants ranged in age from 5–7 years. Students received treatment in groups of 3, one time per week for 1.5 hours over 8 weeks for a total of 12 hours. Denne et al. used a pre-post test design to evaluate growth and reported that, on average, the treated group made significantly greater gains in phonological awareness compared to the untreated group; however, gains on measures of literacy and speech production were smaller and not significantly different than the untreated group.

The final two studies we reviewed include an intervention study and a follow-up study conducted by Major and Bernhardt (1998; Bernhardt & Major, 2005, respectively). Participants were 19 preschool children with moderate or severe SI. Researchers used an alternating treatment design that included (a) phonological training and (b) phonological plus metaphonological training. Children received training three times per week for 45 minutes over 16 weeks. Individual sessions were provided by trained speech-language pathologists for a total of 36 hours of intervention, the longest duration and greatest intensity among studies of children with SI included here. The phonological awareness intervention focused on syllable structure, phonemes, rhyming, alliteration, and segmentation. A visual inspection of the results suggests children made important gains in consonant and vowel production, language production, and metaphonological awareness.

In 2005, Bernhardt & Major followed 12 children from their previous study (Major & Bernhardt, 1998), three years after the preschool intervention. The mean age of the participants at the three year follow-up was 7.2 years. Children were given a comprehensive assessment which included the *Goldman Fristoe Test of Articulation-Revised* (GFTA-R; Goldman & Fristoe, 1986), the *Assessment of Phonological Processes-Revised* (APP-R; Hodson, 1986), the *Test of Language Development-2 Primary* (Newcomer & Hammil, 1988), the PPVT-R (Dunn & Dunn, 1981), the CELF-3 (Semel et al., 1995), the *Test of Nonverbal Intelligence-2* (TONI-2; Brown et al., 1990), and the *Peabody Individual Achievement Test-Revised* (PIAT-R; Dunn & Markwardt, 1989) (reading recognition, reading comprehension, and spelling). As in the initial study, students were their own

controls; however, the authors provided standard scores to allow a comparison to normative peers of the same age. All 12 participants scored average to low-average on vocabulary and language measures (PPVT-R and CELF-3). Seven scored average or above average scores on GFTA-R; nine scored within one SD on metaphonology; ten scored average or above average on reading recognition and reading comprehension (PIAT-R); and seven scored average or above average on spelling (PIAT-R).

In summary, across the 8 studies of the effects of phonological awareness training for students with SI, researchers reported that, on average, students improved on the skills trained. In addition, Gillon and colleagues (Gillon, 2000;2002;2005; Moriarty & Gillon, 2006) indicated that phonological training also resulted in improved decoding and sight word reading. In a three year follow-up to their initial study (Major & Bernhardt, 1998), Bernhardt and Major (2005) reported not only sustained improvement on the skills trained, but also transfer to a metaphonological task for 9 of the 12 participants and to decoding, sight word reading, and comprehension for 10 of the participants. Despite these promising results, caution is warranted when interpreting these 8 studies causally due to important methodological constraints which will be discussed.

Children with Speech and/or Language Impairments in Classroom Settings

The remaining four studies included students described by researchers as having speech or language delays (or both), but they also differ from studies reviewed in the previous two sections because they examine the effects of interventions conducted primarily in classrooms rather than in clinical settings. The only intervention provided exclusively by general education classroom teachers is described in Fuchs et al. (2002). Kindergarten teachers were randomly assigned to one of three conditions: (a) phonological awareness training with Peer Assisted Learning Strategies (PALS), (b) phonological awareness only, or (c) business-as-usual reading (control). Teachers in the first and second conditions led phonological awareness training (activities included syllable awareness, rhyming, blending and segmenting drawn from *Ladders to Literacy*; O'Connor, Notari-Syverson, & Vadasy, 1998) and only teachers in the first condition also trained their students to implement PALS for kindergarten children. During PALS, students were partnered to practice four decoding activities introduced by their teacher at the start of each lesson: (1) saying letter-sounds, (2) reading CVC words (e.g., man, dog), (3) reading sight words (e.g., the, was), and (4) reading simple sentences. A subset of children with disabilities who had participated in a larger study of PALS included several students diagnosed with SI or LI.

Results indicated that treatment was implemented with good fidelity and that, on average, children with SI or LI who received phonological awareness instruction plus PALS scored significantly better than children with LI or SI in the phonological awareness-only or control conditions. However, Fuchs and colleagues (2002) reported large individual differences in response to treatment among the students with SI or LI, and findings from their third grade follow-up study (Al Otaiba & Fuchs, 2006) suggest that relatively weaker verbal ability was associated with non-responsiveness to treatment. Furthermore, although no causal claims can be made, all but one of the students who did not benefit from the early intervention was identified by third grade as having reading disabilities.

In another whole-class study that involved a classroom teacher (who was also a speech-language pathologist), van Kleeck, Gillam, and McFadden (1998) examined whether phonological awareness training would be equally effective for 4-year-olds compared to 5-year-olds with SI and/or LI. Children in this study attended a private school for children with SI or LI (all had normal nonverbal IQ abilities and had been diagnosed with SI or LI by a speech-language pathologist). The children's classroom teacher implemented phonological awareness training in "sound centers" at activity time. Outcome measures demonstrated significant growth in rhyme and phonemic awareness in children with SI or LI, with no significant difference in outcomes of the 4-year-old compared to the 5-year-old groups.

Laing and Espeland (2005) studied six preschool children diagnosed with SI or LI. This group was compared to a typically developing control group of five preschoolers. During the fall semester, participants attended a classroom intervention program that integrated expressive phonological development and a theme based language approach. In addition, individual speech and language therapy was provided three times per week for 30 minutes. No phonological awareness goals were targeted. In the spring semester, participants were provided with a low intensity, short-term, whole class, phonological awareness program focused on rhyme identification, rhyme production, sound categorization, letter identification, and letter-sound correspondence for 15 minutes twice weekly over 8 weeks. Treatment was provided by undergraduate speech-language pathology majors who were supervised by two certified speech-language pathologists (no treatment fidelity was reported, however). The control children did not receive any specific phonological awareness training. Results from nonparametric tests revealed that students in the treatment group showed larger gains than controls in rhyme identification, rhyme production, and categorization.

The final classroom-based study that involved students with LI or SI involved a single-subject multiple baseline design. Roth et al. (2006) reported the effects of treatment for 11 young children (mean age of 4.3 years) with SI or LI. Participants were enrolled in a preschool program for children with communication disorders. They attended half day sessions three days per week; each session included 30 minutes of individual speech and language intervention. As part of their regular literacy curriculum, children received the Orton-Gillingham-Stillman-multisensory approach to alphabetic principles. The intervention was an explicit phonological intervention program that incorporated rhyming, sound segmentation, and blending. Graduate student or advanced undergraduates majoring in speech-language pathology delivered the intervention to individual children three days per week for 30 minutes over 6–8 weeks. Adequate fidelity of treatment was reported. Students with SI or LI were given a battery of speech tests and language tests, an IQ test, and a blending task. Pre- and post-test assessments were conducted for rhyming, segmentation, and blending. Results indicated that compared to their own initial pre-test scores, all children showed significant pre- to post-test gains on blending (ES = 2.87) and rhyming (ES = 0.67), but not on segmenting. It is unclear from the design of the study how much growth was attributable to the intervention or to the classroom curriculum.

As in the prior two sections, the promising results reported within these four studies that students learned the phonological skills they were taught must be interpreted with caution

due to methodological issues. Transfer to reading was only measured by Fuchs et al. (2002), who found that phonological training, combined with letter sound and decoding peer-mediated practice led to significantly greater gains than typical instruction control in blending, segmenting, and word reading skills.

Discussion

The purpose of the present paper was to synthesize the findings of phonological awareness intervention research studies delivered to young children with SI or LI in order to describe how effective various training approaches have been in improving their phonological and, when possible, their early reading skills. We hoped to learn whether sufficient empirical evidence exists to substantiate phonological awareness training as an effective intervention approach for increasing emergent literacy abilities in children with SI or LI. Such research is vital to inform the fields of speech and language and general and special education given the shift toward early intervening services for children who appear to be at risk for reading difficulties. First we summarize findings from the 18 studies reviewed and highlight promising implications for practice, and then we discuss important areas of methodological concern and suggest directions for future research.

Summary of Findings and some Promising Implications for Practice

Students with LI—Five research teams focused on students with LI (n = 132; ranging from 8 to 60 participants with LI per study). With one exception (Pokorni et al., 2004) participants were in preschool or kindergarten. The duration of the interventions provided across these studies ranged from one to 60 hours delivered between 4 and 20 weeks. On the one hand, Fazio (1997a,b) provided the briefest training (one hour) which involved only small group (n = 5) rhyming training, and results indicated that although children increased their ability to recite rhymes, they did not catch up to typically developing peers.

By contrast, Warrick et al.'s intervention (1993), that was still relatively brief and was conducted with a larger group size (5.5 hours delivered to groups of 7 children), incorporated multiple treatment components (including rhyme, blending, and segmenting), and reported positive short and longer term effects. By first grade, children who received intervention in kindergarten had caught up to same age typically developing peers on all measures of phonological awareness. Although caution must of course be used in interpreting Warrick et al.'s relatively small-scale study, findings appear promising and suggest that explicit segmentation intervention in analyzing words to the level of the individual phonemes–as recommended by the NRP (2000) for typically developing children–may also support reading development for students with LI. Thus, it is encouraging that the hierarchy of phonological training components incorporated by Warrick and colleagues are now generally included in most post-NRP (2000) core reading programs, preschool programs, and early literacy interventions (e.g., *Ladders to Literacy*; O'Connor et al., 1998; *Phonemic Awareness in Young Children*; Adams, Foorman, Lundberg, & Beeler, 1998).

Two studies involved computer-assisted interventions delivered to slightly older students with LI. One research team (Segers & Verhoeven, 2004) reported no significant differences

between treated (a brief 3.5 hour computer-assisted training) and untreated students, although effects favored students in the treatment condition. In the Pokorni et al. study (2004), which involved the oldest students with LI (ranging from 7.5 to 9 years of age), the intervention was more intense (60 total hours over a 20-day summer program). Pokorni et al.'s research design was also more robust and the sample size was among the largest in any of the studies reviewed; 60 students were randomly assigned to one of three commercially available interventions (LiPS, Lindamood & Lindamood, 1998; Earobics, Cognitive Concepts, Inc., 1998; or FastForWord, Scientific Learning Corporation, 1999). Researchers reported children who received LiPS showed the greatest gains in blending, and students who received Earobics showed the greatest gains in segmenting. However, these students were already a year behind in reading at the start of the study and, unfortunately, the percentage of students with standard scores below 90 increased after training. It is unclear whether any of these generally effective computer-assisted interventions could have had a greater impact if delivered earlier with greater intensity (more frequent or in smaller groups) or for a longer duration. For example, other research has shown computer-assisted phonological training can improve phonological processing skills of typically developing low to middle income preschoolers (see for example Foster, Erickson, Foster, Brinkman, & Torgesen, 1994; Lonigan et al., 2003).

Students with SI—Eight research teams focused on students with SI (n = 214; ranging from 3 to 60 participants per study). As was the case with the studies targeting students with LI, children with SI were predominantly in preschool and kindergarten (ranging from 3.5 to 8.3 years of age). The interventions ranged in duration from 6.75 hours to about 36 hours. Most interventions combined speech articulation training and phonology. The briefest intervention was provided by Moriarty and Gillon (2006) to three kindergarteners with SI and resulted in improved phonological skills for two of the three children. Major and Bernhardt (1998) conducted the longest and most complex intervention which involved individual phonological and metaphonological treatment that resulted in increased speech intelligibility and phonological skills. They reported that the participants with the most severe difficulties improved only after receiving both phonology and metaphonology training.

Across these 8 studies, the majority of children made short-term improvements in phonological skills after receiving early intervention that combined speech articulation with phonological awareness training; further, in a small handful of studies, longer term effects of training appeared to reduce reading difficulties. Notably, Gillon's training program was among the most thoroughly researched. A line of research including four intervention studies and a follow-up study suggest the program was effective for most students. Further, longitudinal findings indicated the positive effects persisted for up to three years. While further larger scale research is needed, it is encouraging that this intervention (similar to Warrick et al.'s, 1993) is consistent with phonological skills taught in current core beginning reading programs and preschool curricula. However, as in the studies with students with LI, there were large individual differences in response to interventions of the students with SI. An important implication for practitioners was that the collaborative model in which children were seen only once a month was ineffective. We believe a more powerful

approach would be to coordinate service delivery so that speech-language pathologists deliver speech production and phonological training that is linked to classroom teacher-provided small group explicit early literacy phonological awareness training.

Students with SI or LI in classroom-based settings—Four studies provided interventions that were implemented and incorporated into the children's classrooms. These 4 studies included between four and eight participants (n = 45) and interventions were provided for approximately 15 hours (delivered over a range of 8 to 20 weeks) in either preschool self-contained or kindergarten general education classrooms. Treatment practices were generally consistent with core beginning reading programs and preschool curriculum that include rhyme and phonemic awareness activities and letter identification and letter-sound correspondence. All four studies conducted in the classroom reported improvements for children with SI or LI. Notably, however, only one study (Fuchs et al., 2002) was conducted by general education teachers in a general education setting.

Limitations and the Directions for More Robust Future Research

Caution is warranted in interpreting findings from the current literature base: some issues relate to significant methodological constraints within the studies we reviewed and others to our own review procedures. First, in contrast to the wealth of phonological training studies (over 50 studies met the criteria for methodological rigor) reviewed by the NRP (2000), we were concerned that a surprisingly limited research base (n = 18 studies) exists that has been conducted with children with speech or language disabilities. We were far less conservative than the NRP; we did not exclude studies that were not experimental or quasi-experimental and found the existing database included mostly quasi-experimental pre-post treatment group research designs with very small sample sizes. In this review, participants were rarely matched across conditions on phonological skills or reading abilities; rather, researchers employed different types of control groups including: language matched, chronological age-matched, or (most commonly) un-matched typically developing classroom peers. Our findings show that phonological training varied considerably in duration, complexity, and intensity (group size and frequency of treatment), so it is not surprising that researchers reported considerable variability in individual response to treatment. Therefore, caution must be taken in interpreting findings causally until further, and more rigorous, research is conducted with larger sample sizes that involve random assignment to condition. Larger sample sizes will allow researchers to learn more about child by treatment interactions involving potential moderating variables such as age, gender, behavior, and language ability.

In addition to increasing sample sizes and using more rigorous research designs, researchers can take steps to improve the internal validity of the next generation of studies. First, it is important to describe interventions with greater detail and to provide fidelity of treatment information. Relatedly, since most post-NRP (2000) preschool and kindergarten curricula incorporate phonological awareness activities, the participants' classroom setting and classroom primary early literacy instruction should be observed and described in sufficient detail. To date, studies have largely been clinically focused and lack such information. Thus, it is difficult to know what students in a typical classroom control group received or to rule out whether classroom instruction mediated treatment effectiveness.

Second, the field needs more theoretically consistent approaches to measuring the constructs of language, phonological awareness, and reading. Efforts to replicate findings and scale-up should clarify the characteristics not only of the target (impaired) population, but also the control group. Researchers have used a variety of ways and measures to diagnose a SI or a LI, which complicates interpretation of findings. The type or severity of the impairment may moderate responsiveness to intervention. In addition, more extensive language testing should be used to rule out language impairment within SI populations.

It also is critical for our field to advance stronger ways to assess treatment effectiveness. Researchers in the studies reviewed used tests that measured different aspects of the phonological construct which limited direct comparisons across studies. Some, particularly studies with relatively younger children, focused training and assessment on relatively simple skills such as rhyme or initial sound; others took a broader view of training and incorporated more difficult measures involving tasks such as elision. A related issue is that some measures represented “near transfer” assessments of skills that matched the training tasks, whereas a more robust test of training effects would assess transfer to more global phonological tasks and to reading skill development.

Research is needed that reliably measures phonological and reading skills before and after treatment, but that also evaluates skill development over time. This is important because researchers have not consistently reported gains of the SI or LI treatment group to give a sense of whether they (a) caught up to a typically developing control group, (b) reached grade level benchmarks for phonological awareness or reading, (c) achieved skills at a level commensurate with norms on standard tests, or (d) outperformed a matched SI/LI control group. Notably few studies include standardized measures and very little information exists to document (Gillon, 2002; 2005; and Warrick et al., 1993 notwithstanding) longer term effects of intervention. Only 8 of the studies included measures of decoding or sight word reading; only three included reading comprehension. Additionally, none of the studies reviewed used curriculum-based measures that would allow practitioners to screen, monitor progress, and have the necessary data to make instructional decisions. Consequently, given the current research base, we do not know how students with LI or SI develop reading-related skills across elementary school grades or how they compare to either normative local or national samples.

Third, the external validity, or generalizability, of this research base would be improved by demonstrations of what works in school settings. It is surprising, given the IDEA requirements to include children in general education to the greatest extent possible, that only one study (Fuchs et al., 2002) was conducted by general educators within their own classrooms and during their literacy instruction; the remaining interventions were pull-out and administered by speech-language pathologists (including some in training) to individuals or small groups of students. Furthermore, none of the investigations included purposeful collaboration or joint intervention planning for intervention between clinicians and classroom teachers. Nor did any of the research teams collect ongoing student progress monitoring data to allow clinicians to judge the success of intervention or to individualize interventions. Finally, more longitudinal research is needed to learn whether phonological training is sufficient to support Share and Stanovich’s (1995) “self-teaching hypothesis” and

how well developed more complex phonological skills must be to ensure children can decode efficiently enough to comprehend what they read.

Other limitations relate to how we conducted the review. For example, since we did not include dissertations and unpublished research, our findings are likely to have been biased toward published studies and therefore to have been more positive. For the same reason, our review should not be considered exhaustive. We also limited our review to phonological awareness training; we did so because phonological awareness is a critical foundation for word reading, but therefore we did not address other important instructional components such as phonics, vocabulary, or book reading. Finally, given the research designs and small sample sizes, we did not use a meta-analytic approach. As the research base documenting the efficacy of phonological interventions continues to expand, and as stronger designs with larger sample sizes of participants are included, a meta-analysis could be conducted that would allow researchers to compare treatment effects.

Implications for Practice

A first implication of our findings, consistent with prior research, is that speech-language pathologists and educators need to be aware of the large and important initial gap in phonological skills between children with SI and LI and their typically developing peers. This is important because longitudinal research has shown that this gap leads to ongoing reading difficulties (Leitão & Fletcher, 2004; Snowling et al., 2000; Stothard et al., 1998), which in turn undermines poor readers'success in other academic content areas (Bishop & Adams, 1990; Beitchman et al., 1996; Catts, 1991).

A second, and related, implication is the vital importance of intervening *early*. Pokorni et al. (2004) reported that older students (7.5–9 years of age) improved phonological and reading skills, but most had standard scores on phonological and reading measures below 90, even after 60 hours of relatively intensive intervention. This aligns with other cautions expressed by other researchers regarding the difficulty of remediation in older children (Donovan & Cross, 2002). There is promising evidence that younger students with SI and LI can learn phonological skills. Several of the briefer interventions, such as the rhyming training, provided in Fazio 1997a; 1997b and Hesketh et al. (2000) would be very easy for teachers or speech-language pathologists to implement in preschool and kindergarten classroom settings.

However, to prevent future reading difficulties, it is reasonable to assume that students with SI and LI would need additional early intervention that targets phonological skills and explicitly links these skills to reading acquisition. Furthermore, students are likely to need at least the degree of intensity (one-to-one or one-to-three provided daily) or the length of duration of intervention (20 or more hours) that has been shown to be effective in preventing reading difficulties in at-risk populations (NRP, 2000; Torgesen, 2000).

Findings from Warrick et al. (1993) and Gillion (2000, 2003, 2005) show that children with SI and LI benefited from early intervention that explicitly and systematically targets phonological skills found to be linked to later reading acquisition. The researchers targeted phonological skills including not only rhyme, but also sound identification, phoneme

segmentation, and phoneme-grapheme correspondence. Children demonstrated improved performance not only on taught skills, but also in beginning reading skills. The best developed line of research by Gillon and colleagues has included small group intensive intervention, provided by speech-language pathologists, that focused on helping children become aware of speech sounds at the phoneme level, and mapping phonemes to graphemes is well supported by research evidence conducted with children without SI or LI.

A final implication is also cautionary: practitioners may expect large individual differences in response to interventions, so we urge frequent progress monitoring to gauge the success of interventions and to individualize or tailor instruction for children that do not respond well enough to catch up to grade-level. This is particularly important in light of the just-described considerable methodological limitations precluding us from identifying a set of best practices that causally show how to improve phonological and early literacy skills of students with SI or LI or that show if early success leads to a future trajectory of reading development associated with grade-level performance.

In conclusion, findings in the studies we reviewed provide promising evidence of the efficacy of early phonological awareness training on the trained skills and more limited support for immediate and long-term transfer to word reading tasks. These findings are consistent with theoretical models of the importance of phonological awareness as a foundation for reading development (Share & Stanovich, 1995) and are also consistent with 20 years of research demonstrating the efficacy of early explicit and systematic phonological training to enhance reading skill development for children at risk for reading difficulties (e.g., Ehri et al., 2001; NRP, 2000). However, until additional robust research is conducted, it is not possible to establish whether a clear causal relation between phonological awareness training and early reading success also exists for students with LI or SI.

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Table 1

Study design, participants, intervention features, outcome measures, and evidence of treatment effectiveness.

Article	Research Design and Participant Description	Intervention	Outcome Measures	Effectiveness of Intervention
	Children with Language Impairments			
Fazio (1997a)	Quasi-experimental pre- and post-test design; no random assignment to treatment. Matched pairs on gender, classroom, nonverbal mental age, and IQ. Two groups: **1** SwLI (n = 8; M age = 4.6 years) **2** Mental-age Matched Typically Developing Peers (n = 8; M age = 4.6 years)	Research staff taught children 5 nursery rhymes in a whole-class preschool setting. 4 days/week × 6 weeks. Total time cannot be estimated as session time not reported.	RM tasks: rhyme oddity, percentage of nursery rhyme repeated correctly, and partial rhyme (cloze)	Mental-age Matched Typically Developing Peers learned significantly more than SwLI on all tasks. SwLI increased from 2% to 18% in ability to recite nursery rhymes. SwLI able to complete rhyme cloze procedure. $\underline{M}$ = 55% No reliability or validity of measures. No fidelity reported.
Fazio (1997b)	Quasi-experimental pre- and post-test design; no random assignment to treatment. Matched pairs from classroom on chronological age or language age. Three groups: **1** SwLI (n = 16; M age = 5.7 years) **2** Chronological-age Matched Typically Developing Peers (n = 16; M age = 5.4 years) Matched on gender, classroom, age, and race. **3** Language-age Matched Peers (n =16; M age = 4.3 years) Matched on gender, classroom, and language.	Research staff trained children individually to repeat a poem under 4 conditions: with or without hand motions, with or without singing the poem. Setting unspecified. 1 day/week × 15 min × 4 weeks. Total time = 1 hr.	RM tasks: rhyme oddity, percentage of poem repeated correctly, and tests of initial sound oddity	Chronological-age Matched Typically Developing peers and Language-age Matched peers performed significantly higher in all 4 conditions than SwLI on all 3 measures. SwLI in “with hand motion” condition performed significantly higher than the SwLI in the “no hands” condition. No reliability or validity of measures. No fidelity reported.
Warrick, Rubin, & Rowe-Walsh (1993)	Quasi-experimental pre- and post-test design. Twenty-eight SwLI (4–5 year olds) randomly assigned to Treatment vs. No-Treatment condition and compared to Typically Developing Controls (n = 14).	Research staff trained children in small groups (n = 7) in PA (syllable awareness, initial phoneme segmentation, rhyming, and phonemic segmentation) in a classroom setting. 2 days/week × 20 min × 8 weeks. Total time = approximately 5.5 hr.	RM Phoneme Awareness tasks not specified or described: error, repair, manipulation, rhyme, and segmentation WRMT-R Word Identification and Word Attack	Treatment SwLI made significant gains on repairs, manipulations, rhymes, and final segmentation. No significant differences between Typically Developing Controls and Treatment SwLI on any phoneme awareness tasks. Significant differences between Typically Developing Controls and No-Treatment SwLI on manipulation and rhyme.

Article	Research Design and Participant Description	Intervention	Outcome Measures	Effectiveness of Intervention
				One-year follow-up: Treatment SwLI and Typically Developing Cont One-year follow-up: Treatment SwLI and Typically Developing Cont One-year follow-up: Treatment SwLI and Typically Developing Cont One-year follow-up: Treatment SwLI and Typically Developing Cont One-year follow-up: Treatment SwLI and Typically Developing Cont One-year follow-up: Treatment SwLI and Typically Developing Cont No fidelity of treatment reported.
Segers & Verhoeven (2004)	Quasi-experimental pre- and post-test design with random assignment to one of three conditions. All students (n = 36; M age = 5.9 years) had LI and were matched on chronological age, nonverbal IQ, and PA tasks and then assigned to one of three conditions.	Treatment 1: Computer- supported PA program—word, syllable, phoneme analysis, rhyme, syllable and phoneme synthesis. Treatment 2: Same as Treatment 1 but, speech slowed down as in FFW. Control: Computer vocabulary games. 2–3 days/week × 15 min × 5 weeks in a computer lab. Total time = 3.5 hr.	RM PA tasks: rhyme, word awareness, phoneme analysis, syllabic awareness, phonemic synthesis	No significant pre-test differences between groups. Positive effects of intervention for Treatment 1 (Computer- supported PA program). Treatment 1 made more progress than Control on combined PA tasks. No statistically significant differences between Treatment1 and Treatment 2 (Computer-supported PA program with speech slowed down). No statistically significant differences between Treatment 2 and Control. No fidelity reported.
Pokorni, Worthington, & Jamison (2004)	Quasi-experimental pre- and post-test design with random assignment to one of three conditions. SwLI (n = 60; age range = 7.5–9 years) had current IEPs, were enrolled in S/L therapy, and were reading 1 year below grade level.	Trained professional from school district administered the intervention under the supervision of 3 SLPs in a computer lab. Compared 3 PA interventions: **1** FFW: phoneme discrimination, listening comprehension, word meaning, syntax, and processing speed. **2** Earobics Step 2: following directions, sound recognition, auditory memory, segmentation, blending, and sound discrimination. **3** LiPS: discovering oral-motor features of sounds, tracking, reading, and spelling. Students using FFW and Earobics assigned to a computer station with stereo headphones in a computer lab. 3 days/week × 1 hr during 20 day summer program. Total time = 60 hr.	Pre-test measures administered 4–6 weeks before intervention Post-test measures administered 6–8 weeks after intervention CELF-3 Concepts & Directions, Recalling Sentences, and Listening to Paragraphs PAT Phoneme Blending and Phoneme Segmentation WLPB-R Letter-Word Identification, Passage Comprehension, Word Attack, and Spelling	Repeated measures MANOVA combining scores into 3 clusters: **1** Phonemic Awareness: LiPS—significantly better blending scores Earobics —significantly better phoneme segmentation scores **2** Language-Related skills—no significant differences across interventions **3** Reading-Related skills—no significant differences across interventions Percent of students with standard scores < 90 remained high after intervention. No treatment fidelity reported.
Children with Speech Impairments				

Article	Research Design and Participant Description	Intervention	Outcome Measures	Effectiveness of Intervention
Constantine (2001)	Descriptive case-study. Pre-school children with articulation/ phonological disorders (*n* = 4; age range not reported)	Group of 4 students. 2 days/week × 1.5 hrs. × 10 weeks. Total time = 30 hr. 5 SLP graduate clinicians provided the intervention integrating thematic-fantasy play and PA instruction. Intervention consisted of highlighting story events, modeling, supporting turn-taking, and eliciting target responses using popular preschool stories.	RM tasks: rhyme discrimination and rhyme production	All four children showed improvements in rhyme discrimination and rhyme production. No treatment fidelity reported.
Hesketh, Adams, Nightingale, & Hall (2000)	"Semi-random" assignment. Three groups: **1** SwSI in ART therapy (*n* = 30) **2** SwSI in MET therapy (*n* = 31) **3** Typically Developing Controls (*n* = 59) age range = 3.6–5.0 years	ART therapy: Focused on production of phonemes and phoneme classes. MET therapy: Focused on rhyming, syllable clasping, alliteration, blending, and segmenting SLPs conducted individual MET and ART therapy. 10 weekly sessions (no time given).	RM Metaphonological Abilities Battery: rhyme matching, word initial matching, blending phonemes, word initial segmentation/matching, and consonant deletion	Composite scores on the Metaphonological battery revealed MET and ART students had statistically greater growth than controls, and that growth for MET students was similar to growth for ART students. How composite derived not reported. No fidelity reported. No reliability or validity of measures.
Gillon (2000)	Pre- and post-test design; no random assignment. Matched pairs on age, severity of problem, and clinician judgment. 61 Total students with or without SI in four groups: **1** Group 1: Experimental intervention (*n* = 23; *M* age = 6years) **2** Group 2: Traditional intervention (*n* = 23; *M* age = 6.2 years) **3** Group 3: Minimal intervention (*n* = 15; *M* age = 6.2 years) **4** Group 4: Cognitive-age Matched Typically Developing Peers (*n* =30; *M* age = 6.1 years)	Research staff or SLPs individually trained Group 1 students using a PA program (rhyme, phoneme manipulation of sounds, phoneme identity, segmentation and blending, linking speech to print). 2 days/week × 1 hr × 10 weeks. Total time = 20 hr. SLPs individually trained Group 2 using a traditional program for articulation and language skills. 1 hr/week × 10 weeks. Total time = 20 hrs. SLPs consulted with teachers or parents for Group 3. Consultations took place no more than once a month. All children were exposed to a Whole Language approach to reading in their classrooms.	Burt Word Reading Test—New Zealand Revision LAC Letter Identification task Neale Analysis of Reading Ablilty—Revised Nonword reading task from the Reading Freedom Diagnostic Test Ready-to-Read Word Test QUIL	The 3 SwSI groups performed comparably to each other but significantly below their Typically Developing peers at pre-test. Group 1 made significantly greater *growth* than the other 3 groups on PA skills as measured by LAC and QUIL and Reading Measures. At *post-test*, Group 1 not statistically different than Group 4 on LAC. Group 1 made significantly greater *growth* than Groups 2 and 3 on all reading measures. No fidelity reported.
Gillon (2002)	Four Groups: Group 1: *n* = 20 (of the 23 participants in Gillon 2000)	Follow up 11 months post- intervention (Gillon, 2000).	Burt Word Reading Test—New Zealand Revision QUIL	Follow-up only: Group 1 significantly different from Groups 2 and 3.

Article	Research Design and Participant Description	Intervention	Outcome Measures	Effectiveness of Intervention
	Groups 2 and 3: *n* = 20 (38) Group 4: *n* = 20 (30)			Groups 2 and 3 significantly different from Group 4 on PA tasks of QUIL. Group 1 = Group 4 on QUIL. Group 1 and Groups 2 and 3 improved on word-recognition, but Group 1 made more progress over time. Group 1 > Groups 3 and 4 non- word reading test of QUIL.
Gillon (2005)	Quasi-experimental/3-year longitudinal design with random selection of controls. Phase 1 Group 1: Students with moderate or severe speech impairment (*n* = 12; *M* age = 3.5 years) Group 2: Typically Developing peers (*n* = 19; *M* = 3.5 years) Phase 2-Longitudinal Group 1: Subset of students with moderate or severe speech impairments students from phase 1 (*n* = 10; *M* age = 6.0 years) Group 3: Controls with speech impairments who were chosen retrospectively and received no treatment (*n* = 19; *M* age = 6.4 years)	Group 1 received an average of 25.5 intervention sessions delivered by therapists at a university clinic. Treatment divided into 3 blocks; each block 45 min × 2 days/week × 4–6 weeks. Total time = 6–9 hr. One group and one individual session. Focus of intervention: improving speech intelligibility, facilitation of PA, and letter-name and letter- sound knowledge. At 6 years of age (Time 2), performance of Group 1 was compared to Group 3 on PA, reading and spelling measures.	Modified Bradley and Bryant's tasks: rhyme, phoneme matching, and letter recognition Burt Word Reading Test—New Zealand Revision Nonword reading task from the Reading Freedom Diagnostic Test Phonological Variability Test PIPA (to obtain a score of PA and a score of letter knowledge) Spelling task	No statistically significant differences between Groups 1 and 2 on PPVT-3. Group 1 comparable to Group 2 on phoneme awareness tasks at Time 1 and Time 2. Improvements also noted in speech intelligibility. At 6 years of age (Time 2), statistically significant differences were noted between Group 1 and Group 3 on Burt Word Reading Test—New Zealand Revision, nonword reading, combined raw score of the PIPA, and spelling. Results suggest 1) children with speech impairments are at risk and can benefit from PA training starting as early as 3 years 2) integrating PA and speech production therapy can result in the two skills improving concurrently. Treatment fidelity: 12% of total session randomly selected for video analysis.
Moriarty & Gillon (2006)	Single subject with repeated measures; subjects as own controls. Timeline for measurement: baseline, pre- and post. 3 children with childhood apraxia of speech aged 7.3, 6.3, and 6.10 years who were in S/L therapy.	3 days/week × 45min × 3 weeks. Total time = 6.75 hr. Intervention focus: develop phoneme awareness, increase knowledge of phoneme grapheme correspondence, and improve speech.	Burt Word Reading Test—New Zealand Revision PIPA Letter-Sound Knowledge	Two (out of 3) subjects showed improved speech, PA skills, and non-word reading. Four sessions were randomly chosen for evaluation of treatment fidelity. Reliability: point-by-point analyses on 20% of baseline and intervention probes.
Denne, Langdown, Pring, & Roy (2005)	Pre- and post-test design with random assignment to treated and untreated groups. Children with expressive phonological problems (n = 20; age range = 5–7 years)	Groups of 3 students each. SLPs provided Gillon's PA training program in a clinical setting. 1 day/week × 1.5 hrs. × 8 weeks. Total time = 12 hr. Pre- and post-test assessments conducted by different clinicians.	Non-Word Decoding Test PAT WORD	Treated group made significantly greater gains in PA.
Major & Bernhardt (1998)	Alternating treatment design with cycles approach. Children with moderate or severe speech impairments (*n* = 19; *M* age = 3.11 years)	3 days/week × 45 min × 16 weeks. Total time = 36 hr. Individual sessions provided by SLPs. Focus of intervention: syllable structure, phonemes, rhyming, alliteration and/or segmentation.	IPSyn RM tasks: metaphonology and articulation	Significant gains in consonant and vowel production, language production, and metaphonological awareness. No fidelity reported.

Article	Research Design and Participant Description	Intervention	Outcome Measures	Effectiveness of Intervention
Bernhardt & Major (2005)	Descriptive case-study without control group. Three years after preschool intervention. *n* =12 from Major and Bernhardt (1998) *M* age = 7.2 years	No intervention	APP-R CELF-3. GFTA-R PIAT-R (reading recognition, reading comprehension, spelling, math) PPVT-R Rhyming, alliteration, deletion task TONI-2	7/12 students scored average or above average scores on GFTA- R. 9/12 students scored within 1 standard deviation on metaphonology. 12/12 students scored average to low average on PPVT-R/CELF-3. 10/12 students scored average or above average on RR and RC of PIAT-R. 9/12 students scored average or above average on math. 7/12 students scored average or above average on spelling.
Children with Speech and/or Language Impairments				
Fuchs et al. (2002)	Three groups: **1** Students (100%) with SLD who received PA and PALS training (*n* = 8; *M* age= 5.96 years) **2** Students with SLD (83%) who received PA training (*n* = 6; *M* = 5.93 years) **3** Controls with SLD (100%) who received no training (*n* = 10; *M* = 5.76 years)	Classroom teachers in the PA and PA and plus PALS conditions taught whole class PA activities (word and syllable awareness, rhyming, first-sound isolation, onset-rime-level blending, segmenting sounds, blending or segmenting of sounds, manipulation of printed letters) selected from Ladders to Literacy (O'Connor et al., (1998). Teachers in the PA plus PALS teachers conducted PALS. Whole-class instruction 15 min/day (45 min per week) for 20 weeks. Total time = 15 hr.	RM tasks: rapid letter naming, rapid letter sound, segmentation, and blending WRMT-R Word Attack WRMT-R Word Identification WIAT Spelling	Larger effect sizes were reported for the PA and PALS vs. the PA group on all measures. Small to moderate differences favoring PA and PALS over controls. The controls vs. PA comparison favored the controls on 6/8 measures. Adequate fidelity was reported.
van Kleeck, Gillam, & McFadden (1998)	Quasi-experimental. Three groups: **1** Preschool students with speech and/or language impairments (*n* = 8; *M* age = 4.1 years) **2** 2. Pre-K students with speech and/or language impairments (*n* = 8; *M* age = 5 years) **3** Controls with speech and/or language impairment who received no treatment (*n* = 8; *M* age = 6 years)	Research staff and classroom teachers (certified SLPs) conducted small group (*n* = 3 or 4) sound centers. Fall: Rhyme Spring: Phoneme Awareness 2 days/week × 15 min across nine months. Total time = 12 hr.	RM task: Rhyme (composite score derived from 4 tasks, including oddity, identification, production, and fluency) RM task: Phoneme Awareness (composite score derived from 4 tasks, including phoneme judgment and correction, identification and production of initial sounds, identification of final sounds)	No post-test conducted for control group. No statistical comparison at pre-test reported between treatment and control. Both treatment groups made significant growth in rhyme and phonemic awareness. Only later can be attributed to intervention. No statistically significant differences in growth between treated groups. No reliability or validity of measures. No fidelity reported.
Laing & Espeland (2005)	Quasi-experimental pre- and post-test design. Two groups:	Fall 3 days/week × 30 min of individual S/L therapy. Total time = 1.5 hr. Spring	Categorization GFTA Sounds-in-Words Rhyme Identification Rhyme Production	PA training contributed to statistically significant gains in PA (rhyme identification, rhyme production, and categorization) for LI and/or SI students.

Article	Research Design and Participant Description	Intervention	Outcome Measures	Effectiveness of Intervention
	1 Students with SI and/or LI (n = 6; M age = 4.3 years) **2** Typically Developing Controls (n = 5; M age = 4.7 years)	Low intensity, short-term, whole- class, PA program focused on rhyme identification, rhyme production, sound categorization, letter identification, and letter- sound correspondence. 2 days/week × 15 min. Total time = 4 hr. Control students did not receive any specific PA training. Undergraduate SLP students supervised by 2 certified SLPs.		No fidelity reported.
Roth, Troia, Worthington, & Handy (2006)	Single-subject multiple baseline design. Students with speech and/or language impairments (n = 11; M age = 4.3 years)	Preschool program for children with communication disorders. In addition to regular curriculum, Orton-Gillingham-Stillman- multisensory approach to alphabetic principles. PASS blending intervention program delivered individually by either graduate student clinicians or advanced undergraduates. 3 days/week × 30 min. × 6–8 weeks. Total time = 9–12 hr.	Students with speech and/or language impairments given a battery of speech tests, language tests, IQ test, and blending task. RM tasks: rhyming, segmentation, and blending	Treatment fidelity reported. Blending: Average gain was statistically significant with large effect size pre-to post-test. Rhyming: Average gain was statistically significant with a moderate effect size. Segmenting: Average gain was not statistically significant.

Note. SwLI = Students with Language Impairments; RM = Researcher Made. PA= Phonological Awareness.

WRMT-R = *Woodcock Reading Mastery Tests-Revised*. LI = Language Impairment. FFW = Fast ForWord. IEPs = Individualized Education Programs. SLPs = Speech-language Pathologists. LiPS = Lindamood Phonemic Sequencing Program. S/L = Speech/Language. CELF-3 = *Clinical Evaluation of Language Fundamentals-3*. PAT = *Phonological Awareness Test*. WLPB-R = *Woodcock Language Proficiency Battery-Revised*. SwSI = Students with Speech Impairments. ART = Articulation. MET = Metaphonological Articulation. LAC = *Lindamood Auditory Conceptualization Test*. SI = Speech Impairment. QUIL = *Queensland University Inventory of Literacy*. PIPA = Preschool and Primary Inventory of Phonological Awareness. WORD = *Wechsler Objective Reading Dimension*. IPSyn = *Index of Productive Syntax*. APP-R = *Assessment of Phonological Processes-Revised*. GFTA-R = *Goldman Fristoe Test of Articulation-Revised*. PIAT-R = *Peabody Individual Achievement Test-Revised*. PPVT-R = *Peabody Picture Vocabulary Test-Revised*. TONI-2 = *Test of Nonverbal Intelligence-2*. SLD = Specific Learning Disability. PALS = Peer Assisted Learning Strategies. WIAT = *Wechsler Individual Achievement Test*. GFTA = *Goldman Fristoe Test of Articulation*. PASS = Promoting Awareness of Sounds in Speech.