The Efficacy of Phonological Awareness Intervention for Children With Spoken Language Impairment

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Reading is a complex behavior influenced by numerous linguistic, cognitive, and social factors. However, despite its complexities, reading must be seen as largely dependent on a knowledge of spoken language. Without some form of language already existing, reading could not evolve. In particular, a child's awareness of the sound structure of spoken language, referred to as phonological awareness, is considered a crucial link between spoken and written language (Stackhouse & Wells, 1997). It has been widely demonstrated that deficiency in this aspect of spoken language is strongly associated with reading impairment and may even be considered the cause of some children's reading failure (Catts & Kamhi, 1999; Vellutino et al., 1996).

Research has shown that children with expressive phonological impairment perform poorly on measures of phonological awareness (Larrivee & Catts, 1999). Yet the efficacy of phonological awareness intervention for young school-aged children who approach reading instruction with expressive phonological difficulties has not been well documented. An investigation of how children with spoken language impairment[1] (SLI) respond to phonological awareness intervention may provide insights into the relationship between spoken and written language disorders. What effect does enhancing the awareness of sound structure have on speech production? Can such intervention

[1] Children who have a disordered phonological system are referred to in this paper as having a spoken language impairment as suggested by Crystal and Varley (1998, pp. 149–150). Consistent with their model, such children may, or may not, display difficulties in other areas of their spoken language development.

ABSTRACT
Purpose: This study investigated the efficacy of an integrated phonological awareness intervention approach for children with spoken language impairment (SLI) who demonstrated early reading delay. Ninety-one, 5- to 7-year-old New Zealand children participated in this study: 61 children with SLI and 30 children with typically developing speech and language skills. All of the children with language impairment exhibited expressive phonological difficulties and some also had delayed semantic and syntactic development.
Method: The children with SLI participated in either: (a) an integrated phonological awareness program, (b) a more traditional speech-language intervention control program that focused on improving articulation and language skills, or (c) a minimal intervention control program over a 4½-month time period.
Results: Effects of the interventions on phonological awareness ability, reading performance, and speech production were examined. The children who received phonological awareness intervention made significantly more gains in their phonological awareness ability and reading development than the children receiving the other types of speech and language intervention. Despite significant delays in phonological awareness prior to training, children who received the phonological awareness intervention reached levels of performance similar to children with typically developing speech and language skills at post-test assessment. The phonological awareness intervention also improved the children's speech articulation.
Clinical Implications: The findings suggest that integrated phonological awareness intervention may be an efficient method to improve phonological awareness, speech production, and reading development of children with SLI. Findings are discussed with reference to a speech-literacy link model.

KEY WORDS: phonological awareness, intervention, spoken language impairment

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improve both speech production and word recognition skills simultaneously? Can children with SLI benefit from the same type of phonological awareness intervention as children with normal speech development? This study addresses these questions.

In particular, the effect of phonological awareness intervention on improving the word recognition abilities of children with SLI requires investigation. Theories of how a person can access meaning from a word written in isolation involve different central ideas. Readers access the meaning of a word based on phonological decoding skills or through a visual strategy in which the reader remembers that a string of letters represents a particular word. Some theories, such as dual route theories (e.g., Coltheart, 1978), hold that, although these processes are independent, nearly all readers use both processes to some extent. Other theories of word recognition reflect an integrated model, with the word's meaning being partially activated by phonological cues and partially by orthographic cues (e.g., modified dual route theory, Ehri, 1992; parallel distributed processing models, Seidenberg & McClelland, 1989).

It is important for speech-language pathologists to appreciate that a child's phonemic awareness and ability to phonologically decode the printed word is related to word recognition ability, particularly in the early stages or alphabetic phase of reading development (Frith, 1985). Furthermore, differences in word-decoding skills are considered to account for much of the variance in reading comprehension performance (Stanovich, 1985). Thus, programs designed to enhance the phonological awareness skills of young school-aged children with SLI should lead to improved word recognition ability and, ultimately, improved reading comprehension. Currently, there is little evidence from controlled intervention studies to demonstrate this progression.

Intervention studies that have reported positive reading outcomes in response to phonological awareness training have typically involved children without expressive phonological difficulties (Blachman, Ball, Black, & Tangel, 1994; Brady, Fowler, Stone, & Winbury, 1994; Brennan & Ireson, 1997; Defior & Tudela, 1994; Gillon & Dodd, 1995, 1997; Schneider, Kuspert, Roth, & Vise, 1997; Torgesen, Morgan, & Davis, 1992; Truch, 1994). Two previous studies that have examined phonological awareness intervention effects on reading development for young children with language impairment may well have included children with expressive phonological impairments. The 14 kindergarten children who received phonological awareness intervention in the study by Warrick, Rubin, and Rowe-Walsh (1993) performed poorly on formal measures of expressive language ability. Similarly, 80% of the 47 children in a second study (O'Connor, Jenkins, Leicester, & Slocum, 1993) were reported to have significant language delays. Importantly, these two studies demonstrated that rhyming, phoneme segmentation, and blending skills could be successfully taught to children without normal spoken language development, and that these gains resulted in improved reading ability. However, any concurrent speech difficulties of the participants were not identified. It is unclear, therefore, whether children with phonological impairment can benefit from such intervention.

A plausible reason for excluding children with speech difficulties from phonological awareness intervention studies may be the conflicting findings as to the literacy abilities of these children. Not all children with SLI have poor word-decoding ability (Catts, 1993; Dodd et al., 1995). Furthermore, phonological awareness skills may develop in the absence of adequate motor ability to physically produce speech sounds (Dahlgren Sandberg & Hjelmquist, 1997). Other research, however, has shown that children whose SLI has a phonological basis are at particular risk for a reading disorder (Bird, Bishop, & Freeman, 1995), and children who consistently use unusual phonological processes may experience persistent literacy failure (Dodd et al., 1995).

Children with an impaired phonological system may have under-specified phonological representations evident in their omission and substitution of speech sounds (see Larrivee & Catts, 1999, for a discussion of this issue). Similar to poor readers without overt speech disorders, they may also have an impaired ability to access the information contained in the phonological representation. For example, to be able to decode a written word, it is necessary to understand that the word can be segmented at the phonemic level. Children with SLI perform poorly on phoneme segmentation tasks (Leitao, Hogben, & Fletcher, 1997; Webster & Plante, 1992). Furthermore, these children may fail to understand grapheme-phoneme conversion rules as evidenced by their difficulty in reading nonwords (Bird et al., 1995).

Typically, speech-language pathologists working to resolve a child's phonological impairment focus on improving speech articulation and intelligibility. Intervention may indirectly target phonological awareness knowledge as the child's attention is focused on articulating sounds in words or perceiving and producing sound contrasts. The ability to consciously access information about the sound structure of spoken language, however, may not be made explicit for the child. Thus, a critical element related to reading acquisition may be insufficiently developed in the intervention process. Dodd et al. (1995) described how children who were successfully treated for their expressive phonological disorder, and discharged from intervention, performed poorly on phonological processing and reading measures. The clinician had improved the child's expressive phonological skills, but the child's conscious use of this knowledge and the ability to abstract the rules that link spoken to written language were not developed.

The need exists to investigate intervention provided by speech-language pathologists that makes explicit for the child the links between speech and print. The involvement of speech-language pathologists in phonological awareness training is not a new idea. More than a decade ago, Catts and Kamhi (1987) discussed how expertise in spoken language prepares speech-language pathologists to design and implement phonological awareness programs. Subsequent discussions in the literature (Jenkins & Bowen, 1994) and involvement of speech-language pathologists in working with older children with specific reading disability

(Gillon & Dodd, 1995, 1997) have supported this view. However, there have been few evaluations of phonological awareness intervention for young school-aged children who display expressive phonological difficulties.

The first aim of this study was to evaluate the effects of phonological awareness intervention on the phonological awareness ability of children with SLI and to observe any transfer effects to word recognition and reading comprehension performance. It was hypothesized that children receiving phonological awareness intervention would make more gains in their reading ability compared to children receiving regular speech and language intervention and children receiving minimal intervention.

The second aim of the study was to provide insights into the effects of phonological awareness intervention on children's expressive phonology. Stackhouse and Wells (1997) claimed that phonological awareness ability is dependent on a complete speech processing system and discussed how impairment at various levels of phonological development may restrict literacy acquisition. They proposed a one-way linear model from impaired speech processing to speech disorder, to phonological awareness deficit, and subsequent literacy difficulties. Their model suggests that children must pass through the normal stages of speech acquisition in order to develop the foundation skills for literacy. The present study investigated whether children with an impaired speech processing system could benefit from intervention at the phonological awareness level, not only in their reading development, as suggested by the model, but also in their speech production abilities. Enhancing children's awareness of the sound structure of words may help children establish more accurate phonological representations that may lead to improvements in phonological production (Brady et al., 1994; Larrivee & Catts, 1999).

Understanding the influence of phonological awareness intervention on speech production has important clinical implications. It needs to be established that intensive intervention to enhance a child's phonological awareness for reading development is not at the expense of improving the child's expressive phonology. Many phonological awareness activities described in intervention studies also engage children in speech production tasks. Children are frequently required to pronounce individual sounds, syllables, and words during rhyme production, phoneme segmentation, phoneme blending, phoneme identity, and phoneme manipulation activities (e.g., O'Connor et al., 1993; Torgesen et al., 1992; van Kleeck, Gillam, & McFadden, 1998). The emphasis in intervention is on improving the child's phonological awareness skills, but the child is also receiving practice in speech production and is hearing clear models of correct sound and word articulation. Although such speech practice is likely to be more limited than practice provided in regular speech-language intervention, when combined with improvements in awareness of sound structure in words, it may be sufficient to effect change in expressive phonology. It is hypothesized that children with spoken language impairment will make gains in speech production and phonological awareness skills simultaneously in response to phonological awareness intervention.

METHOD

Participants

A total of 91 New Zealand children between ages 5:6 (years:months) and 7:6 participated in the study (M = 73.4 months, or 6:1; SD = 5.8 months). Children start formal schooling in New Zealand at 5 years of age. The participants had therefore received at least 6 months of general education prior to the study. Of the 91 children, 61 had spoken language impairment and 30 had speech and language skills within the normal range. The children were required to have general New Zealand English as their only language; have no hearing, visual, or neurologic disorders (as evidenced by speech-language pathologists' case records); have normal cognitive ability as evidenced by school records; and gain a sandard score above 80 on the Test of Nonverbal Intelligence–2 (TONI–2, Brown, Sherbenou, & Johnsen, 1990). Children with SLI also had to demonstrate skills below the performance range expected for their age on pretest measures and school assessments.

Speech-language pathologists were asked to refer children who demonstrated a delay in expressive phonological development in the absence of severe receptive language or cognitive delays. These children attended mainstream primary schools in one of New Zealand's four major cities or surrounding townships, representing a range of socioeconomic backgrounds. Thirty-nine percent of the children attended schools in high socioeconomic areas, 24% were from schools in middle socioeconomic areas, and 37% were from schools in lower socioeconomic areas (as classified by the New Zealand Ministry of Education). The ethnic background for two of the children was New Zealand Maori. The remaining 59 children were of New Zealand-European decent.

The 30 children who participated in the normal comparison group were referred by their teachers. These children were required to have average literacy development and no history of speech or language difficulties. Their literacy performance was based on teachers' assessments and the children's performance on a battery of literacy tasks administered in most New Zealand schools. This battery included Clay's (1993) Observation Survey tasks: running records, letter identification, concepts about print, word tests, writing, and dictation tasks. These children were drawn from four primary schools in one metropolitan city. Two of these schools were in lower socioeconomic areas and the other two were in middle to higher socioeconomic districts. All of the children in the normal comparison group were of New Zealand-European descent.

Intervention Groups

The children with SLI participated in one of three intervention programs; the children with typically developing speech and language skills participated in their usual classroom literacy program. The four groups were as follows:

- Group 1: Experimental intervention (n = 23, 15 males and 8 females);
- Group 2: Traditional intervention control (n = 23, 15 males and 8 females);
- Group 3: Minimal intervention control (n = 15, 9 males and 6 females); and
- Group 4: Normal comparison (n = 30, 15 males and 15 females).

For ethical reasons, children were not assigned to a no-intervention control group. Rather, children who were unable to access intensive intervention due to service constraints or transportation difficulties participated in a minimal treatment control group. Following the post-intervention assessment, children who received traditional or minimal intervention were offered training in phonological awareness wherever possible. In assigning children to intervention groups, consideration was given to the child's age and the clinician's rating of the child's expressive phonological delay as mild, moderate, or severe to strive for balance in age and severity between the two intervention groups. The children with typically developing spoken language skills were randomly selected from a larger pool of children who had returned permission-to-test slips. From this group, children were matched for age and nonverbal ability to the children with spoken language impairment.

Following group formation, a multivariate analysis of variance showed no significant difference ($p > .05$) between group means for chronological age and nonverbal intellectual ability using the TONI–2. The Peabody Picture Vocabulary Test–Revised (PPVT–R, Dunn & Dunn, 1981) was administered to all participants as a measure of receptive vocabulary and the Word Structure subtest from the Clinical Evaluation of Language Fundamentals–3 (CELF–3, Semel, Wiig, & Secord, 1995) was given as a measure of expressive syntactic skills. The CELF–Preschool Word Structure subtest (Wiig, Secord, & Semel, 1992) was given to children ages 5:6 to 5:11.

Subtest standard scores were used in the analyses. The children with SLI scored significantly lower than the normal comparison group on the PPVT–R [$F(3, 87) = 16.29$, $p < .001$] and on the Word Structure task [$F(3, 87) = 32.30$, $p < .001$]. However, inspection of the standard scores of children with SLI revealed that 78% of their scores on the PPVT–R and 77% of their Word Structure scores were within or above the normal range for their age. There was no significant difference between the three groups with SLI on the PPVT–R and the Word Structure task ($p > .05$). (See Table 1).

Procedure

A pre-post-test design was employed to measure the effects of the intervention programs. The following assessment measures were used at pre- and post-test.

Speech production measures. The speech production skills of children with SLI were measured pre- and post-intervention through the spontaneous production of 56 different words taken from the Goldman Fristoe Test of Articulation Sounds-in-Words subtest (Goldman & Fristoe, 1986), and from the participants' responses on their first trial of the Phonological Variability Test (Dodd, 1995). This latter test employs a single-word elicitation task with the same set of pictures being shown to the children on three occasions with at least a 15-minute interval between trials. The entire sample contained 28 single-syllable words, 15 two-syllable words, 10 three-syllable words, and 3 four-syllable words. The percentage of consonants correctly articulated, from a possible 171, was calculated for each child using Computerized Profiling, PROPH (Long & Fey, 1993). As shown in Table 1, a range of scores was represented in each of the three intervention groups at pretest. No statistical difference was found between the pretest percentage consonants correct (PCC) scores of these groups ($p > .05$). The speech production skills of children with normal development were measured using the PCC score from their responses on the Goldman Fristoe test only. Group performance is shown in Table 1.

Literacy measures. Five literacy measures were employed.

- *The Neale Analysis of Reading Ability–Revised* (Neale, 1988). This test provides a measure of children's reading accuracy (decoding) and reading comprehension when reading connected text aloud. Following a practice passage, the children are asked to read a short passage of text presented in book form with a picture stimulus. The children are then asked comprehension questions. Form 1 was used for initial assessment and Form 2 was used at post-test assessment.
- *Burt Word Reading Test–New Zealand Revision* (Gilmore, Croft, & Reid, 1981). This test of word recognition skills requires the child to read words across a test sheet provided until 10 successive errors are made. The words are graded in order of difficulty.
- *Ready-to-Read Word Test* (Clay, 1993). This informal word-recognition test assesses children's ability to recognize high-frequency words from the early reading books commonly used in New Zealand Schools.
- *Letter Identification task* (Clay, 1993). This test assesses a child's ability to identify both upper and lower case letters.
- *Nonword Reading task.* Thirty nonwords were selected from the Reading Freedom Diagnostic Reading Test (Calder, 1992).

Phonological awareness measures. Two measures of phonological awareness were administered.

- *The Lindamood Auditory Conceptualization Test* (LAC, Lindamood & Lindamood, 1979). This test assesses the ability to discriminate between sounds and to analyze the number and order of sounds in spoken patterns. Form A was used at pretest and Form B at post-test.
- *The Queensland University Inventory of Literacy* (QUIL, Dodd, Holm, Oerlemans, & McCormick, 1996). This test consists of a series of tasks measuring school-age children's phonological awareness ability at three levels. Syllable identification (e.g.,

Table 1. Group performance on verbal and nonverbal measures for the 91 participants.

	Age in months	*TONI–2*	*PPVT–R*	*Word structure*	*PCC*
Group 1 (Experimental *n* = 23)					
M	72.39	104.00	94.78	8.52	66.17
SD	5.37	11.21	8.75	2.63	17.58
Range	66–85	84–123	78–112	3–15	23–95
Group 2 (Traditional control *n* = 23)					
M	73.13	102.30	87.48	6.78	71.21
SD	6.44	10.94	10.23	3.00	17.74
Range	66–86	84–123	73–117	3–13	23–94
Group 3 (Minimal control *n* = 15)					
M	74.80	102.70	85.60	7.93	75.06
SD	7.86	9.90	13.30	2.60	11.09
Range	66–87	82–118	67–116	3–13	52–90
Group 4 (Normal speech, *n* = 30)					
M	73.63	108.63	106.70[a]	13.03[a]	97.83[a]
SD	4.47	10.75	13.78	1.83	2.61
Range	66–88	87–136	87–144	9–17	91–100

Note. TONI-2 = Test of Nonverbal Intelligence –2 standard scores (Brown et al., 1990); PPVT-R = Peabody Picture Vocabulary Test Revised standard scores (Dunn & Dunn, 1981); Word Structure = Word Structure subtest standard scores from the CELF-3 (Semel et al., 1995) or CELF Preschool (Wiig et al., 1992); PCC = Percentage Consonants Correct score from the speech production measure.
[a] Group 4 scores were significantly better than other groups ($p < .05$)

"Which part of *awful* – *helpful* sounds the same"?) and syllable segmentation (e.g., "How many parts are there in the word *table*"?) are assessed at the syllabic level. A spoken rhyme recognition task (e.g., "Do these words rhyme, *jar tar*"?) and spoonerism task (*sit fun* becomes *fit sun*) are presented at the onset-rime level. Phoneme detection (e.g., "Which word has a different sound at the beginning *bed*, *bag*, *mop*, *bus*"?), phoneme segmentation (e.g., "How many sounds can you hear in the word *big*"?), and phoneme manipulation skills (e.g., "Say *told* without the /t/ sound.") are measured at the phonemic level. Practice items were given for each subtest. The use of phonological awareness skills is also assessed in this test by a nonword spelling and a nonword reading task.

Test Administration

The majority of tests were administered at pre- and post-test either by the researcher or by one of three speech-language pathologists employed as research assistants. The QUIL was administered by the children's speech-language pathologists who had been trained in the use of the test. All tests were administered in strict accordance with the instructions provided in the test manuals. The nonwords from the Reading Freedom Diagnostic Reading Test were typed onto individual cards using Century Gothic font size 26 and presented in a game format. The cards were placed face down (four at a time) on the table. The child was required to throw a chip onto the cards, turn over the card the chip landed on, and read the nonword.

The performance of children with SLI was significantly below that of their peers with normal speech and reading development on all pretest measures. There was no significant difference ($p > .05$) between the three groups of children with SLI on all but two pretest measures of literacy and phonological awareness ability. Group 2 demonstrated lower phonological awareness ability at the syllabic level as compared to Group 1 (Tukey, $p < .05$), and at the phonemic level as compared to Group 3. Table 2 and Table 3 show the pretest scores for each group on the main measures of phonological awareness and reading ability, respectively.

Description of Speech Production Skills of Children With SLI

Substitutions versus omissions. The children's consonant errors (excluding any distortions) were classified according to the PROPH analysis as substitutions or omissions. There was no statistical difference for types of errors between the three treatment groups. The children with SLI as a group demonstrated that 96% of their errors were substitutions (range 82.7% to 100%; $SD = 4.73$), with 4% of their errors being omissions (range 0% to 17.3%; $SD = 4.75$). Cluster reduction is classified by the PROPH as a substitution process rather than as an omission error. It is necessary, therefore, to examine the frequency of occurrence of the cluster reduction process to gain a more comprehensive view concerning the incidence of omissions in the participants' responses. Data inspection revealed that 58 of the 61 children had some incidence of cluster reduction: 57% of Group 1, 47% of

Table 2. Group performance on four phonological awareness measures.

	LAC		*Phoneme level*		*Syllable level*		*Rhyme detection*	
	Pre	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*
Group 1								
M	31.00	64.30	23.15	46.29	57.61	73.55	64.85	76.81
SD	12.10	13.90	12.55	13.01	18.49	16.51	18.80	16.53
Range	5–51	42–88	6–50	24–71	4–88	38–100	33–100	50–100
Group 2								
M	31.00	31.65	15.34	20.07	36.95	38.41	54.00	67.39
SD	11.40	11.23	11.00	11.58	22.56	24.59	22.59	22.18
Range	4–52	13–52	0–44	0–53	0–84	0–84	17–92	25–100
Group 3								
M	36.70	36.30	26.80	29.41	41.95	55.00	66.11	64.44
SD	19.50	17.50	11.11	19.19	22.85	23.21	17.67	19.79
Range	9–67	0–70	6–53	0–62	0–75	0–96	25–92	33–100
Group 4								
M	56.23	63.40	43.82	56.86	74.86	85.97	76.66	87.50
SD	14.23	16.57	15.00	15.49	20.17	11.24	33–100	67–100
Range	33–88	28–94	12–77	27–91	29–100	58–100	13–75	25–94

Note. All measures are expressed as a percent correct. LAC = Lindamood Auditory Conceptualization Test (Lindamood & Lindamood, 1979).

Table 3. Group performance on four reading measures.

	Burt		*Reading accuracy*		*Comprehension*		*Nonword reading*	
	Pre	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*
Group 1								
M	9.22	17.74	3.91	11.52	1.48	4.17	0.43	3.95
SD	7.00	9.26	5.18	8.31	1.90	2.84	0.73	3.51
Range	0–26	5–31	0–16	0–26	0–6	0–10	0–2	0–10
Group 2								
M	8.65	12.39	4.43	7.09	1.87	2.26	0.48	0.48
SD	9.32	10.93	6.07	8.22	2.14	2.86	1.12	1.50
Range	0–30	0–37	0–19	0–24	0–6	0–10	0–4	0–7
Group 3								
M	11.14	15.93	6.20	8.73	2.47	2.53	0.80	0.53
SD	9.20	10.19	6.10	8.10	2.64	2.47	1.82	1.30
Range	0–26	2–29	0–16	0–22	0–7	0–8	0–6	0–5
Group 4								
M	28.97	39.23	21.66	31.70	8.43	11.80	3.67	5.97
SD	8.93	11.61	9.26	11.32	3.27	3.48	2.93	2.55
Range	14–55	22–70	8–43	14–67	3–15	5–19	0–9	1–10

Note. Burt Word Reading Test (Gilmore et al., 1981) = number of words read correctly; Reading accuracy = passage score from the Neale Analysis of Reading Ability–Revised (NARA–R, Neale, 1988); Comprehension = reading comprehension score indicating the number of questions correctly answered on the NARA–R; Nonword reading = the number of nonwords read correctly from the first 10 words (level 1) of the nonword reading task.

Group 2, and 47% of Group 3 omitted a consonant from a consonant cluster more than 20% of the time.

Frequency of process use. The frequency of occurrence of phonological processes was calculated according to the PROPH analysis. Each child's data were examined for processes with 40% or higher occurrence rate (Hodson & Paden, 1991). Examination of the data indicated that 74% of the children in Group 1, 73% of the children in Group 2, and 65% of the children in Group 3 produced one or more phonological processes at more than a 40% occurrence rate. Most of the remaining children from each group demonstrated phonological processes at a percentage of occurrence between 20% to 40%. Fricative simplification (e.g., th → f) and liquid simplification (r → w) were excluded from this analysis. Consistent with normal developmental patterns, there was a high percentage of occurrence of these processes in the majority of the children's speech. Analysis indicated that velar fronting, cluster reduction, and palatal fronting were the most commonly occurring processes over the 40% occurrence level for all three groups. Less commonly occurring processes over the 40% occurrence level were stopping, cluster simplification, (Groups 1 and 3), final consonant deletion (Groups 1 and 2), and deaffrication (Groups 2 and 3).

Scoring Agreement

The responses elicited from the children with SLI on the speech production measure were audiotaped and phonetically transcribed by the examiner using broad transcription. The samples were then rechecked by the researcher or a research assistant using the audiotapes. Any differences between the transcript analysis were resolved through repeated listening to the taped response. The computer-generated transcripts were then rechecked against the original transcripts to ensure correct data entry.

Twenty percent of the pre- and post-test transcripts were randomly selected for analysis by two independent speech-language pathologists. One analyzed the pretest transcripts and the second analyzed the post-test transcripts. The percentage of agreement of the consonants transcribed for each word used in the PROPH analysis compared to this independent transcription was calculated. The average percent of agreement for the pretest transcripts was 91.63% (range 87.8–95.9; *SD* = 2.87). Agreement for post-intervention transcripts was 94.71% (range 90.2–98.8; *SD* = 2.57).

Phonological Awareness Intervention (Group 1)

Children participating in this group received an integrated phonological awareness intervention program for two 1-hour individual sessions per week until a total of 20 hours of intervention had been implemented. The children were treated either by their speech-language pathologist in their local area, by the researcher, or by a research assistant (a qualified speech-language pathologist) who saw the children at the university speech and language clinic.

The researcher trained the clinicians implementing the training program. This involved a 1-day workshop followed by a videotape of the researcher demonstrating each intervention activity. The video was given to each participant, and the clinicians referred back to the video during the intervention period to ensure that they continued to implement the activities in the required manner. The clinicians were given a kit containing all the materials they were to use in the program, along with a training booklet that detailed procedures for each activity. Details were recorded by the clinician following each intervention session (e.g., what specific activities had been implemented during the session and the accuracy of the children's responses to the stimulus items). For one child, there was evidence that some intervention activities had not been implemented as instructed and this child's data were excluded from the study.

Principles of the intervention program. The phonological awareness program was designed to improve children's awareness of the sound structure of spoken language and to develop their conscious knowledge of the links between the spoken form of a word and its written representation. Findings from research in phonological awareness intervention directed the development of the program activities. The key principles that formed the basis for the program content and implementation procedures are summarized.

- Phonological awareness intervention should focus on the development of skills at the phonemic level (Brady et al., 1994; Brennan & Ireson, 1997; Cary & Verhaeghe, 1994; Lundberg, Frost, & Petersen, 1988).
- Phonological awareness activities should be integrated with letter-sound knowledge training (Cunningham, 1990; Hatcher, Hulme, & Ellis, 1994).
- A range of phoneme analysis and synthesis activities should be incorporated, with particular attention given to phoneme segmentation skills (Ayres, 1995; O'Connor et al., 1993; Schneider et al., 1997; Torgesen et al., 1992).
- The combination of letter-sound knowledge with phonological awareness activities should include manipulative materials and should engage the child in reflecting on the phonological task (Cunningham, 1990; Defior & Tudela, 1994; Gillon & Dodd, 1995, 1997; Truch, 1994).
- A direct approach to phonological awareness intervention has greater benefits for literacy development than an indirect approach (Ayres, 1995).
- An intensive individual or small group model of service delivery may be necessary for children with severe deficits (Byrne & Fielding-Barnsley, 1995; Torgesen, Wagner, & Rashotte, 1994).
- Phonological awareness intervention is most effective after a period of general language instruction (Ayres, 1995).

Phonological awareness intervention activities

Rhyme. Picture rhyme bingo and odd-one-out games were used to teach children to identify phonological similarities in spoken word pairs. The clinician was required to bring the child's attention to the rime unit in the words. Examples are provided in the Appendix.

Phoneme manipulation of sounds in isolation. This activity was adapted from the Auditory Discrimination in Depth Program (ADD, Lindamood & Lindamood, 1975). Children were required to transfer colored blocks from a large square drawn at the top of a page down to smaller squares at the bottom of the page to represent the number of sounds heard and whether the sounds heard were the same or different. Children were required to repeat the sounds heard. For example, the clinician says; "Show me /p/ /p/." Child says /p/ /p/ and brings down two blocks the same color from the top box to the first two small boxes at the bottom of the page. Then the clinician says; "If that says /p/ /p/ show me /s/ /p/." Child says /s/ /p/ and puts the first block back up to the top square and brings down a different color to place in the first square.

Phoneme identity. Through a variety of activities using colored pictures on game boards, children were required to identify initial and final sounds. The identification of medial sounds was included for children with more advanced phonological awareness skills. Children were required to articulate the word when identifying the phonemes. If the child mispronounced the word, the speech-language pathologist modeled the correct production and encouraged the child to attempt a closer approximation of the target word. Examples are shown in the Appendix.

Phoneme segmentation and blending. A range of activities was used to give the children practice in segmenting and blending words. Two- and three-phoneme words were predominately used in the activities, although four phonemes were occasionally introduced. Activities included tracking sound changes in words with colored blocks, segmenting words into sounds, blending sounds to make words, and moving blocks on picture boards to represent the number of sounds heard in a word (see the Appendix for examples).

Linking speech to print. Activities at this level included grapheme-phoneme correspondence games, real and nonword bingo games, and making words with letter blocks. This latter activity (adapted from the ADD program) extended the tracking sound changes in words with colored blocks activity by replacing the blocks with graphemes on wooden blocks that were 12.5 cm by 12.5 cm. The child engaged in reading and spelling chains of simple one-syllable words. However, unlike the ADD program, nonwords were only used occasionally and the letter names and sounds were used. Examples of the stimuli used are shown in the Appendix.

Program adaptations. Integrated into the activities were additional stimulus items following the same structure as the program items, but designed by the child's speech-language pathologist to meet the expressive phonological needs of individual children. For example; if a child used velar fronting, a reading chain may have focused on correct /k/ in the following manner. "If that says *ar*, this says (*ark*); if that says *ark*, this says (*bark*)*;* if that says *bark*, this says (*book*)*."* The focus remained on increasing phonological awareness and grapheme-phoneme conversion knowledge, but provided appropriate opportunities for the child's speech production.

To maintain the child's interest for the 1-hour session, a number of activities were presented for 5–10-minute periods during a session. A typical session may have included a rhyme activity, a phoneme identity game, a phoneme segmentation game, tracking sound changes with colored blocks, a grapheme-phoneme correspondence game, and tracking words with letter blocks. Not all activities had to be included in each session. Rather, the emphasis changed according to the child's developing skill level. Early in the program, the emphasis was on developing rhyme, phoneme identity, phoneme segmentation, and grapheme-phoneme rule knowledge, whereas later in the program, tracking sounds with letter blocks and phonetically regular word games were emphasized. Because the task of tracking sound changes with colored blocks integrated a range of phoneme analysis skills as well as articulatory skills, this task was implemented in every session.

Children were not required to reach a set performance criterion before the next activity was introduced. Rather, the children were exposed to a range of phonological awareness activities that prior research has supported as important. With the exception of tracking sound changes with colored blocks and letter blocks, an activity was discontinued once the child reached 100% accuracy on all the stimulus items and the clinician was confident the child had acquired the skill (e.g., the child reached 100% accuracy on three occasions).

Traditional Intervention (Group 2)

During this intervention, the children also received two 1-hour individual therapy sessions per week for a total of 20 hours. The intervention focused on improving expressive phonological and language skills. The speech-language pathologists implementing the program were well qualified and experienced in working with children with SLI. They planned the program based on their own assessments of the child's speech and language skills as well as the pretest PROPH analysis. The phonological intervention consisted of a phoneme-orientated approach that developed the child's ability to articulate the target sound correctly in isolation, syllables, words, phrases, and sentences typically following the "Van Riper method," as described in Bernthal and Bankson (1998). The Nuffield Centre Dyspraxia Programme (The Nuffield Hearing and Speech Centre, 1994) was used for children with severe phonological impairment. This program is commonly used in New Zealand and consists of a series of graduated sessions to teach "basic placement and movements required in speech and sound production and to give practice co-ordinating these movements into sequences at all levels" (p. 2). The clinician recorded details following each intervention session, noting the session treatment goals and the child's progress. One child did not receive 20 hours of intervention and the data were not included in the study.

Minimal Intervention (Group 3)

Children in this group received minimal intervention from a speech-language pathologist. Following assessment, the speech-language pathologist consulted with the child's teacher or parents and made recommendations for home or school activities. The frequency of consultations was no greater than once per month. The recommendations aimed to improve speech production skills. For example, the children's parents or teachers were given picture activity sheets for the child to practice saying a target sound in words.

All children continued to receive their regular classroom literacy program that generally followed a Whole Language Approach to reading instruction. None of the children in the study received The Reading Recovery Program or other intensive remedial reading assistance during the course of the interventions.

RESULTS

An average of 4.5 months (*SD* = .87) elapsed between pre- and post-test measurements for children in the intervention groups. There was no significant difference between the length of time taken for children in Group 1 and Group 2 to complete the 20 hours of intervention. The normal comparison group received 5 months of classroom instruction between assessments. Difference scores provide a useful measure of the effects of intervention (Tilley, 1990) and were used in univariate and multivariate analysis of variance (ANOVA and MANOVA) (SYSTAT, Version 6.0).

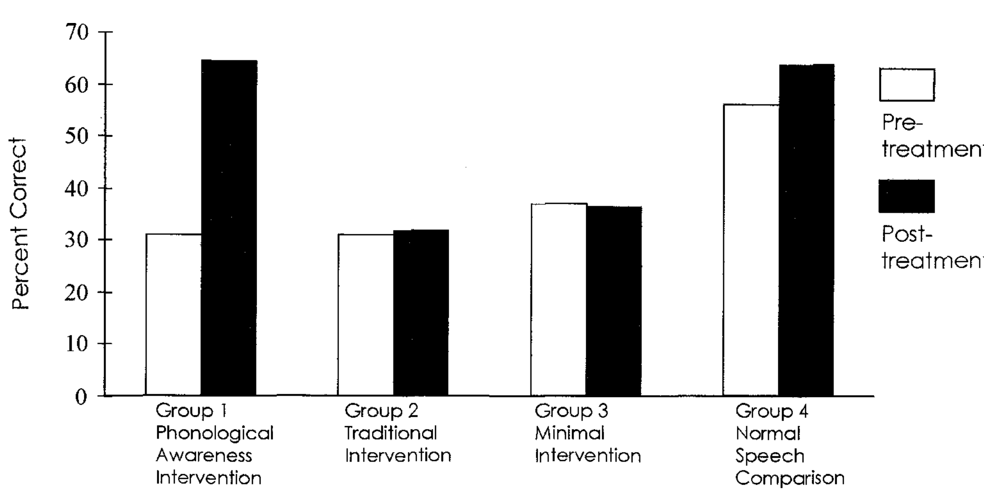
Program Effects on Phonological Awareness Ability

Lindamood Auditory Conceptualization Test performance. The children's converted percentage correct scores, calculated from the scoring procedures of this test, were used in the analysis. Difference scores were compared with a univariate analysis of variance. The group effect was significant [$F(3, 87) = 25.44$, $p < .001$]. Tukey post-hoc comparisons indicated that the improvement made by Group 1 was significantly different from improvement made by the other groups ($p < .001$). There was no statistical difference between the improvement scores of Groups 2, 3, and 4. Figure 1 illustrates Group 1's accelerated progress in phonological awareness ability. The difference between the children with normal development and Group 1's performance at post-intervention was not significant (independent *t* test (*t*) 21 *df* = 51; $p = 0.83$). The range of scores within each group is reported in Table 2.

Queensland University Inventory of Literacy (QUIL) performance. Children's performances on the QUIL were analyzed according to the levels of phonological awareness that the test assesses. At each level (i.e., syllabic, onset-rime, phonemic, and phonological use), the raw scores from subtests were combined and converted to a percentage correct score for analysis. Difference scores at each level were used in a MANOVA to compare the groups' improvement between assessment trials.

The group effect was significant [$F(12, 222) = 6.44$, $p < .01$]. Inspection of univariate *F* tests indicated a significant group effect for each of the phonological awareness measures ($p < .05$). Post-hoc testing (Tukey) indicated that Group 1's improvement differed from all other groups on the phonemic measure. The accelerated progress from pre- to post-test for Group 1 is shown in Table 2. Group 1's improvement was also significantly better than Group 3 for the onset-rime measure and better than Group 2 on the syllabic level measure ($p < .05$). There were no meaningful differences between the improvement of Group 1 and Group 2 on measures of onset-rime. To allow comparison with other studies that have investigated changes in rhyme detection skills (e.g., Webster, Plante, & Couvillion, 1997), the children's performance on the spoken

Figure 1. Pre-and post-intervention performance on the Lindamood Auditory Conceptualization Test (Lindamood & Lindamood, 1979) for the three intervention groups and the typically developing group.



rhyme recognition task was analyzed separately. An ANOVA using difference scores (adjusted for variations in pretest scores) revealed no significant differences in the improvements between groups in recognizing rhyming word pairs. Descriptive statistics are shown in Table 2.

The Tukey multiple comparisons suggested a trend that the phonemic awareness skills of children with SLI receiving minimal therapy were declining relative to children with normal speech and reading development. However, these skills were improving at a similar rate to children with typical speech and language skills for children receiving traditional intervention and at an accelerated rate for children receiving phonological awareness intervention. Consistent with evidence of the influence of skilled reading on complex phonological awareness tasks, Group 4 made significantly more progress than all three groups with spoken language impairment in their use of phonological knowledge ($p < .01$).

Program Effects on Reading Development

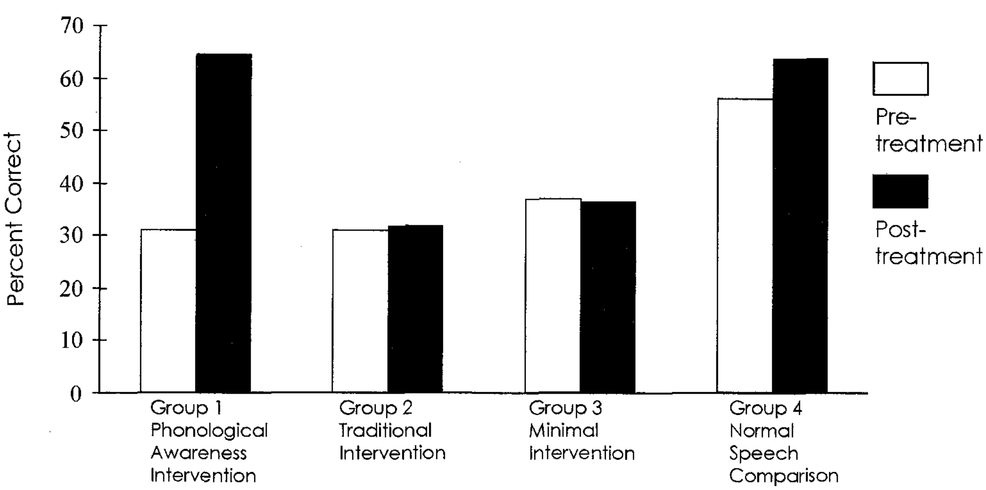
The difference scores on all reading measures were analyzed to compare the performance of the three groups with SLI. The groups' difference scores were converted to z scores to enable comparison across tasks. A MANOVA indicated a significant group effect [$F(12, 96) = 3.38$, $p < .01$]. Inspection of univariate F tests revealed significant differences between groups ($p < .05$) on all measures with the exception of the letter identification task. Tukey multiple comparisons ($p < .05$) indicated that the improvement made by the children in the phonological awareness intervention was greater than the two control groups for word recognition skills, reading and comprehending connected text, and nonword decoding ability. There was no difference between the improvement of Groups 2 and 3 on any of the reading measures. Figure 2 illustrates the gains made in reading skills by Group 1.

Normal group comparison on the Burt Word Reading Test showed a significant group effect [$F(3, 86) = 12.82$, $p < .01$]. There was no difference in improvement levels between Group 1 and Group 4, although Group 4's improvement was significantly greater than improvement made by the two control groups (Tukey $p < .01$). This suggests that the word recognition skills of children with phonological impairment receiving traditional and minimal therapy are declining over time relative to children with normal speech and language development. The average scores of each group pre-and post-intervention on four reading measures are shown in Table 3.

Program Effects on Speech Production

The difference scores for speech production (i.e., PCC scores) for the three groups with SLI were compared. The difference scores were divided by the pretest scores to adjust for the range of speech production abilities within each group prior to the intervention (i.e., post-test minus pretest, divided by pretest). An ANOVA indicated a significant group effect [$F(2, 58) = 4.72$, $p < .01$]. Tukey multiple comparisons indicated that Group 1's improvement in speech production was better than the improvement made by the other groups ($p < .05$). The sample size, however, was not sufficiently large to show a meaningful difference as discussed in the effect size analysis. The speech production skills of all three groups improved over the intervention period: Group 1, M improvement = 13.2%

Figure 2. Group improvement on reading measures. Group 1 (phonological awareness intervention) made more improvement than did the two control groups on all measures except the letter identification task ($p < .05$). NWR = Nonword reading task; Accuracy = reading accuracy passage scores, Comp. = reading comprehension score from the Neale Analysis of Reading Ability Revised (Neale, 1988); Burt = Burt Word Reading Test (Gilmore et al., 1981); Word = Word Test (Clay, 1993); Letter = letter identification task.



(range = 3% to 30%, *SD* = 7.72); Group 2, *M* = 8.19% (range = -2% to 24%, *SD* = 6.8); and Group 3, *M* = 6.34% (range = 0% to 14%, *SD* = 4.38).

Analysis of the children's production of phonological processes suggested similar rates of improvement for children receiving phonological awareness intervention and traditional intervention, with less improvement evident for children receiving minimal intervention. For example, 61.9% of children in Group 1 and 56% of children in Group 2 who demonstrated velar fronting either completely resolved this process or, if they showed evidence greater than 40% occurrence at pretest, reduced to less than 20% at post-test. This compares to similar levels of reduction in velar fronting for only 33% of the children in Group 3.

Profile of Five Children

Torgesen et al. (1994) suggested that phonological awareness intervention might have limited benefits for children with severe phonological deficits. To investigate the changes in phonological abilities for children with more severe SLI in the current study, the profiles of the five children from Group 1 with the lowest speech production measures at pretest were examined. The profiles (shown in Table 4) suggest that phonological awareness intervention had positive effects on both the speech production and phonological awareness abilities for all five children. Transfer effects to reading performance were also evident in four of these children. Child 3 did not show a transfer of skills to reading and follow-up assessments are necessary to ascertain whether the intervention had any long-term benefits for this child.

In comparing the profile of these five children with the average performance of children in Group 1 (shown in Table 2), a trend was observed for these children to perform at the lower end of the group for phonemic awareness and/or reading skills at pretest assessments. However, they appeared to catch up to other children with less severe impairment following intervention.

Table 4. The profile of five children from Group 1: phonological awareness intervention.

		Child 1	*Child 2*	*Child 3*	*Child 4*	*Child 5*
Age		5:10	5:10	6:5	5:6	5:7
Gender		Female	Female	Male	Male	Female
SES		middle	lower	lower	lower	middle
PPVT-R		90	88	96	90	100
TONI-2		93	108	98	123	108
CELF-P		3	9	4[a]	11	8
LAC	pre	28	21	7	33	25
	post	57	61	69	58	88
PA	pre	11.8	14.7	8.8	32.4	23.5
	post	35.3	47.1	26.5	47.1	52.9
Burt	pre	3	1	5	5	14
	post	11	10	5	14	30
PCC	pre	22.8	37.3	38.9	51.2	51.5
	post	52.6	65.7	57.9	70.7	78.2
Processes						
VF	pre	56	82	37	42	56
	post	37	76	66	0	0
FCD	pre	27	6	41	0	30
	post	6	0	0	0	0
ES	pre	42	30	0	0	20
	post	35	6	0	0	0
LS	pre	40	60	59	41	40
	post	22	36	45	30	3
CLR	pre	88	66	59	41	40
	post	77	46	45	30	3
PF	pre	50	25	0	100	0
	post	50	25	0	50	0
Other substitutions						
No.	pre	24	9	17	4	14
	post	11	3	7	3	11

Note. Age= years:months; SES = socioeconomic status; PPVT–R = Peabody Picture Vocabulary Test–Revised (Dunn & Dunn, 1981); TONI–2 = Test of Nonverbal Intelligence–2 (Brown et al., 1990); CELF–P = Clinical Evaluation of Language Fundamentals–Preschool Word Structure standard score (Wiig et al., 1992); LAC = Lindamood Auditory Conceptualization Test (Lindamood & Lindamood, 1979); PA = phonemic awareness measure; Burt = Burt Word Reading Test (Gilmore et al., 1981); PCC = percentage consonants correct. Processes = total process usage expressed as a percent; VF = velar fronting; FCD = final consonant deletion; ES = early stopping; LS = later stopping; CLR = cluster reduction; PF = palatal fronting; Other substitutions = the number of less common substitutions not analyzed in PROPH's process analysis.
[a] CELF–3, Clinical Evaluation of Language Fundamentals–3 Word Structure standard score (Semel et al., 1995)

An examination of the children's changes in expressive phonology revealed that all five children showed growth towards the suppression of phonological processes. Table 4 details changes in five phonological processes.

Sample and Effect Size Analyses

Sample size and effect size post-hoc analyses were conducted to determine if the significant differences in improvement between children in the experimental group and traditional intervention group may generalize to the larger population (Pocock, 1983). Given 23 children in each group and a $p < .05$ α level, a meaningful difference was able to be detected for all six phonological awareness and literacy variables at an 80% power level and for five of these variables at a 90% power level. A group sample size ranging from 7 to 23 children would have been sufficient for these variables. The variable that required a larger sample size for 80% power (36 children in each group) was the speech production measure.

Summary of Results

Pertinent findings are as follows. First, children in Group 1 (phonological awareness intervention) made significantly more improvement in their phonological awareness skills at the phonemic level as compared to children in Group 2 (traditional intervention) and in Group 3 (minimal intervention). Following intervention, the phonemic awareness skills of children in Group 1 were similar to those of children with typical speech and language development (Group 4). Second, Group 1 also showed significantly more improvement than Groups 2 and 3 in their word decoding skills (evident in their reading of real and nonwords) and in their ability to read and comprehend connected text accurately. Finally, there was a trend for children in Group 1 to show more improvement in their spontaneous articulation of single words than children in Groups 2 and 3.

DISCUSSION

The findings of this study indicate that an integrated phonological awareness intervention approach can have a significant effect on improving the phoneme awareness, speech production, reading accuracy, and reading comprehension skills of children with SLI. Results support the hypothesis that phonological awareness intervention would have greater benefits for the children's reading development than traditional and minimal speech and language intervention. The results suggest that, despite being at risk for reading failure, children with SLI have the potential to make accelerated gains in their reading development and in skills that underlie successful literacy acquisition. Importantly, the benefits of phonological awareness intervention for reading were not at the expense of improving the children's expressive phonology. In support of the second hypothesis, the results indicate that phonological awareness and speech productions skills can be improved simultaneously when an integrated approach is adopted.

Brady et al. (1994) offered the tentative hypothesis that phonemic awareness may have positive consequences for speech production. Their study investigated the effects of phonological awareness training for 5-year-old children from low socioeconomic backgrounds who had no overt speech production disorders. Increases in phonological awareness were associated with improvements in accuracy on a speech production task (a multisyllabic nonword repetition task). This occurred in the absence of any direct training in multisyllabic word production.

The presence of expressive phonological difficulties does not restrict a child's access to the benefits of phonological awareness intervention. The same type of direct phonological instruction that has proven successful in developing the literacy skills of children who have no overt speech errors was shown to be appropriate for children with SLI. The efficiency of the training program was demonstrated through the participants' concurrent gains in phoneme awareness, speech production, and early reading skills.

The findings from this study lend support to Stackhouse and Wells' model (1997) of the importance of phonological awareness skills for establishing links between speech and print. The data indicate that phonological awareness intervention may be necessary for these children to make accelerated literacy growth. However, the findings of this study as a whole do not support the one-way linear progression in the Stackhouse and Wells's model. Consequently, the clinical assumption that training skills at earlier stages of speech development will facilitate skills at the later meta-phonological level cannot be supported. The current study showed that traditional speech and language intervention was effective in improving the children's speech production, but had little effect on developing phonemic awareness skills or reading development. Harbers, Paden, and Halle (1999) also observed that significant improvements in the production of a targeted phoneme for preschool children with phonological impairment did not result in improvements in a child's ability to detect the targeted sound in a phoneme awareness task.

The findings from the current study also appear contrary to Webster and Plante's (1995) conclusions, which support a one-way linear model from primary phonology to phonological awareness, but not the reverse. It is necessary, therefore, to carefully examine the studies to understand the nature of the apparent inconsistencies. Webster and Plante (1992, 1995) and Webster et al. (1997) investigated the relationship between speech and phonological awareness abilities for young children diagnosed as having moderate to severe phonological impairments. A group of 29 children were monitored from the ages of 3:6 to 6:0 and their performance was compared to that of 16 children with normal phonology. Webster and Plante observed that, from the ages of 3 to 6 years, the ability of children with delayed phonological development to detect words that rhymed or started with the same sound could be predicted by improvements in speech production skills. Thus, as speech improved, so did the children's performance on early developing phonological awareness tasks.

Analysis of the tasks tapping early developing phonological awareness skills used in the current study support this result. Significant differences were not found between improvement on rhyme detection for children receiving phonological awareness intervention and children receiving traditional intervention, despite phonological awareness intervention providing explicit instruction in rhyme knowledge. Consistent with Webster and Plante's (1995) argument, children's improvement on rhyme may have been influenced by improvements in speech production. However, this pattern was not evident for later developing phonological skills. Improvement in speech production through traditional speech and language intervention had little effect on enhancing children's awareness at the phonemic level or in their use of phonological knowledge.

It is plausible that the initial link from speech to phonological awareness for young preliterate children can be represented by a one-way linear model. The establishment of accurate phonological representations for speech production positively influences a child's early awareness concerning sound structure of words. However, as the continuum of phonological awareness knowledge develops to more complex levels, the ability to access and reflect consciously on the representation of a word's phonological structure is necessary. It is at this level that a one-way linear relationship no longer holds between improvement in speech production and improvement in phonological awareness and reading skills. Rather, bidirectional influences may be hypothesized. Explicit phoneme awareness and knowledge of grapheme-phoneme relationships may assist children in establishing accurate phonological representations. For example, becoming consciously aware of the number and order of phonemes in a word, and having access to the orthographic cues from the word, may help children realize the breakdown in their communication attempt and provide cues to repair their attempt. In addition, the opportunities for speech production practice that many phonological awareness activities provide may contribute to improvements in children's expressive phonology. Research examining the effects of phonemic awareness activities with, and without, the integration of speech production practice is necessary to more fully explore the relationship between phonological awareness and speech production in children with SLI.

The findings from the current study support recent research with preschool children with speech and language disorders (van Kleeck et al., 1998). In the van Kleeck et al. study, improvement in young children's rhyming ability was not dependent on specific intervention, but improvement at the phonemic awareness level was attributed to the training procedures. Consistent with these results, the rhyme skills of children in the current study could not be attributed to the phonological awareness intervention. In contrast, the children's phonemic analysis skills required explicit instruction.

The involvement of speech-language pathologists in phonological awareness intervention has proven to be an effective and efficient practice. The results from this study provide evidence for previous recommendations (e.g., Catts & Kamhi, 1987) that speech-language pathologists have an important role in promoting children's literacy development. The timing of clinicians' involvement in intensive phonological awareness training is an important consideration. Children whose SLI restricts their learning of the alphabetic principle may be in particular need of intensive instruction in phoneme analysis skills and in understanding phoneme-grapheme relationships. Chapman and Tunmer (1997) demonstrated that children's self-perception of their reading ability begins to influence their reading performance during the latter part of their second year of schooling. To prevent the negative spiraling effects of poor reader self-perception, it is critical that the underlying phonological skills necessary for successful reading acquisition are addressed early in children's school years.

A limitation of the large group design employed in this study is the masking of individual differences in phonological awareness intervention. It was evident from the descriptive statistics that a wide performance range existed within the groups. Data inspection revealed that, although some children made dramatic gains in speech production and reading tasks, a few children made only limited progress. These "treatment resisters" need to be examined in future studies (Blachman, 1997). Ongoing research is needed to address a series of questions raised by this study related to types of phonological errors, age of intervention, and related linguistic factors that may have contributed to an individual's success. Controlling for children's educational history and grouping children by the severity of their phonological awareness deficit may provide insights into predicting which children with SLI benefit the most from phonological awareness intervention.

The influence of clinician-child interactions and environmental conditions were not controlled in this study, as a number of children were treated by their local speech-language pathologist in differing parts of the country. Involving children's local speech-language pathologists has the potential advantage of generalizing results to clinical conditions, but further research controlling for environmental variables is necessary to confirm the optimal types of interactional styles and conditions for successful phonological awareness intervention.

The participation of children from around the country was necessary to ensure adequate numbers of children in each intervention. However, group size did compromise treatment fidelity. Although the clinicians recorded details from each session, these records could not be objectively verified because their work environments did not have the advantages of the university clinic video recording and observation facilities. The training package the clinicians received and the use of identical materials for each child's intervention were implemented to help minimize treatment variation. The large difference in scores on post-test measures of phonological awareness between those children who received the program and those who did not suggests that the program was sufficiently robust to withstand variations in program interpretation that may have been present. The accurate measurement of this variation requires addressing in future studies (Troia, 1999).

It is important to keep the benefits of phonological awareness intervention in perspective with regard to children's language development as a whole. Consistent with previous findings demonstrating semantic and syntactic deficits in poor readers (e.g., Gillon & Dodd, 1994), some children with SLI in this study also demonstrated semantic and syntactic weaknesses. Thus, although phonological awareness intervention may be particularly important in enhancing the early reading acquisition of these children, intervention to resolve other linguistic difficulties is also necessary. In adopting an interactive view of skilled reading (Rumelhart, 1977), the child will ultimately need skills across linguistic domains to access semantic, syntactic, and phonological cues in decoding text. Continued research directed at understanding the relationship between spoken and written language disorders will contribute to the ability of children who are at risk for reading failure to succeed in their literacy acquisition.

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APPENDIX. EXAMPLES OF PHONOLOGICAL AWARENESS INTERVENTION ACTIVITIES

Rhyme Bingo

Clinician: "I've picked up a picture of a pie. What rhymes with pie?" The clinician moves the picture of a pie along the rhyme bingo board, asking the child to identify whether the words rhyme. "Do pie boat rhyme? … no, they don't end the same. They don't rhyme.
Do pie tie rhyme? …pie tie. Yes, they sound the same at the end. p..ie, t..ie (segmenting the onset-rime units) they both end in *ie*. Pie and tie are rhyming words."

Phoneme Identity: Identifying Initial and Final Sounds

Using the colored pictures, identify words that start and end with the same sound.

Clinician: "Do cat and cow start with the same sound?"
Child: "Cat, cow, yes they start the same."
Clinician: "Good listening. Cat, cow, both start with a /k/ sound."
Clinician: "Do seal and pig end with the same sound?"

Phoneme Identity: Sound Categorization Activity

Ask the child to identify all the words on the picture sheets that start with a target sound.

Clinician: "Let's find the pictures that start with a /b/ sound" (pointing to the *b* letter block). Encourage the child to say each word as you find the picture.

Phoneme Identity: Odd-One-Out Game

Clinician: "I'm going to point to three pictures. Listen to the beginning of each word and tell me which one starts with a different sound; bear, ball, car."
Child: "Car"
Clinician: "Yes, car starts with a /k/ sound (pointing to the letter c) and bear and ball start with a /b/ sound" (pointing to the letter b).

Phoneme Segmentation: Identifying Sounds in Words

A picture of a horse in a barn and four carrots spaced apart underneath the barn is placed in front of the child. A set of small colored blocks is at one side of the picture. Target words to segment are: horse, barn, food, hay, rein, eat, nose.

Clinician: "Here is a picture of a horse. He'd like some carrots to eat. I'll say some words and I want you to tell me how many sounds you hear in the word. We'll give the horse one carrot for each sound we hear. This horse lives in a barn. How many sounds in the word barn?"
Child: "B-ar-n (segmenting the word and placing one block at a time on a carrot below the horse to represent each sound heard). Barn (repeating the word with the sounds blended together). I heard three sounds so I gave the horse three carrots to eat."

Phoneme Segmentation: Identifying Sound Changes with Colored Blocks (Adapted from the ADD Program)

Clinician: "I'm going to say some words and I want you to show me the sounds you hear with the colored blocks. I'll try some first. Arm. I heard two sounds *ar-m* (segmenting the word) so I'll put out two different colored blocks….arm. That says arm and now I want to show art, arm…. art …I hear a different last sound so I'll change the last block. (Touch the first block for the *ar* sound and the second block for the *t* sound). If that says art show me oot" (as in boot).

Linking Speech to Print

Example: making words with the following grapheme blocks by adding, deleting, or changing one sound at a time: m, ch, f, a, ee, t, p.

Clinician: "Show me *at*."
Child: The child puts the a and t letter blocks together and says "at."
Clinician: "If that says *at* show me *fat*."
Child: Adds the letter *f* to the front of *at* and says: "fat, I added a letter."
Clinician: "If that says *fat* show me *feet*."