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Facilitating Phoneme Awareness Development in 3- and 4-Year-Old Children With Speech Impairment

Gail T. Gillon
University of Canterbury, Christchurch, New Zealand

Many young children with phonologically based speech impairment experience difficulty in learning to read and/or spell (Bird, Bishop, & Freeman, 1995; Larrivee & Catts, 1999). Despite therapy intervention that resolves these children's speech error patterns, children with speech impairment[1] may exhibit delayed reading development or spelling weakness that persists well into their school years (Gillon, 2002; Lewis, Freebairn, & Taylor, 2000). One area that appears critical to these children's early literacy success is their phonological awareness ability (i.e., explicit awareness of the sound structure of spoken words). Phonological awareness and rapid naming are more closely related to first-grade written word recognition for these children than are measures of receptive and expressive language (Catts, 1993). This study investigated whether early phonological awareness can be stimulated in children with speech impairment during their preschool years (i.e., 3–5 years), when these children frequently receive therapy to improve speech intelligibility. The study also examined whether stimulating early phonological awareness development helps prevent the reading and spelling difficulties that many children with speech impairment currently experience.

[1]The term speech impairment will be used throughout this article to refer to children who have phonologically based speech errors in the absence of any other significant physical, sensory, or cognitive impairment.

ABSTRACT: **Purpose:** This study investigated the phonological awareness and early literacy development of 12 children who presented at 3 years of age with moderate or severe speech impairment. The children's response to early intervention that included specific activities to facilitate phoneme awareness and letter knowledge, in addition to improving speech intelligibility, was examined.
Method: Using a 3-year longitudinal design, the children's development in phonological awareness was monitored and compared to that of a group of 19 children without speech impairment. During the monitoring period from 3 to 5 years of age, the children with speech impairment received, on average, 25.5 intervention sessions. At 6 years of age, the children's performance on phonological awareness, reading, and spelling measures was also compared to that of the 19 children without impairment as well as to a matched control group of children with speech impairment who had not received any specific instruction in phonological awareness.
Results: The results indicated that (a) phoneme awareness can be stimulated in children with speech impairment as young as 3 and 4 years of age, (b) facilitating phoneme awareness development can be achieved concurrently with improvement in speech intelligibility, and (c) enhancing phoneme awareness and letter knowledge during the preschool years is associated with successful early reading and spelling experiences for children with speech impairment.
Clinical Implications: The data provide evidence to support the clinical practice of integrating activities to develop phoneme awareness and letter knowledge into therapy for 3- and 4-year-old children with moderate or severe speech impairment.

KEY WORDS: phonological awareness, intervention, preschool children, speech impairment

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RELATIONSHIP BETWEEN PHONOLOGICAL AWARENESS AND LITERACY DEVELOPMENT

Children's phonological awareness ability at preschool is a powerful predictor of later reading and writing success (Bradley & Bryant, 1983; Lundberg, Olofsson, & Wall, 1980; Torgesen, Wagner, & Rashotte, 1994). Phonological awareness is a multilevel skill and is generally considered to encompass syllable awareness (e.g., the ability to segment words into syllables), onset-rime awareness (e.g., perceiving rhyming patterns in words or generating rhyming words), and phoneme awareness (the conscious awareness that words are made up of individual sounds, e.g., segmenting a word into phonemes). Skills in all of these areas may contribute to successful reading or spelling performance, but phonological awareness skills at the phoneme level are the most critical for literacy development (Hulme et al., 2002).

A reciprocal relationship exists between phonological awareness and reading and spelling development (Cataldo & Ellis, 1988). Learning to decode and encode print stimulates increased awareness of how words can be divided into sound units. The bidirectional relationship between phoneme awareness and literacy growth that is evident in school-age children is also evident at the preschool level in relation to letter knowledge acquisition. Burgess and Lonigan (1998) demonstrated that learning letter-name and letter-sound knowledge between 4 to 5 years of age and growth in phonological awareness skills positively influenced each other. However, the researchers also recognized that letter knowledge and phonological awareness contribute independently to written language development and are not measures of the same underlying construct. A vast array of research using differing populations and alphabetic languages has established that children who approach literacy instruction with strong phonological awareness knowledge are likely to succeed in early reading and spelling. In contrast, children who demonstrate very poor awareness of the phonological structure of words are more likely to experience difficulty in acquiring competency in reading and spelling (see Gillon, 2004, for a review of this literature). Severe phonological awareness deficits and other types of phonological processing difficulties, such as difficulty in rapidly recalling phonological information, have proven resistant to general classroom literacy instruction as well as many forms of remedial reading help. Children who have been identified as having dyslexia, for example, may display persistent phonological awareness deficits into their adult years (Bruck, 1992).

LITERACY RISK FACTOR FOR CHILDREN WITH SPEECH IMPAIRMENT

Children with speech impairment may or may not have co-occurring language disorders. Longitudinal research has established that young children who have receptive and expressive language impairments that include semantic, syntactic, as well as speech impairment are likely to have worse literacy outcomes than children who have isolated speech impairment (Snowling, Bishop, & Stothard, 2000). Reading is an interactive process whereby knowledge from differing linguistic sources such as knowledge of vocabulary items, sentence structures, story structure, phonological structures, as well as listening comprehension ability, interact with orthographic knowledge and influence reading performance. For children with pervasive spoken language impairment, breakdown at all of these levels contributes to their written language difficulties. Of interest in this study are those children with moderate or severe speech impairment in the absence of other significant language impairments. These children's primary disorder is restricted to the phonological domain and is not associated with poor receptive vocabulary or cognitive delay.

One body of research that strongly supports the identification of children with speech impairment as being at high risk for literacy difficulties (despite intact development in other language skill areas) has focused on the development of these children's phonological awareness. For example, Rvachew, Ohberg, Grawburg, and Heyding (2003) investigated phonological awareness ability in 13 children with moderate or severe speech delay as compared with 13 children with normal speech development. These Canadian preschool children were aged between 4;0 (years;months) and 4;11 and were monolingual speakers of English. Their family socioeconomic grouping was described as middle class. Results revealed that the performance of children with speech impairment was significantly inferior to that of children with normal speech development on rhyme matching, initial phoneme matching, and phoneme perception tasks. The group difference was evident despite the groups being carefully matched for within-average range performance on a measure of receptive vocabulary and no significant difference between the groups' letter-name knowledge.

Rvachew et al.'s (2003) findings are consistent with previous research that has indicated inferior group performance for children with speech impairment on phonological awareness tasks; for example, 15 American children (aged 3–4 years) showed early delay in acquiring rhyme knowledge (Webster & Plante, 1992); 61 New Zealand children (aged 5–7 years) performed poorly at the syllable, onset-rime, and phoneme level before intervention (Gillon, 2000); 31 British boys (aged 5–7 years) performed poorly on rhyme and phoneme identity tasks (Bird et al., 1995); and 29 Australian children (aged 6 years) showed delay in phoneme deletion, phoneme segmentation, and phoneme blending (Leitao, Hogben, & Fletcher, 1997). Poor phonological awareness development is evident for children with speech impairment irrespective of whether these children have deficits in other language areas (e.g., grammar and vocabulary) or whether they display isolated speech impairment (Bird et al., 1995; Leitao et al., 1997).

In Raitano, Pennington, Tunick, Boada, and Shriberg's (2004) investigation of 101 children aged 5–6 years with a history of speech impairment, participants were classified as having persistent speech difficulties, language impairment, or normalized speech patterns (i.e., speech error

patterns had resolved). These children were tested on a range of phonological awareness and letter knowledge tasks as well as a rapid serial naming task. The results indicated that the children with persistent speech impairment and co-occurring language impairment demonstrated more difficulty on phonological awareness tasks than did the children whose speech error patterns had resolved. However, this latter group showed significantly inferior phonological awareness development as compared to a control group of 41 children without a history of speech impairment. These findings provide further evidence that a history of speech impairment places a child at heightened risk for literacy difficulties irrespective of whether the speech disorder resolves or is accompanied by other language difficulties.

Raitano et al.'s (2004) findings are consistent with a modified "critical age hypothesis" proposed by Nathan, Stackhouse, Goulandris, and Snowling (2004). Originally, Bishop and Adams (1990) predicted that if speech error patterns of preschool children with speech impairment resolved before formal literacy instruction commenced, then these children would likely have normal literacy development. The researchers termed this the critical age hypothesis for predicting literacy outcomes. Subsequent research examining this hypothesis has, however, led to a modified hypothesis. Nathan et al. (2004) suggested that in addition to the presence of persistent speech impairment when a child engages in reading instruction, the level of a child's phoneme awareness is a critical factor in determining the child's literacy outcome. What has been lacking to date in longitudinal studies monitoring the literacy outcomes of children with speech impairment is detailed knowledge of these children's acquisition of phonological awareness and the effects of intervention on facilitating this acquisition. Children with speech impairment who develop more favorable literacy outcomes over time may have received intervention that stimulated their phonological awareness development. Longitudinal research is required to examine the effects of early intervention on phonological awareness and subsequent literacy development for preschool children with speech impairment. The study reported in this article begins to address this need.

PHONOLOGICAL PROCESSING PROFILES OF CHILDREN WITH SPEECH IMPAIRMENT

Carroll and Snowling (2004) suggested that the phonological awareness profiles of children with speech impairment are comparable to those of children who have been identified as being at risk for dyslexia but who have no diagnosed speech impairment. In this study, the performance of 17 children ranging in ages from 4 to 6 years who had speech difficulties but normal language development (speech-risk factor) was compared with that of 17 children who had a parent or sibling with a diagnosis of dyslexia (family-risk factor) and 17 children with typical speech and language development and no genetic disposition for reading disorder. The groups were matched for age and receptive vocabulary performance. Statistical analysis revealed no significant differences between the two at-risk groups on a composite phonological awareness score. Both groups showed delayed development in phonological awareness at the onset-rime and phoneme level as compared to children without risk factors. Both at-risk groups also showed weaker performance on a novel phonological learning task and on phonological processing tasks (e.g., nonword repetition, expressive phonology, and mispronunciation detection task). The researchers concluded that young children with speech impairment and children with a genetic disposition for dyslexia are indeed at high risk for reading problems based on their phonological processing difficulties. The researchers hypothesized that these children may have a common risk factor in that their underlying phonological representations of words are poorly specified.

Carroll and Snowling's (2004) findings are of particular clinical importance as they confirm in a controlled research design that it is not just the obvious speech output difficulties of children with speech impairment that place them at risk for reading disorder. The children in the family-risk group, although showing marked breakdown when their expressive phonological system was stressed in the nonword repetition task, did not have any overt speech disorder that required intervention. Yet, both groups exhibited similar patterns of breakdown in phonological processing and phonological awareness tasks. As has also been discussed by other researchers (e.g., Elbro, Borstrøm, & Petersen, 1998; Swan & Goswami, 1997), it is the quality of the underlying phonological representation and the ability of a child to access this representation and use phonological information in a conscious manner that is critical for reading and spelling development.

Understanding the importance of evaluating phonological performance in a more comprehensive manner than simple measures of articulation helps to explain apparent inconsistencies in the literature. Studies that have shown weak relationships between speech impairment and reading disorder have focused primarily on articulation measures for single-syllable words (Catts, 1993). However, a strong relationship between speech, reading, and spelling difficulties has been observed in children when phonological measures have included the articulation of multisyllabic words as well as measures of phonological awareness and phonological decoding (Gillon, 2000). Larrivee and Catts (1999) demonstrated that kindergarten children with severe speech impairment, as measured by the percentage of consonants correctly articulated on multisyllabic words and nonwords, were likely to be poor readers at the end of the first grade. Larrivee and Catts hypothesized that articulation of multisyllabic words is a more sensitive measure of the quality of children's phonological representation than is articulation of single-syllable words and thus is more closely related to reading performance. This measure of multisyllable word articulation and a measure of phonological awareness ability accounted for a significant amount of the variance in the children's reading performance. In contrast, the children's composite

language score at kindergarten was unrelated to their word recognition performance at the end of first grade (Larrivee & Catts 1999).

Phonological processing deficits in children with speech impairment appear to be persistent in nature and are not resolved through general classroom instruction and some forms of speech-language intervention. For example, Gillon (2000; 2002) demonstrated in a controlled, alternative treatment designed study that school-age children with speech impairment required direct and relatively intensive therapy (e.g., 2 hr per week for a 10-week period) targeting phoneme awareness and phoneme–grapheme knowledge to resolve phonological awareness deficits at the phoneme level and to accelerate early reading and spelling performance. Other forms of therapy that children in the control groups received were effective in improving speech intelligibility but did little to develop the underlying phonological skills that are critical for literacy. Further evidence of the persistent nature of phonological awareness deficits in children with speech impairment was provided by Snowling et al. (2000). These researchers discovered that 10 children who had been diagnosed as having isolated speech impairment at 4 years of age had significant difficulty at age 15 as compared to their peers on two phonological processing tasks. The tasks were nonword repetition and a spoonerism task (i.e., a complex phonological awareness task involving skills in onset-rime segmentation and phoneme manipulation and blending).

STUDY HYPOTHESES

The research evidence supports the identification of preschool children with speech impairment as being at risk for later reading and spelling difficulties. These children have a specific deficit in the phonological domain that restricts the efficient development of early printed word recognition and the ability to use phonological information when spelling. Thus, interventions that specifically aim to facilitate these children's phonological awareness skills from a young age are well supported by both theoretical and clinical perspectives. This study explored three hypotheses:

- Intervention to enhance early phoneme awareness and letter knowledge, combined with intervention to improve speech intelligibility, will ensure that children with speech impairment approach literacy instruction with age-appropriate phonological awareness development.
- Allocating time in therapy sessions to enhance phoneme awareness and letter knowledge will *not* be at the expense of improvement in children's speech production skills.
- Intervention specifically targeting the development of early phoneme awareness and letter knowledge will result in successful early reading and spelling experiences for children with speech impairment.

METHOD

Context for Research Methodologies Selected

The methodologies used in the current study are best viewed within the context of the range of intervention studies that have examined the benefits of phonological awareness for reading and spelling. Robey and Schultz (1998) presented a five-phase framework to consider clinical outcome research. This model may be usefully applied to phonological awareness research. Phase 1 of clinical outcome research introduces a new treatment, usually with small samples, and develops important hypotheses for later testing. Phase II includes developing foundations for testing the efficacy of the treatment, such as developing assessment tasks and forming a theoretical basis for expected outcomes. Phase III tests the efficacy of the intervention using, for example, larger sample sizes, external controls with random assignment to treatment conditions, standardized treatment protocols, and optimal treatment conditions. Phase IV assumes that the general efficacy of the intervention approach is established and focuses on the benefits of the approach for subpopulations. Phase V begins once a treatment has been introduced into the community and examines the effectiveness of a treatment in clinical practice. Rigorous controls may not be employed because the efficacy of the treatment has already been established. Rather, the study may focus on other aspects such as efficiency and cost effectiveness of the treatment or differing models of service delivery.

The research methodologies used in this current study reflect outcome research at Phases IV and V of Robey and Schultz's (1998) model. The focus is on examining phonological awareness intervention with a specific subpopulation (i.e., preschool children with speech impairment). Intervention at this phase is appropriate because the general efficacy of phonological awareness instruction has been well established through, for example, Ehri et al.'s (2001) meta-analysis of 52 controlled intervention studies that predominantly involved children with typical development. The first research method selected for the current study (described in detail in the next section) examines the effect of intervention on phonological awareness development over a 3-year time period in preschool children with speech impairment as compared to phonological awareness development over the same time period for children with typical development. Characteristics of Phase IV and V clinical outcome research are evident in the design, such as variability inherent in clinical populations and treatment schedules that reflect clinical practices of tailoring the length of therapy to children's needs (rather than predetermined intervention schedules that are characteristic of Phase III clinical outcome research). The second research method employed in this study involves selecting a control group of children with speech impairment who did not receive phonological awareness intervention using a retrospective design. Given the established efficacy of phonological awareness characteristic of Phase III clinical outcome research, it was considered unethical to withhold

this type of treatment for the 3-year period of the study for a group of children who were considered at risk for literacy difficulties.

RESEARCH METHOD 1

The first phase of this longitudinal study examined the development of phonological awareness in children with speech impairment as compared to children with typical speech development from the average ages of 3 to 6 years. The intervention for the children with speech impairment included activities to stimulate early phoneme awareness and letter-sound knowledge.

Participants

Twelve children (3 girls and 9 boys) with speech impairment participated in the experimental group. They were aged between 3;00 (years;months) and 3;11 at the commencement of the study (*M* age = 41.16 months, *SD* = 3.78 months). These children were referred to the project on a rolling basis through usual screening procedures of new referrals administered by local speech-language pathologists (SLPs) employed by the New Zealand Ministry of Education. The screening procedures identified that the children appeared to have specific speech difficulties that required further assessment. These children were then referred to the university speech-language therapy clinic for possible inclusion in the study. If accepted into the study, they did not receive any other speech-language pathology services from government SLPs for the duration of the study.

Study inclusion criteria required the children to have speech difficulties in the absence of diagnosed sensory, neurological, physical, or intellectual disabilities and to have a moderate or severe speech delay (as evidenced by less than 65% of consonants being correctly articulated on a single-word elicitation test). The children also needed to demonstrate receptive vocabulary knowledge within or above the normal range (as evidenced by a standard score of 85 or higher on the Peabody Picture Vocabulary Test—Third Edition [PPVT–III; Dunn & Dunn, 1997]). The average standard score for the 12 children who participated in the experimental group was 104.91 (*SD* = 9.48).

Eleven of the 12 children who participated attended a preschool center, play group, or kindergarten on a sessional basis (e.g., three afternoons per week). In New Zealand, it is common for 3-year-old children to attend a local free kindergarten for afternoon sessions of 2 hr in length or to attend private early education centers on a sessional basis. These facilities follow a national early educational curriculum framework that aims to facilitate children's development in five areas: well-being, belonging, exploration, communication, and contribution. Early literacy knowledge is promoted through activities such as shared book reading, story telling, nursery rhymes, and exposure to letter knowledge through alphabet puzzles and alphabet books. In general, New Zealand families are encouraged by preschool teachers, the community, and the media to read to their children from a very young age. Many New Zealand children begin school at 5 years with at least some alphabetic knowledge. The kindergartens or preschool centers that the children attended were predominantly in suburban areas considered to be of middle or high socioeconomic status. One child was from a semi-rural area and 2 children attended kindergartens in lower socioeconomic neighborhoods.

Nineteen children (7 girls and 12 boys) with typically developing speech and language skills participated in the control group (*M* age = 41.89 months, *SD* = 3.63 months). These children were part of a group of 20 children who were randomly selected from the enrollment register of local kindergartens or child care centers (mostly from the same preschool facilities that the children in the experimental group attended). Children with diagnosed disabilities, or children whom the child care teachers had referred for any type of specialist assessment, were excluded before the random selection. One child was subsequently excluded because he demonstrated speech disfluency and mild speech delay during the research assessment battery. Each child gained a standard score within the average or above-average range on the PPVT–III (*M* = 107.57, *SD* = 7.08). All the children in the study spoke standard New Zealand English as their only language.

There were no significant differences between the experimental and control groups for chronological age, $F(1, 29) = 0.286$, $p = 0.597$, or receptive language performance, $F(1, 29) = 0.799$, $p = 0.379$. A significant group effect was obtained for the speech production measure, $F(1, 29) = 168.083$, $p < .001$. This measure was the percentage of consonants that were correctly articulated from a list of 75 words pronounced in isolation to a picture or toy stimulus and analyzed using Profile of Phonology, Computerized Profiling software (Long, Fey, & Channell, 2002). The word list consisted of the 50 items from the Assessment of Phonological Processes—Revised (Hodson, 1986) and the first trial from the Phonological Variability Test (Dodd, 1995, p. 270). This latter test involved each participant naming a set of 25 pictures on three occasions during the one assessment session. Each assessment was separated by another activity. Many of the target words in this test are multisyllabic words (e.g., dinosaur, elephant, helicopter, umbrella, kangaroo). The average percentage of consonants correctly articulated (PCC score) for the group with speech impairment was only 33.07 (*SD* = 16.59). This compared to a mean PCC score for the group without speech impairment of 89.11 (*SD* = 7.29).

The common speech error patterns made by the children in the experimental group are displayed in Table 1. Phonetic transcription accuracy of the children's performance on the speech measures was ensured through the following process: The children's speech was recorded using high-quality tape recorders (Sony TCM-5000EV) or a Sony digital audiotape deck (TCD-D8) and a SHURE SM58 microphone. The examiner transcribed the child's utterances online using broad transcription techniques. Following the assessment session, the examiner rechecked online transcriptions from the tape recording. An independent examiner (experienced in phonetic transcription of

Table 1. Speech error characteristics of the children with speech impairment.

	Age	*PCC*	*Examples of common error patterns (percentage of usage[a]) and speech error characteristics*	*PCC school entry*
1	3;01	2.9	Consonants limited to h, m, p, b, n in consonant-vowel patterns; high use of glottal stops; word shape predominantly vowels (e.g., black- /ae/). Error breakdown: Substitutions, 39.5%; Omissions, 60.5%.	71.3
2	3;04	12.8	Substitutions, 57.5%; Omissions, 42.5% (e.g., uvular fricative used in 40% of consonant substitution errors; final consonant deletion [FCD], 79%).	74.6
3	3;11	19.5	Substitutions, 84.6%; Omissions, 15.4% (e.g., Cluster reduction [CR], 95%; FCD, 36%; abnormal glottal insertion, 30%).	65.5
4	3;05	28.5	Substitutions, 76.8%; Omissions, 23.2% (e.g., velar fronting [VF], 47%; FCD, 52%).	72.5
5	3;0	31.5	Substitutions, 69.8%; Omissions, 30.2% (e.g., FCD, 68%; VF, 41%)	92.4
6	3;10	32.2	Substitutions, 68.6%; Omissions, 31.4% (e.g., FCD, 64%; palatal fronting, 40%).	77.5
7	3;05	32.3	Substitutions, 52.9%; Omissions, 47.1% (e.g., FCD, 93%; CR, 75%).	73.4
8	3;06	38.1	Substitutions, 97.2%; Omissions, 2.8% (e.g., VF, 29%; palatal fronting, 67%; later stopping 29%).	79.3
9	3;11	38.3	Substitutions, 73.6%; Omissions, 26.4% (e.g., CR, 67%; VF, 41%; FCD, 35%).	99.3
10	3;04	42.8	Substitutions, 91.2%; Omissions, 8.8% (e.g., VF, 33%; CR, 82%; later stopping, 21%). Lateralized s, z, sh production also noted.	59.4
11	3;01	57.2	Substitutions, 87.3%; Omissions, 12.7% (e.g., CR, 47%; VF, 29%).	92.5
12	3;04	60.8	Substitutions, 94%; Omissions, 6% (e.g., CR, 67%; VF, 35%).	98.6

Note. Age is in years;months; PCC = percentage of consonants correctly articulated from 75 words; Error breakdown = the percentage of the total number of speech errors that were either substitution errors (i.e., substituting one sound for another) or omission errors (i.e., deleting a sound from the word); PCC school entry: *M* age = 60.0 months, *SD* = 1.9 months.

[a]Percentage of error pattern usage; for example, FCD: "Final consonant deletion 79%" means that for 79% of the opportunities to use a word-final consonant in the speech sample, the child deleted the final consonant, e.g., pronounced fish as fi); VF: velar fronting (e.g., gum – dum); CR: cluster reduction (e.g., smoke – moke); later stopping: stopping of v, z, ch, dg, and th (e.g., vase – dase); palatal fronting (e.g., shoe – soe); abnormal glottal insertion (e.g., soap – hoap).

children's unintelligible speech) analyzed each child's tape-recorded speech sample. Any differences between the two examiner's transcriptions were resolved through both examiners repeatedly listening to the utterance. In some instances, a third examiner (an expert in phonetic transcription) listened to the child's recorded utterance to resolve any disagreements.

The consistency of the children's error patterns on the 25-word Phonological Variability Test was analyzed according to Dodd (1995, p. 270). Dodd suggested that a child has an inconsistent phonological disorder if more than 40% of the target words are produced inconsistently incorrect over the three trials. Using this analysis, Child 2 (see Table 1) showed highly inconsistent errors, with an 88% inconsistency rating, and Child 3 showed some level of inconsistency in his error patterns (32% inconsistent). The other children showed consistent speech error patterns across the three trials.

Phonological Awareness Assessment

The experimental phonological awareness assessment tasks were modelled after Bradley and Bryant's (1983) tasks that were used with 3- and 4-year-old children with typical development. Colorful pictures were used to capture the children's attention. The rhyme oddity task required the children to select from three pictures the one picture that did not rhyme. For example, "Which word doesn't rhyme: pig, hat, bat?" The phoneme matching task required children to select the word that started with a target phoneme. For example, Target /m/ for mouse: "Which word starts with /m/: doll, milk, bear?" Two practice items and ten test items were administered for each task. (See www.cmds.canterbury.ac.nz/people/gillon to download pictures and assessment items used.) All of the children were administered the rhyme and phoneme tasks on three assessment periods (at approximately a 7–8-month interval) between the ages of 3–5 years. At Assessment 1, the average age of the participants was 41.7 months (*SD* = 3.6); Assessment 2, 48.1 months (*SD* = 4.0); and Assessment 3, 56.8 months (*SD* = 4.6). To control for performance variability that is typical in young children, the participants were presented with the rhyme oddity and phoneme matching tasks on two occasions (usually a couple of days apart) at each assessment period. Each child's highest score from the two administrations was used in the analysis. Letter recognition assessment probes that required the child to point to a letter named by the examiner were also included in the test battery. The letters were presented in groups of six letters written in lower case using 90-point type onto an A4 sheet of card.

At approximately 5 years and 6 years of age, the Preschool and Primary Inventory of Phonological Awareness (PIPA; Dodd, Crosbie, MacIntosh, Teitzel, & Ozanne, 2000) was administered to the children as a formal measure of phonological awareness development. This test is designed

for children aged 3;0 to 6;11 and measures syllable segmentation of unfamiliar words, rhyme awareness, alliteration awareness, phoneme isolation, phoneme segmentation (the child is trained to use counters to segment the words), and letter-sound knowledge (e.g., "What sound does this letter make?"). The test was administered individually to the children at the university clinic in strict accordance with the manual's instructions.

Intervention Model

Children in the experimental group received intervention on a rolling basis as they entered the study. The children received two or three blocks of therapy between the ages of 3 and 5 years, with their first block of therapy being implemented following their initial assessment at 3 years of age. The number of blocks received depended on their speech production needs (i.e., if speech error patterns had largely resolved following two blocks of therapy, a third block was not offered). Each block of therapy (which typically lasted between 4–6 weeks depending on the availability of children and therapists) followed the same model: two 45-min[2] therapy sessions per week consisting of one group session with 2 or 3 other children participating in the study and one individual session each week. The children's primary caregiver usually attended the sessions but acted in a support role only (i.e., they were not specifically trained to implement the therapy procedures at home). The average number of therapy sessions received by the children before school entry was 25.5 sessions (*SD* = 5.8; range = 16–34). The range in therapy sessions was related to the number of therapy blocks received, as detailed above. Three children received an additional block of therapy 10–12 hr following school entry (between ages 5;06 and 6;0) to further improve speech intelligibility. All of the therapy sessions were administered at the university's speech and language therapy clinic. The researcher, or a qualified SLP trained by the researcher, administered all of the group sessions. These sessions were conducted in a clinic room that was fitted with a soundfield system to provide optimal listening conditions. A senior speech-language therapy student administered the individual sessions under the supervision of a qualified SLP who was trained on program content by the researcher. Sessions were videotaped using a Sony Handycam (CCD-TR3E) video camera with an audio telex Dynamic microphone (AMX516) to allow detailed analyses of the children's responses and to validate the treatment content.

The children continued to receive their regular early childhood education program at their kindergarten or preschool but received no other speech-language therapy or specialist services. The children in the control group were exposed to the same types of early education program at their kindergarten or preschools as the children in the experimental group and received no other type of educational intervention during the study.

[2]Therapy sessions were timetabled for 60 min to ensure that at least 45 min of intervention was administered. Children were offered a short break in the middle of the session.

Intervention Content

Each treatment session targeted three areas:

- improvement of the child's speech intelligibility,
- facilitation of phonological awareness at the phoneme level, and
- letter-name and letter-sound knowledge.

Speech intelligibility. Improvement in the children's speech production was targeted following a Cycles Phonological Remediation Approach (Hodson & Paden, 1991). The principles underlying this treatment approach and treatment details are discussed in Hodson and Edwards (1997). Treatment activities included auditory bombardment with amplification and drill play activities in which the child was required to articulate a set of five target words. Each set of words was individualized for a child's speech production goals. A picture of each target word was pasted or drawn onto a card and the target word was written under the picture.

Phonological awareness and letter knowledge. The phonological awareness and letter knowledge intervention was based on the following theoretical assumptions:

- Approaching reading and spelling instruction with awareness that words are made up of sound units and some understanding of the relationship between phonemes and graphemes helps children engage in the "self-teaching" process for reading that has been hypothesized by researchers (Share, 1995; Share & Stanovich, 1995). That is, from each successful decoding attempt, children learn specific information about the word's orthography. This learning helps to establish orthographic representations of words that are necessary for fluent reading. Thus, the value of the intervention that was implemented in the current study to later reading and spelling development was assumed via the importance of phoneme awareness and letter knowledge to successful early experiences in decoding and encoding print.
- Phonological awareness at the phoneme level is more strongly related to later reading success than are syllable or rhyme awareness (e.g., Muter, Hulme, Snowling, & Taylor, 1997). Further, phoneme awareness requires more specific teaching in at-risk children than do syllable and rhyme awareness (Gillon, 2000, 2002). Rhyme awareness may develop with improvement in speech production (Webster & Plante, 1995; Webster, Plante, & Couvillion, 1997) or may develop through general language stimulation that is provided at home or in an educational context. Thus, the therapy intervention activities employed focused on early phoneme awareness rather than on rhyme or syllable awareness.
- A developmental progression in phonological awareness is evident. Typically developing 3- and 4-year-old children only begin to acquire phoneme awareness before literacy instruction. Thus, the emphasis in intervention was on facilitating early phoneme awareness (such as identifying the initial phoneme in

words) rather than on skill mastery of complex phoneme awareness tasks.

- Teaching letter knowledge and phoneme awareness together may help facilitate their mutual development (Burgess & Lonigan, 1998). In addition, intervention studies with older children have clearly demonstrated stronger treatment effects when training combines letter knowledge with phoneme awareness than when phoneme awareness is taught in isolation (Hatcher, 1994).

Phonological Awareness Intervention Activities

The phoneme awareness and letter knowledge activities used in the intervention involved clinician-directed play activities that encouraged the children's active participation. Tasks included facilitating the following skill areas: phoneme detection (e.g., "Lets find the word that starts with an /f/ sound?" or "Does ball start with an /s/ sound?"); phoneme categorization (e.g., "Find all the toys that start with /k/."); initial phoneme matching (e.g., "Corn starts with a /k/ sound. Let's find the one that starts the same as corn: carrot, potato."); and phoneme isolation (e.g., "What sound does mouse start with?). Teaching examples are provided in the Appendix. Gillon (2004) provides further detail of teaching content and a guide for adjusting task difficulty. As the children approached school age, attention to segmentation and blending at the onset-rime level (e.g., cat = c – at) and phoneme level (dog = d- o- g) were introduced in common words with simple consonant-vowel or consonant-vowel-consonant structures.

Letter-name and letter-sound knowledge were introduced using recognition activities as these tasks are easier than letter-sound recall tasks (Dodd & Carr, 2003). Letters were gradually introduced into the sessions. A small group of letters with wide visual contrast that may have been associated with the child's name and speech targets (e.g., s, p, m) were initially introduced to the teaching sessions. Once children gained confidence recognizing two or three letters, another group of two or three was introduced. The letters c and k were presented simultaneously, and the children were told that both letters can make a /k/ sound. The letters were typically presented in game activities using large poster-size pieces of white card with lower case letters handwritten in very large print using a red or black felt pen. The relationship between phonemes and graphemes in word-initial position was brought to the child's attention in consonant bingo games. Picture cards, with the name of the picture clearly written underneath the picture, were used in the game (e.g., "Do you have a word that starts with the letter s that makes an /s/ sound?").

An integrated approach to therapy sessions was employed whereby the activities to stimulate phoneme awareness and letter knowledge were interspersed with activities targeting speech production goals. Speech production target words were also used in the phoneme awareness activities and letter knowledge games. For example, if a speech production goal was to eliminate the process of velar fronting (e.g., articulating the word *car* as *tar*), then phoneme awareness games focused on words that started with /k/, and the letters c and k were included in the letter game activities.

Treatment Fidelity

Fifteen group therapy sessions and twenty individual sessions (i.e., 12% of the average number of total sessions implemented) were randomly selected for video analysis. An independent examiner was asked to describe the teaching activities viewed on the videotape and to indicate whether she perceived the primary purpose of each activity was to (a) target a speech production goal, (b) facilitate phoneme awareness, or (c) teach letter knowledge. Analysis indicated that all of the group therapy sessions included activities in each of these three areas. The examiner's description of the therapy sessions validated that the activities described for the program in phoneme identity, phoneme isolation, phoneme matching, phoneme categorization, and letter knowledge were included in the therapy sessions. The most commonly observed phonological awareness activity involved the children identifying the initial phoneme in single-syllable words.

The examiner's analysis indicated that all of the individual treatment sessions included activities for speech production. One individual session did not include activities targeting phoneme awareness as the primary teaching goal, although awareness of initial sounds in words was integrated to some extent with the letter knowledge activity used in the session. One session did not include any activities specifically targeting letter knowledge. All of the other individual sessions observed by the examiner included activities for speech production, letter knowledge, and phonological awareness, as described in the program content. The only exception to program content noted by the examiner was the inclusion of a rhyme bingo game in two of the individual therapy sessions. None of the other group or individual therapy sessions included any direct teaching in recognizing or generating rhyming words as the instructors were trained to focus on phonological awareness at the phoneme level.

Results

Phonological awareness experimental task performance. Data were first analyzed to investigate the children's development on the experimental rhyme oddity, phoneme matching, and letter knowledge tasks between 3 and 5 years of age. Repeated measures designs are useful for examining developmental trends over time (Portney & Watkins, 2000), and a mulitvariate repeated measures analysis of variance, Wilks's lambda, (Assessment Time 1, 2, and 3 × Group) was therefore used in the analysis. The results indicated a significant time effect for rhyme oddity, $F(2, 28) = 28.002$; $p < .001$; phoneme matching, $F(2, 28) = 116.534$, $p < .001$; and letter recognition, $F(2, 28) = 46.365$, $p < .001$. Table 2 illustrates that the groups' average performances improved at each assessment time. There was no significant interaction between time and

Table 2. Group performance at each assessment (Time 1, Time 2, and Time 3) for the experimental tasks.

	Rhyme (oddity)			*Phoneme matching*			*Letter recognition*		
	T1	*T2*	*T3*	*T1*	*T2*	*T3*	*T1*	*T2*	*T3*
Group 1 (Speech impairment)									
M	37.5	61.7	75.8	29.6	74.2	90.8	35.1	69.3	87.5
SD	23.8	26.9	23.9	12.8	23.1	17.3	31.2	30.9	18.4
Group 2 (Typical speech)									
M	41.1	50.0	73.7	38.9	61.6	88.4	44.1	66.8	87.2
SD	13.7	29.6	22.9	11.0	23.6	17.1	31.5	30.9	18.7

Note. Mean ages: T1 = 3;05, T2 = 4;00, T3 = 4;08. Percentage correct scores are reported.

group for rhyme and letter recognition. This suggests that the groups improved at a similar rate on these tasks. However, the interaction between assessment time and group for the phoneme matching task was significant, $F(2, 28) = 3.603$, $p < .05$. Further inspection of the two groups' development in phoneme awareness was therefore undertaken. Univariate analysis of variance (ANOVA) revealed a significant group difference, $F(1, 29) = 5.341$, $p < .05$, at Time 1, but no significant group difference at Time 2, $F(1, 29) = 2.120$, $p = 0.156$, or Time 3, $F(1, 29) = 0.145$, $p = 0.706$. Table 2 shows that the average raw score of children with typical development was higher than that of children with speech impairment on the phoneme matching tasks at 3 years of age. Analysis using gain scores (which are commonly used in clinical research to evaluate treatment outcomes [Portney & Watkins, 2000]) was conducted. Variability in Time 1 and Time 2 measurement was controlled (i.e., Gain 1 score = Time 2 score – Time 1 score ÷ Time 1 score; Gain 2 score = Time 3 score – Time 2 score ÷ Time 2 score). Analysis of variance using the gain scores indicated that the children with speech impairment made significantly more growth between assessment Time 1 and 2 than did the children with typical development on the phoneme matching task, $F(1, 29) = 9.945$, $p < .01$, as shown in Table 2. There was no significant difference in the gain scores from assessment Time 2 to Time 3, $F(1, 29) = 2.988$, $p = 0.095$. Effect size analysis for the groups' average growth in the percentage of items correct from Time 1 to Time 2 was moderate (Effect size = 0.5, at alpha 0.05 and 0.80 power). Sample size analysis indicated that 16 participants in each group were necessary to achieve the desired power of 0.80.

The rhyme and phoneme awareness experimental tasks had a high chance factor. Thus, performance variability and improvement over time may have been influenced through differing levels of success from the children's guessing behavior. For example, a child could gain a score of four items correct simply by selecting the last card displayed in the row for each test item (i.e., demonstrate a favored position response). To further examine the children's development on these tasks, the percentage of each group that scored significantly above chance level was calculated. A criterion of seven correct items was adopted as probability testing indicated that with a choice of three pictures for each test item, the probability of gaining a score of seven out of ten correct by chance was less than 0.001. Further, from a clinical perspective, a 70% success rate on a given task suggests that a skill area targeted is becoming established. The percentage of each group gaining a score of at least 70% correct is displayed in Table 3. No child demonstrated this level of competency at initial testing for the phoneme matching task. However, by Time 2, 67% of Group 1 demonstrated competency at 70% correct or better in phoneme matching as compared to only 36% of children in Group 2. Proportional testing indicated that this difference was significant ($\chi^2 = 18.016$, $p < .01$). The increase in the number of children in Group 1 reaching criterion at the second assessment supports the significant group difference observed in gain scores from Time 1 to Time 2 assessment and suggests that this gain was evident even when the factor of chance was taken into consideration.

Reliability of experimental tasks. Rater reliability for the rhyme and phoneme matching tasks was analyzed

Table 3. Percentage of each group that performed significantly above chance level (i.e., scored 70% correct or better).

	Rhyme (oddity)			*Phoneme matching*			*Letter recognition*		
	T1	*T2*	*T3*	*T1*	*T2*	*T3*	*T1*	*T2*	*T3*
Group 1 (Speech impairment)	16	33	50	0	67	84	20	67	83
Group 2 (Typical speech)	11	32	58	0	36	84	37	63	79

through the video recordings of the assessment sessions. An independent examiner viewed 10% of the assessment sessions and scored the rhyme and phoneme matching tasks from viewing the children's pointing responses. The total score correct obtained by the independent examiner was compared to the original examiners' scores. There was 100% agreement between scores.

Internal consistency of the experimental tasks was examined at each assessment trial using Cronbach's coefficient alpha. Consistent with data indicating that children typically scored below chance levels at Time 1 (3 years of age), low internal consistency was found at this first assessment (Cronbach's alpha = 0.43 phoneme task; 0.3 rhyme task). However, moderate to high internal consistency was demonstrated at Time 2 (Cronbach's alpha = 0.69 phoneme; 0.77 rhyme) and at Time 3 (Cronbach's alpha = 0.73 phoneme; 0.75 for rhyme).

Phonological awareness standardized test performance. Close to school entry at 5 years of age or within a few months of starting school (*M* age = 61 months, *SD* = 2.1 months), the groups' performance on the PIPA was compared. Three children from the control group were not available for reassessment. A MANOVA (Wilks's lambda) showed no significant group effect, $F(6, 21) = 0.564$, $p = 0.754$. Mean raw scores are shown for each group in Table 4.

Approximately 1 year post school entry (*M* age = 73 months, *SD* = 2.6 months), 10 children from the experimental group remained in the study. Their performance was compared to that of 10 children from the control group (matched for chronological age) on the PIPA subtests. A MANOVA (Wilks's lambda) showed no significant group effect, $F(6, 12) = 1.309$; $p = 0.325$, indicating that the phonological awareness skills of the children with speech impairment were similar to those of the children without speech impairment.

Table 4. Group performance on the PIPA subtests[a] at school entry (*M* age = 5 years) and following approximately 1 year of school (*M* age = 6 years).

	Group 1		*Group 2*	
	5 years	*6 years*	*5 years*	*6 years*
Rhyme				
M	6.9	9.3	7.7	10.6
SD	3.1	2.5	2.1	2.1
Alliteration				
M	7.1	11.1	6.8	10.3
SD	3.1	1.1	3.2	1.3
Syllable				
M	7.6	10.0	7.5	10.1
SD	1.7	2.2	2.8	1.7
Isolation				
M	7.4	10.7	8.8	10.1
SD	4.2	1.3	3.0	1.8
Segmentation				
M	1.7	3.4	0.9	2.9
SD	2.5	2.9	1.5	2.5
Letter Sound				
M	15.1	28.0	16.4	29.2
SD	7.9	3.2	6.8	2.2

Note. Each subtest had 12 items, with the exception of letter-sound knowledge, which had 32 items. Raw scores are reported.

Development in speech production skills. Following the initial speech production assessment battery, the children's speech development was monitored periodically using the single-word elicitation test from the Goldman-Fristoe Test of Articulation (Goldman & Fristoe, 1986) and one trial of the 25-word Phonological Variability Test (Dodd, 1995). Descriptive statistics showed rapid growth in speech production during the first 8–12 months of the study for the children with speech impairment. The group average PCC score developed from 33.1 (at age 3;6) to an average PCC score of 71.2 (*SD* = 18.5) (*M* age = 4;02, *SD* = 6.8 months). The group average PCC score at school entry was 79.7 (*SD* = 13.1)(*M* age = 60 months, *SD* = 1.9 months). Given the significance that researchers have placed on articulation ability at school entry, each child's PCC score at 5 years is reported in Table 1. Four children showed little difficulty with speech articulation, gaining an accuracy score greater than 90% correct. The remaining 8 children in the experimental group approached formal literacy instruction with a moderate speech impairment. As a group, the speech performance of the children with speech impairment at 5 years of age was significantly inferior to the control group of children's speech performance at study entry when they were only aged 3;05, $F(1, 29) = 6.693$, $p < .05$.

Baseline assessment indicated a wide range in speech severity for the children in Group 1. Analyses using a Pearson correlation matrix and Bonferroni probability were therefore conducted to ascertain whether there was a relationship between initial speech production measure (PCC score) and performance on phonological awareness tasks. Analysis revealed no significant correlations between initial speech production and performance on the experimental rhyme and phoneme awareness tasks at any of the assessment trials. (Correlations were all less than 0.353.) Consistently, there were no significant correlations between speech production at 5 years of age and standardized phonological awareness measures from the PIPA. (Correlations were all below 0.391, with the exception of the correlation between speech production and the phoneme isolation task, which was 0.583.)

RESEARCH METHOD 2

This second phase of the study employed a retrospective control design. At an average age of 6 years, the performance of the 10 children in the experimental group who remained in the study (Group 1) was compared to that of a control group of children with speech impairment (Group 2) on phonological awareness, word recognition, spelling, and nonword reading measures. Children in the control group had not received phonological awareness intervention during their preschool and school program.

Selection Process for Control Children

Using a database search, 27 children who were assessed by an SLP at 3 or 4 years of age as having specific speech impairment and who were aged between 5;06 and 7;06 at the time of the study were identified. The parents of these children were contacted and permission was sought for review of the child's case file and possible inclusion of the child in the study. From the pool of returned permission-to-review slips, children were matched to children in the experimental group through a stepped process. First, the children were required to speak standard New Zealand English as their first and only language. Second, if the children's case records indicated that their receptive language performance at either 3 or 4 years of age was below the average range (e.g., as measured by the Clinical Evaluation of Language Fundamentals—Preschool [CELF–Preschool; Wiig, Secord, & Semel, 1992]), they were eliminated from the pool. Children were then administered the PPVT–III to measure their current receptive vocabulary performance. To remain in the control group, children were required to gain a standard score within or above the normal range. (The average standard score from the participants selected was 101.3, *SD* = 10.5, range = 85–121). Next, the children were matched as closely as possible to the experimental group for current age and severity of speech impairment at 3 and 4 years of age. Where it was possible to match 2 children from the database to a child in the experimental group, similarity between the children's socioeconomic background and type of preschool facility attended were taken into consideration. Thus, 10 matched pairs were formed. An ANOVA indicated no significant difference between these matched groups for current age, $F(1, 18) = 0.153$; $p = 0.700$, and age seen for initial speech assessment, $F(1, 18) = 0.033$; $p = 0.857$. There was, however, a significant group difference for the speech measure from the initial preschool speech assessment, $F(1, 18) = 4.478$; $p = 0.049$, as indicated by PCC. The children in the experimental group showed more severe speech difficulties. The mean PCC score for the 10 children in the experimental group at 3 years of age was 32.6 (*SD* = 18.2) as compared to an average score of 47.5 (*SD* = 12.8) for the matched control group. This latter finding must be interpreted cautiously, however, because the calculation of the PCC score for the children in the control group relied on the assessment data available in the case files. No reliability data were reported in the files.

The children in the control group (8 boys and 2 girls) were from another city in New Zealand to the children in the experimental group and had not received phonological awareness intervention in their preschool years or during their first year at school, as indicated by the SLPs' details in treatment records and teacher reports. However, the children had all received speech therapy intervention before school entry. Therapy intensity for these children ranged from five individual therapy sessions followed by a structured home program to 70 individual therapy sessions (*M* = 28.8 therapy sessions; *SD* = 22.4). There was no significant group difference between the number of therapy sessions received by the children in the control group and the children in the experimental group, $F(1, 18) = 1180$; $p = 0.74$. The SLPs' detailed case notes for each child indicated that therapy for these children in the control group focused on improving speech intelligibility. Therapy approaches used included metaphon therapy (Dean, Howell, Waters, & Reid, 1995) or the cycles approach (Hodson & Paden, 1991) for 8 of the 10 children. Two children received oral motor articulation-based therapy. At the time of inclusion in the study, 2 of the children in the control group were continuing to receive speech-language therapy services. The other eight cases had been closed and these children were seen for assessment only for the purposes of this study (i.e., the children no longer qualified for Ministry of Education speech-language therapy services due to the mild nature of their speech difficulties or their speech difficulties were considered to have resolved).

Assessment Measures

The children in the control group were administered the same assessment battery as was administered to the children in the experimental group. An independent SLP (experienced in the use of the assessment tasks) administered the assessments individually to the children in the control group in a quiet setting in the children's schools. The assessment battery included the following:

- ***A single-word articulation test.*** This measure consisted of naming the pictures in the Single-Word subtest of the Goldman-Fristoe Test of Articulation (Goldman & Fristoe, 1986) and the pictures from the 25-word Phonological Variability Test (Dodd, 1995). The PCC from a possible 171 was calculated using the Computerized Profiling software.
- ***PIPA (Dodd et al., 2000).*** Raw scores from each subtest were calculated. The raw scores from the phonological awareness tasks were combined to provide an overall phonological awareness score and the score from the Letter Knowledge subtest was analyzed separately.
- ***The Burt Word Reading Test—New Zealand Revision (Gilmore, Croft, & Reid, 1981).*** This test of word recognition skills requires the child to read words across the test sheet until 10 successive errors are made. The words are graded in order of difficulty. The number of words correctly read was used in the analysis.
- ***Nonword reading task.*** Ten nonwords were selected from the Reading Freedom Diagnostic Reading Test (Calder, 1992). The words were of consonant-vowel-consonant structure (e.g., sim vab). The total number of correct phoneme–grapheme matches from a possible 30 was calculated and was used in the analysis.
- ***Spelling task (described in Gillon, 2002).*** The children were required to spell the following words: *rain, fish, girl, teeth, cake, bridge, chips, shark, dinosaur,* and *kangaroo*. (The 2 youngest children, 1 from the control group and 1 from the experimental

group, who were still in their first year at school, were not administered the spelling task.) The children's responses were scored according to procedures described in Gillon (2002). One point was awarded for each match (e.g., fish = 3 pts, fis = 2 pts as the digraph *sh* was not completely represented). Additional points were awarded for vowel change knowledge (e.g., cak = 3 pts, cake = 4 pts, teth = 3 pts, teeth = 4 pts). The total possible was 43 points, and a PCC was calculated for the analysis.

Results

The data were first analyzed to compare group performances. An ANOVA indicated no significant group differences in current-age, speech production abilities (PCC scores), $F(1, 18) = 3.320$, $p = 0.085$, or letter-sound knowledge (PIPA subtest raw scores), $F(1, 18) = 3.245$; $p = 0.088$, as indicated in Table 5. A significant group difference was obtained for the phonological awareness score (combined raw scores of the PIPA subtests), $F(1, 18) = 7.41$, $p < .001$; word recognition performance, $F(1, 18) = 14.1$, $p < .001$; nonword reading performance; $F(1, 16) = 22.4$, $p < .001$; and spelling performance, $F(1, 16) = 4.896$, $p < .05$. Table 5 illustrates that the performance of children in the experimental group (Group 1) was superior to that of the children in the control group on all of these measures.

Rater reliability for the phoneme segmentation and phoneme isolation tasks for the PIPA was undertaken. An independent examiner listened to tape recordings for 10% of the assessment sessions and scored each item as correct or incorrect based on the child's verbal response. These scores were compared to the original examiner's scores. There was 100% agreement between scores.

Sample and Effect Size

Sample size and effect size post hoc analyses were conducted to determine if the significant differences between children in Group 1 and children in the retrospective control group (Group 2) may generalize to the larger population (Pocock, 1983). Given a $p < 0.05$ alpha level and 80% power level, a meaningful difference was able to be detected for three of the four variables: Combined phoneme awareness effect size was 0.642, word recognition effect size was 0.924, and nonword reading measure effect size was 1.172. A sample size of between 4 and 10 participants would have been sufficient to achieve an 80% power level for these variables. The variable that required a larger sample size for 80% power (15 children in each group) was the spelling measure. The effect size for this analysis was 0.526.

Comparison With Normative Databases

To investigate individual differences in phonological awareness as measured by the PIPA, each child's performance was compared to the normative sample for this test according to the test's scoring procedures. Children were identified as being at risk if their performance on two or more subtests was below the 16th percentile (i.e., at least 1 *SD* below the mean). Data inspection indicated that the majority of children ($n = 7$) in the control group were identified as being at risk, with only 2 children performing within the average range on all subtests. In contrast, the majority of children ($n = 6$) in the experimental group performed within or above the average range on all subtests, with 2 children identified as being at risk. Inspection of individual subtest performance indicated that children in the control group had particular difficulty compared to the experimental group with rhyme oddity, alliteration, and phoneme segmentation subtests, as shown in Figure 1.

The data were analyzed to further investigate individual word recognition performance because the group data indicated a wide performance for the children in the experimental group on the Burt Word Recognition Test. Each child's performance was therefore compared to the

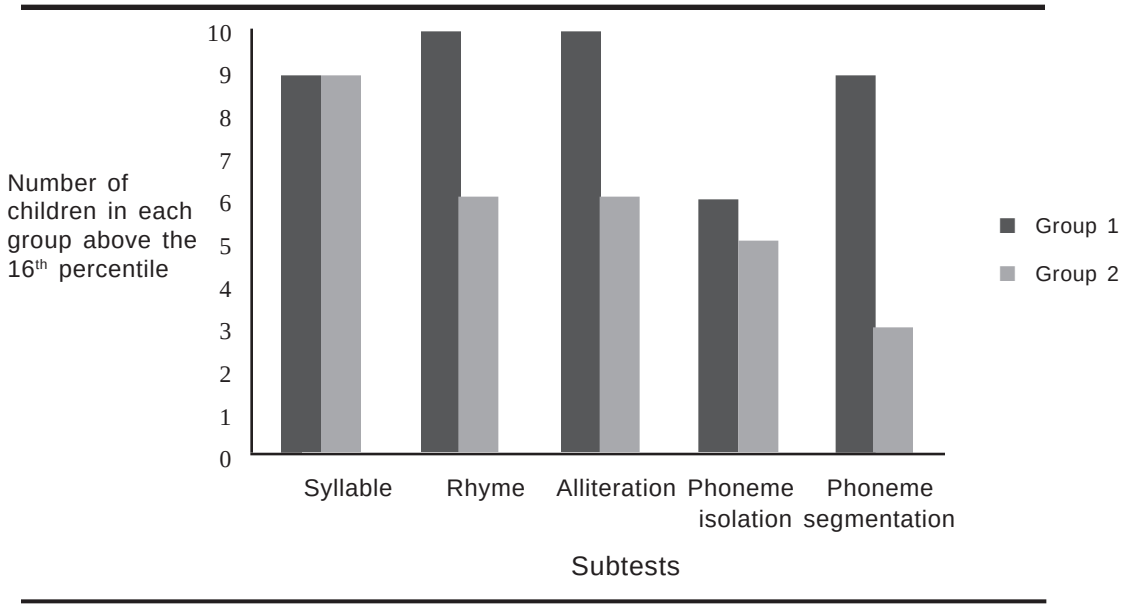
Table 5. Group comparison on speech and literacy measures.

	Age (in months)	*PCC*	*Letter*	*BURT**	*NWR**	*PHON**	*SPELL**
Group 1 (Received intervention)							
M	75.3	93.8	29.4	42.6	25.8	47.5	78.78
SD	6.8	4.8	2.3	17.6	4.5	6.1	19.48
Range	66–87	86.7–100	24–32	25–86	18–30	38–56	47–78
Group 2 (Retrospective control group)							
M	77.3	88.1	26.3	20.8	11.4	39.8	60.0
SD	3.9	8.6	4.9	6.5	7.9	6.5	16.39
Range	69–83	71.8–97.6	17–31	11–33	1–21	30–53	33–84

Note. PCC = percentage of consonants correct; Letter = Letter Knowledge subtest raw score from the Preschool and Primary Inventory of Phonological Awareness (PIPA; Dodd et al., 2000); BURT = number of words correctly read on the Burt Word Reading Test; NWR = number of correct phoneme–grapheme matches in the nonword reading task; PHON = combined raw score from the PIPA phonological awareness subtests; SPELL = percentage of correct phoneme–grapheme matches in spelling 10 words.

*Significant group difference at $p < .05$.

Figure 1. The children's performance on individual PIPA subtests compared to the test's normative sample. Children in Group 1 received phonological awareness during their preschool years. Children in Group 2 had not received any specific phonological awareness intervention.



normative database of New Zealand children's performance for this test. This normative data show the age band at which children can typically read a given number of words. Age bands for boys and girls are presented separately. Each participant's reading score was classified as average if the child's chronological age was at, or within, the equivalent age band (EAB) from the normative data; below average if the EAB was within 6 months of the child's chronological age; and well below average if the EAB was more than 6 months below age-expected levels. The child's performance was classified as above average if the EAB was above the child's chronological age and well above average if this score was more than 6 months above age-expected bands. For example, a boy from Group 1 read 49 words correctly and received an EAB of 8.01–8.07. This performance was described as well above average because his chronological age was only 6;05. A boy from Group 2 read 15 words correctly. His EAB was rated as below a 6;00 level. Because the boy was aged 6;07, his performance was described as well below average. Figure 2 illustrates the results of this analysis. All of the children with speech impairment who received phonological awareness intervention in their preschool years (i.e., Group 1) were reading at or above the expected level for their age. In contrast, the majority of children in the control group showed delayed development in word recognition.

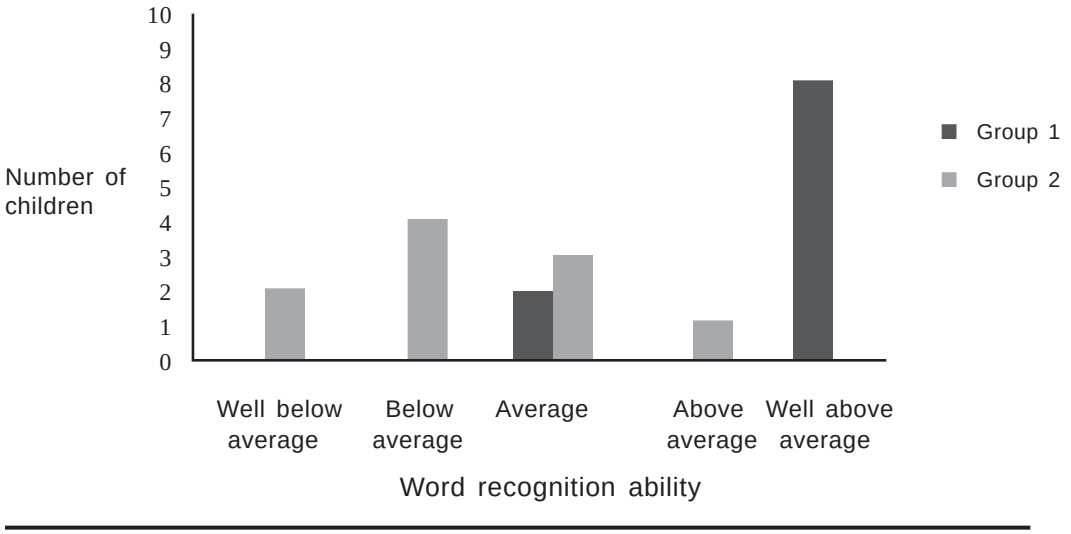
DISCUSSION

This study examined the phonological awareness and early reading and spelling development of a group of 3-year-old children with moderate or severe speech impairment. The children's development was monitored from initial assessment at 3 years of age through until their first or second year at school. The children received an average of 25.5 therapy sessions before school entry. This therapy was administered in two or three blocks, with each block consisting of one group therapy session and one individual therapy session per week. The therapy targeted improving speech intelligibility, facilitating phoneme awareness, and teaching letter knowledge.

The first hypothesis tested was that early intervention to facilitate phoneme awareness and letter knowledge would ensure that these children's phonological awareness was at least equal to that of their peers without speech impairment at school entry. This hypothesis was supported by the data analyses. Following the first intervention period, the children with speech impairment showed accelerated growth in early phoneme awareness as compared to a control group of children with typical development. This suggested that the intervention was effective in enhancing the skills targeted, and that even as young as 3 or 4 years of age, children with speech impairment can be taught to become consciously aware of sounds within words through simple game activities.

Previous research has indicated that children with typical development begin to acquire early phonological awareness skills rapidly around 4 years of age, with stability in performance becoming evident between 4 and 5 years (Dodd & Gillon, 2001). This pattern was mirrored for the children with speech impairment in the current study who received phonological awareness intervention. At 5 years, when these children started formal literacy instruction, there was no significant difference between children with or without speech impairment in phonological awareness skills at the syllable, onset-rime or, most importantly, phoneme level. Continued growth in phonological awareness and development of more advanced phoneme awareness skills such as phoneme segmentation was evident for both groups

Figure 2. Descriptions of the participants' word recognition ability when compared to the number of words correctly read in the normative data on the Burt Word Recognition Test—New Zealand Version. Children in Group 1 received phonological awareness during their preschool years. Children in Group 2 had not received any specific phonological awareness intervention.



during their first year at school. At 6 years of age, there continued to be no significant group differences on any of the phonological awareness measures, suggesting that the reciprocal relationship between literacy instruction and phoneme awareness expected in typically developing children was also evident for the children with speech impairment who received early intervention in phonological awareness.

The finding in the current study that children with speech impairment were advancing in more complex phoneme awareness skills (i.e., phoneme isolation and phoneme segmentation as measured by the PIPA) at a similar rate to their peers is in strong contrast to previous research. American, Australian, British, Canadian, and New Zealand children with speech impairment, for example, have all demonstrated inferior phonological awareness skills at the phoneme level in previous studies. Given no remarkable differences between the population in the current study and populations of children with speech impairment in other studies suggests that the early intervention that the children received in phoneme awareness and letter knowledge contributed to these children's success on phoneme awareness tasks at 5 and 6 years of age. This latter conclusion is supported by the finding in the current study that a matched control group of children with speech impairment who did not receive early phoneme awareness training showed significantly inferior phoneme awareness skills to the experimental group at 6 years of age.

The second hypothesis tested in this study was that early phoneme awareness and letter knowledge could be facilitated without compromising improvement in speech intelligibility for children with moderate or severe speech impairment. This hypothesis was supported by the results. All of the children with speech impairment in the experimental group showed steady improvement in their accurate articulation of single and multisyllabic words from 3 to 5 years of age. Although most of the children commenced literacy instruction at 5 years of age with error patterns still evident in their speech, they all demonstrated only mild impairment at the last assessment trial at 6–7 years. There was no significant difference in speech accuracy between the experimental group and a control group of children with speech impairment whose therapy had focused solely on improving speech intelligibility. This finding suggests that the inclusion of phonological awareness activities into therapy sessions did not detract from the children making gains in their speech production. Indeed, phonological awareness and knowledge of how speech relates to print may facilitate accurate speech production through establishing more fully specified underlying phonological representations and allowing children to use print cues to self-correct speech errors. The effects of phonological awareness on speech development require further investigation, but this study suggests that intervention that integrates phonological awareness and speech production can result in the two skills improving concurrently. Further, the results demonstrated that, consistent with previous findings (Gillon 2000, 2002), improvement in speech production alone does not necessarily facilitate improvement in phonological awareness at the phoneme level. The speech production of children in the retrospective control group improved over time, but as a group, these children remained significantly delayed in phoneme awareness skills.

The third hypothesis addressed in this study stated that the inclusion of activities to facilitate phoneme awareness and letter knowledge in therapy for young children with speech impairment would result in successful early reading and spelling experiences. The data strongly support this hypothesis. All of the children in the experimental group were reading at or well above their expected reading age in the first or second year at school. Their performance was

significantly superior to that of the control group of children with a similar history of speech impairment who were typically struggling with early reading development. Importantly, the children who received phonological awareness intervention showed strong ability in phonetic decoding and encoding, as evidenced by accuracy in the nonword reading task and phonetically accurate spelling attempts. This suggests that these children understood how to use phonological information in the reading and spelling process and thus had developed a strong basis for reading and spelling development in later grades. This is the first controlled study to demonstrate such strong early reading and spelling outcomes for a group of children with moderate or severe speech impairment. Previous studies (e.g., van Kleeck, Gillam, & McFadden, 1998) that have demonstrated gains in phonological awareness development for preschool children with speech-language impairment have not examined the children's literacy outcomes once formal schooling commenced. Thus, the benefits of early phonological awareness intervention for these children's reading and spelling acquisition were not fully understood. However, ongoing monitoring of the reading and spelling development of children with speech impairment is necessary to examine their performance as written language demands increase in complexity and intensity through the school years.

A few of the analyses employed in the study were limited by the sample size. The use of clinical populations and the intensity required to implement the interventions typically restricts the numbers of participants within intervention studies at Phase IV and V of the clinical outcome research model. This issue may be addressed in future studies through the possibility of multiple intervention sites to examine the effectiveness of the treatment approach in a variety of clinical contexts with varying populations.

The findings from this study suggest that strong phonological awareness skills at the phoneme level are indeed a critical factor in determining successful early reading and spelling experiences for children with speech impairment. Despite a history of moderate or severe speech impairment and a known risk factor of commencing literacy instruction with persistent speech impairment, the children in the experimental group demonstrated average or well above average reading performance in their first or second year at school. They also demonstrated strong early spelling knowledge. A difference between these children and populations used in previous studies investigating reading performance in children with speech impairment was their good letter knowledge and age-appropriate phonological awareness skills at the syllable, onset-rime, and phoneme level at school entry. The design of the study suggests that early intervention that is aimed specifically at facilitating phoneme awareness and letter knowledge in addition to improving speech intelligibility contributed to these children's strong phoneme awareness development and subsequent success at decoding and encoding the printed word. The study results provide valuable evidence to support the clinical practice of integrating phoneme awareness and letter knowledge activities into therapy sessions for 3- and 4-year-old children who have speech impairment.

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Contact author: Gail T. Gillon, Department of Communication Disorders, University of Canterbury, Private Bag, 4800, Christchurch, New Zealand. E-mail: gail.gillon@canterbury.ac.nz

APPENDIX. EXAMPLES OF GROUP ACTIVITIES USED IN THE INTERVENTION TO STIMULATE AWARENESS OF INITIAL PHONEMES IN WORDS AND TO TEACH THE RELATIONSHIP BETWEEN PHONEMES AND GRAPHEMES

Activity 1: Sorting toys and "animal friends" by the initial phoneme of their name

Clinician: "This is my friend turtle. Turtle starts with a /t/ sound. This letter is *t*, and it makes a /t/ sound (referring to a large poster-size letter of *t*). Turtle wants to find a friend that starts with /t/."
The clinician asked the children to name other soft toys such as teddy, mouse, and seal and helped the children find the toy that started with /t/.

Activity 2: Finding pictures or toy objects that start with a target sound with the assistance of a puppet

Clinician: "Here is the letter *m*. It makes an /m/ sound (large poster size letter of an m). Can you help me make the /m/ sound? My friend 'munching monkey' is going to eat the pictures that start with an /m/ sound. Let's help him find the pictures that start with an /m/ sound."
At the end of the activity, the clinician placed all the pictures that started with an /m/ sound beside the letter *m* for review. "Listen to all these pictures that start with an /m/ sound: meat, milk, man, mouse." The children were encouraged to articulate the words with the clinician.

Activity 3: Selecting toy objects or picture cards from a mystery bag

Clinician: "Let's see what you can find in the mystery bag. (Children took turns to select an object.) Tell me what you've found. Yes, you've found a car in the mystery bag. (The child was encouraged to articulate the word correctly as appropriate to speech production goals.) Car starts with a /k/ sound and this letter can make a /k/ sound (pointing to a large poster-size letter of *c*). Drive the car to the letter *c*" (child has a choice of *c* or *m*).

Activity 4: Using the computer

The "word shop" activity from Winnie the Pooh Kindergarten (Disney, 1999) was used in the intervention. This activity teaches children to identify words that start with a target grapheme and phoneme. With the use of a small data projector, the clinician projected the computer image onto a blank wall and engaged the children in running up to touch the target words or letters. Dimming the lights in the therapy room ensured a strong projected image on the wall and helped capture the children's attention.

Activity 5: Speech-to-print matching and early decoding activity (introduced before school entry at 5 years, e.g., between 4;06 and 4;11)

Clinician: "This word says *cat* (word written in very large print on a white board). Let's read the word together. I want to make a new word. Can you come up and use your magic duster to rub off the /k/ sound?" (Children took turns and were prompted as necessary.) Now I'm writing the letter m: m..at. The new word says….. mat." The children were encouraged to read the word together.