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Building upon Sound Foundations

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Abstract

Phonological awareness has been acknowledged as an important predictor of, and influence upon, reading progress. This study offers an independent evaluation of the Sound Foundations phonological awareness program, and investigates the differential impact of session frequency on the acquisition of phonological awareness, phoneme identity training on phonological decoding ability, and the generalisation of taught phonological awareness skills to untaught phonological awareness and decoding tasks. Participants, part-way through their first year of formal education, were assigned to either a group that received the standard Sound Foundations program, a group that received the same Sound Foundations program more frequently over a shorter period, or a comparison group that did not participate in the Sound Foundations program. Pre-test and post-test measures employed a number of relevant reading related measures, and the data were analysed using a priori orthogonal polynomial contrasts and Cohen's d effect sizes. A positive linear trend was found on the CTOPP Phonological Awareness Score that indicated participation in the Sound Foundations program improved phonological awareness, and greater improvements were found when the program was delivered more frequently over a shorter intervention period. Statistically significant changes in the phonological decoding abilities of participants in each group were found across time, however improvements in this ability were not statistically significantly different between groups. The data also indicated that taught skills generalised to some areas of phonemic awareness, and not to others.

Building upon Sound Foundations

Both Australian and overseas research has indicated that many children fail to obtain the skills necessary for proficient reading in the classroom. Marks and Ainley (1997) indicated that 30 per cent of Australian teenagers do not achieve adequate levels of literacy. In recognition of this outcome, some schools offer remedial reading programs to their students. However, research has found that children who make a slow start in reading acquisition do not typically catch up to their age peers (Juel, 1988; Torgesen & Burgess, 1998). One Australian study noted that by Year 10, the lowest 10 per cent of students had made no reading gains since Year 4 (Hill, 1995). Therefore, the aim of all educators should be to ensure that children at risk of reading failure are identified early and assisted in the task of reading acquisition.

Alphabet knowledge and phonological awareness have been identified as two important predictors of reading development (Lovett, Steinbach, & Fritjers, 2000; Rack, Hulme, Snowling, & Wightman, 1994; Torgesen, 1998a; Wagner & Torgesen, 1987). It is generally believed that, although alphabet knowledge is the single best predictor of early reading success (Snow, Burns, & Griffin, 1998), it is only a marker for a range of significant literacy-related experiences, rather than a powerful intervention focus itself. Thus, learning letter-sounds and names is necessary for reading progress, but does not stimulate it. In contrast, phonological awareness has been implicated as a causal agent in reading acquisition, either alone (Lundberg, Frost, & Petersen, 1988) or in concert with the teaching of letter-sound correspondences, blending and segmenting (Hatcher, Hulme, & Ellis, 1994).

Phonological awareness may be an efficient instructional focus for identifying and intervening with children before they enter the reading failure spiral. Phonological awareness more accurately predicts reading ability than many common correlates of school achievement, such as IQ scores, age, and socio-economic status (Share, Jorm, Maclean, & Matthews, 1984). Children with poor phonological awareness are more likely to experience reading difficulties, whereas children with well developed phonological awareness are more likely to become proficient readers (Schneider, Roth, & Ennemoser, 2000). It has been estimated that 80 to 90 per cent of school age struggling readers have poor phonological processing abilities (Shaywitz, Escobar, Shaywitz, Fletcher, & Makuch, 1992).

Phonological awareness is considered to develop on a continuum (Solomons, 1992). The continuum begins with the recognition that speech is composed of words (Pikulski, 1989), and progresses to an understanding that words are composed of phonemes (smallest sound unit of spoken language, e.g., /k/ as in cat) that can be manipulated to complete various tasks (Allor & McCathren, 2003). Stanovich (1992) refers to the development of phonological awareness as a progression from shallow to deep awareness. Adams (1990) refers to this model as the depth-chart model. The model presumes children progress from segmenting larger, more obvious speech units (words) to smaller, less obvious units (e.g., syllables) until they are aware and

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able to manipulate the smallest, most abstract unit of speech (phonemes) (Murray, Smith, & Murray, 2000). When children understand that spoken words are made up of phonemes, and that phonemes can be blended to make words (e.g., /k-a-t/ blend to make cat), they are said to be phonemically aware, and in conjunction with letter-sound knowledge (e.g., c = /k/), they are able to create and read words (Adams, 1990). It is this sophisticated level of phonological awareness, phonemic awareness, that better predicts later reading success (Ehri & Wilce, 1980, 1985; Liberman, Shankweiler, Fischer, & Carter, 1974; Perfetti, Beck, Bell, & Hughes, 1987).

For some children phonemic awareness develops readily without the need for instruction, whereas for others the sophisticated level of phonological awareness thought necessary for proficient reading ability may require explicit, carefully sequenced phonologically-based intervention (Alexander & Slinger-Constant, 2004). Phonemic awareness can be developed in children through explicit training prior to formal education (Ball & Blachman, 1988, 1991; Bradley & Bryant, 1985; Lundberg et al., 1988; O'Connor, Jenkins, & Slocum, 1995). In a meta-analysis of 34 phonemic training studies, Buz and van Ijzendoorn (1999) confirmed that phonemic awareness training can reliably enhance phonemic and, subsequently, reading skills. This finding is consistent with the results of a meta-analysis of 52 studies on phonemic awareness conducted by the National Reading Panel (National Reading Panel, 2000).

In their comprehensive review of the phonemic awareness literature, the National Reading Panel (2000) found phonemic awareness instruction to be more effective under certain conditions. Instruction focusing on one or two types of phoneme awareness manipulations was more effective than instruction that attempted to teach three or more types. Learning was also greater when instruction was delivered in small group format rather than individual or classroom format, and instructional programs lasting from five to 18 hours were more effective than shorter or longer programs.

The National Reading Panel (2000) also found that phonemic awareness training was more effective in improving reading ability if the training included letter-sound training. Hatcher, Hulme, and Ellis (1994) termed this 'The Phonological Linkage Hypothesis' (p. 42). Hatcher et al. set out to investigate whether an intervention that involved a combination of phonemic awareness training and reading instruction would be more effective than an intervention involving either reading instruction, or phonemic awareness training, in isolation. They concluded that training in phonemic awareness alone is not the most effective means of enhancing reading development. Consistent with the findings of Ball and Blachman (1988, 1991), Hatcher et al. found that the greatest improvements in reading skill were made when phonemic awareness training was combined with the teaching of letter names, letter sounds, and simple spelling skills.

Byrne and Fielding-Barnsley (1991b, 1993, 1995, 2000) conducted a longitudinal study that examined the impact of early phonemic awareness training on reading development. They found that training in the identification of a subset of phonemes (phoneme identity training) promoted the development of letter string decoding and resulted in modest and sporadic improvements in other aspects of reading. The six year follow-up showed small but significant superiority in word identification levels for those students who had received the phonemic awareness training. These findings have important implications in the research on reading acquisition as they indicate that even after several years of formal education, which Byrne and Fielding-Barnsley acknowledge may have included explicit instruction in the alphabetic code for program participants and comparison participants, six to seven hours of instruction in phoneme identity in the pre-school years can place students at an advantage in the reading acquisition process.

Byrne and Fielding-Barnsley's (1991b, 1993, 1995, 2000) longitudinal study utilised their phonemic awareness training program Sound Foundations (Byrne & Fielding-Barnsley, 1991a). The Sound Foundations program fits the National Reading Panel (2000) guidelines for effective instruction in phonemic awareness. The program focuses on one type of phoneme awareness manipulation, is appropriate for delivery in a small group format, involves between six and nine hours of instruction (depending on the number of phonemes taught), and includes some letter identification training. The program focuses solely on the phoneme identity component of phonemic awareness. Phoneme identity is one of the easiest and earliest acquired components of phonemic awareness (Solomons, 1992; Stahl & Murray, 1994; Yopp, 1988). Phoneme identity refers to an awareness of the identity of phonemes across words (e.g., the ability to notice that big and ball start with the same sound and that stop and tip end with the same sound). Byrne and Fielding-Barnsley (1991b) reported that the principle of phoneme identity can be generalised across phonemes once a subset of phonemes has been explicitly taught. This economy of curriculum makes training in phoneme identity very efficient.

A search of the empirical literature databases found the Sound Foundations pre-reading program has been independently validated by Whitehurst et al. (1994). Robust gains in phonological awareness, print concepts, and writing relative to children in control classrooms were also reported in the Whitehurst et al. (1999) follow-up study. In contrast to the Byrne and Fielding-Barnsley (1991, 1993, 1995) findings, Murray (1998) did not find improved phonemic awareness following training in phoneme identity. This was an odd result given that there was a positive impact on phonetic cue decoding. Murray ascribed the null effect on phonemic awareness to a poor choice of phoneme identity measure. He suggested that the improvement in alphabetic insight was actually an indirect measure of improvement in phonemic awareness.

One aim of the current study is to replicate the program design of Byrne and Fielding-Barnsley (1991b) to independently evaluate the impact of participation in the Sound Foundations program on phonemic awareness, and to examine whether such skills transfer immediately to phonological decoding. The longitudinal research of Byrne and Fielding-Barnsley (1993, 1995) indicated that the phonemic awareness advantage obtained after participating in the Sound Foundations program extended to superiority in pseudo-word decoding (as in Word Attack) in Years 1 and 2. It was of interest whether such transfer might occur immediately following phonemic awareness instruction for a sample of school beginners as opposed to preschool learners. Hence, in the current study the Word Attack subtest of the Woodcock Tests of Reading Mastery – Revised (Woodcock, 1987) was administered before and immediately after participation in the Sound Foundations program. The Word Attack subtest provides a measure of decoding ability using a list of legal non-words. To succeed on the task the child is required to segment the non-words into graphemes (printed letter/s), convert the graphemes into phonemes (letter sounds), blend the phonemes, and verbally articulate a response.

A difficulty in the phonemic awareness research is the vast array of phonemic awareness tasks and measures. Torgesen (1998b) identified more than 20 tasks that have been used to measure the construct of phonemic awareness. These tasks range from rhyme recognition ("does cat rhyme with mat?") and sound-to-word matching ("does mat begin with /m/?") to phoneme isolation ("what is the first sound in mat?"), phoneme blending ("what does /m-a-t/ say?"), phoneme segmenting ("say each sound in mat") and phoneme deletion ("say mat without /m/") (Stahl & Murray, 1994).

Despite the range of tasks and levels of complexity, correlations among most phonemic skills are high (Yopp, 1988). The skills, according to Torgesen (1998b), can be grouped into three broad categories: sound comparison, phoneme segmentation, and phoneme blending. The correlations between the tasks indicate that they all seem to be closely related to the same general ability (Hoien, Lundberg, Stanovich, & Bjaalid, 1995; Stanovich, Cunningham, & Cramer, 1984; Yopp, 1988). It therefore may be that explicit training in one component of phonemic awareness will generalise to skill development in other areas of phonemic awareness, either immediately or over time.

Cunningham (1990) and O'Connor et al. (1995) presented evidence to support the generalisation of phonemic awareness skills between trained and untrained components. Both studies found that skills obtained through training in first sound identity, segmentation, and blending transferred to other types of phonological manipulations measured with the Lindamood Auditory Conceptualization Test (Lindamood & Lindamood, 1979). However, participants in a study by Qi and O'Connor (2000) did not display such skill transference. Children in this study received instruction in either segmentation and blending, or rhyming and first sound identification during two sessions per week for 10 weeks. Following instruction, each child completed the Lindamood Auditory Conceptualization Test. Children in neither group transferred what they had learned to other phonemic skills. O'Connor, Jenkins, Leicester, and Slocum (1993) also found that training in one phonological area did not lead to improvements in other phonological skills. The research of Byrne and Fielding-Barnsley (1991b, 1993, 1995) cannot shed light on this question as they trained phoneme identity and measured phonemic awareness using only tests of phoneme identity.

Knowledge about the transference or generalisation of skills is an important issue in curriculum design. If skills can be transferred from one domain to another then fewer skills need be taught, whereas if skills do not generalise, curriculum must address each relevant skill independently. Understanding the facilitation among the components of phonemic awareness would then allow instructional designers to make use of tasks that have the widest impact on phonemic awareness and ultimately on reading acquisition (O'Connor et al., 1993). A further aim of this study is to investigate whether training in phoneme identity improves other components of phonemic awareness.

An additional aim of the study is to investigate the impact of session frequency on the acquisition of phonemic awareness skills. Empirical research on this issue is sparse. The National Reading Panel (2000) made no recommendations regarding the optimal frequency of instruction. However, they did indicate that reading assistance provided to a low-achieving older reader may fail to exert a significant impact if the instruction is not sufficiently intense.

Some researchers have suggested that daily sessions of 10 to 30 minutes duration are necessary for an intervention to be successful (Adams, as cited in Diamond & Mandel, 1996; Binder, Haughton, & Bateman, 2002; Calfee & Moran, 1993; Diamond & Mandel, 1996). In a meta-analysis of one-to-one interventions, Elbaum, Vaughn, Hughes, and Moody (2000) reported that short and intense programs were more effective than those of a longer, less-intense nature. Similarly, Torgesen (2004) observed that increased success was evident when instruction occurred for 20 to 45 minutes per day for four to five days per week.

Hempenstall (1999) noted that students may have difficulty remembering new material if lessons are of insufficient frequency, requiring more time to be spent re-learning previously presented material, rather than new material, in subsequent sessions. Hempenstall suggests a strong emphasis be placed on sufficient massed practice for mastery, and spaced practice for retention.

Anecdotal evidence presented by Horowitz (2000) suggests best results in reading instruction are obtained "by providing a little instruction every day, rather than lengthy periods with days between sessions" (p. 26). Alexander and Slinger-Constant (2004) also assert that four to five sessions per week produces more effective instructional outcomes. The National Literacy Strategy (Department for Education and Employment, 1998) involves a daily "literacy hour" to attempt to address the problem of reading failure. As an example, the empirically validated Corrective Reading program (Grossen, 1998) was designed on a schedule of five lessons per week (Engelmann et al., 2002). Reports from teachers regarding the Corrective Reading program suggest that error counts increase when lesson frequency drops from five to four per week, and even more so when lesson frequency drops to three lessons per week (Hempenstall, 2001). The Denton and Mathes (2003) study noted that high program intensity had the most markedly positive effect on those in greatest need of assistance.

In the Torgesen et al. (1999) study of at-risk students in their first year of schooling, interventions were scheduled for 20 minutes per day, four days a week for three years.

The general aim of the current study is to contribute knowledge about the conditions conducive to children deriving optimum benefit from phonemic awareness instruction. The effects of session frequency and the presence of skill generalisation will be investigated. The impact on phonemic awareness of participating in the Sound Foundations program will also be evaluated. Four research questions are posed:

1. Does instruction in phoneme identity improve phonemic awareness skills?
2. Does the frequency of instruction provide differential impact on the acquisition of phonemic awareness?
3. Does instruction in phoneme identity transfer to improvements in other components of phonemic awareness (elision or blending abilities)?
4. Does instruction in phoneme identity transfer to immediate improvements in phonological decoding?

Method

Participants

Ethics approval was applied for and granted by the Human Research Ethics Sub-Committee of the Faculty of Applied Science, RMIT. Permission to conduct the study in a Victorian government school was granted by the Department of Education and Training, Victoria.

Participants in the study were recruited through a letter to the parents of all children enrolled in their first year of formal education (Prep grade in Victoria, n = 106) at a state government primary school in the Northern Metropolitan Region of Victoria. Seventy-two responses were received. Three participants withdrew from the study prior to completion of the program: two participants relocated to other schools before post-intervention assessments could be conducted, and the third student was absent from more than half of the program sessions due to illness. The remaining 69 students, 38 male, 31 female, participated in the study. Participants ranged in age from five years to six years four months with a mean age of five years seven months.

Materials

A pre-reading program and three assessment tools were used to conduct this study. Each of the materials is described below.

Sound Foundations program

The Sound Foundations program (Byrne & Fielding-Barnsley, 1991a) contains materials to teach nine phonemes. Byrne and Fielding-Barnsley (1991b) demonstrated that the principle of phoneme identity could be generalised across phonemes once a subset of phonemes had been explicitly taught. The program composition of six phonemes (/s/, /m/, /t/, /l/, /p/, /a/), used by Byrne and Fielding-Barnsley (1991b), was replicated in the current study.

Materials provided with the Sound Foundations program include large colourful posters for each phoneme in the initial and final positions. The posters are a collage of items that begin or end with one of the phonemes (i.e., poster for /t/ in the initial position has pictures of toast, treasure, teeth, telephone, etc; the poster for /t/ in the final position has pictures of paint, ant, cat, bat, etc). Each poster is also replicated in a black and white A4 size worksheet. Two additional worksheets for each phoneme, in initial and final positions (excluding vowels), are also provided. A poem and short story for each phoneme, in each position, is also provided on an audio-cassette. Byrne and Fielding-Barnsley (1991a) also provided two card games, which are adaptations of the traditional "Dominoes" and "Snap" games. The aim in each of the games is to match sounds in either the initial or final position. The phonemes /s/, /p/, /t/, and /l/ are represented in the games. Whereas the Byrne and Fielding-Barnsley (1991b) study displayed the letter that represented the phoneme-in-training in each session, their 1991a study did not provide the letter cards during the program. To ensure that the current study was a replication of Byrne and Fielding-Barnsley (1991b), A5 size cards with the corresponding letter for each phoneme were developed and displayed at the appropriate session.

In order to teach the six phonemes, twelve 30-minute sessions were required. One session was dedicated to the teaching of each phoneme in the initial position (e.g., /t/ as in teddy), and followed in the next session by the teaching of the same phoneme in the final position (e.g., /t/ as in paint). Vowels were only taught in the initial position. Each session, regardless of phoneme position taught, followed the same sequence. Students entered the room to find the poster and letter card on the wall. The researcher began each session by introducing the phoneme and position "Today is /s/ day. We are going to look at words that begin with /s/". Children were then asked to identify any names that began with the sound. A version of "I Spy" using the designated sound was played, with each child having the opportunity to select the word. Children were corrected if they used the letter (i.e., "I spy with my little eye something beginning with t") rather than the sound (i.e., "I spy with my little eye something beginning with /t/"). The correction procedure was "that is the letter, what is the sound". Children were also corrected if they suggested a word that did not start or end with the target sound. The correction procedure in this instance was "that does not start/end with target sound. Can you think of a word that starts/ends with target sound?" The game of "I Spy" was followed in each session by the poem and short story. Children then began colouring the pictures on their worksheets that began or ended (depending on session) with the phoneme being taught. Finally, taking turns, children called out an item they could see on the big poster that began or ended with the phoneme. The researcher then put a label on the poster, and the children coloured in the item on their worksheet. This continued until all items were identified. The Sound Foundations program does not require children to learn to criterion. Thus, children were not required to meet any benchmarks before progressing to the next session.

Comprehensive Tests of Phonological Processing

One of the principal uses of the Comprehensive Tests of Phonological Processing (CTOPP; Wagner, Torgeson, & Rashotte, 1999) was as a measurement device in research studies investigating phonological processing. The version of the CTOPP used in the current study contains seven core subtests and one supplemental test. Three of the core subtests, Blending, Sound Matching, and Elision combine to give a Phonological Awareness Quotient (PAQ). These subtests were included in the data analysis of the current study because they assess aspects of phonological awareness that are directly relevant to reading instruction. Combined, these subtests provide a measure of an individual's awareness of, and access to, the phonological structure of oral language. According to the CTOPP manual, the PAQ has good content validity (.96), test-retest reliability (.79) and inter-rater reliability (.97).

The Blending subtest contains 20 items with six practice items. The task for the child is to combine individually presented sounds into the target word (e.g., /k/, /a/, /t/). The sounds were presented on an audio-tape to ensure consistent delivery to each participant at pre- and post-intervention assessments. This was important because the researcher was not blind to experimental condition of each participant. A replacement for the US-accented audio-tape was made by the research supervisor in an Australian accent, and presented two sounds per second as indicated in the CTOPP Manual.

The Sound Matching subtest contains 10 items in which a common initial sound between a target item and three options is to be matched (e.g., "Which word starts with the same sound as pan? Pig, hat, or cone?"), and 10 items in which a common ending sound is to be matched (e.g., "Which word ends with the same sound as hill? Doll, hat, or whip?"). Three practice items for the initial sound and three practice items for the ending sound are included in the subtest. The design of this subtest is the same as that used by Byrne and Fielding-Barnsley's (1991) evaluation of the Sound Foundations program.

The Elision subtest contains 20 items with six practice items. The child is asked to pronounce the target item and then pronounce it with a part missing. For example, "Say toothbrush. Now say toothbrush without saying tooth". Beyond item four, a phoneme rather than a larger unit of language, is removed from the test item.

The Peabody Picture Vocabulary Test – 3rd edition

The Peabody Picture Vocabulary Test – 3rd edition (PPVT-III; Dunn & Dunn, 1997) is a norm referenced, individually administered achievement test of receptive vocabulary. It also provides an estimate of verbal ability. It is a multiple-choice test that requires the child to select a picture from four choices that matches a spoken word. The mean score is 100, with a standard deviation of 15. The test has internal consistency of .92 to .98 and split-half reliability of .86 to .97. When correlated with the WISC-III criterion, related validity was found to be .92 (Dunn & Dunn, 1997). The PPVT-III was used in the current study to provide a baseline measure of each participant's receptive vocabulary and to provide a means of ruling out verbal ability as a confounding factor.

Woodcock Reading Mastery Tests – Revised – Word Attack subtest

In this subtest (Woodcock, 1998), the child is required to read a list of legal non-words (dee, ap, ift, raff, bim, nan, un etc). Psuedo-word tasks are considered the purest measure of decoding, as words can only be read through the child's knowledge of letter-sound rules (Barker & Torgesen, 1995; Lovett et al., 1994). The Word Attack subtest is a commonly used decoding measure (Share & Stanovich, 1995; Wood & Felton, 1994) and is designed for students from age 5.6 to 18.6 years. The median split half reliability coefficient for the Word Attack subtest is .87. Validity was assessed using the Iowa Test of Basic Skills, the Peabody test, and the Woodcock-Johnson Reading Scale (Revised). The total reading score provides correlations ranging from .78 to .92 with these other recognised reading tests across the age range chosen. The Word Attack subtest compared with another recognised Word Attack scale in the Woodcock-Johnson Reading Scale (Woodcock, 1978, cited in Woodcock, 1987) provides correlations from .64 to .9 across the age range chosen.

Procedure

Pre-testing

The PPVT-III, Woodcock Word Attack, and the CTOPP Phonological Awareness subtests were individually administered to each student during the first three weeks of Term 2 in their initial year of primary school. The principal investigator and two Psychology Masters students, who had been trained in the administration of the assessment tools, conducted the assessments, taking approximately one hour per student.

To control for any teaching differences in the four individual classrooms, students were grouped according to classroom and sex, and then randomly assigned to one of the three groups so that sex and classroom were approximately evenly distributed across the groups.

Standard Intervention Group

In addition to their regular classroom instruction, students in the standard intervention group were removed from their classroom, in groups of six students, twice per week for 30 minutes over a six-week period to participate in the Sound Foundations program. The program was completed in the last week of Term 2.

Higher Frequency Intervention Group

During the fourth week of the standard intervention group's program, the students in the higher frequency group began their Sound Foundations program. This ensured that both groups completed the program on the same day, therefore controlling for any recency or memory effects on the post-intervention assessment data. In small groups of six, students were removed from their classroom for 30-minute daily sessions over 12 consecutive school days. The program was completed in the last week of Term 2.

Wait-list Comparison Group

Students assigned to the wait-list comparison group participated in their regular classroom instruction and were not removed from their classroom during the intervention phase of this study. Following the administration of post-test assessments, students in the wait-list comparison group participated in the standard version of the Sound Foundations program.

Post-testing

Participation in the Sound Foundations program for students in the standard and higher frequency intervention groups was completed in the last week of Term 2. Students had a two-week break from school before returning for Term 3. During the first two weeks of Term 3, each participant was individually

Table 1: Mean standard scores, standard deviations, score ranges, and effect sizes for study groups on various measures

	n	CTOPP PAQ	CTOPP Elision	CTOPP Blending	CTOPP Sound Matching	Word Attack	PPVT-III
Comparison	22						
Pre-test							
Range		79-121	6-16	6-15	7-14	0-10	75-119
M		102.82	10.55	10.91	10.32	2.41	102.86
SD		12.70	2.70	2.56	2.10	3.10	10.90
Post-test							
Range		79-132	6-13	7-20	6-14	0-17	
M		109.64	10.55	13.18	10.82	4.05	
SD		14.45	2.26	3.46	2.24	5	
d		0.5	0.0	0.75	0.23	0.39	
(95% CI)		(-0.11, 1.09)	(-0.59, 0.59)	(0.12, 1.34)	(-0.37, 0.82)	(-0.21, 0.98)	
Standard	24						
Pre-test							
Range		76-115	6-13	6-13	6-12	0-5	80-124
M		94.83	9.17	9.71	8.75	0.61	103.88
SD		10.60	1.90	1.73	1.98	1.34	11.51
Post-test							
Range		83-124	6-14	9-15	6-14	0-14	
M		106.25	10.08	12.17	10.67	3.48	
SD		11.94	2.39	1.83	2.24	4.42	
d		1.02	0.42	1.38	0.91	0.88	
(95% CI)		(0.40, 1.60)	(-0.16, 0.99)	(0.73, 1.99)	(0.30, 1.49)	(0.27, 1.46)	
High Frequency	22						
Pre-test							
Range		79-126	6-16	7-13	6-14	0-14	66-127
M		97.33	9.33	9.87	9.54	1.91	101.87
SD		11.65	2.50	1.99	2.13	3.82	11.91
Post-test							
Range		85-143	7-18	7-18	6-16	0-21	
M		113.09	11.18	13.05	11.86	4.59	
SD		14.56	2.68	2.68	2.38	5.25	
d		1.20	0.71	1.35	1.03	0.58	
(95% CI)		(0.53, 1.81)	(0.09, 1.31)	(0.67, 1.98)	(0.38, 1.64)	(-0.03, 1.18)	

administered the CTOPP and Word Attack by either the principal investigator or two trained colleagues.

Results

The raw data collected during this study were entered into the SPSS v. 13 (SPSS Inc., 2004) and analysed for variances between pre-test measures and post-test measures. The data were explored for data entry errors and violation of parametric assumptions. All variables met the assumptions of normality, linearity, and homogeneity of variance. Mean standard scores, standard deviations and the range of standard scores for comparison, standard and higher frequency groups at pre-test and post-test on the combined and individual subtests of the CTOPP and Word Attack subtest are presented in Table 1. Also presented in Table 1 are the pre-test to post-test effect sizes for each group calculated using Cohen's (1988) d pre-test scores from the PPVT-III for each group are also presented.

Analysis of the Composite Phonological Awareness scores, Elision subtest scores, Blending subtest scores, Sound Matching subtest scores, and Word Attack subtest scores were performed using five single-factor between-subjects analysis of covariance. The experimental condition (i.e., standard, higher frequency, comparison) served as the sole factor and the Composite Phonological Awareness scores, Elision, Blending, Sound Matching, and Word Attack subtest scores served as the single dependent variables in each of the analyses. The covariates were the Peabody Picture Vocabulary Test scores and the respective pre-intervention score for each analysis.

Because the levels of the independent variable varied according to an underlying ordinal scale (i.e., no intervention, standard intervention, higher frequency intervention), it was considered that single degree of freedom a priori contrasts using orthogonal polynomials (i.e., trend analysis) would generate the most informative results. A significant linear trend would indicate that improvement was related to the frequency of phonemic awareness training.

Effect size d (Cohen, 1988) was calculated for each dependent variable (CTOPP PAQ, CTOPP Elision, CTOPP Blending, CTOPP Sound Matching, Word Attack) to provide information on the magnitude of the observed changes. The calculation of effect size was based upon the ratio of the difference between the group means at pre- and post-test for each experimental condition (comparison, standard, higher frequency) and the pooled standard deviation of each group at pre- and post-test. In line with Cohen's convention an effect size of 0.2 is considered small, 0.5 medium, and 0.8 a large effect size. Slavin (2003) argued that an effect size of 0.2 is the minimum required for significance and that an effect size above 0.25 should be considered educationally significant (Slavin, 1990).

Paired samples t-tests were also carried out on the Blending and Word Attack variables to investigate whether significant differences occurred across time in each group.

For the composite phonological awareness score results, no significant quadratic trend was evident, $p = .62$; however there was a significant linear trend, $p = .003$. The significant linear trend indicates a consistent level of improvement related to the frequency of phonemic awareness training. The greatest improvement in phonemic awareness ability (as measured by the CTOPP PAQ) was obtained for the higher frequency intervention group, followed by the standard intervention program, and then the comparison group. A moderate effect size was obtained for the comparison group on the CTOPP PAQ ($d = 0.5$), and large effect sizes for the standard group ($d = 1.02$), and higher frequency group ($d = 1.20$).

For the Elision subtest score results, no significant quadratic trend was evident, $p = .36$; however, there was a significant linear trend, $p = .019$. The greatest change in measured ability was found in the higher frequency intervention group, followed by the standard intervention group, again indicating a consistent level of improvement related to the frequency of phonemic awareness training. For the CTOPP Elision variable, no effect was found for the comparison group ($d = 0.0$), a small to moderate effect size was found for the standard group ($d = 0.42$), and a moderate to large effect size was found for the higher frequency group ($d = 0.71$).

For the Sound Matching subtest score results, no significant quadratic trend was evident, $p = .79$; however, there was a significant linear trend, $p = .004$. The linear trend indicates that improvement in sound matching ability related to the frequency of phonemic awareness training. Participants in the higher frequency intervention group improved more than the standard intervention group, who also improved more than the comparison group in sound matching ability. Large effects were again obtained for the standard ($d = 0.91$) and higher frequency ($d = 1.03$) groups on the CTOPP Sound Matching variable, and a small effect size was obtained for the comparison group ($d = 0.23$).

For the Blending subtest score results, no significant quadratic trend – $p = .25$ – or linear trend – $p = .44$ – was evident. These results indicate that for the Blending subtest no statistically significant difference in performance between the three groups was evident, though two-tailed paired sample t-tests found there was statistically significantly improved performance between pre-test and post-test for each group (standard: $t(23) = 6.45$, $p < .001$; higher frequency: $t(21) = 5.19$, $p < .001$; comparison: $t(21) = 4.88$, $p < .001$). Large effect sizes were obtained for the standard ($d = 1.38$), and higher frequency ($d = 1.35$) groups on the CTOPP Blending variable, and a moderate to large effect size was obtained for the comparison group ($d = 0.75$).

For the Word Attack subtest score results, no significant quadratic trend was evident, $p = .30$; nor was a significant linear trend evident, $p = .17$. These results indicate that for the Word Attack subtest, no statistically significant difference in performance between the three groups was evident, though two-tailed paired sample t-tests found there was statistically significantly improved performance between pre-test and post-test for each group (standard: $t(22) = 3.79$, $p = .001$; higher frequency: $t(21) = 4.41$, $p < .001$; comparison: $t(21)$

= 2.29, p = .032). A small to moderate effect size was found for the comparison group (d = 0.39), a moderate effect size was found for the higher frequency group (d = 0.58), and a large effect size was found for the standard group (d = 0.88).

Discussion

The data show that phonemic awareness was improved by participating in the Sound Foundations program. The significant linear trend obtained for the Phonological Awareness Composite score indicated that participants who completed the Sound Foundations Program made greater gains in their phonemic awareness than participants who did not receive any training. A moderate effect size obtained for the comparison group indicated that some of the improvement in phonemic awareness may have occurred as a result of influences outside of the Sound Foundations program, for example, through classroom instruction. However, large effect sizes were obtained for the standard and higher frequency groups, indicating that participation in the Sound Foundations program made an educationally significant contribution to the phonemic awareness of pre-readers. This finding is consistent with the findings of Byrne and Fielding-Barnsley (1991b, 1993, 1995) and provides independent support for the utility of the Sound Foundations program (Byrne & Fielding-Barnsley, 1991a) in improving the phonemic awareness of pre-readers.

The data suggests an advantage when the Sound Foundations program is delivered in a higher frequency regime. The positive linear trend obtained for the Phonological Awareness Composite score indicated that an increasing level of improvement in phonemic awareness was recorded as the session frequency increased. The degree of this improvement was evident in the effect sizes obtained for the standard, higher frequency, and comparison groups. A moderate effect size was found for the comparison group, whereas a large effect size was found for the standard group, and an even larger effect size was produced for the higher frequency group. The study offers empirical evidence for the proposal that phonemic awareness can be enhanced when instruction is delivered at a higher frequency than originally intended.

Clinical observations of the participants in the study support the argument that lessons are best presented daily. Those students in the higher-frequency group appeared to adapt to the structure and routines of each session more quickly than those in the less-frequent group. Less time was spent by the researcher discussing the structure and tasks of each session in the higher-frequency group, thus allowing more time for the content of the session to be explored. Although no formal measures were adopted, observation indicated that the students in the higher-frequency group were also able to generate more examples of words with the target sounds during the various tasks of each session, and they also displayed stronger engagement in the content of each session. This group appeared to have mastered the task requirements more readily than those in the standard group despite an absence of significant pre-test differences in phonemic awareness. Participants in the two intervention groups spent the same amount of time in each session; however, the apparently increased academic engaged time of the high frequency group may have contributed to the improved outcomes for this group. The high frequency of sessions may have led to more efficient time usage, and thus more learning opportunity.

The longitudinal data of Byrne and Fielding-Barnsley (1991b, 1993, 1995) indicated that the letter string decoding abilities of students developed following participation in phoneme identity training. It is this ability that allows students to produce pronunciations for printed words. Byrne and Fielding-Barnsley (1991b, 1993, 1995) took measures of letter string decoding ability at time delays of one, two, three, and four years following phoneme identity training. In this study, a measure of letter string decoding ability was taken immediately following completion of the intervention program. No significant linear or quadratic trend was found in the letter string decoding abilities of participants in the current study. However paired sample t-tests indicated that significant improvements in the word attack abilities of participants in each group did occur across the study period. Further, the reported effect sizes for the Word Attack variable for the three groups indicated that differential change in the letter-string decoding abilities of participants did occur. A moderate effect size was recorded for the higher frequency group, a large effect size was recorded for the standard group, and a small effect size was recorded for the comparison group. However, these effect sizes need to be interpreted with caution. First, the effect size for the standard group is influenced by floor effects that resulted in a small standard deviation, a factor that influences effect sizes. Second, the 95 per cent confidence interval of the comparison and higher frequency group effect sizes extend below zero indicating they may not be reliable effect sizes. The wide confidence intervals and the absence of a significant trend may be consequences of the small sample size. The effects on decoding may become clearer if a larger sample were employed. If a larger sample size produced a similar group of effect sizes, then an explanation may be that a basal level of decoding improvement occurred as a consequence of the school's reading program, and the Sound Foundations program contributed further to the overall influence on decoding. The statistically significant t-tests reported for the Word Attack variable support this proposition. They add to the possibility that generalisation of the phoneme identity training was partly submerged in the effects of the school reading program participants were receiving concurrently.

In this study, the data did not support the hypothesis that phoneme identity training directly and immediately enhances word attack abilities. This outcome is consistent with other findings (Murray, 1998) that phonemic skills are necessary, though not sufficient, to ensure skilled decoding is evoked. However the lack of data regarding participants' letter-sound knowledge and perhaps floor effects of the Word Attack subtest may explain the lack of significant findings on the Word Attack subtest.

It could be argued that phoneme identity training better prepares a student to approach the task of learning to read, rather than training in phoneme identity directly evincing reading skills. Following training in phoneme identity, students may approach the task of reading with a greater capacity to understand and incorporate the concept of decoding into their repertoire of skills. This is consistent with the view that phonemic awareness is a necessary but not sufficient condition for reading acquisition. Longitudinal follow-up of the current cohort of students would allow this hypothesis to be tested. In considering additional necessary elements, Pokorni, Worthington and Jamison (2004) suggest that reading programs do need to include phonological awareness activities, but should also include alphabetic recognition and word decoding, and be of sufficient intensity, if they are to evoke reading progress.

The current study also set out to investigate the generalisability of phoneme identity training to blending and elision skills, neither of which were directly taught. The generalisability of phonemic awareness skill has important implications for program design. As O'Connor et al. (1993) stated, "understanding the facilitation from one phonological domain to another would allow instructional designers to make use of tasks with the widest transfer value" (p. 533). The significant linear trend for the phoneme elision variable indicated training in phoneme identity generalised to improved phoneme elision ability, and again added weight to the higher frequency schedule's worth. The relative value of the two schedules is evident in the moderate and moderate to large effect sizes obtained for the standard and higher frequency groups, respectively. The zero effect size of the comparison group suggests that elision ability does not develop without assistance (at least in the short term), and may not be a part of the school's regular curriculum.

Perhaps the crucial component of the elision task that facilitated generalisation was the need to identify a phoneme and subsequently delete that phoneme. Qi and O'Connor (2000) claim that practising first sound identity is an indirect segmentation activity. Phoneme elision requires that a word be segmented into phonemes, and then the appropriate phoneme deleted. Therefore, perhaps inadvertently, students who participated in the Sound Foundations program did receive training in at least some elements of the phoneme elision task.

The data fail to note a reliable advantage for phoneme identity training in expanding blending skill beyond that produced by factors external to this study (i.e., school instruction). No significant trends were obtained for the blending variable; however, large effect sizes for the standard and higher frequency groups were recorded and a moderate to large effect size was recorded for the comparison group. Despite the lack of statistical significance, the effect sizes measured for this variable suggest that something positive is happening to the blending abilities of the children who participated in this study. It is simply not possible to claim that the program caused the effects. As noted in the discussion of the decoding results, a larger sample size may have provided the power needed to achieve a statistically significant advantage for the intervention group. However, the data that are available imply that influences external to the study (such as classroom instruction) impacted on the blending abilities of the children who participated in the study. The data also suggest that participation in the Sound Foundations program did have a real effect on blending skill, as evidenced in the larger effect size of the two intervention groups over the comparison group.

The existing data cannot demonstrate whether blending is a component of phonemic awareness that needs to be explicitly taught in order for the skill to be mastered for many children. Murray (1998) suggests two elements to phonemic awareness – phoneme identity and phoneme manipulation. He argued that, for some children at least, each requires explicit instruction.

We are grateful to an anonymous reviewer for pointing out that there may be a relationship between the blending and the decoding outcomes. The current understanding of reading development has blending and decoding as closely related reading skills. It is possible that the effect on blending of the intervention was real, but insufficiently large to promote decoding development. Hence, the capacity to decode nonsense words was not enhanced as much as expected because the pre-requisite blending skill did not advance sufficiently.

The current study contains several limitations. No follow-up data were collected to ascertain whether the advantages of frequent phoneme identity training sessions on phonemic awareness would be sustained over a long period of time or would facilitate reading acquisition. Given that the aim of phonemic awareness training is to facilitate the reading acquisition process, this remains a very important research area that warrants further longitudinal investigation. A limitation of the Sound Foundations Program is that participants are not required to learn to criterion as they move through the program. Perhaps instructional modifications, such as a choral responding system with inbuilt correction procedures as in the Corrective Reading Program (Engelmann et al., 2002) would enhance the Sound Foundations effects.

A further limitation of this study is that the experimenter, who also served as the trainer, was not blind to the experimental group assignment of each of the participants. The experimenter followed all standardised procedures in the administration of pre- and post-tests and made every effort to ensure a consistent delivery of the program free from bias in each program session. Further, the experimenter is not a trained teacher, and there were no fidelity checks on the experimenter's presentation of the program.

The study indicated that the higher frequency delivery regime was superior to the standard delivery regime in improving some aspects of phonemic awareness. This has implications for program and curriculum design. Future research that investigated high frequency regimes of teaching in other phonemic awareness programs and indeed other curriculum areas (e.g., spelling, decoding) would be beneficial to the field of education.

In summary, the findings of the current study contribute to the knowledge about the optimum design of phonemic awareness training programs for pre-readers. Past research has demonstrated that phonemic awareness training is beneficial to the reading acquisition process when it helps in the attainment of the alphabetic principle (Ball & Blachman, 1988, 1991). The meta-analysis conducted by the National Reading Panel recommended that phonemic awareness instruction should focus on one or two types of phoneme awareness manipulations, be delivered in a small group format for five to 18 hours, and include letter-sound training. Byrne and Fielding-Barnsley (1995, 2000) have shown that phoneme identity can improve phonemic awareness and facilitate reading. They also found that it was necessary only to teach a subset of phonemes. The results of the current study support Byrne and Fielding-Barnsley's conclusion that phoneme identity training can improve phonemic awareness, and beyond that, delivering the training in a higher frequency regime resulted in greater improvements in phonemic awareness. The current study also showed that phonemic identity training transferred to improved elision ability, suggesting that not all phonemic awareness tasks need to be explicitly taught in addition to phoneme identity training. However, the study could not demonstrate that blending ability reliably improved following phoneme identity training; thus, based on the evidence currently available, the optimum training program in phonemic awareness should include explicit instruction in blending. Further, the study did not demonstrate that training in phoneme identity was sufficient to immediately enhance decoding ability.

There are numerous questions regarding the role of phonological processes in developing skilled reading. Both small and large-scale studies on issues such as that addressed in this study can add to the developing knowledge base.

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