

# Letter knowledge precipitates phoneme segmentation, but not phoneme invariance

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There is a wealth of evidence linking letter knowledge and phoneme awareness, but there is little research examining the nature of this relationship. This article aims to elucidate this relationship by considering the links between letter knowledge and two sub-skills of phoneme awareness: phoneme segmentation and phoneme invariance. Two studies are reported. The first study consisted of an eight-month longitudinal study with 56 pre-literate children. No child within this group was successful on any phoneme awareness task unless they knew at least one letter. Letter knowledge was also a significant predictor of later phoneme completion and deletion. The hypothesis that letter knowledge is an important precursor for phoneme awareness was then investigated in a small-scale intervention study with ten children. These children were taught letters and their phoneme awareness was monitored. It was found that letter knowledge was specifically related to the development of phoneme segmentation in pre-literate children. Possible reasons for this finding are discussed.

There is a substantial body of evidence suggesting that phonological awareness is one of the most important predictors of learning to read in young children. Children with good early phonological awareness go on to show good reading skills (Bryant, Maclean & Bradley, 1990; Wagner & Torgesen, 1987), children with poor reading skills normally show concomitant weak phonological awareness (Bradley & Bryant, 1978; Snowling, 1981; Swan & Goswami, 1997), and training in phonological awareness can improve reading progress (Bradley & Bryant, 1978; Hatcher, Hulme & Ellis, 1994; Troia, 1999). More recently, evidence has come to light that it is awareness of phonemes, rather than of larger segments such as rimes and syllables, that is most closely predictive of learning to read (Hulme, Hatcher, Nation, Brown, Adams & Stuart, 2002; MacMillan, 2002; Muter, Hulme, Snowling & Taylor, 1998).

Given that phoneme awareness is the form of phonological awareness most closely related to reading, determining how phoneme awareness develops is a matter of some importance. Phoneme awareness is not common in pre-school children (Bryant, Maclean, Bradley & Crossland, 1990; Fox & Routh, 1974), but develops quite quickly once children start school (Duncan, Seymour & Hill, 1997). Some researchers (Goswami & Bryant, 1990; Treiman & Zukowski, 1991) have suggested that awareness of larger phonological segments such as syllables and rimes is an important precursor to phoneme awareness. Goswami & Bryant (1990) in particular suggest that awareness of syllables

and rimes develops 'naturally' in the pre-school years; while phoneme awareness develops out of this awareness once children have been taught to read.

There is a good basis of evidence suggesting a reciprocal relationship between reading and phoneme awareness, as described by Goswami and Bryant (1990). Gombert (1992) suggested that learning to read forces children to move from epilinguistic phonological awareness (or global sensitivity to sound similarity), to metalinguistic phonological awareness (or explicit awareness of sound segments), and there is some evidence in favour of this view. Studies examining the phonological awareness of pre-readers (Lieberman, Schankweiler, Fischer & Carter, 1974) and illiterate adults (Morais, Cary, Alegria & Bertelson, 1979) have shown that reading seems to play a role in the development of explicit phonemic awareness. More specifically, learning letters seems to be the element of reading that is causally related to phoneme awareness. A further study by Read, Zhang, Nie & Ding (1986), showed that the development of explicit phonemic awareness was limited to languages with an alphabetic writing system. Thus the learning of letters must play a crucial role in the development of phonemic awareness.

There is evidence of the link between these two skills from studies of children beginning to read. Bowey (1994) compared the phoneme awareness of readers and non-readers with high and low levels of letter knowledge. Children with high letter knowledge showed higher levels of phoneme awareness than children with low letter knowledge, even after general language abilities were controlled. Johnston, Anderson and Holligan (1996) found that only children with some letter knowledge showed any success on a phoneme awareness task, and that letter knowledge was more closely related to phoneme awareness than rhyme awareness was.

Longitudinal studies have also shown a close relationship between the two sets of skills. Wagner, Torgesen and Rashotte (1994) found that early letter knowledge predicted later phoneme awareness, and Lonigan, Burgess, Anthony and Barker (1998) found an interaction between phoneme sensitivity and letter knowledge through the pre-school years. There is less evidence from intervention studies, though Murray, Stahl and Ivey (1996) found that teaching letters to pre-school children did improve performance on a phonemic awareness task. Researchers have also found a close relationship between letter knowledge and phoneme awareness within intervention studies aimed at improving reading; several studies now converge upon the idea that the most effective interventions involve teaching both skills in tandem (Hatcher, Hulme & Ellis, 1994; Troia, 1999).

There is, therefore, a growing body of evidence that learning letters is a precursor to phoneme awareness in young children beginning reading instruction. This paper aims to build upon this body of evidence by examining more closely the ways in which learning letters influences the development of phoneme awareness by considering the performance of young children upon phoneme awareness tasks that differ in terms of the task demands.

There are a great variety of phoneme awareness tasks, and they vary in the skills they require of a child. Byrne (1998) suggests that phoneme awareness can be divided into segmentation and invariance skills, where segmentation involves separating a phoneme from its phonetic context, and invariance involves detecting that two phonemes are in some respects the same across differing phonetic contexts. Tasks such as phoneme isolation or phoneme completion involve segmenting a phoneme from the speech stream, while other tasks such as phoneme matching involve noticing some invariant properties of a given phoneme across words. The extent to which children segment phonemes from words in a phonological matching task is debatable. Some researchers have suggested that these tasks can be completed on the basis of global similarity, without segmentation

(Byrne & Fielding-Barnsley, 1993; Cardoso-Martins, 1994; Carroll & Snowling, 2001). If this is true, then phoneme isolation and phoneme matching can be regarded as complementary tests of the two elements that Byrne regards as making up the concept of full phoneme awareness. Other phoneme awareness tasks, such as phoneme deletion, involve further processes of mental manipulation in addition to segmentation and phoneme invariance. For this reason, the relationship between letter knowledge and each of these three tasks, phoneme isolation, phoneme matching and phoneme deletion will be considered. It is hypothesised that letter knowledge will be most strongly associated with segmentation, the ability to segment phonemes within words, as measured by the phoneme isolation task. When children learn letter sounds they are presented as isolated phonemes or as phonemes with a following schwa sound (for example, 'buh' is the letter sound for B). Learning sounds in this way may encourage children to isolate phonemes within their own speech.

This paper reports two studies examining the relationships between letter knowledge and phoneme awareness. In the first, letter knowledge was measured at both points of testing in a longitudinal study, allowing its role in the development of phonological awareness to be assessed. The second is an intervention study in which a small group of children was given training in letters over the course of four weeks. The influence of this training on the development of phoneme awareness was assessed.

The children taking part in the two studies were attending local authority schools in the city of York and as such were receiving tuition according to the National Curriculum (The National Literacy Strategy; Framework for Teaching, 1998). In nursery, specific letter sounds were not taught, though they were mentioned informally. By the end of nursery, children were expected to recognise their name and understand what letters were, but were not necessarily expected to know the names or sounds of individual letters. In reception class the children were given quite intensive tuition in letter sounds. Letter names were not introduced until the end of reception year, after the final testing point of these studies. Hence, letter name knowledge is low throughout these studies.

## Study 1

Previous research has suggested that learning letters precipitates the development of explicit phoneme awareness. The current study aimed to confirm this finding using a longitudinal design in which letter knowledge and phoneme awareness were assessed in a group of pre-school children in the earliest stages of learning letters. Vocabulary was measured as an index of language. It was anticipated that both early vocabulary and letter knowledge would predict later phoneme awareness.

## Method

### *Participants*

Fifty-six children were tested twice, seven months apart. At the first time of testing they had a mean age of 4.2 years (range 3.6 years to 4.9 years) and at the second point of testing 4.9 years (range 4.1 years to 5.4 years). The children were selected from two state-run nursery schools in the city of York; Nursery A, in a largely working class area and

Nursery B, in which the distribution of working-class and middle-class families was more mixed. Word reading level was not formally assessed, but discussion with the children's teachers confirmed that none of the children knew how to read any words at the first point in testing.

### *Tasks*

*Letter knowledge.* The child was given a card with a single lower-case letter on it and asked which letter it was. If they responded with the letter's name, they were asked if they knew its sound. At Time 1, the children were given an abbreviated set of 18 letters to name. These letters were selected as the earliest letters learnt according to Stuart and Coltheart (1988). At Time 2, they were given all 26 letters to name. At each time point, testing was discontinued if the child produced ten incorrect responses or eight non-letter responses (such as 'eight' or 'don't know').

*Receptive vocabulary.* As a measure of the children's general abilities, they were asked to complete the British Picture Vocabulary Scale (Dunn, Dunn, Whetton & Pintilie, 1982). This is a standardised test of receptive vocabulary. Children hear a word, and then are asked to point to one of four pictures that represents the word they heard. The test is graded and continues until a child makes six errors within eight items.

*Phoneme awareness tasks.* At Times 1 and 2, the children were asked to complete an initial phoneme matching task, described fully in Carroll and Snowling (2001). They were given a cue word and asked which of two alternatives had the same first sound as the cue word. Pictures were used for each of the words to reduce memory load. For example, they would be shown a picture of a dish, and asked which word had the same initial sound as dish – duck or beach. The incorrect items were varied systematically for phonological and semantic similarity to the cue word. Scores on these differing distractors are presented in Carroll and Snowling (2001), and so are not described here. Feedback was given throughout the task, in an effort to achieve the best possible scores on the task for each child. Previous research has shown that feedback on phonological awareness tasks can facilitate understanding (Content, Kolinsky, Morais & Bertelson, 1986). Reliabilities for this task were  $\alpha = 0.67$  at Time 1 and  $\alpha = 0.89$  at Time 2.

At Time 2, the children were also given two explicit phoneme awareness tasks. These were phoneme completion and initial phoneme deletion, from the Phonological Abilities Test (Muter, Hulme & Snowling, 1997). In the phoneme completion task, the child had to supply the final phoneme of a single syllable word. For instance, they saw a picture of a gate and heard 'gay'. They had to supply /t/ to complete the word. Internal reliability is quoted as  $\alpha = 0.93$  in the Phonological Abilities Test handbook (Muter, Hulme & Snowling, 1997). In initial phoneme deletion, children had to remove the initial sound from a single syllable word. For instance, they would hear the word 'bus' and have to reply 'us'. Internal reliability is quoted as  $\alpha = 0.97$  in the handbook.

## **Results and discussion**

Table 1 shows the mean scores for the different variables at Time 1 and Time 2. Vocabulary standard scores were slightly above average for the population. Floor effects

were evident for both of the letter knowledge measures at Time 1, as shown by the high standard deviations for these variables. Transformation of the variables did not alter any of the results, and so raw scores were used for these analyses. Most children knew substantially more letter-sounds than letter-names, and their letter-sound knowledge increased dramatically between Time 1 and Time 2, during which time most of the children entered formal schooling. Because of the higher levels of letter-sound knowledge and the likely links between letter-sound knowledge and phonological awareness, letter-sound knowledge will be used in future analyses. Correlations between the different measures are shown in Table 2. Letter knowledge is significantly correlated with each of the three phoneme awareness tasks, and these three tasks show a good degree of intercorrelation.

*The longitudinal relationship between letter knowledge and phoneme awareness*

Hierarchical multiple regressions were carried out to determine the relationship between letter knowledge and phoneme awareness. The regressions from Time 1 to Time 2 are shown in Table 3. Age was entered at the first step in each analysis, vocabulary at the second step and letter knowledge at the final step. Letter knowledge at Time 1 was not a significant predictor of phoneme matching ability at Time 2. However, it was a significant predictor of phoneme completion and deletion ability at Time 2. This is particularly striking given that almost half of the children at Time 1 knew no letters at all.

This analysis suggests that letter knowledge is an important factor in the development of phoneme segmentation, as measured by the phoneme completion task, but not so

**Table 1.** Mean scores (with standard deviations in parentheses) on the letter knowledge, vocabulary and phoneme awareness tasks over time.

	Time 1	Time 2
Vocabulary (standard score)	105.36 (12.16)	106.75 (12.58)
Letter-sound knowledge	3.91 (5.33)	15.76 (6.87)
Letter-name knowledge	2.09 (4.44)	3.75 (4.99)
Phoneme Matching (/16)	8.79 (2.95)	11.63 (3.50)
Phoneme Completion (/8)	–	4.25 (3.36)
Phoneme Deletion (/8)	–	1.75 (2.72)

**Table 2.** Correlations between the measures at Time 1 and Time 2.

	Vocab T2	Letter sound T1	Letter sound T2	Phoneme matching T1	Phoneme Matching T2	Phoneme Completion T2	Phoneme Deletion T2
Vocab T1	0.703**	0.267*	0.179	0.342*	0.412**	0.165	0.044
Vocab T2	–	0.120	–0.025	0.311*	0.324*	0.104	0.218
Letter sound T1	–0.072	–	0.482**	0.490**	0.248	0.335**	0.463**
Letter sound T2	–0.115	0.433**	–	0.207	0.486**	0.654**	0.420**
Pho. matching T1	0.093	0.459**	0.208	–	0.323*	0.289*	0.438**
Pho. matching T2	0.109	0.134	0.438**	0.227	–	0.561**	0.372**
Pho. comp T2	0.058	0.279*	0.619**	0.275*	0.532**	–	0.541**
Pho. del T2	0.357**	0.445**	0.341*	0.492**	0.362**	0.510**	–

Notes: Pho matching = initial phoneme matching; pho del = phoneme deletion; pho comp = phoneme completion.

**Table 3.** Multiple regressions predicting explicit phoneme awareness at Time 2 from Time 1 variables.

Step	Variable	Beta	% $R^2$ change	Sig.
Dependent variable: Phoneme matching				
1	Age	0.158	2.5%	ns
2	Vocabulary	0.415	17.2%	<0.001
3	Letter knowledge	0.111	1.1%	Ns
Dependent variable: Phoneme completion				
1	Age	0.215	4.6%	ns
	Vocabulary	0.145	2.1%	ns
2	Letter knowledge	0.284	7.1%	<0.05
Dependent variable: Phoneme deletion				
1	Age	0.296	8.8%	<0.05
	Vocabulary	0.043	0.2%	ns
2	Letter knowledge	0.427	16%	<0.01

important in the development of phoneme invariance, as measured by the phoneme matching task. However, given the somewhat skewed distribution of both the phoneme awareness and letter knowledge tasks, individual inspection of the data points may also be informative.

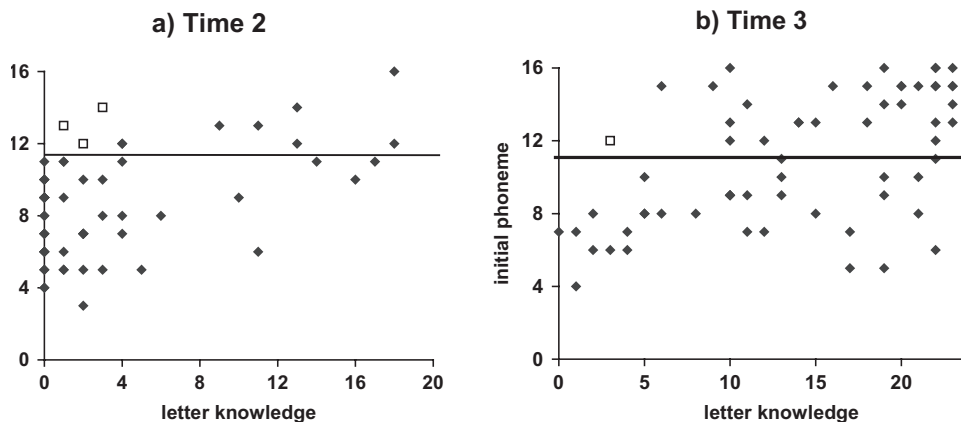
#### *The concurrent relationship between letter knowledge and phoneme awareness*

It was hypothesised that letter knowledge is a necessary precursor to the development of phoneme awareness. In order to examine this, a series of scatter graphs were plotted. First, letter-sound knowledge was compared to initial phoneme matching ability concurrently at Times 1 and 2. Chance level on the initial phoneme matching task was determined by calculating the binomial probability of each score. It was determined that a score of 12 or above was significantly above chance at  $p < 0.05$ . The relationship between letter knowledge and initial phoneme matching is shown in Figure 1.

All of the children who were above chance (score > 11) on the initial phoneme matching task at Time 1 or 2 knew at least one letter. Three of the eleven children at Time 1 who were above chance on the initial phoneme matching task knew fewer than four letter sounds, shown as squares rather than diamonds on Figure 1a. At this point in testing, 71% of the sample knew fewer than four letter sounds. At Time 2, all but one of the thirty-four children who were above chance on the initial phoneme matching measure knew at least four letters, and this child knew three letters.

Scatter diagrams were then constructed to investigate whether letter knowledge was also crucial for the successful completion of the phoneme completion and phoneme deletion tasks at Time 2. The scatter diagrams showing the relationship between phoneme completion and deletion and letter knowledge is shown in Figure 2.

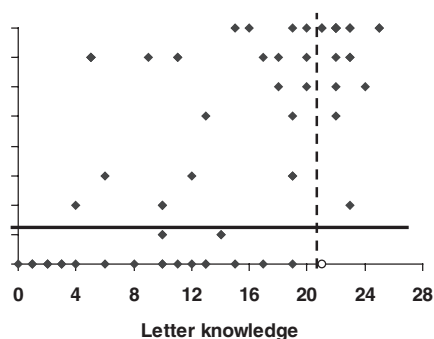
No child scored two or more correct on either the phoneme completion task or the phoneme deletion task unless they knew at least four letter sounds. It seems that knowing at least a few letter sounds is a threshold for the development of phoneme awareness. However, it is by no means the case that knowing a certain number of letters automatically confers phoneme awareness on children. In the graphs depicting the relationship between initial phoneme matching, phoneme deletion and letter knowledge, there are subgroups of children with good letter knowledge and poor phoneme awareness. The exception to this pattern is the phoneme completion task. The dashed line on Figure



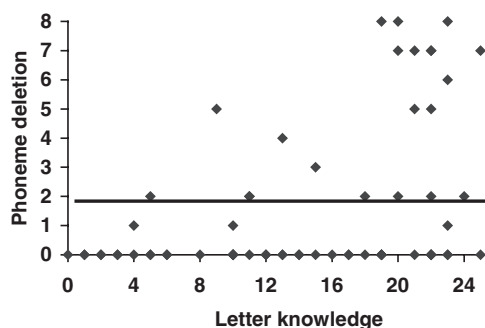
**Figure 1.** Scatter diagrams showing the relationship between letter knowledge and initial phoneme matching at Times 2 and 3.

*Notes:* the bold lines represent the level above which children are significantly above chance.

### a) Phoneme completion



### b) Phoneme deletion



**Figure 2.** Scatter diagrams showing the relationship between letter knowledge and phoneme completion and deletion at Time 2.

2a separates the group of children who scored in the top third of the sample on the letter knowledge task. Only one of these twenty-two children scored zero correct on the phoneme completion task. All of the other children scored at least two correct. There appears to be a close relationship between phoneme completion and letter knowledge, illustrated both by the overall correlations and by examining the scatter diagram in Figure 2a. This task is the only one that only requires children to be able to isolate phonemes. The other two tasks require additional skills: the ability to match phonemes or the ability to manipulate phonemes, respectively. Perhaps learning letters teaches children how to isolate or segment phonemes, while additional skills are required for successful completion of the phoneme matching and deletion tasks.

The study does, however, have a limitation, in that many children made large gains in letter knowledge between the two points in testing; most of them started formal schooling within that period, and letters are taught intensively during the first year of schooling in Britain. This makes it difficult to determine what patterns would exist in children soon after they had learnt their first few letters. For this reason, data are presented from a small-scale intervention study in which children were given training in letter knowledge, and their phonological awareness was monitored. This allows us to look more closely at the relationship between letter knowledge and phoneme awareness at the level of individuals.

## Study 2

This study extends the findings from Study 1 using an intervention paradigm. Study 1 suggested that letter knowledge is closely related to the development of phoneme awareness. If this is the case then it can be predicted that training in letter knowledge will increase children's ability to isolate and identify phonemes, but not necessarily their ability to compare or manipulate phonemes.

A group of children taken from Nursery A used was given daily letter knowledge training for a period of four weeks. Nursery A was in a largely working-class area of York and the children were not taught letters or phonological awareness within the nursery. The children were tested before and after the intervention for letter knowledge and phoneme matching ability. It was hypothesised that the letter knowledge training would improve their awareness of single phonemes. Seven weeks after training was completed, a full assessment of phoneme awareness was given, including an initial phoneme matching task, a phoneme completion and a phoneme deletion task.

## Method

### *Participants*

Ten children with a mean age of 4.3 years (range 4.1 years to 4.5 years; two boys and eight girls) participated in the study. These children, with two exceptions, were in their final term of nursery before beginning formal schooling. The youngest two children were to begin school the term after that. One further child took part in training, but was removed from the analyses as she had severe speech difficulties.

### *Training*

The children in the experimental group were given 20 minutes of training in groups of three or four, five days a week for 18 sessions in total. During this time eight letters were taught: s, m, k, t, p, r, a and o. The children were introduced to each letter in the following manner: first, they were read the 'Letterland' storybook that corresponded to each letter. The Letterland series of books all feature letter-shaped characters. For instance, 's' is represented by Sammy the Snake. The letter's shape and distinctive features would be talked about. The children would then spend the rest of that session and the next session drawing that letter, colouring in pictures of that letter, finding that letter in a variety of contexts and finding pictures of things that began with that letter sound. The training therefore concentrated on linking the letter shape with the letter sound, though there was



a little work on finding words that began with the corresponding sound. At the mid point and the end point of training, the children had a 'game day', where they played games involving the letters they learnt. These games were variations of twister and snap.

#### *Pre- and post-testing*

The children in the experimental group were given a set of tests immediately before and after training. These consisted of letter knowledge, as measured in Study 1, and ten items taken from an initial phoneme matching task taken from Byrne and Fielding-Barnsley (1993). The items are listed in the Appendix. Within this task the global similarity between the incorrect foils and the cue words was matched to the global similarity between the cue word and the target word (e.g. cue word pig, alternatives beak and pool). This matching of global phonological similarity means that to score well on the test a child must use the matching of two identical segments, rather than overall similarity, as both word pairs are equally similar overall. This test would therefore require both phoneme segmentation and invariance, as the child would have to match on the basis of phonemes within the words. The task used picture cues for each of the words, and consisted of two practice trials with feedback, and ten test trials with no feedback.

#### *Follow-up testing*

The children in the experimental group were retested around seven weeks after the end of training. The tasks given in this reassessment were: letter knowledge, initial phoneme matching and the phoneme completion and deletion sub-tests from the Phonological Abilities Test. In each case, these measures were the same as those given at Time 2 in the longitudinal study.

## **Results and discussion**

#### *Pre- and post-testing*

First, the pre- and post-test scores were compared to determine whether the children in the experimental group had learnt a significant number of letter sounds during training. The results are shown in Table 4. Because of the skewed distribution of the scores at pre-test, non-parametric tests were used. Letter knowledge improved significantly from pre-test to post-test. However, there was not a significant difference between pre- and post-test scores on the initial phoneme matching task.

#### *Follow-up testing*

There are several possible explanations for the lack of improvement on the phoneme awareness post-test. First, there was a great deal of individual variation in how responsive the children were to the letter training. Second, the phoneme matching test was a measure requiring both phoneme segmentation and phoneme invariance, and letter knowledge may only influence one of these sub-skills. Lastly, it may be that letter knowledge does not have an immediate effect on phoneme awareness, but a more long-term or 'sleeper' effect. Table 5 shows the performance of the individual children on the three phoneme awareness tasks seven weeks after training had ceased. These children were no longer being formally taught letters within the nursery, yet their letter knowledge did show a

**Table 4.** Mean pre- and post-test scores on letter knowledge, rime matching and initial sound matching (standard deviations in parentheses).

Variable	Pre-test	Post-test	Wilcoxin	$\eta^2$
Letter knowledge	2.6 (4.72)	4.2 (4.61)	$Z = -2.156, p < 0.05$	0.328 (pre-foll = 0.717)
Initial phoneme matching	5.2 (1.75)	5.1 (1.29)	$Z = -0.570, p = ns$	0.001

**Table 5.** Individual performances of the children during and following letter training in letter knowledge and phonological skills.

Name	Letter knowledge		Phoneme awareness		
	Post-test	Follow up test	Phoneme completion	Phoneme matching	Phoneme deletion
EW2	16	18	7	13	0
DD2	8	9	7	15	5
SP2	3	13	5	10	0
OC2	4	5	7	8	0
ZD2	3	4	2	6	1
RM2	2	5	7	8	0
LJ2	2	3	0	6	0
RN2	1	8	0	8	0
LC2	2	0	0	7	0
KF2	1	3	0	6	0
Mean ( <i>SD</i> )	4.20 (4.61)	6.80 (5.37)	3.50 (3.37)	8.70 (3.09)	0.60 (1.58)

small improvement. Those children who were successful on the phoneme completion task at the follow-up testing point were, with one exception, those children who had a solid base of three or more letters known at post-testing. The two children who were above chance on the initial sound matching task at follow-up testing both showed a solid base of more than eight known letters at post-testing. One of these two children also achieved a score of 5 on the phoneme deletion task. It seems likely that successful completion of these tasks requires both an ability to recognise similar sounds across words and an understanding of the role of letter sounds.

### General discussion

The influence of letter knowledge on the development of phoneme awareness was investigated in two studies: a longitudinal study and a letter training intervention study. In both cases, letter knowledge was related to the development of phoneme awareness. Both studies also suggested that letter knowledge was most directly related to performance on the phoneme completion task, though it was also important for the initial phoneme matching and phoneme deletion tasks.

The finding that letter knowledge was an important factor in the development of phoneme awareness is in line with previous work showing the interaction between the two (Hatcher, Hulme & Ellis, 1994; Lonigan et al., 1998). In particular it fits with previous findings that knowing at least a few letters is an important precursor to early phoneme awareness (Bowey, 1994; Johnston, Anderson & Holligan, 1996), and that

teaching letters improves phoneme awareness (Murray, Stahl & Ivey, 1996). The present work extends these findings by showing that the growth of letter knowledge affects different phoneme awareness tasks to different extents. Letter knowledge was most closely associated with phoneme completion, and less closely associated with phoneme matching and deletion.

Both studies suggested that letter knowledge is crucial to the development of phoneme completion ability. The two measures showed a moderate correlation in Study 1, and close examination of the individual scores suggested a specific association between the two measures. In both studies, no child was able to complete this task unless they knew at least three letters. In the longitudinal study, only one of the twenty-two children who knew more than 20 letters was unsuccessful on this task. In the intervention study, all of the children who showed a post-test knowledge of more than three letters were able to complete the phoneme completion task successfully two months later. It appears that phoneme completion ability is an almost automatic consequence of learning letters. This task required children to segment and reproduce the final phoneme of a single syllable word, and therefore it seems likely that letter knowledge is important in the development of phoneme segmentation.

Though the present research goes beyond previous evidence in examining which skills within phoneme awareness are most closely related to letter knowledge, the question of how letter knowledge improves phoneme segmentation is still open. It is possible that learning letters helps children to begin to segment phonemes in several different ways. For example, learning letters teaches children a series of individual sounds, and links them with visual symbols. These are likely to aid children as they search for sounds within words. If they already know several individual sounds, they can mentally search through a word to see if they can equate the sounds they hear with any letter sounds that they already know.

Letter learning is also likely to help children segment sounds in a more fundamental way than this. In several cases, children were able to isolate sounds in the phoneme completion task even when they did not know the letters that these sounds corresponded to in the letter knowledge task. It is probably true that learning letters and learning how letter sounds fit into words encourages children to consider word sounds explicitly, and this in itself has a role in teaching children to isolate phonemes within words.

It is important to remember that the ability to isolate phonemes within words does not constitute full phoneme awareness. As Byrne (1998) suggested, children must also realise that sounds within different words can be different instances of the same phoneme. This skill was required for successful completion of the initial phoneme matching task. As with the phoneme completion task, it was true that no child was successful on this task without knowing at least three letters. However, several children who did know many letters were still unsuccessful on this task, and letter knowledge was not a significant longitudinal predictor of performance on this task. It appears therefore that this skill does not arise from letter learning alone. The same is true of the phoneme deletion task. In cases, additional skills or knowledge were required for successful completion of the task, and by extension for the understanding of phoneme invariance. Following from the characterisation of Gombert (1992), it may well be that a child must have some kind of global sound sensitivity, or the ability to recognise that words and syllables sound similar or different, before they are able to recognise that smaller segments sound similar or different. Full phoneme awareness would therefore require the integration of two skills; phoneme segmentation, which seems to be precipitated by letter knowledge, and an

understanding that phonemes sound similar in different contexts, an understanding that seems to progress from a sensitivity to sound similarity at the word or syllable level.

It could be said that the phoneme matching and phoneme deletion tasks both involve the processing of initial phonemes that are also onsets, and therefore these tasks could be solved on the basis of onset-rime awareness. This may provide a potential explanation for why letter knowledge was most closely related to phoneme completion. However, there is a growing body of evidence that, while tasks using initial phonemes may be the easiest type of phoneme task for young children, they are separable from rhyme tasks. These phoneme tasks are substantially harder than corresponding rhyme tasks (Carroll & Snowling, 2001), and performance on these tasks correlates more closely with performance on other phoneme tasks rather than with performance on rhyme tasks (Muter et al., 1998).

The research presented here is preliminary, but suggests that learning letters is an important factor in helping children to isolate phonemes within words. However, some further understanding is needed for full phoneme awareness. If a child learns letters, but has not yet developed a sensitivity to sound similarities, they will be unable to move to full phoneme awareness. This may well be the case for some children with family history of dyslexia, who show weak phoneme awareness in the face of average letter knowledge (Carroll & Snowling, 2004).

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### Appendix

Items used in the phoneme matching task in Study 2, taken from Byrne & Fielding-Barnsley (1993).

	Cue word	Foil	Correct answer
Practice 1	hit	rake	hose
Practice 2	pot	duck	peach
1	nail	bed	nose
2	tap	leg	tin
3	pig	beak	pool
4	map	net	moon
5	beak	shed	bowl
6	feet	sick	fan
7	sock	fat	sun
8	chin	shell	chop
9	cage	head	coat
10	bin	game	boat