Developmental Psychology
2003, Vol. 39, No. 5, 913–923

0012-1649/03/$12.00 DOI: 10.1037/0012-1649.39.5.913

The Development of Phonological Awareness in Preschool Children

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A short-term longitudinal study was carried out on a group of 67 preschool children. At three points in time over a 12-month period, the children were given tests measuring their syllable, rime, and phoneme awareness, speech and language skills, and letter knowledge. In general, children's rime skills developed earlier than their phoneme skills. Structural equation models showed that articulatory skills and syllable and rime awareness predicted later phoneme awareness.

Phonological awareness is one of the most important predictors of reading in normally developing children (Rack, Hulme, Snowling & Wightman, 1994; Wagner & Torgesen, 1987). In addition, children with dyslexia often show phonological processing difficulties, and training in phonological awareness can improve the efficacy of reading instruction (Bradley & Bryant, 1983; Hatcher, Hulme, & Ellis, 1994; Lundberg, Frost, & Peterson, 1988). Despite this relationship, the origins of phonological awareness in preschool children have received little attention. In the present study, we investigated the nature, progression, and predictors of phonological awareness in preschool children.

Goswami and Bryant (1990) argued that during the preschool and early school years, children progress through three levels of phonological awareness: from awareness of syllables to awareness of onsets and rimes and finally to phoneme awareness. According to this theory, children become aware of each of these different word segments in turn, and children use this conscious awareness of sound segments to complete phonological awareness tasks. A different conceptualization was proposed by Gombert (1992), who suggested that phonological awareness could be separated into two types: epilinguistic awareness and metalinguistic awareness. *Epilinguistic awareness* consists of a global sensitivity to similarities between speech sounds, and *metalinguistic awareness* consists of a conscious awareness of phonological segments within words, normally phonemes.

There is some evidence that young children use global sound-processing strategies when solving phonological awareness tasks. Both Byrne and Fielding-Barnsley (1993) and Cardoso-Martins (1994) examined the performance of children on phonological matching tasks in which the distractors were equated in global similarity. In both studies, the children found the task in which global similarity was controlled much more difficult than the standard phonological matching task. Similar findings were reported by Carroll and Snowling (2001), who used two of the phonological awareness tasks from the present study.

One of the most effective ways of assessing the adequacy of Goswami and Bryant's (1990) and Gombert's (1992) models of the development of phonological awareness is with a longitudinal study. In the present study, 3- and 4-year-old children were tested three times over the course of a year on a range of phonological awareness tasks. Two-alternative forced-choice tasks measuring syllable, rime, and initial phoneme awareness were used. Goswami and Bryant's theory predicts that the children will find the syllable matching task the easiest and that the rime and initial phoneme tasks will be of equivalent difficulty because they both involve the same level of awareness (onset–rime).

The tasks are all epilinguistic according to Gombert's (1992) characterization, because they require a choice between two alternatives. Thus, Gombert's theory makes no specific predictions about which tasks would be easiest. However, because Gombert proposed that children use overall sound sensitivity to complete epilinguistic tasks, it might be predicted that the easiest task would be the one with the word pairs that sound most similar overall. In this study, that would be the rime task. Although the segments to be matched in the syllable task are larger (full syllables rather than just rimes), the syllable task uses two-syllable words, and therefore larger segments of each pair of words will sound different. For instance, the words *firework* and *fireman* have two phonemes in common, in spoken British English, but they also have three differing phonemes. In contrast, the rhyming words *cat* and *hat* share two phonemes and differ on only one phoneme and so would sound more similar overall. The initial phoneme matching task would be the hardest, because the word pairs share only one phoneme and differ on two phonemes.

All of the matching tasks could be solved using implicit strategies—awareness of the segments involved was not necessary for success. At Time 3, some tasks requiring explicit verbal responses were added to the battery. These were syllable completion, phoneme completion, and phoneme deletion. The battery therefore

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This research was carried out as part of Julia M. Carroll's doctoral work, with support from a Biotechnology and Biological Sciences Research Council studentship. Preparation of the manuscript was supported by Economic and Social Research Council Postdoctoral Fellowship T026271158.

We thank the teachers and staff of Knavesmire and Haxby Road Primary Schools and all of the children who took part in this study.

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included implicit and explicit phonological awareness tasks using different segment sizes.

As well as examining the nature of the development of phonological awareness, we also aimed to examine the precursors of phonological awareness. Some researchers have found that preschool language abilities correlate with later phonological awareness (e.g., Chaney, 1998; Olofsson & Neidersoe, 1999), and others have found that early language development is related to later reading development (Bishop & Adams, 1990; Bryant, MacLean, & Bradley, 1990). However, studies that link individual subskills of language to phonological awareness are relatively uncommon. One recent study that investigated the relationship between early language development and later phonological awareness was carried out by Silven, Niemi, and Voeten (2002). They found that receptive and expressive vocabulary at 2 years of age predicted onset–rime sensitivity at 4 years of age.

Some researchers (e.g., Nittrouer & Crowther, 1998; Walley, 1993) have suggested that increases in children's phonological awareness are closely tied to the development of increasingly segmentalized lexical phonological representations. This "lexical restructuring" theory rests on the idea that children begin by representing words in a holistic manner and subsequently develop the representation of the sounds within words during the preschool and early school years. Because phonological awareness tasks measure a child's knowledge of the sounds within words, it is a reasonable hypothesis that this awareness is highly dependent on the status of a child's lexical representations. If these representations change substantially during the preschool years, then this change may provide an explanation for the observed increases in phonological sensitivity that tend to arise at around 4 years of age.

There is some evidence that lexical representations do change in the preschool years. Observational studies of infants articulating words in their 2nd year of life show that these children appear to represent syllables as a set of articulatory gestures with little differentiation of different positions within a syllable (Ferguson & Farwell, 1975). This finding is also reflected in the speech errors of young children. Both Aitchison and Chiat (1981) and Vihman (1981) found that preschool children are most likely to reproduce the most phonologically salient aspects of a word, whereas adults are more likely to reproduce initial and final phonemes. Vihman (1981, 1996) suggested that there are at least two "changeover points" in phonological development: the first occurring when children's productions start to resemble those of adults at between 2 and 4 years and the second occurring when written language is internalized during the school years. She proposed that children progress from early holistic word-specific phonological patterns to a productive rule-based phonology some time in their 3rd year and that phonological representations become altered again when orthographic representations become internalized.

Psychophysical experiments examining the speech perception and production of young children (Nittrouer & Studdert-Kennedy, 1987; Nittrouer, Studdert-Kennedy, & McGowan, 1989) show that young children pay more attention to phonetic cues that are distributed across phonemes, such as coarticulation, and less attention to those that occur within phonemes, such as voice onset time, than do older children and adults. Walley (1988) found that 4-year-old children were less likely to reject nonwords that differed from words according to the initial phoneme in a lexical decision task than were 5-year-olds. This evidence suggests that 4-year-old children are less likely to have a lexicon organized according to initial phoneme, as adults are assumed to do.

On the basis of the lexical restructuring hypothesis, it has been predicted that children's early phonological awareness is related to the development of their lexical representations. Walley (1993) proposed that vocabulary growth is the main driver of lexical restructuring in the preschool years. If this is the case, then vocabulary level should provide some indication of the status of a child's underlying lexical representations. However, it is also desirable to measure these representations more directly. Several researchers have developed tasks designed for this purpose. Most of these are naming tasks in which a child's production is scored as to its accuracy (e.g., Elbro, Borstrom, & Peterson, 1998; Swan & Goswami, 1997). The naming task has the advantage that it is easily completed by young children. However, task demands may affect performance. For instance, children who have difficulties in *articulating* certain phonemes may score badly on the task despite accurately *representing* those phonemes in the words. It is therefore important to also examine the quality of a child's phonological representations without requiring a verbal response from the child. Walley (1988) used a listening-for-mispronunciations task to assess the detail included in children's representations at different ages. Children had to detect whether a word was correctly pronounced or misarticulated by a single phoneme. In the present study, both articulatory accuracy on a naming task and mispronunciation detection were included as expressive and receptive measures of the quality of phonological representations.

Walley (1993) proposed that awareness of single phonemes develops as a result of lexical restructuring. The lexical restructuring theory does not make specific predictions about the development of syllable and rime awareness, which, as described above, seem to precede and predict the development of phoneme awareness. It is possible that the status of lexical representations is related to phoneme awareness indirectly via syllable and rime awareness, and we also investigated this hypothesis.

Many researchers have found that learning letters is another vital precursor to the development of phoneme awareness. Morais, Cary, Alegria, and Bertelson (1979) showed that illiterate adults did not show explicit phoneme awareness in spite of well-developed rhyming skills, and a study by Read, Zhang, Nie, and Ding (1986) showed that explicit phonemic awareness was limited to children learning languages with an alphabetic writing system. Longitudinal studies also suggest that the learning of letters plays a crucial role in the development of phonemic awareness. Wagner, Torgesen, and Rashotte (1994) conducted a longitudinal study of a group of 244 children from kindergarten to second grade in an effort to examine the reciprocal influences of phonological processing abilities, decoding, and letter knowledge. According to their findings, phonological processing abilities influenced the later development of reading and letter-name knowledge, but there was no evidence that reading development influenced the development of phonological processing abilities. However, letter knowledge was a significant longitudinal predictor of phonological analysis and synthesis abilities.

Burgess and Lonigan (1998) examined the relationship between phonological awareness and letter knowledge in prereading 4- and 5-year-old children. They found evidence of reciprocal relationships between the two abilities, with phonological awareness predicting growth in letter knowledge and letter knowledge predicting growth in phonological awareness once age and general language abilities had been taken into account.

Some researchers have proposed that learning letters may alter the nature of a child's phonological representations. For instance, Treiman and Bourassa (2000) suggested that learning letter–sound correspondences helps to develop phoneme-based phonological representations. A similar point was raised by Byrne and Liberman (1999), who pointed out that learning letters may help children to focus on the sounds, rather than the meanings, of words.

The current 1-year longitudinal study examined the influences of language development and letter knowledge on the development of phonological awareness in a group of preliterate 3- and 4-year-old children. The study examined three main questions:

1. Does the development of phonological awareness follow the progression of syllable, then onset and rime, then phoneme?

2. Are language skills such as vocabulary, detection of mispronunciations, and articulation related to the development of phoneme awareness?

3. What role does letter knowledge play in the development of phonological awareness?

Method

Participants

Sixty-seven children were tested three times over the course of a year. At Time 1, the average age was 3 years 10 months, with a range from 3 years 2 months to 4 years 5 months. Time 2 occurred 4 months later, when the average age was 4 years 2 months, and Time 3 occurred 8 months after that, when the average age was 4 years 9 months. Twenty-eight children were male, and 39 were female. The sample consisted of children from two separate state-run day nurseries. The sample contained children from a wide range of socioeconomic circumstances. Most of the children began formal schooling between Time 2 and Time 3 of testing.

Procedure

The children were tested individually in a quiet corner of the nursery. The tasks were administered over a period of between a week and a fortnight, depending on the number of days per week a child attended the nursery. At Time 1, the letter knowledge, vocabulary, and phonological matching tasks were given. At Time 2, these tasks were given again and two further tasks were included in the battery: mispronunciation detection and articulation. At Time 3, all of these tasks were given again (with the exception of the syllable matching task), and the explicit phoneme awareness tasks were added to the battery. The phonological matching tasks were presented in a fixed order. Syllable matching was presented first, then rime matching, and finally the initial-phoneme matching task. All of the phonological awareness tasks were presented in separate sessions. The language tasks were interspersed with the phonological awareness tasks.

Phonological Matching Tasks

All of the tasks chosen followed the two-alternative forced-choice format used by Locke (1997). The tasks were presented in sets of eight, with feedback following each trial. Most of the words used were taken from an age-of-acquisition database (Morrison, Chappell, & Ellis, 1997) that characterized them as words of high frequency that were in most children's expressive vocabularies earlier than 3½ years of age. Many of the pictures used were taken from the Snodgrass and Vanderwart (1980) picture set, whereas 26 of them were drawn by hand. All of the pictures were given to children of the same age in a pilot study to ensure that the pictures were readily nameable and that the words were in the children's vocabulary. The rime and initial phoneme tasks were presented at each point in testing. When the initial-sound matching task was given to the first group at Time 1, substantial floor effects were found. Fifteen of the 67 children were not given this task because they had shown no understanding of the other phonological matching tasks. When the syllable tasks were given to a subset of the children at Time 3, the performances of a large majority of the children were at ceiling, so this task was not given to the full sample at Time 3.

Initial-syllable matching task. This task began with two compound words and then used no further compound words as the matched targets. The words used were two-syllable words, with two exceptions (*television* and *telephone*). These words had a mean rated frequency of 3.30 (on a scale ranging from 1 to 5, where 1 = *infrequent* and 5 = *highly frequent*) and a mean age of acquisition of 26.1 months (Morrison et al., 1997). The eight items not taken from the Morrison et al. database were as follows: *fireworks*, *fireman*, *reindeer*, *rainbow*, *butter*, *island*, *puppy*, and *puppet*.

At the start of the task, the children were introduced to a puppet, Gerry Giraffe, who liked to collect words that started with the same syllable. For each trial, Gerry held a picture card, and the children were asked, for instance, "Gerry has a picture of *butter*. Which of these words, *sandwich* or *button*, has the same sound at the beginning as *butter*?" If the child said he or she did not know, he or she was encouraged to "think carefully and then choose." When the child had chosen, the cards were turned over to see if the child was correct—the correct alternative had a colored sticker on the back that was the same color as the cue card. The distractor card had a differently colored sticker. If the child had picked correctly, the experimenter said, for instance, "Yes, that's right. *Butter* and *button* have the same sound, *but*, at the beginning. *Sandwich* is the odd one out." If the child had chosen the wrong alternative, he or she was told, "No, *button* and *butter* have the same sound, *but*, at the beginning. *Sandwich* is the odd one out." In this way, the children were given immediate feedback after every trial, because previous researchers (e.g., Content, Kolinsky, Morais, & Bertelson, 1986) found that feedback on phonological awareness tasks could facilitate understanding of the task requirements.

Final-syllable matching task. This task was presented in the same way as the previous task except that the puppet used this time was Roger Badger, who liked to collect words that had the same final syllable. The mean rated frequency of these words was 2.63 (on a scale from 1 to 5), and the mean age of acquisition was 29.4 months (Morrison et al., 1997). Eight words were used that were not from the database (*postman*, *palace*, *bracelet*, *bucket*, *seesaw*, *greenhouse*, *tree house*, and *garden*). As before, the tasks started with two sets of compound words and then used no further compound words. Four of the eight distractors used were semantically related to the target word.

Rime matching task. As before, the task was presented as a two-alternative forced-choice task. The words used were, as far as possible, single-syllable consonant–vowel–consonant (CVC) words. The mean rated frequency of the words was 3.31, and the mean age of acquisition was 27.5 months (Morrison et al., 1997). One word (*pen*) was used twice in different trials. Twelve of the 46 words were not from the Morrison et al. database (*dish*, *red*, *white*, *green*, *man*, *night*, *pin*, *tin*, *rock*, *top*, *tap*, and *mop*). Four of the words were not CVC words but had initial consonant clusters (i.e., CCVC words). There were 16 trials, presented in two blocks of eight, with a break in between.

This time, the puppet Ryan Lion was used, and the children were told that he liked to collect words that rhymed. For each trial, Ryan held a picture card and the children were asked, for instance, "Ryan has a picture of a *cat*. Which of these words, *dog* or *hat*, rhymes with, or sounds the same at the end as *cat*?" As before, the children were given immediate feedback after every trial.

Initial-phoneme matching task. This task was presented on a day subsequent to the day of the rime matching task and took the same form—two blocks of eight trials. Again, CVC words were used. The mean rated frequency of these words was 4.2, and the mean age of acquisition for the words was 25.3 months (Morrison et al., 1997). Seven of the words were used twice in different trials. Five words were used that were not from the Morrison et al. database (*mouth*, *nut*, *beach*, *dish*, and *bean*). This time the puppet used was Carrie Cow, who liked to collect words with the same initial sound. As before, feedback was given after each trial.

Explicit Phonological Awareness Tasks

Syllable and phoneme completion. At Time 3, the children were also given the syllable completion and phoneme completion tasks from the Phonological Abilities Test (Muter, Hulme, & Snowling, 1997). For the syllable completion task, the child was shown a picture and told, for instance, "This is a *cabbage*. The word *cabbage* has two parts. I'll say the first part and you say the second part. *Ca-*." The child was expected to reply *bidge* to complete the word. There were two practice items and eight test items. For the phoneme completion task, the child was shown a picture of a one-syllable word and told, for instance, "Here is a *gate*. The word *gate* has two parts, I'll say the first part and you say the second part. *Gay-*." The child was expected to produce the final phoneme, /*t*/. Again, there were two practice items and eight test items. In contrast to the procedure detailed in the manual, the children were given feedback on their answers in an effort to facilitate understanding of the task.

Phoneme deletion (initial sound). The phoneme deletion (initial sound) task from the Phonological Abilities Test (Muter et al., 1997) was also used at Time 3 only. In this task, the children were shown a picture and told, for instance, "Here is a *hat*. What is *hat* without the /*h*/?" There were four training items and eight test items. With the training items, the word was segmented for the child. For instance, the experimenter would say, "Here is a *hat*. *Hat* has two parts: *h-at*, *h-at*. So what is *hat* without the /*h*/?" After each item, the child was given corrective feedback. This task was not presented if the child scored less than 2 correct on the phoneme completion task.

Language Tasks

Mispronunciation detection. In this task, the children were introduced to a puppet that looked like Cookie Monster from Sesame Street. They were told that he was a baby monster who was just learning to talk. Sometimes he said words right, but sometimes he said words wrong. They were asked to listen carefully to what he said and to tell him if he had said each word right or wrong. To make sure that the child understood the task, we gave three practice items, with full feedback and a brief discussion of what the monster said and what he was trying to say. The child then heard 23 words. The words varied as to whether they were one-syllable words or three-syllable words and whether they had a high or low age of acquisition. Eight of the 23 words were correctly pronounced, and 15 were mispronounced in a single consonant. Seven of these had their initial consonant mispronounced (e.g., *nuck* for duck), and eight had a later consonant mispronounced, either a medial consonant (e.g., *golilla* for gorilla) in the case of the three-syllable words or a final consonant (e.g., *moush* for mouse) in the case of the one-syllable words. These words are shown in the Appendix.

Receptive vocabulary. Vocabulary knowledge was measured with the British Picture Vocabulary Scale (long version; Dunn, Dunn, Whetton, & Pintilie, 1982). In this test, the child hears a word and is asked to point out which picture the word depicts from a set of four alternatives. The test continues until a child makes six errors in eight items.

Articulation. In order to measure the quality of each child's articulation, the children were given a confrontation naming task. The test involved 21 pictures of objects that the children were asked to name. The names were two- and three-syllable words with an observed age of acquisition of less than 4 years. Seven of the words had an unstressed initial syllable (e.g., *gorilla*), seven of them contained consonant clusters (e.g., *screwdriver*), and seven of them contained a syllabic vowel (e.g., *caterpillar*). Eleven of the words were also used in the mispronunciation detection task. If a child failed to name an item correctly, he or she was given a semantic clue. If the child was still unable to name the picture, he or she was told the correct name and retested on that item at the end of the test. If the child still failed to produce that item, then it was assumed that the child did not know that word, and it was removed from that child's total. Each child's responses were recorded onto a minidisk and transcribed at a later date. The transcriptions were then scored for percentage consonants correct for all of the words that the child had produced spontaneously.

Letter Knowledge

Letter–sound knowledge was tested at each of the three points of testing. The child was given a card with a single lowercase letter on it and asked which letter it was. If the child responded with the letter's name, the child was asked if he or she knew its sound. At Time 1 and Time 2, the children were given an abbreviated set of 18 letters to name. These letters were those selected by Stuart and Coltheart (1988) as the earliest letters learned. At Time 3, the children were given all 26 letters to label. At each time point, testing was discontinued if a child produced 10 incorrect responses or 8 nonletter responses (such as "eight" or "don't know").

Results

Data Preparation

During the matching tasks, we found that some children would pick items only from the same side throughout a task. If a child had picked all of his or her answers on a task from the same side, that child's score on that task was omitted from the analyses. Scores on the two-syllable tasks were not significantly different at Time 1 ($t = 2.01$, *ns*) or Time 2 ($t = 2.00$, *ns*). Scores on the two tasks were therefore combined to create a single "syllable" variable.

Summary Data for the Phonological Awareness Tasks

The means and standard deviations for each of the phonological matching tasks at each point of testing are shown in Table 1. In these tasks, the maximum possible score was 16, and the expected score due to chance was 8. According to the binomial distribution, given a task with 16 trials, a score of 12 is significantly above chance. The percentage of children who scored significantly above chance on each of the phonological matching tasks is also shown in Table 1. It can be seen from the percentage of children above chance at each time of testing that the syllable and the rime tasks were easier than the initial phoneme task and in fact showed similar mean scores. At Time 1, mean scores on the syllable and rime tasks were similar, but more children scored significantly above chance in the rime task.

The syllable and rime tasks at Time 1 and Time 2 were analyzed with a two-way repeated measures analysis of variance (ANOVA). There was a main effect of time of testing, $F(1, 66) = 27.67$, $p < .01$, but no significant effect of task ($F < 1$), showing that scores on the two tasks did not differ from one another. The rime task, but not the syllable task, contained distractors that were phonologically similar to the target words (e.g., *pin* and *pen*). To confirm that the two tasks were of equivalent difficulty, we conducted a further

Table 1
Means (and Standard Deviations) for Each of the Phonological Matching Tasks at Each Point in Testing

Variable	Time 1	Time 2	Time 3
Syllable (maximum = 16)			
M (*SD*)	9.62 (2.68)	10.88 (3.12)	
% above chance	14.93	38.81	
Rime (maximum = 16)			
M (*SD*)	9.53 (3.59)	11.27 (3.60)	12.47 (3.52)
% above chance	23.88	44.77	65.67
Initial phoneme (maximum = 16)			
M (*SD*)	8.24 (1.92)	8.65 (2.92)	11.18 (3.58)
% above chance	2.99	16.42	50.75
Phoneme completion (maximum = 8)			
M (*SD*)			4.04 (3.38)
% above 1			63.64
Phoneme deletion (maximum = 8)			
M (*SD*)			1.58 (2.60)
% above 1			31.82

analysis using only the items from the tasks that had unrelated distractors. The same results were obtained: There was a main effect of time, $F(1, 43) = 12.47$, $p < .01$, but no effect of task ($F < 1$). A separate ANOVA comparing the rime and initial phoneme tasks was carried out. Here there was a main effect of time of testing, $F(1, 66) = 41.14$, $p < .01$, and a main effect of task, $F(1, 66) = 40.01$, $p < .01$, reflecting the fact that the scores on the rime task were higher than the scores on the initial phoneme task. There was also a marginally significant interaction, $F(1, 66) = 3.92$, $p = .052$, showing that there was greater improvement between Time 2 and Time 3 in the initial phoneme task than in the rime task.

The pattern of progression over time from syllables to onsets and rimes to phonemes is therefore not clear-cut; in fact, scores on the syllable and rime awareness tasks were similar at Times 1 and 2. Furthermore, fewer children scored above chance on the syllable matching measure than on the rime matching measure at both of these points in time. In contrast, scores on the initial-phoneme matching measure were poorer than scores on the rime task, suggesting a stronger distinction between large and small units than between syllable and onset–rime awareness.

Means and standard deviations for the explicit phonological awareness tasks are also shown in Table 1. Although there is no chance level for these tasks, we considered children who scored more than one correct on any task as showing some understanding of the task requirements. The percentage of children who scored more than one correct for each task indicates that the completion task was easier than the deletion task.

Summary Data for the Language Tasks and Letter Knowledge

Descriptive data for the language tasks and letter knowledge are shown in Table 2. Standard scores are shown for the vocabulary task to allow interpretation of the scores against the norms for the general population. However, raw scores were used in the correlation and regression analyses reported later. Because there were uneven numbers of correctly and incorrectly pronounced items in the mispronunciation detection task, we formed a proportion correct score by separately calculating the proportions correct on the correctly and the incorrectly pronounced items, adding the two scores, and dividing by two. This procedure provided a control against changes in scores that were due to the biased responding on the part of the participants. Cronbach's alpha reliability coefficients were also calculated for the mispronunciation detection task at both points of testing. The reliability coefficients were .77 at Time 2 and .64 at Time 3.

In order to examine developmental improvements on the tasks, repeated measures ANOVAs were carried out on the measures administered at three points in time, and paired-samples *t* tests were carried out on the measures administered at two points in

Table 2
Mean Performance (and Standard Deviations) of the Children Across the Language Tasks at Each Time of Testing

Variable	Time 1	Time 2	Time 3
British Picture Vocabulary Scale (standard score)	101.67 (11.73)	104.03 (12.06)	105.16 (12.48)
Articulation (% consonants correct)		80.75 (13.27)	86.18 (11.45)
Mispronunciation detection (proportion correct)		0.75 (0.15)	0.82 (0.12)
Letter sound knowledge			
Raw score (out of 26)	2.70 (4.36)	3.36 (5.02)	14.36 (7.30)
% children knowing any letters	59.7	58.2	98.5

time. A repeated measures ANOVA on the raw scores from the British Picture Vocabulary Scale showed that there was a significant effect of time of testing, $F(2, 132) = 86.93$, $p < .01$. There were also significant effects of time of testing for the articulation, $t(63) = 3.98$, $p < .01$, mispronunciation detection, $t(64) = 4.07$, $p < .01$, and letter knowledge, $F(2, 132) = 194.36$, $p < .01$, tasks. Post hoc difference contrasts in the case of the repeated measures ANOVAs showed that scores at each time of testing were significantly different from each other.

Letter knowledge showed significant floor effects at Time 1 and Time 2, with only 58% of the sample knowing any letters at all. There was a substantial increase in letter knowledge between Time 2 and Time 3, when most of the children entered formal schooling, $t(66) = 14.11$, $p < .01$, and at Time 3, only 1 child knew no letters at all.

Relationships Among the Tasks

Correlations among the language, letter knowledge, and phonological awareness variables are shown in Table 3. Bivariate correlations are shown above the diagonal, and partial correlations controlling for age are shown below the diagonal. The phonological tasks, with the exception of the initial phoneme task at Time 1, were all moderately intercorrelated. The lack of correlation in the case of initial-phoneme matching at Time 1 is probably due to the fact that only 2 children performed above chance on this task. Controlling for age did not weaken the strength of these correlations significantly. Because syllable completion, phoneme completion, and phoneme deletion were not normally distributed, nonparametric correlations (Spearman's rho) were also calculated. These did not alter the patterns of correlations and so are not reported. The language tasks were also moderately intercorrelated and correlated well with the phonological awareness tasks. The exception to this finding was the articulation task, which at both Time 2 and Time 3 correlated with the syllable and phoneme matching tasks at Time 2 but not with the rime task at any point in time.

Structural Equation Models of the Longitudinal Data

A path analysis model was used to explore the predictive relationships between (a) measures of language and phonological skills at Time 2 and (b) emergent phonemic awareness at Time 3. The model was fitted to the variance/covariance matrix using a maximum-likelihood procedure. As a precursor to the path model, a confirmatory factor analysis was used to explore the relationships between the variables at Time 2. Because of a trend toward a floor effect in letter knowledge at Time 2, a grouping variable was created, with participants classified according to whether they knew any letters or not. Rime and syllable matching at Time 2 both loaded onto a single "large-segment awareness" latent variable. Three alternative measurement models were evaluated, each with a different theoretical view of the relationships between the speech and language tasks. The first model was the simplest and proposed that the vocabulary, mispronunciation detection, and articulation measures all loaded on the same latent variable. The second model proposed that these tasks could be divided into semantic and phonological processes, with mispronunciation detection and articulation loading on a single latent variable and vocabulary included as a manifest variable. The final model proposed that the tasks could be divided into receptive and expressive processes, with mispronunciation detection and vocabulary loading onto a single latent variable and articulation included as a manifest variable. The three models all fit the data adequately: the single-factor model, $\chi^2(8, N = 67) = 8.784$, $p > .1$, comparative fit index (CFI) = .994, standardized root mean square residual (SRMR) = .047; the semantic–phonological model, $\chi^2(6, N = 67) = 7.645$, $p > .1$, CFI = .988, SRMR = .049; and the receptive–expressive model, $\chi^2(6, N = 67) = 6.077$, $p > .1$, CFI = .999, SRMR = .048. However, the receptive–expressive model showed marginally better fit characteristics than the other two and has the theoretical advantage of drawing a distinction between measures of input phonological processing and output phonological processing (see the Discussion section). This measurement model (see Figure 1) was therefore retained for use in the path analysis. All of the correlations between the latent factors and manifest variables were significant in this model. It is notable that the correlations between receptive language and large-segment awareness (.679) and between letter group and large-segment awareness (.648) were particularly high.

A latent phoneme awareness factor at Time 3 was created with the initial-phoneme matching, phoneme completion, and phoneme deletion variables. This factor accounted for 56% of the variance in the three manifest variables. The relationship between the Time 2 measurement model and phoneme awareness at Time 3 was then examined in a path model in which the latent variables and manifest variables from the measurement model (receptive language, large-unit awareness, letter knowledge, and articulation) were all used as predictors of phoneme awareness. The fit statistics for the original model were adequate: $\chi^2(20, N = 67) = 36.254$, $p = .014$, CFI =.926, SRMR = .064. Within this model, nonsignificant paths were dropped iteratively and changes to the fit of the model were then observed with the aim of obtaining the most parsimonious model that gave an adequate fit to the data (McDonald & Ho, 2002). Dropping the paths from receptive lexical knowledge at Time 2 to phoneme awareness at Time 3 and from letter knowledge at Time 2 to phoneme awareness at Time 3 made no significant difference to the fit of the model. The resulting simplified path model is shown in Figure 2. Though the model provides a less than perfect fit to the data, as evidenced by the significant chi-square value, $\chi^2(22, N = 67) = 36.67$, $p = .026$, a rule of thumb is that a model in which the value of chi-square is less than two times the model degrees of freedom may be acceptable (Tabachnick & Fidell, 2001). Additional fit indices considered suitable for moderate to small samples (CFI = .934, SRMR = .066, McDonald & Ho, 2002) suggest an adequate fit of the model to the data (CFI is above .9 and SRMR is less than .08; Hu & Bentler, 1999; Tabachnick & Fidell, 2001). The unstandardized coefficients and standard errors of each parameter (McDonald & Ho, 2002) are available from Julia M. Carroll on request.

This simplified path model supports the conclusion that both articulation and large-segment phonological awareness have significant independent longitudinal influences on the development of phoneme awareness. However, given the large correlations between receptive lexical knowledge and both articulation and large-segment awareness, it should not be concluded that receptive lexical knowledge has no influence on the development of phoneme awareness. Rather, its influence is mediated by articulation

Table 3
Correlations Between the Language Tasks and the Phonological Awareness Variables (n = 67)

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. Age t1	—	.093	.180	.010	.051	**.331**	.127	.033	.047	.204	.233	.195	**.277**	−.150	.034	**.247**	**.326***	.220	.228	.236	**.517***
2. Vocab t1		—	**.746***	**.609***	**.606***	**.500***	**.286**	.209	**.318**	**.383***	**.341**	**.321***	**.456***	.036	.204	**.508***	.223	**.307**	.181	.204	**.285**
3. Vocab t2		**.744***	—	**.706***	**.625***	**.465***	**.258**	.176	**.423***	**.423***	**.318***	**.407***	**.456***	.045	**.334***	**.511***	.158	.195	**.344***	**.328***	**.346***
4. Vocab t3		**.611***	**.716***	—	**.517***	**.381***	**.304**	**.276**	**.465***	**.482***	**.332**	**.362***	**.490***	.096	**.314***	**.420***	**.258**	.187	.213	.222	.212
5. Mispro t2		**.605***	**.627***	**.517***	—	**.516***	**.339***	**.255**	**.378***	**.505***	**.348***	**.475***	**.567***	−.039	**.344***	**.488***	.223	**.308**	.198	**.268**	**.163**
6. Mispro t3		**.499***	**.436***	**.401***	**.530***	—	**.412***	**.260**	**.279**	**.269**	.236	**.339***	**.328***	−.073	.131	**.437***	.221	**.346***	.133	.142	**.251**
7. Artic t2		**.278**	.241	**.305**	**.336**	**.394***	—	**.824***	.159	.278	.162	.141	.151	.038	**.294**	**.264**	**.320***	**.331***	**.333***	**.408***	**.260**
8. Artic t3		.207	.173	**.276**	.254	**.264**	**.827***	—	.111	**.319***	.152	.117	.145	.147	**.292**	.179	.218	**.334***	**.281**	**.321**	.214
9. Syll t1		**.316**	**.422***	**.465***	**.376***	**.279**	.154	.109	—	**.542***	**.504***	**.601***	**.484***	.165	**.412***	**.437***	**.436***	.211	.135	.179	.121
10. Syll t2		**.374***	**.401***	**.490***	**.506***	.218	**.260**	**.319***	**.544***	—	**.514***	**.704***	**.464***	**.285**	**.427***	**.383***	**.440***	**.418***	**.358***	**.446***	**.343***
11. Rime t1		**.330***	**.289**	**.339***	**.346***	.173	.137	.149	**.508***	**.491***	—	**.529***	**.468***	.130	**.299**	**.518***	**.330***	**.382***	.078	.164	**.299**
12. Rime t2		**.310**	**.386***	**.367***	**.475***	**.297***	.120	.113	**.604***	**.691***	**.507***	—	**.608***	.004	**.470***	**.534***	**.336***	**.358***	**.251**	**.354***	**.295**
13. Rime t3		**.450***	**.430***	**.507***	**.576***	**.261**	.122	.142	**.491***	**.433***	**.432***	**.588***	—	−.226	**.400***	**.606***	**.424***	**.323***	**.268**	**.318***	**.282**
14. Onset t1		.051	.074	.099	−.032	−.025	.058	.154	.174	**.326***	.172	.035	−.194	—	.202	−.132	.116	.000	.052	−.021	−.066
15. Onset t2		.202	**.333***	**.314***	**.343***	.127	**.292**	**.291***	**.411***	**.429***	.299	**.473***	**.407***	.210	—	**.323***	**.411***	.225	**.415***	**.505***	**.263**
16. Onset t3		**.503***	**.490***	**.431***	**.492***	**.388***	.242	.176	**.440***	**.351***	**.488***	**.512***	**.578***	−.099	**.324**	—	**.424***	**.568***	.191	**.298**	**.570***
17. Pho del		.205	.107	**.270**	.219	.127	**.298**	.219	**.446***	**.404***	**.277**	**.294**	**.367***	.177	**.423***	**.375***	—	**.517***	**.389***	**.467***	**.422***
18. Pho comp		**.295**	.162	.190	**.305**	**.297**	**.313**	**.335***	.207	**.390***	**.349***	**.329***	**.280**	.035	.223	**.543***	**.483***	—	.259	**.341***	**.605***
19. Letters t1		.165	**.316**	.217	.192	.063	**.314**	**.281**	.128	**.327***	.027	.217	.219	.089	**.419***	.143	**.342***	.220	—	**.915***	**.448***
20. Letters t2		.188	**.299**	.226	.264	.069	**.392**	**.323***	.173	**.418***	.116	**.323***	**.271**	.015	**.512***	**.254**	**.425***	**.305**	**.910***	—	**.515***
21. Letters t3		**.278**	**.300**	**.242**	.160	.099	.229	.230	.114	**.284**	.215	.231	.169	.014	**.286**	**.533***	**.313**	**.589**	**.396***	**.473***	—

Note. Bivariate correlations are shown above the diagonal, and partial correlations controlling for age are shown below the diagonal. Correlations significant at $p < .05$ are shown in bold. Vocab = British Picture Vocabulary Scale receptive vocabulary; Mispro = mispronunciation detection; Artic = articulatory accuracy; Syll = syllable matching; Rime = rime matching; Onset = initial phoneme matching; Pho del = phoneme deletion; Pho comp = phoneme completion; Letters = letter sound knowledge; t1, t2, and t3 = Time 1, Time 2, and Time 3.
* $p < .01$.

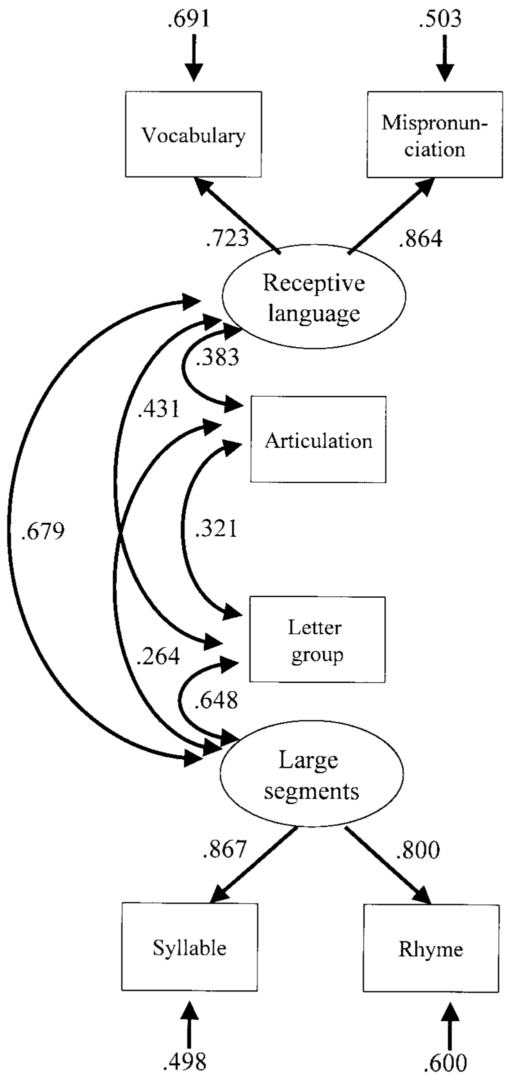

Figure 1. A confirmatory factor analysis of the data at Time 2. CFI = comparative fit index; SRMR = standardized root mean square residual.

(.38 × .26 = .10), which might be regarded as an index of expressive lexical knowledge, and to a rather greater extent by large-segment phonological awareness (.69 × .64 = .44). The same is true of letter knowledge: Although it was not directly related to later phoneme awareness, it had an indirect influence via large-segment awareness (.66 × .64 = .42) and to a lesser extent via articulation (.32 × .26 = .08).

Discussion

In this study, we explored the early stages of the development of phonological awareness among a large group of preschool children, starting when most of the children were less than 4 years old. Although a great deal is already known about the development of phonological skills in school-age children, by comparison little is known about the early development of phonological skills and how these developments relate to other aspects of language. The present longitudinal study has yielded clear evidence on some key theoretical questions about the nature and origins of the early phonological abilities that are the critical foundations for learning to read and spell.

The Sequence of Development of Early Phonological Skills

A widely held theoretical view is that the development of phonological awareness progresses through a relatively invariant developmental sequence, with children first being aware of words as units of speech, followed successively by awareness of syllables, onset–rime units, and finally phonemes (Goswami & Bryant, 1990). It was clear in the present study that children tended to develop syllable and rime awareness before phoneme awareness. However, there was little sign of any difference in levels of performance between syllable and rime awareness tasks. It is also notable that in our confirmatory factor analysis of data from Time 2, both syllable and rime awareness loaded highly on a single underlying latent variable (large-segment awareness). It seems, therefore, that a better way of characterizing development might simply be as a progression from awareness of large units (syllables and rimes) to awareness of small units (phonemes). This characterization is broadly in line with Gombert's (1992) separation between epilinguistic and metalinguistic phonological awareness.

A further point of some importance is the relationship between children's awareness of large segments of speech and their other language skills. The high correlation between receptive lexical knowledge and large-segment awareness is in line with the view that early global sound sensitivity may be related to the growth of vocabulary knowledge (Nittrouer & Crowther, 1998; Walley, 1993). However, because the relationship between these factors is correlational, the present data cannot address the issue of whether the growth of vocabulary is a cause of growth in large-segment awareness, as suggested by Walley (1993). One possible explanation for the onset of implicit phonological awareness in the preschool years is that it is a natural consequence of structuring the lexicon in terms of the subphonemic gestures within words. Studdert-Kennedy (1987) suggested that children begin to represent the articulatory gestures (or features) within words some time during the 3rd year of life. This allows them to exploit similarities between words, and words that contain the same articulatory gestures can be stored using similar sets of perceptual weights (Harm & Seidenberg, 1999). Because there are hundreds of different syllables in the English language, but a limited set of articulatory gestures that can be used in these syllables (cf. Byrne & Liberman, 1999), this restructuring allows for much more efficient storage of phonological sequences.

It should be noted that in line with a number of previous studies, the present one provides evidence that rime awareness and phoneme awareness are separable skills (Hoien, Lundberg, Stanovich, & Bjaalid, 1995; Muter, Hulme, Snowling, & Taylor, 1998). Foy and Mann (2001) also found that these skills correlate differently with a range of language and reading measures. Within their study, rime awareness correlated with speech perception and short-term memory measures, whereas phoneme awareness correlated with reading and letter knowledge. This study is part of a growing body of evidence, therefore, that rime and phoneme tasks tap fundamentally different processes.

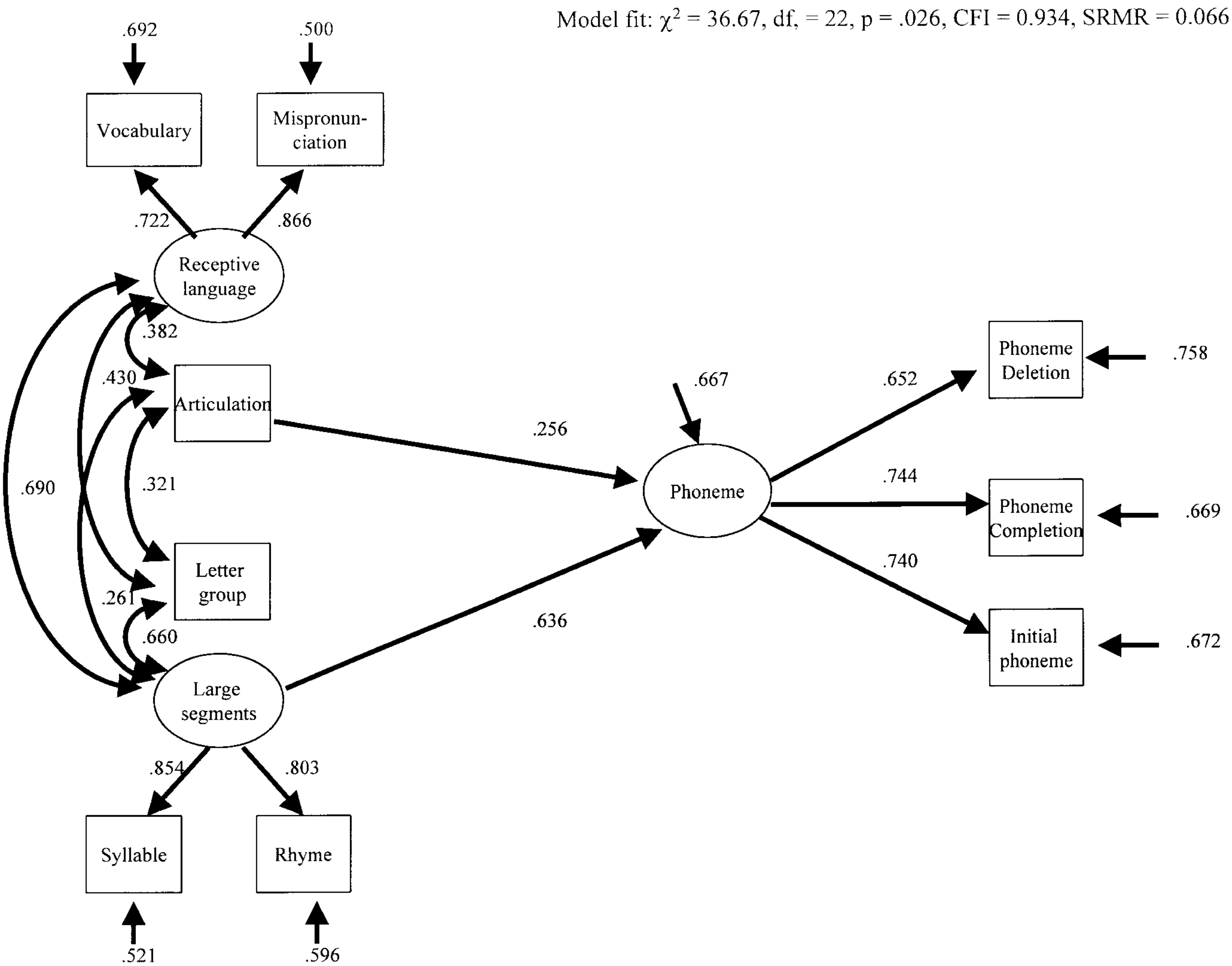

Figure 2. A structural equation model showing longitudinal prediction of phoneme awareness at Time 3 from Time 2 data. CFI = comparative fit index; SRMR = standardized root mean square residual.

The Origins of Phoneme Awareness

There is a good deal of evidence indicating that phonemic awareness is a particularly important skill for the development of reading (word recognition) skills (Byrne, 1998; Hulme et al., 2002; Muter et al., 1998; Wagner et al., 1994). A critical issue, therefore, is understanding the origins of phonemic awareness in the preschool period. Our path analysis provides important evidence bearing on this issue. Phoneme awareness at Time 3 (at an average age of 4 years 9 months) was strongly predicted by measures of large-segment awareness and, to a lesser extent, by the accuracy of articulation measured some 7 months earlier. This finding argues for continuity between early large-segment awareness skills—possibly based on relatively holistic (nonsegmental) phonological representations—and later phonemic awareness skills—presumably based on segmental (phonemic) phonological representations. The additional unique prediction of phonemic awareness from the accuracy of articulation suggests that the process of refining early holistic phonological representations into segmentally organized representations may depend critically on accurate articulation. These conclusions must remain tentative given that this path analysis was conducted with a relatively small sample size and showed adequate, rather than good, fit characteristics, but the findings sit well with previous research. For instance, clinical observations suggest that providing training in articulatory skills may be a useful method for developing phonemic awareness in poor readers (Wise, Ring, & Olson, 1999). More broadly, if articulation is considered as a measure of output phonology, this finding is in keeping with previous findings that children with reading difficulties (and hence phoneme awareness difficulties) tend to show impairments in expressive (output), but not receptive (input), phonology (Hulme & Snowling, 1992).

We had expected that letter knowledge would also be an important predictor of the growth of phonemic awareness in the preschool period. Our failure to demonstrate this effect (this path was not significant in our path analysis) may be due to the relatively low levels of letter knowledge our children possessed at

Time 2 and to the relatively rapid growth in letter knowledge that occurred between Time 2 and Time 3. In fact, letter knowledge at Time 3 was well correlated with phoneme awareness, and no child who knew no letters at Time 3 was successful on any of the phoneme awareness tasks. We believe that there is an important reciprocal relationship between the growth of letter knowledge and phoneme awareness (cf. Burgess & Lonigan, 1998; Johnston, Anderson, & Holligan, 1996), and more research in this area is needed.

In summary, the results of the present study suggest that preschool phonological awareness can be divided into an early implicit sensitivity to sound similarity and a later explicit awareness of phonemes. Implicit, large-segment sensitivity is a skill that grows out of normal language development. In fact, it seems to interact closely with receptive lexical knowledge and might therefore be better considered a part of normal linguistic, rather than of metalinguistic, development. The later development of the explicit awareness of phonemes appears to build on the foundation of earlier large-segment awareness and to depend, in addition, on the accuracy of a child's articulation skills. We propose that the development of these two types of phonological awareness reflects the development from global to segmental phonological representations.

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Appendix

Words Used in the Mispronunciation Detection Task

	Word type and age of acquisition			
	1-syllable words		3-syllable words	
Variable	< 3 years	4 years	< 3 years	4 years
Task condition				
Unchanged	hat moon	nail swan	kangaroo umbrella	crocodile screwdriver
Initial phoneme changed	vish (fish) nuck (duck)	tice (dice)	delephone (telephone) panana (banana)	domato (tomato) garavan (caravan)
Final/medial phoneme changed	moush (mouse) flad (flag)	goad (goat) torsh (torch)	aeroblane (aeroplane) elevant (elephant)	golilla (gorilla) envenope (envelope)
Age of acquisition (in months)	24.2	47.8	24.05	51.78
Frequency (1–5)	2.89	2.34	2.89	2.71
No. of phonemes	2.34	3.67	6.83	7.17

Note. The words that the nonwords are derived from are shown in parentheses.

Received July 12, 2002
Revision received April 22, 2003
Accepted April 22, 2003 ■