

# Training Phonological Awareness: A Study with Inner-City Kindergarten Children

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*A small-scale, longitudinal, phonological awareness training study with inner-city kindergarten children was conducted in four classrooms. The central goals of the study were the creation and evaluation of a phonological awareness training program and a preliminary look at the consequence of that training on basic phonological processes.*

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*Assessment of phonological awareness and basic phonological processes was carried out in the fall of the kindergarten year, and again in the spring following an 18 week training program which incorporated both auditory and articulatory techniques for fostering metaphonological development. Follow-up evaluation of promotion to first grade and of reading achievement took place a year later. The children in the two experimental classes receiving training had significantly greater gains in phonological awareness at the end of kindergarten, were significantly more likely to be promoted to first grade rather than to pre-one, and had a trend toward better reading skills in first grade than did the smaller group of children promoted to first grade from the control classes. In addition, there were some indications that development of phonological awareness was accompanied by changes in the underlying phonological system as well. Here we focus on the rationale and implementation of our training program and discuss the implications of the findings for a potential large-scale study.*

The success of early reading instruction depends upon a child's appreciation of the components of language to which letters refer. In order for an alphabetic writing system to be acquired, the child has to understand the central principle of the alphabet: words comprise phonemes and, in print, phonemes are represented by letters. Numerous prediction studies demonstrate that the greater a child's awareness of the phonological structure of words prior to reading instruction, the greater will be that child's success in learning to read (e.g., Share et al. 1984; for a review, see Bowey and Frances 1991). Although reading instruction certainly enhances phoneme awareness (e.g., Morais et al. 1979; Perfetti 1987) longitudinal studies now confirm that some degree of prior phonological awareness is essential if children are to benefit even from explicit "phonics" instruction (Juel, Griffith, and Gough 1986; Tunmer and Nesdale 1985; see also Byrne and Fielding-Barnsley 1993). And yet, despite its central importance for reading acquisition, studies with middle-class children find that nearly one-third of first-graders fail to fully realize the phonemic structure of words (Adams 1990). Recent evidence (Raz and Bryant 1990; Robertson 1993) indicates that the proportion is even higher for disadvantaged children, suggesting that phonological awareness deficits may be a noteworthy factor in the alarming rate of reading failure among the socially disadvantaged.

Fortunately, explicit awareness of the phonological composition of words can be instilled in young children. Training

studies illustrate that a lack of phonological awareness is not an immutable condition. One particularly influential such study (Bradley and Bryant 1985) involved intensive training of five- and six-year-old children who were notably deficient in phonological awareness. Those who received phonological awareness training achieved significantly higher reading and spelling scores than control subjects at ages 8 and 9 years and again at 13 years (Bradley and Bryant 1991). This was true despite the fact that some of the control subjects had been receiving remedial help in reading for nearly five years by the end of the study. Other well-controlled longitudinal projects have corroborated the effectiveness of early instruction in phonological awareness for later reading success (e.g., Ball and Blachman 1991; Lundberg, Frost, and Petersen 1988). In each of these studies, the level of phonological awareness at the beginning of reading instruction was the strongest predictor of later reading and spelling performance.

If reading success hinges on facility in phonological awareness, as the research so clearly suggests, the causal question backs up a step, leading us to ask what in turn is responsible for individual differences in phonological awareness. One important hypothesis, and the one on which we focus, proposes that "the poor reader's difficulty with analyzing words into their constituent units is one among several symptoms of a general deficiency in the phonological component of the child's natural capacity for language" (Lieberman, Shankweiler, and Liberman 1989, p. 17). This point of view is supported by the evidence that deficits in phonological tasks which do not obviously require conscious awareness of the phonemic structure of speech are also associated with reading disability. The affected areas include more basic phonological processes such as verbal working memory, speech perception and production, and lexical access. Research has consistently indicated that poor readers have shorter verbal memory spans, have greater difficulty repeating words or pseudo-words, are less fast and less accurate in retrieving the phonological labels (names) of objects, and require more exposure to learn names for new vocabulary items (for reviews, see Brady 1991 and Wolf 1991).

Although basic phonological processes are clearly implicated in reading, it is not known exactly how they relate to phonological awareness or even to each other. A central question has been whether differences in phonological processing affect the acquisition of metaphonological skills. Studies examining the

correspondence of phonological abilities in kindergartners have reported some association between phonological awareness and phonological coding in memory in this age group (Wagner et al. 1987; Gathercole, Willis, and Baddeley 1991). Torgesen (1994) found that growth in blending skills following training in phonological awareness was best predicted by a combination of invented spelling performance (requiring phonological awareness and letter knowledge) and rapid naming for digits (generally thought to tap basic phonological processes).

An alternative, though less often asked, question is whether the very process of acquiring phonological awareness facilitates changes in the nature of the phonological representations of words. That is, the direction of influence may be from phonological awareness to basic processes rather than vice versa. This hypothesis stems from evidence that the lexical representations of young children may differ from those of adults. This evidence suggests that children initially represent words as holistic phonological units made up of overlapping gestures or articulatory routines that extend through the word (for a review, see Fowler 1991). Over time, under pressure of an increasing vocabulary, these gestures gradually become reorganized into sublexical perceptuomotor structures that recur within words. Ultimately, perhaps as late as school age, the perceptuomotor structures take on a phoneme level organization (Fowler 1991; Studdert-Kennedy 1987). Fowler hypothesizes that the level of phonological organization used by a child (be it predominantly word, sublexical or, phoneme level) may have consequences not only for performance of metaphonological tasks, but also for the efficiency and accuracy of a variety of basic phonological processes such as lexical access or recall in short-term memory. By this reasoning, the discovery by the child of phonemic segments via training in phonological awareness or through instruction in reading may lead to changes in the way words are structured cognitively.

To best explore how basic phonological processes and metaphonological awareness depend upon each other requires a longitudinal design. Ideally one would assess performance in each domain before training in phonemic awareness, and then reassess after training is completed. In this way one could investigate how basic phonological processes interrelate prior to awareness, whether underlying phonological skills prior to training predict success in achieving awareness, and whether change in the awareness of the phonemic structure of words is accompanied by changes in other more basic phonological tasks.

### Goals of this Study

Three goals shaped the design of the present study. First, impressed by the importance of phonological awareness in influencing the success of reading instruction, we sought to determine whether we could effectively translate what we have learned from ideal training conditions into ordinary classrooms where they are needed most. At the same time, because children display such large variation in phonological awareness, we wished to understand what cognitive and linguistic abilities influence children's success in learning phonological awareness concepts. And third, it is of theoretical and practical significance to investigate whether phoneme awareness instruction affects performance on more basic phonological tasks such as memory, lexical access, speech perception, and speech production. Our present study is but a first step toward defining and exploring these questions; a full-fledged investigation would require a large subject pool, multiple measures of each construct to be evaluated, and control conditions in which children receive training in something other than phonological awareness.

Toward these goals, we set out to do a small-scale training study, putting our efforts largely into the development of a phonological awareness training program and into evaluation of cognitive tasks assessing a range of phonological skills. We decided to work with children who attend inner-city schools for two reasons: first, for experimental reasons, to reduce the likelihood that the participants would enter the project with either advanced phonemic awareness or reading skills; and second, because this sample represents a large, at-risk population for whom it is crucial to find effective intervention strategies. We hoped to demonstrate that school-based instruction aimed at the kindergarten level can offset initial disadvantage and reduce the too-common occurrence of later reading failure.

Four kindergarten classes from inner-city public schools took part. Two of the classes participated in an 18-week training program conducted by the regular classroom teachers, the two other kindergarten classes followed the usual curriculum which adopted a "whole language" approach designed to foster interest in literacy. A year later at the end of first-grade, we assessed the reading performance of matched groups of children from the experimental and control groups. To explore the interrelationship of phonological awareness and more basic phonological processes, all of the children were given a battery of achievement and phonological measures in the fall before the training program began and in the spring after training was completed.

Because our training study achieved some promising results, and was in turn based on the successes of several prior training studies, in this paper we focus attention on the rationale for the training techniques we employed and provide some details regarding its implementation. We introduce some encouraging results from this training, both on promotion to first grade and on first-grade reading scores. Finally, we comment on the appropriateness of the experimental measures employed to assess change over the kindergarten year and make some cautious observations regarding the interplay between basic phonological processes and phonological awareness.

## Method

### Design of the Training Program

The training program was designed to facilitate phoneme awareness so that we could examine its impact both on reading success and on more basic phonological processes. By providing training, we would also increase the likelihood that continued failure stems more from individual differences than from experiential factors. In this section, we first discuss the conceptual requirements of learning to read and write an alphabetic writing system, clarifying what is meant by *phoneme awareness* and distinguishing it from *phonological awareness*. We next go on to provide the rationale for our training sequence, and outline the actual training in some detail.

*Defining terms.* We argue that in order to use the alphabetic cipher, the child must be able to *segment* the spoken word into those units to which alphabetic letters refer. That is, to read (or spell) the word *pat*, the child must appreciate the fact that the spoken word is composed of three separate elements "p" "a" "t". While deceptively easy for a literate adult, there is a solid body of evidence suggesting that segmentation ability is *not* a natural consequence of learning the spoken language. Instead, learning to segment requires that explicit attention be drawn to the phoneme level, either through beginning reading instruction (i.e., learning letters) or by activities that focus attention on the units within the spoken word (see Liberman et al. 1989 and Fowler 1991 for reviews and further discussion).

In order to exploit the alphabet, the child must be able, not only to segment words, but to *categorize* or *identify* common phoneme elements across different contexts. Thus, the child needs to recognize that the first sound in *pat* is the same as the last sound in *tap*. While even young children may be able to

distinguish globally between *bat* and *pat*, that kind of discrimination seems not to require the conceptual recognition that *pat* and *Pete* share a common initial sound. This latter identification task, as with segmentation, has proven beyond the ken of the pre-literate child (e.g., Bowey and Francis 1991).

Although prior training studies have focused on one or the other of these two components of *phoneme awareness*, we considered both aspects to be critical to alphabetic literacy, and hypothesized that the two processes would build on and inform each other (for interesting discussion of the two types of phoneme awareness, refer to Byrne 1992 and Byrne and Fielding-Barnsley 1990). Our target training goal, therefore, was to provide children with the ability to isolate phonemes within the syllable (segmentation) and to categorize common phonemes across different words (identification), thereby removing barriers that hinder alphabetic literacy.<sup>1</sup> These phoneme-level skills, can, in turn, rightly be considered a subset of the more general concept of *phonological awareness*, by which we refer to a general awareness of sound as distinct from meaning. Whereas phoneme awareness is an unnatural insight rarely observed in children younger than five years, the "sound play" that constitutes a more general phonological awareness is evident in some children as young as two or three years of age (for reviews, see Mann 1991 and Brady, Fowler, and Gipstein submitted). Thus, children may discover, for example, that *rag* rhymes with *bag* or that *cowboy* and *cowgirl* share a common segment. These are insights that many children achieve in the normal course of language play, without formal instruction. Although this emerging awareness of the sound structure of words does not guarantee attaining awareness of phonemes, individual differences in phonological awareness at four and five years of age appear to be an excellent predictor of later reading ability. Indeed, Bowey and Francis (1991) argue that, whereas phoneme awareness requires training and appears to be the proximal factor in reading success, it derives in turn from a more general phonological awareness.

Guided by a review of the "natural" emergence of phonological awareness starting from two and three years of age, and of the previous training studies, we designed a study with three different components: Phase I: Achieving phonological

<sup>1</sup>In the present study, blending (i.e., combining units that have been isolated into a syllable form) was not addressed. Some prior research has indicated that success on this task is secondary to analysis; children receiving blending training benefited only if they could already segment at the outset (Fox and Routh 1976).

awareness above the level of the phoneme, Phase II: Isolating the phoneme, and Phase III: Representing the internal structure of the syllable.

*Phase I. Phonological awareness above the level of the phoneme (Weeks 1 through 4; three 20-minute sessions per week).* To provide a solid foundation on which to introduce the phoneme segment, our first goal was to encourage children to focus on sound as distinct from meaning, bringing to their attention rhyme, alliteration, and syllabification. This all falls under the heading of general *phonological awareness*. Our decision to start at this level was motivated by three factors. First, individual differences in the achievement of phonological awareness appear to be related to attaining both phoneme awareness and reading success. Second, on the basis of what we have learned about the emergence of rhyme awareness during the pre-school years, we felt confident that almost any group of kindergarten children would be able to learn to attend to phonological factors at this level of analysis. In this way, both the children and the teachers could experience success before moving on to demonstrably harder tasks. Third, by starting with more easily accessible units of analysis, it would be possible to introduce the *tasks* that would be used throughout the 18 weeks of training, carrying the child from larger units of phonology down to the phoneme unit. We wanted both the teacher and students to be very comfortable with the games before placing higher demands on the units of analysis. Although training on metacognitive tasks alone will not ensure success with phoneme analysis (Bradley and Bryant 1983), there is some evidence from kindergarten children that a lack of general metacognitive skills may serve as an obstacle in achieving either phoneme awareness or early reading success (Turner 1988). With more accessible units of linguistic analysis, we could focus on the metacognitive task itself before introducing the concept of the phoneme.

Four different kinds of activities were employed to focus attention on the phonological level of language: (a) rhyming, (b) segmentation, (c) categorization, and (d) identification.

(a) *Rhyming.* The rhyming games began with exercises revolving around highly familiar nursery rhymes.<sup>2</sup> We started by asking the children to listen to a nursery rhyme such as Humpty Dumpty and then to complete the rhyme themselves (e.g., "Humpty Dumpty sat on a wall, Humpty Dumpty had a

<sup>2</sup>Though this still seems a sensible starting point, in reality, few of the children knew any of the nursery rhymes.



great \_\_\_\_"). Next we focused on the rhyming pair (e.g., "wall, fall, those two words rhyme") and went on to elicit other words that also rhymed (e.g., "ball, tall, Paul," etc.). Other games were derived from a variety of standard early childhood source books and included *riddles* in which the child had to supply the missing word (e.g., "I'm a box of tinker toys, I'm lots of fun for girls and \_\_\_\_"); straightforward *rhyme generation* tasks (eliciting from different children several rhymes for a word such as "at"); an *Ear-Training Game* in which the child has to add to a list (e.g., "sand, band, land: see my right \_\_\_\_ [hand]"); and the ever-popular *Namegame* (i.e., where the child thinks of a silly rhyme for his or her own name, starting with examples like "Gary Bedary" or "Linda Sporinda"). As the children progressed, one game that we found particularly useful for making the rhyme task more explicit was a *jingles* exercise in which the child was asked to listen to a couplet and extract the two words that rhyme (e.g., "One, two, three. Come to me").

(b) *Segmentation training* procedures were adapted from Fox and Routh (1976) and Rosner and Simon (1971). The tasks focused on breaking up sentences, phrases, and words into progressively smaller units, until children were comfortable with dividing multi-syllabic words into component syllables. To introduce segmentation, we employed Fox and Routh's "say a little bit of . . ." procedure and asked the children to break sentences into phrases and then phrases into words. We quickly progressed to analyzing two-syllable compound words such as "Batman" or "cowboy," asking children to segment both parts, each of which was itself a familiar meaningful word. When the children were able to decompose compound words, we introduced a *syllable deletion* task modeled after Rosner (1975). That is, we now asked them to "say Batman, but without the Bat," working up to "say Batman without the man." Alternating between the "say a little bit of . . ." and the "say x without y" procedures, and modeling the correct response whenever a child was confused, we worked toward flexibility in syllable segmentation and deletion.

Up to this point, children had been asked only to segment words into *morphemes*, component parts that are themselves meaningful. However, it is the ability to segment words into units that are defined in terms of sound rather than meaning that constitutes the hallmark of true phonological awareness. To this end, we next presented simple two- and three-syllable words such as "penny" or "butterfly," for which meanings of individual syllables (if such exist) do not combine to make the

meaning of the whole. Working with one word at a time, we again moved from straightforward segmentation ("say a little bit of . . .") to deletion ("say x without y"). (For example, "Can you say a little bit of *butterfly*? Good, can you say a little bit of *butter*?" Then, "Can you say *butterfly* without the *but*? Now, how about *butter* without the *ter*?") We concur with Rosner (1975) in finding this to be excellent practice for becoming fluent with listening to words and for becoming aware of the sounds in them.<sup>3</sup>

(c) *Categorization* was introduced with an "odd one out" activity (Bradley and Bryant 1985) in which the child was to select the one word out of four which did not rhyme with the others. For example, we would hand out a page with four pictures on it, asking the children to repeat the name of each as it was introduced (e.g., "mop, top, pop, and can"). Then we would ask them to say all four words together a couple of times. Finally, we would suggest that "one of the pictures doesn't belong because its name doesn't sound the same as the others" and ask them to pick which word does not belong. Before each new session, the children reviewed items with which they had been successful during the previous session.

(d) *Identification* (i.e., finding syllables in various positions throughout the word). The final kind of activity employed to heighten general phonological awareness focused on syllable identification. In this case the child's attention is drawn to a syllable (e.g., *all* /al/) and then the child is asked to determine whether that syllable is hidden in a variety of words (e.g., "do you hear the syllable "all" in *always*? [yes]; in *recall*? [yes]; in *illness*? [no]").

*Phase II. Isolating the phoneme (Weeks 5 through 10; three 20-minute sessions a week).* As discussed above, the central goal of our training was to teach children to isolate the phoneme. By the end of Phase I, with the games themselves well understood, we could begin to focus on the phoneme unit itself. In introducing the phoneme, an important feature of our procedure was its focus on *articulation*. This decision was motivated by two fac-

<sup>3</sup>Recent evidence questioning the role of syllable awareness in the development of phonological awareness indicates that analysis into canonical syllables is probably not mandatory as long as the word is getting subdivided into progressively smaller units (see Brady, Fowler, and Gipstein submitted, for further discussion). Further, the recognized difficulty in reaching agreement about the location of syllable boundaries within words suggests that teachers need to be flexible about *how* a child subdivides a word: any response that provides a smaller portion of the word demonstrates that the child is making progress.

tors. First, practitioners have made a persuasive, if anecdotal, case that an articulatory approach, focusing on how words are produced, is often more successful than a purely perceptual approach, in which the child only listens to how words sound (see Golinkoff 1978, for a review). Second, from a theoretical perspective this emphasis fits with current conceptions of how the phoneme is represented in the very young child's lexicon (see Fowler 1991, for discussion). In particular, it has been suggested that the earliest lexical representations comprise a loose bundle of articulatory gestures (e.g., lip closing, tongue raising, velar opening), and that over time the coarticulated gestures become tightly organized into a set of recurrent groupings; these recurrent combinations come to constitute the phonemes (e.g., /p/ involves lip closing, lip releasing simultaneous with aspiration, and no voicing). Consistent with this theoretical account, focussing on the articulatory characteristics of the phonemes (e.g., "do you close the lips?", "is it hissy?") seems to be an effective way to make the phoneme unit salient.

Both developmental and training studies suggest that an awareness of phonemes in isolation is easier to obtain for certain phonemes than for others. Specifically, fricatives (e.g., f, v, s, z, sh, zh) and nasals (e.g., m, n) in initial position are more readily isolated than stops (e.g., p, t, k, b, d, g). Therefore, we began with fricatives (s/z) and nasals (m/n) in Weeks 5 and 6; introduced some vowels (a/ee/o) in Weeks 7 and 8; and progressed to some stops (p/b and t/d) in Weeks 9 and 10. We restricted ourselves to these 11 phonemes, rather than including the entire inventory of English phonemes, to allow us time for other tasks focusing on the internal structure of the syllable.

To facilitate the development of articulation awareness, we relied heavily on the procedures outlined in Lindamood's *Auditory Discrimination in Depth (ADD)* (Lindamood and Lindamood 1975), introducing one pair of phonemes at a time. The commonalities and contrasts were highlighted by providing descriptive articulatory labels and by employing mirrors so that children could receive feedback on mouth and tongue positions while making the sounds. For example, /p/ and /b/ were introduced as "lip poppers" and attention was drawn to the air that was released and could be felt (or seen on the mirror) when these sounds were produced. In turn, we distinguished between /p/ and /b/ on grounds of "noisiness." To sense the difference in vibration between the "quiet" brother (/p/) and the "noisy" brother (/b/), children put their hands on their Adams' apples while producing words containing them.

Because we wished to ensure a solid phonological representation for each of the identified phonemes, we supplemented the ADD instructions with a variety of activities to allow for substantial practice with one pair of items before moving on to the next. These activities were similar to those in the Phase I except that the emphasis was at the phoneme level rather than at the word and syllable level. For example, in the segmentation task, often used to introduce a new pair of phonemes, children were asked to "say a little bit of 'pan' or 'boat'." Later, they would be asked to decide whether that isolated sound was a "quiet" or a "noisy" lip-popper. Similarly, in the sound categorization task, children were asked to group words on the basis of a shared final lip-popper, eliminating the one item that "did not go together with the others." Other exercises included *phoneme deletion* tasks, such as "can you say boat without the noisy lip popper" (modified after Rosner and Simon 1971) and *phoneme identification* tasks (e.g., "which one of these words starts with a lip popper: pool or light?").

*Phase III. Representing the internal structure of the syllable (Weeks 11 to 18; three 20-minute sessions/week).* The final phase of the training program focused on the overall internal structure of the syllable. This portion of the training program was based on the "say it and move it" procedure successfully used by Blachman (1987; see also Ball and Blachman 1988, 1991).<sup>4</sup> The introduction of this final step in our training sequence was motivated by the finding that knowledge of, and even training in, sound symbol association alone is not sufficient to ensure reading success (e.g., Bradley and Bryant 1985). That is, even if children learn that lip poppers are b's and p's, they must also learn to segment and order these phonemes within the structure of the syllable.

In this training, children were taught to analyze words consisting of either two or three phonemes. Because the sequencing of sounds is a temporal phenomenon, visual markers were provided to help make the segmentation more concrete. A picture of the word was presented and empty squares under the picture represented the word segments. The children were provided with tiles which they were to put in each square as they analyzed the word into phonemes (i.e., as they said the word slowly [e.g., mmm-aaa-nnn]). All the words used in this task comprised phonemes learned during the articulation training.

<sup>4</sup>The "say it and move it" procedure was, in turn, a modification of a task developed by Elkonin (1973).

We also continued with the earlier segmentation and deletion games that focussed on a phonemic analysis of the syllable.

The training in phonological awareness for the two experimental classes began in November and was conducted by the regular classroom teachers. These teachers were trained in two four-hour sessions and were provided with weekly packets of information detailing activities and instructions. A research assistant also visited each experimental classroom on a weekly basis for one-to-two hours in order to provide teacher support and to help children who needed extra practice. Subjects in the control group continued with the regular, unmonitored curriculum that stressed a "whole language" curriculum.

#### Assessment Measures

At the beginning of the school year the kindergartners participating were assessed individually on a number of phonological and cognitive measures before the training program began. The assessments were done by one of two testers in three sessions lasting approximately 20 minutes each. Beginning in April, the subjects remaining in the study were again assessed individually on the battery of tasks used in the fall. A year later subsets of the experimental and control groups were retested on reading skills.

#### Cognitive Measures

*Receptive Vocabulary.* Forms L (fall testing) and M (spring testing) of the Peabody Picture Vocabulary Test-Revised (PPVT-R) (Dunn and Dunn 1981) were used to assess each subject's receptive knowledge of English vocabulary. The scores in the analyses are standardized scores based on the number of vocabulary items correctly identified.

*Nonverbal Concept Formation.* The Triangles subtest of the Kaufman Assessment Battery for Children (K-ABC) (Kaufman and Kaufman 1983) was given as a nonverbal measure of mental processing. The children's raw scores were converted to scaled scores.

#### Academic Achievement

*Letter and Word Identification and Word Attack.* Forms G (fall testing) and H (spring testing) of the Woodcock Reading Mastery Tests-Revised (Woodcock 1986) were used to assess letter and word knowledge. The Supplementary Letter Checklist was chosen to evaluate letter knowledge because it presents let-

ters in a *sans serif* type style common in many beginning reading materials. The Word Identification test was used to measure ability to read sight words, and the Word Attack test was used to assess ability to apply phonic and structural analysis skills in order to pronounce unfamiliar words. The scores entered in the analyses represent the number of letters, words, or nonwords correctly read.

*Spelling and Arithmetic.* The Wide Range Achievement Test-Revised (WRAT-R) (Jastak and Wilkinson 1984) was selected to measure spelling skills (including copying symbols and name writing) and arithmetic ability (both oral and written). Scores consist of the number of items correctly answered.

#### Phonological Awareness

*Rhyme Generation.* Subjects were given one minute to say as many words as they could that rhymed with "eel" (RHYME). They were given one practice trial using the word "cat"; corrective feedback was given for the practice trial. The score was the total number of rhyming words said (including nonwords).

*Phoneme Segmentation.* An adaptation of a task introduced by Yopp (1988) was used to measure the ability to isolate phonemes (SEG). Subjects were asked to separate 24 words into their parts by sound. For example, the word "so" has two parts: "s" and "o." Three practice trials with corrective feedback were given. The task was discontinued if the subject made four consecutive errors. The final score was number of words correctly segmented into phonemes.

*Phoneme Deletion.* Rosner and Simon's (1971) Auditory Analysis Test was used to measure the subject's ability to delete syllables and phonemes (DELET). Subjects were taught the task and given two practice trials with corrective feedback. The child was asked to produce a word without a specified segment (e.g., say "smile" without the "s"). The test consisted of 40 trials and was discontinued if the child made four consecutive errors. The score was the number of correct responses.

#### Basic Phonological Processing

*Memory for Word Strings.* This task measures phonological recoding and storage in working memory (MEM). The child was asked to repeat strings of words that were presented at one-second intervals (Rapala and Brady 1990). Six four-word strings and six five-word strings were tape recorded and presented to the child through headphones. The children were asked to repeat the words in the sequence in the same order they had heard them. Two practice trials were given. The score

represents the number of words remembered in the correct order.

*Perception.* This task taps ability to establish phonological representations (PERCEPT). Subjects were asked to repeat 24 words presented in white noise (Brady, Shankweiler, and Mann 1983). The words were tape recorded and the child heard them through headphones. There were four practice words presented before the test words were given, two without noise and two with noise. The score was the total number of words perceived correctly.

*Tongue Twister.* This task is a measure of speech production (PRODUC). Each child was asked to repeat quickly, but carefully, two-syllable pseudowords (e.g., "bublu") until told to stop (i.e., after 10 to 12 repetitions) (Rapala and Brady 1990). Each subject was given two practice items and eight test stimuli. On each trial the subject first said the stimulus once to ensure that it had been heard properly, and then was asked to repeat the pseudoword several times in a row. Performance was scored for the average number of correct productions occurring on the first ten repetitions of the eight stimuli.

*Lexical Access.* The *Boston Naming Test* (BNT) (Goodglass and Kaplan 1983) was used as a confrontation naming measure. Children were asked to identify pictures of objects. The score used in the analyses included here constitutes the number of items that were correctly produced within five seconds following presentation of each picture.

### Subjects

Four classes of kindergarten children ( $n = 96$ ) participated in this study, one from each of four inner-city public schools. The schools were selected by school administrators cooperating with our request to conduct the study in schools serving largely working class, lower socio-economic communities. We had also stipulated that we wished, as much as possible, to minimize the inclusion of bilingual children because of the difficulties in accurately assessing cognitive abilities in bilingual individuals and because many of the measures are specific to English phonology. Two classes (one training, one control) met in the morning, and two (one training, one control) met in the afternoon. At the end of the school year, 61 subjects remained in the study; 19 had moved, 10 were eliminated because they were bilingual, and 3 were eliminated for other reasons (e.g., severe speech difficulties). These numbers do not include the three children who demonstrated some reading skills at the outset o

the study (i.e., they could read at least one word on the Word Identification task). (Although the scores for these children are not included with the others, we will comment later on the progress of the two children who made sizeable gains in reading development.)

Of the 61 subjects who completed the project, 24 were in the training group and 37 were in the control group. Two concerns arose regarding the remaining subjects: (a) a few subjects in both groups had low IQ scores, and (b) a number of subjects in the control group had high IQ scores. Spring, rather than fall, PPVT-R scores were used to determine IQ level because the spring scores were felt to be more representative of the subjects' true ability. Many of the children in the study had sizable discrepancies between fall and spring PPVT-R scores (i.e., as much as a 46 point difference). We speculated that since many of the subjects came from disadvantaged backgrounds, the fall scores reflected lack of exposure to middle-class vocabulary items.

Subjects whose Peabody Picture Vocabulary Test (PPVT-R) IQ scores were below 80 even after one year in kindergarten were not included in subsequent analyses. These included three from the training group and five from the control group. Of the 34 subjects remaining in the control group, several had IQ scores that were considerably above those in the training group. In order to achieve comparable groups, the 21 children in the training group were matched with children who had similar ages and PPVT-R scores (spring) from the control group. (The pairing was done by a person who only had access to the age/IQ information and who had not participated in testing the individual children.) The final sample for analyses consisted of 21 in each of the training and control groups. In the training group, 15 of the children were caucasian, 4 were black, and 2 were oriental. The control group consisted of 20 caucasian children and 1 black child.

The mean age of the kindergarten subjects at the beginning of the study was 5 years, 4 months, with no significant difference between the training and control groups. Means and standard deviations for each pretest variable are included in table I.

## Results

### Comparability of the Group Measures

Comparability of the training ( $n = 21$ ) and control groups ( $n = 21$ ) at the beginning of the study was assessed. As noted earlier, the fall PPVT-R scores did not appear to accurately reflect chil-



Table I  
Fall Means and Standard Deviations for Age, Cognitive Ability, Achievement,  
and Phonological Processing Measures,  $n = 42$

	Training Group		Control Group	
	Mean	SD	Mean	SD
Age (in months)	64.62	4.32	62.48	3.17
<i>Cognitive ability:</i>				
PPVT-R (Spring)	82.96	11.81	84.98	16.39
KABC Triangles	8.62	2.40	8.70	2.34
<i>Achievement:</i>				
Letter ID (upper)	9.12	10.47	9.86	8.77
Letter ID (lower)	3.74	6.72	3.06	4.70
Word ID	0.00	0.00	0.00	0.00
Word Attack	0.00	0.00	0.00	0.00
Spelling	7.27	4.01	6.87	4.84
Arithmetic	6.64	2.87	6.18	3.37
<i>Phonological awareness:</i>				
Rhyme	0.70	1.06	0.70	1.43
Segmentation	0.00	0.00	0.00	0.00
Deletion	0.05	0.22	0.41	0.74
<i>Basic Phonological processes:</i>				
Perception	7.18	2.10	6.47	2.39
Memory span	8.92	8.02	5.92	5.16
Boston Naming Test	15.23	3.53	14.57	2.94
Production	6.20	2.29	6.93	2.05

dren's receptive vocabulary abilities; the majority of the children demonstrated a notable increase in IQ-equivalence scores by the end of the kindergarten year. Because of the marked change in receptive vocabulary scores, comparability of verbal aptitude was evaluated in three ways. First, the groups were compared on their fall vocabulary scores, and no significant differences were obtained. Second, the groups were compared on the magnitude of the increase in receptive vocabulary IQ-equivalence scores occurring between the fall and spring. The mean gain in PPVT-R IQ score for the training group was 7.95 ( $SD = 10.36$ ). Within the control group an average gain of 9.19 ( $SD = 14.30$ ) was observed. Once again, the groups did not significantly differ. Because the

spring scores were more likely to reflect aptitude, as opposed to experience, a Multivariate Analysis of Variance (MANOVA) using spring PPVT-R scores and fall K-ABC Triangles scores was used to determine whether the two groups were equivalent in cognitive ability. The outcome was nonsignificant. Thus, although there were noteworthy changes in receptive vocabulary scores as a result of the kindergarten experience, the groups appear to be comparable in terms of entering receptive vocabulary knowledge, in gains during the year, and in overall aptitude.

In comparing the groups on achievement, phonological awareness, and basic phonological processing, a nonparametric statistic, the Mann-Whitney U, was used because the scores were not normally distributed on several of the measures. The separate Mann-Whitney U analyses run for each of the achievement measures (math, reading [Word ID, Word Attack], spelling) revealed no significant pretreatment differences between the two groups. On the phonological awareness measures (RHYME, SEG, DELET), the control group was found to be significantly better than the training group on one of the phonological awareness measures (DELET)( $U[21,21] = 167.5, p = .04$ ). What this reflects is that some of the control subjects were able to perform one of the syllable deletion items at the beginning of the test. Since the difference favored the control subjects, we were reassured that the evaluation of the efficacy of the training program on this skill would not be confounded by an initial advantage for the training subjects. Mann-Whitney U analyses were also calculated for each of the basic phonological measures (PERCEPT, MEM, PRODUC, BNT). No significant group differences were evident.

Overall, the two groups had negligible differences in the fall on cognitive ability, achievement, phonological awareness, and basic phonological processing. At the same time it should be pointed out that the performance levels in all of the areas assessed tended to be low. Not only were the participants nearly entirely nonreaders, they also demonstrated very limited phonological awareness in comparison to middle-class children tested in other studies. For example, middle-class children in this age-range generally do very well on rhyme tasks (e.g., Stanovich, Cunningham, and Cramer 1984; Yopp 1988). In contrast, in the present study 27 of the 42 children were unable to generate a single rhyme at the beginning of the school year.

#### Outcome measures

Means and standard deviations for each posttest variable are included in table II. Multivariate Analysis of Variance on the cognitive ability variables (Spring PPVT-R scores and

Table II  
Spring Means and Standard Deviations for Cognitive Ability, Achievement,  
and Phonological Processing Measures,  $n = 42$

	Training Group		Control Group	
	Mean	SD	Mean	SD
<i>Cognitive ability:</i>				
PPVT-R (Spring)	91.77	9.13	94.16	8.76
KABC Triangles	9.83	2.82	10.07	3.06
<i>Achievement:</i>				
Letter ID (upper)	17.60	8.41	17.60	9.87
Letter ID (lower)	9.88	9.45	11.25	8.19
Word ID	0.24	0.54	0.04	0.30
Word Attack	0.00	0.00	0.00	0.00
Spelling	11.36	3.22	10.49	4.35
Arithmetic	10.28	3.09	9.87	3.20
<i>Phonological awareness:</i>				
Rhyme	3.90	1.81	1.48	1.79
Segmentation	0.76	1.55	0.13	0.44
Deletion	3.46	2.93	2.67	2.42
<i>Basic Phonological processes:</i>				
Perception	8.51	2.89	7.36	2.60
Memory span	13.03	9.78	9.93	6.32
Boston Naming Test	18.40	3.52	16.95	4.26
Production	7.80	1.67	7.27	1.95

Spring K-ABC Triangles scores) indicated no significant difference between groups. In order to take into consideration each subject's level of knowledge prior to treatment, difference scores (posttest scores minus pretest scores) were used in the achievement and phonological processing analyses. Multivariate Analysis of Covariance (MANCOVA) using pretest scores as covariates was not used because homogeneity of regression problems were found. Once again, because assumptions for parametric statistics were violated, the Mann-Whitney U was used to compare group performance on the achievement, phonological awareness, and basic phonological processing variables. No significant differences were found in any of the posttest achievement measures. Thus, comparable gains

were made by the training and control groups in letter knowledge, reading and spelling, and in arithmetic. Basically, children in all of the classes increased their knowledge of letters, remained nonreaders, and made limited gains in math concepts. The two children who did show real progress in reading provide an interesting insight into the potential benefits of incorporating phonological awareness into the early literacy curriculum. (These two children were excluded from the group analyses, as noted earlier.) One of the children with notable reading development came from one of the control classes. She was able to successfully read 16 words in the fall and 32 in the spring. Despite this impressive sight word vocabulary, she was unable to sound out *any* pseudowords on the spring assessment of decoding (Word Attack). For example, for the item "ree", she said, "I know that that's in the word 'tree', but I don't know what it is." The other "good reader" came from one of the training classes (word identification: Fall = 19; Spring = 52). He demonstrated considerable pseudoword reading skills in the spring (16 items), indicating that he would be able to read many words even the first time he encountered them in print. The reading prowess attained by both children was certainly unusual for this cohort. It is interesting to note that the vocabulary scores, though high for both, did not correspond with relative reading attainment (PPVT-R: Control S, Fall = 123, Spring = 131; Training S, Fall = 91, Spring = 114).

In the spring, the training group performed significantly better than the control group on two phonological awareness measures, the RHYME task,  $U(21, 21) = 73, p < .01$ , and the SEG task,  $U(21, 21) = 167.5, p < .04$ . Whereas the majority of children in both groups had not been able to generate a rhyme at the beginning of the study, in the spring this was only true for one subject in the training group. In contrast, twelve of the twenty-one children in the control group remained unable to generate even a single rhyme. Likewise on the segmentation task, in the spring six of the training children were able to correctly segment some of the words into the phonemes. (None of the children in either group had been able to correctly segment any of the words in the fall.) Unfortunately, the testing procedure we followed did not allow a partial scoring technique to be used, so progress in dividing words into subword elements (e.g., green -> gr-ee-n) was not documented. Only one of the control subjects was able to correctly segment any of the stimuli in the spring. On the other phonological awareness measure, DELET, the training group had reversed the pretraining pattern and

were now markedly, though not significantly, better than the control group.

In short, the training program yielded significant gains in phonological awareness (RHYME) and increases in phonemic awareness (SEG and DELET). This pattern fits with the current understanding of the development of phonological awareness and, given the deficits in phonological awareness at the outset of the study, represents an encouraging degree of progress. It is also encouraging to consider the potential benefits of phonological awareness training for low ability children. Of those children whose PPVT-R scores in the spring were below an IQ-equivalent score of 80 (not included in the above group data), the three in the training group all had some ability to rhyme in the spring, while three of the five low IQ subjects from the control classes still had scores of zero. Two of the three low IQ children in the training classes also were able to get some of the items on the deletion task correct.

Our hypothesis that phonological awareness training might exert effects on more basic phonological processes received some support. On the basic phonological processing measures, significant differences were obtained in favor of the training group on the speech production measure,  $U(21, 21) = 127, p = .02$ . This is of particular interest because the phonological awareness training did not have any activities that were similar to the PRODUC task. In the articulation training, the children were told to think about how they produce speech sounds (e.g., to look in a mirror and to watch how the lips close on lip poppers), not to practice producing phonemes rapidly and accurately, as is required on the speech production measure. While significant differences were not obtained on the other phonological tasks (i.e., PERCEPT, MEM, and BNT), a display of the z-scores for spring-fall difference scores for all of the phonological measures hints that the impact of phonological awareness training may have consequences for more basic phonological processes as well (see figure 1).

#### Outcome for Promotion and Reading

The following spring we located the 42 children, who had dispersed to 12 different elementary schools within the state, for follow-up assessment of reading development. Not all of the children had been promoted to first grade. Though the training and control groups had been comparable in the fall and the spring of the kindergarten year on both achievement (letter knowledge, reading, spelling, math) and general apti-

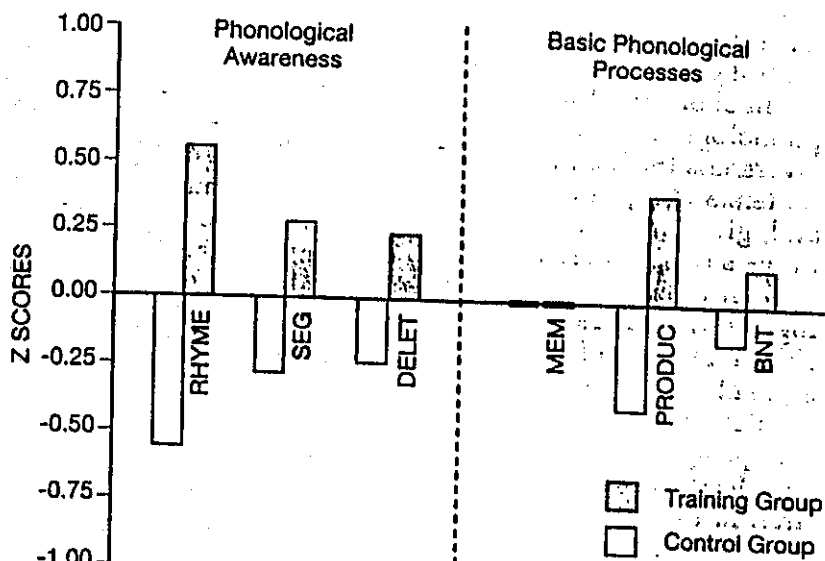


Figure 1: A plot of the z-scores based on the difference values (Spring minus Fall) for the phonological awareness and basic phonological processing tasks.

tude measures (PPVT-R, KABC), a strong effect of training was observed on promotion ( $\chi^2 [1] = 5.46, p = .02$ ). Three of the 21 children from the training group were put in pre-one classes, rather than in first grade, while ten of the 21 children from the control classes were placed in pre-one classes.<sup>5</sup>

All 42 children were tested on word identification and decoding abilities, except for one child from the training group who was not tested on the word attack task because of an oversight by the tester. The training group ( $\bar{x} = 27.8, SD = 19.11$ ) performed significantly better on the Word Identification subtest than did the children from the kindergarten control classes ( $\bar{x} = 16.6, SD = 14.6$ ),  $F(1,40) = 4.6, p = .04$ . Likewise, on the Word Attack subtest the training group ( $\bar{x} = 10.4, SD = 12.4$ ) had higher scores than the control group had ( $\bar{x} = 3.5, SD = 7.03$ ). Since the extent of reading instruction and writing activities in pre-one classes is likely to be less than in first grade, a second comparison was made using only the scores of those children who had been promoted to first grade (Training:  $n = 18$ ; Control:  $n = 11$ ).

<sup>5</sup>Because of the confidentiality of teacher records, it was not possible to look at promotion patterns in other years to evaluate whether the observed contrast between the training and control classes reflected teacher differences in inclination to retain/promote or a distinct pattern for this particular year.

The reading scores for the children from the training group were again higher on the Word Identification task (Training:  $\bar{x}$  = 31.9,  $SD$  = 17.3; Control:  $\bar{x}$  = 24.6,  $SD$  = 15.6) and on the Word Attack measure (Training:  $\bar{x}$  = 12.2,  $SD$  = 12.6; Control:  $\bar{x}$  = 6.5,  $SD$  = 8.8), though neither comparison reached significance.

While there was a wide range of performance in both groups, half of the control group ( $n$  = 10) at seven years of age were already one year behind in schooling. Of those who were physically in the first grade ( $n$  = 11), only two were at grade level on word attack skills at the end of first grade and only three on word identification skills. In contrast, only three of the children from the training classes were a year behind in entering first grade—seven of those in first grade were on grade level for word attack and eight were on grade level for word identification.

### Discussion

In this paper we have presented a study exploring the feasibility of conducting a training study with a longitudinal component. Our ultimate aim is to investigate the pattern of relations among phonological processes and how these change as a function of phonological awareness training. Because this was a feasibility study, important subgoals of the project were to develop a phonological awareness training program that could be incorporated into the curriculum of classroom teachers and to assess the utility of the tasks selected to measure language and cognitive processes in this age-group and segment of the population. Our quest was in many ways successful: the training program yielded significant differences with the trained group achieving significantly higher levels of phonological awareness in kindergarten and of promotion to first grade, and, though now down to a small number of subjects, a trend toward better reading progress in first grade. We also obtained some intriguing indications that development of phonological awareness was accompanied by broader changes in the phonological system. These findings will be commented on below, with further discussion of the implications for future research.

#### Assessment of the Training Program

A central purpose of this study was to develop a phonological awareness training program that can be conducted in regular classes of kindergarten children. For the most part, we were satisfied with the design and implementation of our program

(see Blachman 1993; Byrne and Fielding 1993; Griffith and Olson 1992; Yopp 1992, for recent papers reporting other valuable training procedures). Moving from larger to smaller units in order to increase the children's specific knowledge was productive, and probably necessary given the low starting point for most of the children taking part in the study. Incorporating articulatory awareness training, in addition to the more common auditory activities, seems to be a particularly effective way to make the concept of phonemes salient, even for children with reading disability (see also Alexander et al. 1991). The various exercises used in the training program were well received by the teachers, and the children responded enthusiastically to the games and activities. Although we had hoped to make even greater gains than we achieved in the acquisition of phonological awareness, the degree of progress seemed respectable given the circumstances of our participants: problems experienced by some of the children included food and money shortages, drug abuse in the home, and physical violence. High rates of absenteeism and behavior problems were often noted. The recent evidence (Robertson 1993) confirming that kindergarten children from low socio-economic circumstances are likely to have marked deficits in phonological awareness underscores the urgent need for this kind of instruction for this population. (See Snow et al. 1991 for discussion of other influences on literacy attainment in socially disadvantaged children.)

At the same time, a number of modifications in the training program seem advisable. First, it would be beneficial for aiding reading acquisition to provide instruction relating phonemes to letters. Several studies have demonstrated that when instruction on phonemic awareness is linked with letter training, greater gains are seen in reading development (see Blachman 1991 for a review). For the more practical end of preparing children to learn to read, we agree entirely with those who propose that letters be judiciously introduced in conjunction with phonemic segmentation and categorization activities (i.e., to gradually introduce letters to represent those phonemes that the children are able to isolate and identify). It should be noted that when only letter training is provided, gains in phonological awareness and spelling are not observed (e.g., Ball and Blachman 1991).

For theoretical reasons, in the present study we focussed on phoneme awareness without explicitly tying phonemes to letters. By employing tokens rather than letters, we wished to make the point that phoneme awareness does not necessarily entail letters, but is enhanced by the use of concrete symbols



(see also Elkonin [1973] and Lundberg [1991] for supporting evidence). In addition, we were interested in determining whether phoneme awareness training per se, rather than the orthographic representations that would ultimately emerge from reading instruction, would modify basic phonological processes in an interesting fashion. As it turned out, we have no way to ascertain how much letter training our teachers did outside of the training activities or whether any links were drawn to the phoneme activities they were conducting, so this issue remains to be further evaluated. Still, the fact that the two groups were equivalent in letter knowledge in the spring suggests it was phoneme awareness that led to observed changes in basic phonological processing.

A second change in the training program concerns the pace of training, both for the whole class and for individuals. Incorporating at least informal assessment of whether the majority of the children are ready to progress to the next phase of training would be a desirable move toward a criterion-referenced schedule. In addition, although the training program presented here was taught nearly entirely by the classroom teacher, it would clearly help to have supplemental help from teacher aides, Chapter 1 personnel, etc. to provide extra instruction for those children slower to grasp the concepts. These activities are also easily given to parents for further practice by children at home. More specifically, it was our impression that the children caught on to the concept of rhyme rather quickly. It might be possible to alter the portion of the year spent on rhyme activities, if the children demonstrate an adequate appreciation of this construct, to allow more time for the more difficult phoneme-level activities. We also observed that the bridging activities above the level of the word, which were intended to help children begin to segment words into smaller units (i.e., say a little bit of a sentence), were misleading to a number of children and are probably better left out.

The issue of timing also brings up whether the training in phonological awareness should be restricted to the kindergarten year. The evidence that phonological awareness precedes phoneme awareness highlights the fact that phoneme awareness is but one step in a continuous process. We wish to stress the often overlooked fact that phoneme awareness is a *gradual* attainment, rather than an all-or-none phenomenon. The refinement of phoneme awareness continues for an extended period, well after the critical discoveries that words have an internal structure and that letters represent phonemes. Typically, even after children in first and second grade have ac-

quired the basic decoding skills allowing them to read simple consonant-vowel-consonant trigrams (e.g., cat), they continue to have difficulty analyzing clusters or multisyllabic words (e.g., reading 'silk' as 'sik') (see Bruck and Treiman 1991). Thus all children, not only those who happen to be progressing more slowly with a kindergarten curriculum such as this one, would benefit from continued instruction on phonological awareness concepts. In our study, only a kindergarten "inoculation" was provided and benefits were observed, though not as extensively as one would hope. This kind of training, prior to or in conjunction with reading instruction, sets the stage for virtually any method of reading instruction. We echo the well-reasoned recommendations of those who advocate incorporating a foundation in phonological awareness instruction with a balanced program of code-based and whole language methods (e.g., Adams 1990; Chaney 1990; Vellutino, 1991).

The need for including instruction in phonological awareness in the curriculum is revealed in the very common spelling errors produced by beginning readers and by poor readers. As several researchers and educators have discussed, spelling errors generally provide a window on the child's level of phonological awareness and give clear indications of what concepts need to be targeted (e.g., Rubin and Eberhardt submitted; Treiman 1993). For example, writing 'pinsos' for 'princess' or 'sik' for 'silk' points to a difficulty isolating the individual phonemes in clusters. Similarly, 'wet' for 'went' indicates that the child has yet to recognize the distinctness of the vowel and the nasal phonemes. Conversely, spelling 'by' for 'biy' reveals a keen ear for the diphthongs in 'by', but the need for instruction in spelling conventions. If a teacher has been trained to recognize the bases of error patterns, the nature of feedback offered to children can be tailored to each child's level of insight.

An important part of our training was the transmission of phonological awareness concepts to classroom teachers, who, in turn, imparted them to the children. Unfortunately, current teacher training methods too often omit instruction on phonological awareness with the result that even experienced teachers are found to lack insight both about the underlying reasons for the difficulties demonstrated by their students and even about the phonological composition of words (e.g., confusing phonemes with letters, leading them to say, for example, that there are four sounds in 'sing') (Moats 1994). In one noteworthy instance (Blachman 1987), when such training for teachers was provided and there was continuity in phonological awareness

instruction across the early elementary grades, striking gains in reading skill were seen in two urban schools (i.e. in two years one of the two schools involved improved from an achievement rank of 13th out of 24 schools in the district to a rank of 5th place; the other school moved from 17th out of 24 schools to 7th). Further, it is now well documented that older poor readers continue to have the same difficulties with phonological awareness and decoding characteristic of beginning readers (for a review see Fowler and Scarborough 1993), pointing to the need to also provide training about phonological awareness for teachers of older students and for remedial instructors.

#### Assessment of Change in Phonological Processes

The second goal of this study was to begin to explore how basic phonological processes and metaphonological awareness interrelate. Here we obtained some intriguing evidence that increases in phonological awareness were accompanied by changes in accuracy on a speech production task. As noted earlier, although the training included a focus on how certain phonemes are articulated, it did not include any practice involving accurate or rapid production of words. Although significant effects of training on the other measures of basic phonological processes were not obtained, we are inclined to think that the result on the speech production task signals something worth looking into further. A report of pilot data from a second research project also cites parallels between acquisition in phonological awareness (again taught by the Lindamood articulatory method) and change on tasks assessing basic phonological processes (Torgesen 1994). In that study, marked effects of training were seen on both sentence recall and listening comprehension measures. Further, in other research undertaken by us (Fowler et al. submitted) five-year-old children who had attained some degree of phonemic awareness (without formal training) were found to perform differently on a speech perception task than did same-age children who had not yet attained phonemic awareness. These cases converge to support the hypothesis that development of phonemic awareness reflects and/or has consequences for the nature of underlying phonological representations (Brady et al. submitted; Fowler 1991).

Of course, further empirical support is clearly needed to evaluate the nature and extent of the basic phonological changes hypothesized to occur. In this future work, we would recommend longer term follow up to evaluate whether any changes observed are stable and if other changes in processing

subsequently emerge. We would also recommend a number of improvements over our current battery of tasks. In general, the use of a single task to measure a construct (e.g., lexical access, memory) may not provide the most valid or reliable measures. It would be advisable to include multiple measures of each construct to attain more robust information. More specifically, we had some concerns about some of the tasks we used and about substitutions or additions that seem warranted. The phonological awareness measures appropriately tapped a continuum of difficulty. It is clearly important to assess a range of abilities from rhyming to segmentation to phonemic analysis. However, the procedure used on our segmentation task (scoring a response as correct or incorrect and discontinuing after three errors) failed to capture useful information that can be gleaned from this kind of task (e.g., ability to segment the onset from the rest of the word represents greater skill than inability to break apart any portion of the word) (also see Bentin and Leshem 1993 for concerns about the efficacy of this task). A partial scoring procedure, capturing the extent of segmentation, would be a more sensitive measure of an individual's level of development. Recent evidence (Yopp 1992) from cross-lag correlational analyses that blending ability precedes and predicts phonemic awareness suggests that a measure of blending skill should be included. Likewise, the dynamic assessment procedure reported by Spector (1992) might add valuable information about level of ability.

We would also suggest changes in the set of tasks designed to assess basic phonological processes. The speech perception-in-noise task was difficult for all the children. On average, the children were able to identify only one-third of the words; and only two children were able to identify more than 12 of the 24 words. Increasing the signal-to-noise ratio to ensure a broader range of correct responses might help increase sensitivity, or a noise-free condition might be useful with this age-group. Pseudoword repetition is a variation of this task proving very sensitive to individual differences both in language development (Gathercole and Baddeley 1990) and in reading ability (e.g., Stone and Brady 1993; Taylor, Lean, and Schwartz 1989). With young children one might wish to pair administration of repetition tasks with an evaluation of articulation in order to determine if difficulty repeating certain items stems from problems in articulation, possibly normal for this age range, or from problems establishing a phonological representation of words. Alternatively, having the children make a picture choice identi-

fication would help with response clarity (cf., Elbro). A pseudo-word repetition task would also serve as an index of phonological memory and could be combined with the more standard word string task such as the one employed here and with a sentence recall measure (e.g., Mann, Shankweiler, and Smith 1984) to provide multiple measures of brief phonological storage.

Although the Boston Naming Test (Goodglass and Kaplan 1983) is a widely used measure of lexical access, the task did not seem appropriate for use with this population. Factors other than the ability to retrieve phonological labels from the lexicon seemed to influence the results (e.g., vocabulary deficits related to cultural disadvantage; lack of attention; distractibility). In addition, the task was frustrating for some children because of the combination of item sequences and the rule for discontinuing the task. For example, if a child had five incorrect responses but then identified a picture correctly, the discontinue sequence would start over, and the child would be faced with six more words he or she did not know. Both children and examiners found this process frustrating. An alternative confrontation naming task (e.g., the Posner task<sup>6</sup>) may be a more appropriate measure. In future work we would also include at least one rapid naming task because of the accumulating evidence that performance on this kind of measure may reflect different phonological processes than those tapped by phonological awareness or phonological coding in memory (Wagner et al. 1987) and that it may correspond with a particular component of reading skill (i.e., word identification) (Felton and Brown 1990). However, we would recommend not using any kind of orthographic stimuli (i.e., letters or numbers) because of the confound this introduces in interpretation: if the goal is to explore the causes and/or consequences of reading achievement, rather than merely to select tasks that will identify reading groups, it is important to use measures that cleanly target the hypothesized substrate of reading difficulty.

In sum, preliminary evidence emerged concerning a relationship between the development of phonological awareness and changes in basic phonological processes. Here this effect was observed in a measure of speech production, even though the gains in phonological awareness by our subjects were mod-

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<sup>6</sup>For the Posner task, the stimuli are line drawings of pairs of objects. The task is to sort the cards into one pile if the two objects have the same name (e.g., a horse's head and a whole horse) and into another pile if the two objects have different names (e.g., a horse's head and dog sleeping). The score on the task is the time to complete two sorts of 30 cards (see Wagner et al. 1987).

est, and generally fell short of full-fledged phonemic awareness. These results indicate the merit of further research carefully documenting growth and change in basic phonological processes from an early stage in phonological awareness ability until complete phonemic awareness is attained.

### Summary

In general, the results of this project are encouraging. First, the phonological awareness training program had some success, and ways to improve it have been identified. It is our hope that sharing the rationale for the training techniques will be of utility to educators designing training programs or to researchers interested in further studies incorporating a training component. Further, the results point to the consequences on the basic phonological system of discovering the sound structure of spoken language. It remains to confirm these effects and to study the extent to which changes in phonological processes parallel the gradual emergence of phonological awareness.

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