

Research Report

THE EFFECTS OF AGING AND FIRST GRADE SCHOOLING ON THE DEVELOPMENT OF PHONOLOGICAL AWARENESS

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Abstract—*The independent influences of aging and schooling on the development of phonological awareness were assessed using a between-grades quasiexperimental design. Both schooling (first grade) and aging (5–7 years) significantly improved children's performance on tests of phonemic segmentation, but the schooling effect was four times larger than the aging effect. The schooling effect was attributed to formal reading instruction, whereas the aging effect probably reflects natural maturation and informal exposure to written language. These data support a strong mutual relation between reading acquisition and phonological awareness.*

Phonological awareness is the ability to recognize the internal phonemic structure of spoken words. It is usually assessed by testing the subjects' ability to isolate and manipulate individual phonemic segments in words.

Although a child makes phonemic distinctions as soon as he or she can understand and produce speech, the ability to manipulate phonemic segments consciously develops only around the first grade. For example, Liberman, Shankweiler, Fischer, and Carter (1974) found that no prekindergarteners, only 17% of kindergarteners, but 70% of the first graders were able to parse words into phonemes.

The significant improvement in phonological awareness in first graders may be primarily ascribed to one of two factors (which are not mutually exclusive): (1) cognitive-linguistic skills that mature at about the age of six, independent of formal reading instruction (Bradley & Bryant, 1983); or (2) learning to read in an alphabetic orthography (Bertelson,

Morais, Alegria, & Content, 1985). In contrast to speech, where phonemes are coarticulated and overlap in the acoustic stream, in writing the phonemes are represented by clearly defined orthographic segments, the letters (see Liberman & Mattingly, 1989). As children learn about letter-sound correspondence when they learn to read, it seems likely that they become aware that words are formed of the sounds that the letters represent.

Owing to the impossibility of experimenting with school attendance, the effect of reading instruction on phonological awareness has been investigated only indirectly in studies that have relied on natural variation. Most of these studies suggested that learning to read triggers, or at least promotes, the development of phonological awareness. For example, adults who learned to read in adulthood were superior to illiterate adults on tests of phonemic segmentation (Morais, Cary, Alegria, & Bertelson, 1979; Morais, Castro, Scliar-Cabral, Kolinsky, & Content, 1987). In Chinese, Read, Zhang, Nie, and Ding (1986) found higher phonological awareness in subjects who learned to read the alphabetic (pinyin) orthographic system than in subjects who read only the logographic system (kanji). Equivalent results were found comparing reading instruction methods; children who learned according to the "analytic" (segmental) method performed better on tests of phonemic segmentation than those who learned by the "global" (holistic) method (Alegria, Pignot, & Morais, 1982).

However, while the studies cited suggest that literacy influences the development of phonological awareness, they do not prove this claim. The caveat is a possible confounding of differences in the extent or method of reading acquisition with other variables that may have influenced phonological awareness (e.g., the amounts of informal linguistic experience). Therefore, there is still a need to specify the effect of schooling in general, and reading acquisition in particular, on

the improvement in phonemic segmentation ability in the first year of schooling.

The present study circumvents the confounding problem by utilizing a quasiexperimental paradigm that allows for the post hoc disentangling of the effects of age and schooling (Cahan & Davis, 1987). This approach entails administration of the same test to at least two adjacent grade levels and takes advantage of the school cutoff that is imposed in most countries. The overall cross-sectional increase in mean test scores as a function of age is decomposed into within-grade and between-grades segments that can be attributed to age and schooling effects, respectively.

Theoretically, this goal could be achieved by comparing children born one day before the cutoff with children born one day after (Morrison, 1988); those children will differ by only one day in age, but by a full year of schooling. Similarly, children who are born on the first and the last days of one school year will differ in age by a full year while being in the same grade. Unfortunately, this approach suffers from a serious shortcoming of selection, because the cutoff is never strictly imposed. Moreover, those exceptions are not random: Children who are pushed ahead are usually intellectually advanced, whereas those who are held back tend to be underdeveloped. Such selective misplacement leads to overestimation of the schooling effect (Cahan & Cohen, 1989).

A possible solution to the selection problem is to base the estimation of age and schooling effects on the predicted (rather than empirically obtained) mean test scores of the youngest and the oldest children in each grade. Prediction would be based on the regression of test scores on chronological age across the entire legal age range in that grade, excluding the selection-tainted birthdates near the cutoff. This idea underlies the recently proposed between-grades regression discontinuity design (Cahan & Davis, 1987). In the present study we applied this design

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to the estimation of the independent effects of one year of schooling (during which reading acquisition was the primary curricular activity) and one year of aging on the development of phonological awareness as evidenced by tests of phonemic segmentation.

METHOD

Design

The "between-grades" paradigm relies on two assumptions: (1) The "allocation" of children to birthdates is random; and (2) admission to school is based only on chronological age. If these assumptions are valid, the age and schooling effects are estimated by means of a regression discontinuity design (Cook & Campbell, 1979), involving regressions of test scores on chronological age. The effect of age is reflected by the slope of the within-grade regressions, whereas the effect of schooling is reflected in the discontinuity between the two regression lines.

The first assumption of the model is reasonably met. The second is more problematic because, as mentioned, in practice the admission to school is not solely a matter of the child's birthdate. The frequency of grade misplacement is particularly high near the official cutoff, which in Israel usually falls in December (Cahan & Cohen, 1989). In order to cope with this problem, we excluded from the computation of the within-grade regressions two groups of children: (1) children who did not fall into the official age range of their cohort and (2) first graders born in November or December 1982, the months with the highest proportion of "missing" children.

Subjects

The sample consisted of all first graders born in 1981 (with the exceptions described above) in the seven schools serving four neighborhoods of Jerusalem (319 children of both sexes), and all children born in 1982 from the 19 kindergartens serving the same neighborhoods (352 children of both sexes). The selected neighborhoods represented upper middle-class, middle-class, and lower middle-class populations.

Tests and Materials

Phonological awareness was measured by a battery of four subtests of constrained phonemic segmentation (Goldstein, 1976), each containing 20 items, selected from a battery devised and validated by Leshem (unpublished doctoral dissertation) (for a survey of various types of segmentation tests see Content, Kolinsky, Morais, & Bertelson, 1986). The tasks were:

1. Isolation of the first phoneme in spoken words. The children were instructed to utter the first phoneme in words pronounced by the examiner.
2. Isolation of the first phoneme in self-generated pictures' names. The children were shown pictures of common objects and asked to pronounce the first phoneme in the name of each object.
3. Isolation of the last phoneme in spoken words. Similar to test 1 except that the last phoneme had to be isolated. The words were different than those in test 1.
4. Isolation of the last phoneme in self-generated names of pictures, as in test 2, except that the last phoneme in the name of each object had to be isolated. The objects were different than in test 2.

The words and object names were selected in collaboration with teachers in the respective grades to be part of the children's vocabulary. They were one- to three-syllabic words. Both consonants and vowels were used as initial or final phonemes.

Measures of phonological awareness

The phonological awareness score of each child was the percentage of correct responses across all four subtests. In addition, two error scores were calculated: (1) the percentage of syllabic (rather than phonemic) segmentation; and (2) the percentage of subsyllabic (i.e., consonant + vowel) segmentation. This distinction was particularly desirable because in Hebrew, vowels are represented primarily by diacritical marks appended to conso-

nantal letters. Hence, the basic phonemic unit that is mostly emphasized during reading acquisition is larger than a single phoneme, including a consonant and a vowel. In many cases, however, this CV unit does not form a syllable. Thus, it is possible that, unlike in Italian or English, learning to read in Hebrew should develop some awareness to subsyllabic rather than phonemic segments.

Procedure

The sample was tested within the last two weeks of February. Hence, the school children had had five months of reading instruction. The examiners were 20 students who received special training; most of them tested both first grade and kindergarten children.

The tests lasted from 30 to 40 min and were administered individually. For each task, the child was given a fixed number of practice items, preceded by an example. During practice, but not during the test, feedback was provided and errors were corrected.

RESULTS

The percentage of correct responses was higher in school children (76%, $SD = 14\%$) than in kindergarten children (35%, $SD = 23\%$) [$t(674) = 29.12, p < .0001$]. This difference reflects the combined effects of age and schooling. The separate effects of these two factors are revealed in the analysis of the within-grade linear regressions of phonological awareness scores on age (Fig. 1).

Owing to the insignificant difference in the slopes within the two grade levels, it was concluded that the two regression lines were parallel. Accordingly, the net effects of age and schooling were obtained from the regression coefficients of age and grade level in the multiple regression equation of test scores on age and grade. The net effect of one year difference in chronological age was 9% ($SE = 3.0\%$), and that of one year of schooling was 32% ($SE = 3.4\%$) (see Fig. 1). Both effects and the difference between them were significant ($p < .05$).

As would be expected, improved phonemic segmentation, whether as a function of age or of schooling, was accompanied by a reduction in the percentage

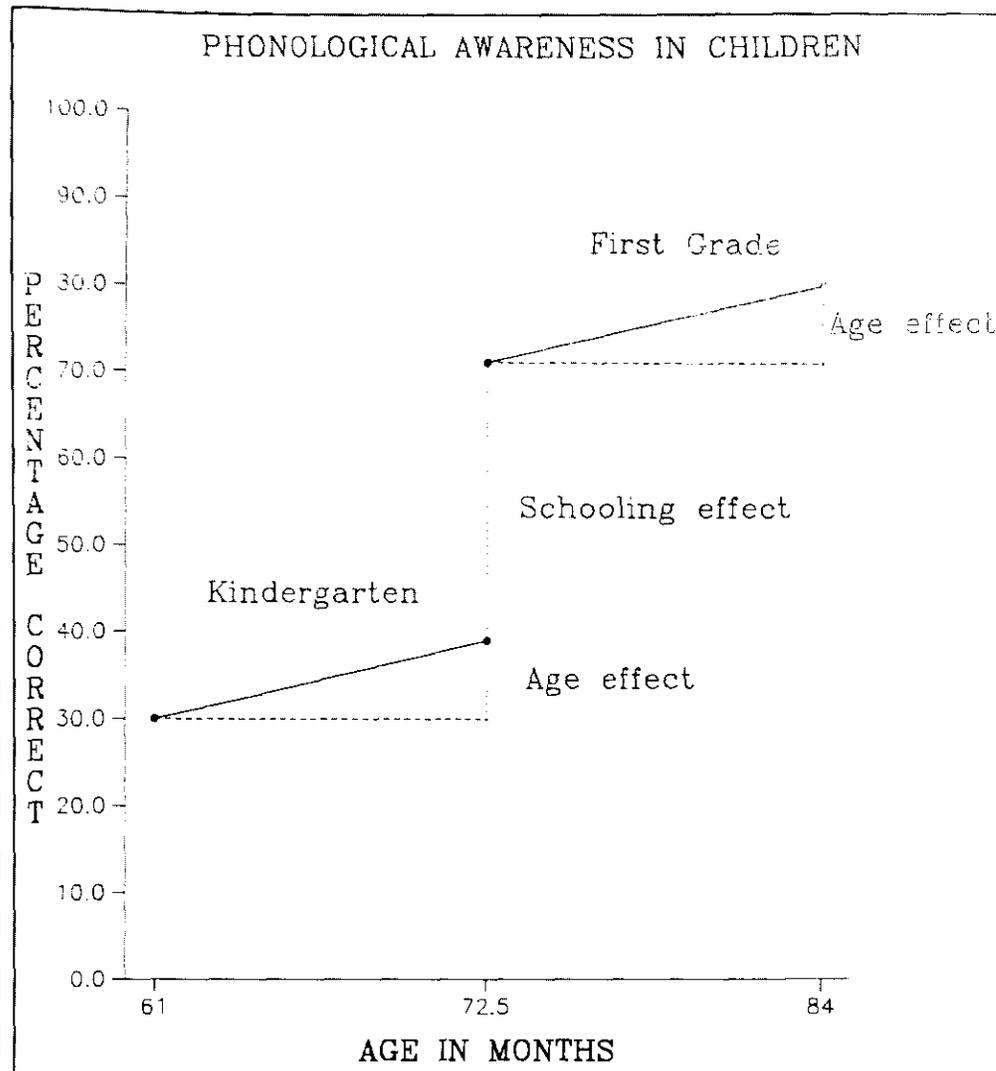


Fig. 1. The regression of phonological awareness scores on age in kindergarten and school (grade 1) children.

of errors. Separate analyses of the effects of schooling and age on syllabic and subsyllabic segmentation revealed that schooling had a larger effect than aging in reducing both types of errors. However, while schooling reduced syllabic segmentation more than CV segmentation, the effect of age was larger on CV than on syllabic segmentation (Table 1).

DISCUSSION

The results of the present study point to schooling as a major factor affecting the development of phonological awareness. Although they prove that an age difference of one year significantly improves performance on some segmentation tests, the present results revealed that the experience accumulated during the first five months of schooling en-

hanced phonological awareness four times as much. This effect was impressive in both absolute and relative terms: 32% correct answers corresponds to an effect size of 1.4 kindergarten standard deviations.

Interpreting the schooling effect, we should consider that it is based on only

Table 1. Percentage (SD) of syllabic and subsyllabic segmentation errors made by kindergarten and first grade children

	Kindergarten	Grade 1
Syllabic errors	12 (5)	8 (6)
Subsyllabic errors	27 (13)	13 (7)

the first five months in school.' Although during the first grade, Israeli school children are involved in a variety of scholastic topics, the curricular activity during the first half of the year is dedicated almost entirely to reading instruction. The kindergarten activity, however, includes no formal exposure to the alphabet. Consequently, we suggest that the schooling effect reflects primarily reading instruction and, therefore, that the present results support the contention that learning to read significantly enhances phonological awareness.

Additional support for a connection between reading instruction and the development of phonological awareness is provided by the analysis of errors. Indeed, the method of reading instruction adopted by a great majority of Israeli schools ("without secrets") emphasizes the sound of individual orthographic segments. However, as already mentioned, many orthographic segments in Hebrew are mapped into two phonemes, a consonant and a vowel. Accordingly, although schooling reduced errors caused by subsyllabic (CV) as well as syllabic segmentation, the former were reduced less. This trend is in contrast with the usual findings in other languages where a direct transition from syllabic to phonemic segmentation has been observed (Cossu, Shankweiler, Liberman, Katz, & Tola, 1988), and is best explained by the specificity of the Hebrew orthography. Thus, the schooling effect on the pattern of errors suggests that reading instruction fosters phonological awareness by manipulating language-specific orthographic segments.

The significant influence of the process of reading acquisition on the devel-

1. We assume that the "grade effect" reflects primarily the drastic change in scholastic activities from kindergarten to school rather than the much smaller changes between the type of experience accumulated during the second and the first half of the year in kindergarten. This assumption is supported by a comparison of phonological awareness of the same children at the beginning and the end of the last year in kindergarten (Leshem & Bentin, in preparation). This comparison showed that in absence of specific training, phonological awareness during that year improved at about the same rate as suggested by the "age" effect in the present study.

Development of Phonological Awareness

opment of phonological awareness should not, however, be interpreted as evidence against the importance of phonological awareness in reading acquisition. In fact, several studies have revealed that improving phonological skills in kindergarten has a positive influence on reading acquisition (for a recent review, see Goswami & Bryant, 1990). Moreover, the significant age effect that was also observed in the present study suggests that some form of phonological awareness is achieved in kindergarten and is independent of formal reading instruction. These data suggest that cognitive-linguistic skills necessary for achieving phonological awareness mature by the age of six, promoted by natural development or informal linguistic experience. It is possible that this maturation is a necessary condition for reading acquisition in the first grade to trigger phonological awareness.

The significant-age effect is more difficult to interpret. Obviously, this effect could be due to spontaneous cognitive maturation. However, maturation is not the only possible explanation. Six-year-old children not only are one year older than five-year-old children but are also more experienced in areas that might be relevant to phonological awareness. Although in Israel formal instruction in the kindergarten does not include learning the alphabet, the children are informally exposed to orthographic symbols while watching TV, looking at street signs, etc. The amount of informal experience with letters is proportional to age. Therefore, the within-grade increase in phonological awareness might reflect the increased linguistic experience rather than "pure" cognitive maturation. In other words, both the schooling and the age effects might have been mediated by the same underlying factor, the amount of experience with printed language.

Finally, one caveat should be considered. In the present study, we tested phonological awareness by tests of phonemic segmentation. Other studies suggest that our conclusions might not hold for other tests of phonological awareness. One example is syllabic segmentation ability, which was quite good in kin-

dergarten (Leshem & Bentin, in preparation; Liberman et al., 1974). Another is the differential effects of literacy on phonemic and syllabic or subsyllabic segmentation in illiterate adults found by Bertelson and his associates (Bertelson & de Gelder, 1989; Bertelson, de Gelder, Tfouni, & Morais, 1989). These studies showed that illiterates performed reasonably well in tests of vowel deletion and rhyme judgment but poorly on consonant deletion, suggesting that phonological awareness is a heterogeneous metalinguistic ability that involves "separate components which obey different developmental mechanisms." Considering the existing pattern of evidence, including our own, we adhere to this proposition. We suggest that sensitivity to highly resonant vocalic centers that form syllabic nuclei develops naturally during speech perception. On the other hand, explicit deciphering of coarticulated individual phonemes and ability to consciously manipulate phonemic segments is significantly enhanced by learning to read an alphabetic orthography.

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