The Effects of Aging and First Grade School on the Development of Phonological Awareness*

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The independent influence of aging and schooling on the development of phonological awareness was assessed using a between-grades quasi-experimental 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 bigger 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 aptitude of being aware of the phonemic structure of spoken words. It is usually assessed by testing the subjects' ability to isolate and manipulate individual phonemic segments in words.

Although as soon as a child is able to understand and produce speech he obviously makes phonemic distinctions, the ability to manipulate phonemic segments consciously develops only around the first grade in the elementary school. For example, Liberman, Shankweiler, Fisher, and Carter (1974) found that none of the pre-kindergartners and only 17% of the kindergartners tested were able to parse words into phonemes, while 70% of the first graders tested succeeded in doing so.

The significant improvement in phonological awareness at this age may be primarily ascribed to one of two factors (which are not mutually exclusive): (1) cognitive-linguistic skills which 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 individual 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). Assuming that children learn about these letter-sound correspondence when they learn to read, it seems likely that during the acquisition of reading skills they become explicitly aware that words are formed of the sounds which the letters represent. Owing to the impossibility to experiment with elementary school attendance, the effect of reading instruction on phonological awareness has been investigated only indirectly in studies that have relied on natural variation: (1) between literate and illiterate adults; (2) between different orthographic systems (alphabetic vs. logographic) among literates; or (3) in the emphasis upon letter-sound correspondence between reading instruction methods within the alphabetic system (e.g., “analytic” vs. “global” methods).

Most of these studies suggested that learning to read triggers, or at least promotes the development of phonological awareness. For example, Morais, Cary, Alegria, and Bertelson (1979) reported that the performance of illiterate adults on tests of phonemic segmentation was inferior to that of other adults from the same rural community who learned to read in adulthood (see...
The "between-grades" quasi-experimental paradigm (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, in practice, the admission to school is not solely a matter of the child birth date. As mentioned in the introduction, relatively bright children might enter the first grade "early," whereas children who are not sufficiently developed (intellectually or emotionally) remain an additional year in kindergarten. The frequency of grade misplacement is particularly high near the official cut off point (which in Israel is based on the Hebrew calendar and falls sometime in December; see Cahan & Cohen, 1989 for details). In order to cope with this problem of selection, 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 (i.e., the oldest in their class), the months with the highest proportion of "missing" children (Cahan & Cohen, 1989).

Subjects. The sample consisted of all first graders born in 1981 (with the exceptions described above) frequenting the seven elementary schools serving four neighborhoods of Jerusalem (319 children of both genders), and all children born in 1982 from the 15 kindergartens serving the same neighborhoods (352 children of both genders). The selected neighborhoods represented the same neighborhoods (352 children of both genders). The selected neighborhoods represented upper-middle-class, middle-class, and lower-middle class population.

Tests and Materials. Phonological awareness was measured by a battery of four sub-tests of constrained phonemic segmentation (Goldstein, 1976; Zhurova, 1973) each containing 20 items. The sub-tests were selected from a battery devised and validated in a pilot study (H. Leshem, unpublished doctoral dissertation), and were chosen because they did not require subjects to perform cognitive operations other than phonemic segmentation (for a survey of various types of segmentation tests see Content, Kolinsky, Morais, & Bertelson, 1986; Stanovitch, Cunningham, & Cramer, 1984). 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 in test 2.

4. Isolation of the last phoneme in self generated pictures' names. Similar to 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 uni- to three-syllabic words. Both consonants and vowels were used as initial or last phonemes.

Measures of phonological awareness. The phonological awareness score of each child was the percentage of correct responses across all four sub-tests. In addition, two error scores were calculated per subject: (1) The percentage of syllabic (rather than phonemic) segmentation. (2) The percentage of sub-syllabic (i.e., consonant + vowel) segmentation. This distinction was particularly desirable in this study because in Hebrew vowels are represented primarily by diacritical marks that are always appended to consonantal letters. Hence, the basic phonemic unit that is mostly emphasized by teachers during the processes of reading acquisition is bigger 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, in Hebrew learning to read should develop some awareness to sub-syllabic rather than phonemic segments.

Procedure. The entire sample was tested within the last two weeks of February. Hence, the school children had 5 months of reading instruction. The examiners were 20 students of education or psychology who received special training; they were sent at random to first grade classes and kindergartens and most tested both groups of children.

The tests, which lasted together from 30 to 40 minutes, were administrated individually in a separate room in the school (or kindergarten). Before performing 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

As expected, the percentage of correct responses on the phonemic segmentation battery was higher in school children (76%, SD=14%), than in the
kindergarten (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 (Figure 1).

Owing to the insignificant difference in the slopes obtained within each grade level, it was assumed that the two regression lines were parallel. Accordingly, the net effects of chronological age and schooling were obtained from the regression coefficients of age (in months) 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 the net effect of one year of schooling was 32% (SE=3.4%) (see Figure 1). Both effects and the difference between them were significant (p<.05).

As would be expected, improved phonemic segmentation, whether as a function of chronological age or of schooling, was accompanied by a reduction in the percentage 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 maturation was bigger on CV than on syllabic segmentation (Table 1).

<table>
<thead>
<tr>
<th></th>
<th>Kindergarten</th>
<th>Grade A</th>
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<tbody>
<tr>
<td>Syllabic errors</td>
<td>12 (5)</td>
<td>8 (6)</td>
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<tr>
<td>Sub-syllabic errors</td>
<td>27 (13)</td>
<td>13 (7)</td>
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Discussion

The results of the present study point to schooling as a major factor affecting the development of phonological awareness. While 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 enhanced 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, which is an unusually large effect.

Figure 1. The regression of phonological awareness scores on age in kindergarten and school (Grade 1) children.
Interpreting the schooling effect we should consider that we tested our sample during the last two weeks of February. Hence, this effect is based on only the first five months in school. Although during the first grade Israeli school children are involved in a variety of scholastic topics, the main curricular activity during the first half of the year is dedicated almost entirely to reading instruction. At the same time, the kindergarten activity 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, in fact, mapped into two phonemes, a consonant and a vowel. Accordingly, although schooling reduced errors caused by sub-syllabic (CV) as well as syllabic segmentation, the former were reduced less. This trend contrasts the usual findings in other languages where a direct transition from syllabic to phonemic segmentation was observed (e.g. Cosset al., 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 foster phonological awareness by manipulating language-specific orthographic segments. The latter hypothesis was supported by the results of a recent study of bilingual children (Bentin & Bork, unpublished). The results of that study showed that learning to read Hebrew improved performance on segmentation tests in English only about half as much as in Hebrew.

The significant influence of the process of reading acquisition on the development of phonological awareness should not, however, be interpreted as evidence against the importance of phonological awareness on reading acquisition. In fact, several studies revealed that improving phonological skills in kindergarten has a positive influence on reading acquisition (Bradley, 1989; Bradley & Bryant, 1983; 1985, Bentin & Leshem, in press; see also Perfetti, Back, Bell, & Hughes, 1987; Vellutino & Scanlon, 1987; for a recent review see Goswami & Bryant, 1990). Moreover, the significant age effect that was observed in the present study suggests that some forms of phonological awareness is achieved in kindergarten and is independent of formal reading instruction.

These data suggest that cognitive-linguistic skills that are necessary for achieving phonological awareness mature by the age of six, promoted by natural development and/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 within-grade (age) effect is more difficult to interpret. Obviously, this effect can be due to spontaneous cognitive maturation. However, maturation is not the only possible explanation. Six years old children are not only one year older than five years old children but 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, street signs, etc. The amount of informal experience with letters is proportional to age. Therefore, the within-grade increase in phonological awareness observed in the present study might reflect the increased linguistic experience rather than "pure" cognitive maturation. In other words, both the "grade level" and the "age level" effects in the present study might have been mediated by the same underlying factor, the amount of experience with printed language. Hence, the difference between the two effects might reflect the difference between formal reading instruction and informal experience with printed language.

Before concluding, one caveat should be considered. In the present study, we tested phonological awareness by tests of phonemic segmentation. Other studies suggest that the present results might not be valid for other tests of phonological awareness. For example, syllabic segmentation ability was quite good in kindergarten (Bentin & Leshem, in press, Liberman et al., 1974) and that sensitivity to rhymes and alliterations develops naturally between the age three and five, before the children can read (Maclean, Bryant, & Bradley, 1987). Different effects of literacy on phonemic and syllabic or sub-syllabic segmentation was found also in illiterate adults (Bertelson & de Gelder, 1989; Bertelson, de Gelder, Tfouti & Morais, 1989). That study showed the illiterates performed reasonably well in tests of vowel
deletion and rhyme judgment, but poorly on consonant deletion. On the basis of their findings, Bertelson et al., (1989) propose that phonological awareness is a heterogenous meta-linguistic ability that involves “involve 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.

REFERENCES


FOOTNOTES

*Psychological Science, 2(IV), 271-274 (1991).*

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