

Applied Psycholinguistics 16 (1995), 463-487

Printed in the United States of America

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Phonological awareness in illiterates: Observations from Serbo-Croatian

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ABSTRACT

Adult illiterate and semiliterate speakers of Serbo-Croatian were assessed on reading, writing, phonological, and control tasks. Most subjects had acquired measurable literacy skills despite a documented lack of formal instruction. The individual differences in these skills were highly specific. They were related to measures of phoneme segmentation and alphabet knowledge, but only weakly related to general cognitive abilities. Three groups, categorized with respect to the subjects' ability to identify the letters of their Cyrillic alphabet, differed on phoneme deletion and phoneme-counting tasks, but not on syllable-counting, picture vocabulary, or tone-counting tasks. Alphabet knowledge was more tightly coupled with phoneme awareness than has been found in speakers of English. Cross-language similarities and differences are discussed, highlighting the role that phonological transparency of the orthography may play in the acquisition of literacy.

It has long been argued that, in order to master reading and writing in an alphabetic system, the learner must become aware that words come apart into sequences of phonemes (Liberman, 1973). Lacking that insight, a beginner would be unable to grasp the alphabetic principle. A considerable body of research has borne out that a new learner's ability to segment words phonologically is the most powerful predictor of future reading and spelling

segmentation by phoneme. Because speech is highly coarticulated, the speech signal is quasicontinuous; it is not discretely partitioned into the phonemes we represent alphabetically in writing. If this circumstance does contribute to the difficulty of achieving phonemic awareness, it would cut across all languages.

Other factors may act to modulate the difficulty of achieving full awareness of phoneme segmentation, and these may vary with particular characteristics of the language and orthography. Languages are known to differ on phonological characteristics such as the complexity and variety of syllable types (DeFrancis, 1989; Mattingly, 1992). They also differ in how transparently and consistently the orthographic representations map onto the phonology (Liberman, Liberman, Mattingly, & Shankweiler, 1980). In so-called phonologically shallow orthographies, constraints on sound sequences are the only sources of constraints on letter sequences. The orthography can be said to represent more directly the phonology. In phonologically deep orthographies, restrictions on letter sequences derive not only from phonological constraints, but also from constraints relating to the etymology and morphology of the written language. Serbo-Croatian is said to anchor one end of an orthographic depth continuum and is closely allied with the Romance languages; Hebrew and logographic Chinese are at the other extreme; while English is nearer the middle of the continuum. To the extent that such positionings make a difference in the course and outcome of literacy instruction, all alphabetic systems are not equally learnable. In particular, learning to read a phonologically shallow orthography may be characterized by a more rapid development of phonological awareness and a correspondingly rapid development of word-decoding skills.

This article reports on an experiment using adult illiterates and near-literates whose language is Serbo-Croatian. Given that each grapheme has only one phonemic interpretation and there are no silent or double letters, the orthography-phonology link is explicit. Of concern are the segmentation abilities of Serbo-Croatian speakers and, in particular, the question of how these abilities compare with those demonstrated by speakers of languages which may (or may not) differ on this dimension. Before considering the particulars of the experiment, we will present evidence that led to our predictions about the role of the language environment in the development of reading skill.

The role of phonological awareness in reading acquisition

As remarked at the outset, a grasp of the alphabetic principle would seem to require an awareness of the segmental structure of speech; in fact, some measures of segmental awareness are good predictors of future reading skill. A number of tasks have been used to evaluate segmental awareness. Subjects may be asked to count the number of segments in an utterance, reverse its segments, add a segment to the front, or delete one. They might be required to choose those utterances whose relevant segments match or differ. The segments in question can include syllables as well as phonemes.

Somewhat related are tasks directed at rhyme sensitivity in which subjects are asked to supply a rhyme for a target utterance or to choose the rhyming members from a sequence of utterances. Phonological awareness is not of a piece: tasks involving phonemes, syllables, and rhymes reflect different levels of phonological structure, with awareness of phoneme segmentation being most closely related to reading skill.

Research in several language communities has found that children who cannot yet read have great difficulties with tasks that tap awareness of phonemes. Liberman and her colleagues (Liberman et al., 1974) demonstrated that syllable segmentation develops earlier than phoneme segmentation in English-speaking American children, and it continues to be easier for the young child from preschool through first grade. Moreover, early phoneme analysis skills are a better predictor of later reading achievement than syllable analysis skills (Mann & Liberman, 1984). Italian children show two of these patterns: syllable segmentation skills develop earlier than phoneme segmentation skills, and phoneme analysis skills are a better predictor of later reading achievement than syllable analysis skills (Cossu, Shankweiler, Liberman, Katz, & Tola, 1988). Swedish and Danish children, too, show that phoneme analysis skills in kindergarten outstrip syllable analysis and rhyme production skills in correlating with first- and second-grade reading achievement (Lundberg et al., 1988; Lundberg, Olofsson, & Wall, 1980, reanalyzed in Wagner & Torgesen, 1987). A similar failure by rhyming tasks to predict reading success in English was possibly due to a limited range of item difficulty, given that the rhyme task was performed at ceiling (Stanovich et al., 1984; Yopp, 1988). Interestingly, even though the degree of difficulty of phoneme tasks varies widely, with phoneme deletion being especially difficult, their predictive power is more or less equivalent (Stanovich et al., 1984).

Preschool children, though unable to segment words by phoneme, are nonetheless aware of some aspects of phonological structure. In addition to the evidence that syllables are identified earlier than phonemes, there is also evidence that the appreciation of rhyme and alliteration precedes the development of phoneme awareness. Moreover, it has been suggested that these coarser aspects of phonological awareness may play a facilitating role in children's grasp of the alphabetic principle. On the basis of such findings, the Oxford group maintains that an appreciation of rhyme may be a prelim-

English. A more rapid development of phonological awareness and a more rapid progress in learning the code might be expected in a language that maintains a one-to-one correspondence between graphemes and phonological units. Support for this contention comes from a comparison of Italian and American children provided by Cossu et al. (1988): Italian children performed better than their American counterparts on phoneme tasks at the preschool level and in each of the first two school years. Their superiority on syllable tasks also reflected language differences: Italian has fewer vowel distinctions, morphophonological alternations, and syllable types than English.

Comparisons of successful and unsuccessful readers

With respect to beginning reading, phoneme awareness tasks distinguish children who have acquired the alphabetic principle from those who have not. In addition, older children categorized as good or poor readers (on the basis of teachers' evaluations, reading achievement tests, latencies and errors in decoding pseudowords) are differentiated on tasks that seem to implicate phonological abilities. For example, over and above differences in IQ, good readers are better than poor readers at remembering both printed and spoken nonsense syllables, letter strings, and words (see Mann, 1984, for a review); they do not differ in memory for faces or nonsense drawings (Lieberman, Mann, Shankweiler, & Werfelman, 1982).

Perhaps most telling are those manipulations that hinder the success of good readers precisely because they are phonologically analytic. For example, recall of consonant strings with phonetically confusable names (e.g., CEGVZ) is much more difficult for good readers than recall of consonant strings with phonetically nonconfusable names (e.g., OFQYX) – so much so that their mean number of errors approaches that of marginal and poor readers (who have difficulty with both types of strings) (see Shankweiler, Lieberman, Mark, Fowler, & Fischer, 1979). Similarly, although good readers make fewer errors on both meaningful and semantically anomalous sentences, if the constituent words are phonetically confusable, their errors rival those of poor readers (Mann, Lieberman, & Shankweiler, 1980). A parallel result has been obtained in Serbo-Croatian: skilled readers are hindered more by phonological ambiguity¹ than are less skilled readers (Feldman, Lukatela, & Turvey, 1985).

Phonological awareness in adult literacy

Evidence from a number of languages suggests that adults who cannot read an alphabetic orthography are unable to manipulate phonemes. The results of several studies by the Brussels-based group, who explored metalinguistic abilities in adult illiterates living in rural Portugal (Morais, Bertelson, Cary, & Alegria, 1986; Morais, Cary, Alegria, & Bertelson, 1979; Morais, Content, Bertelson, Cary, & Kolinsky, 1988), indicated that illiterates performed very poorly on tasks that assessed their ability to carry out analysis of spoken words into phonemes. For example, illiterate subjects could nei-

ther add a consonant to nor delete a consonant from the beginning of a nonsense word (Morais et al., 1979); in addition, they could not segment speech into units smaller than the syllable (Morais et al., 1986). Illiterate subjects were able to delete syllables and detect rhymes, but their performance was nonetheless inferior to that of ex-illiterates (those who had participated in a course of reading instruction as adults). A picture recall task revealed that, although illiterates worked with smaller sets than ex-illiterates (i.e., showed poorer short-term retention), both groups showed poorer performance on rhyming sets, reflecting the use of speech-related codes. Even when the ex-illiterates were separated into good (fast, fluent, error-free) and poor readers (slower, less fluent, with occasional errors), the differences between illiterates and poor readers on most tests were large compared with the differences between good and poor readers (Morais et al., 1986). An exception surfaced in the control task, which required the subjects to segment melodies (reproducing the last three notes of a four-note sequence): illiterates and poor readers were equivalent to each other though inferior to good readers.

Adult quasi-illiterate speakers of English are similarly impaired on phonemic segmentation tasks. Nine men enrolled in a community literacy class (who had some schooling and who reported serious difficulties in spelling) were able to achieve only a 58% success rate in a phoneme segmentation task tested by consonant deletion (Liberman, Rubin, Duquès, & Carlisle, 1985). This contrasts with a 75% performance by 11- and 12-year-old American school children (Rosner & Simon, 1971). A large sample of men of low-literacy (fifth grade reading level or below), studied by Read and Ruyter (1985), performed very poorly on segmentation tasks. As has been found with children, the difficulties were greater with phonemes than with syllables: 39% correct on phoneme counting, 48% correct on phoneme addition, 77% correct on syllable counting. The poor level of success in reading nonwords (57%) was comparable to a group of fifth graders (taken from Richardson, DiBenedetto, & Adler, 1982) who were a year or more below grade level (58%), in contrast to fifth grade good readers (93%) (Read & Ruyter, 1985).

Corroboration of the view that experience with an alphabetic orthography facilitates the acquisition of phonemic segmentation comes from a study carried out in China with logographically literate adults. The subjects were grouped according to whether they had received instruction in the alphabetic *pinyin* orthography (which, since 1958, has been taught for 4 weeks in the first grade) (Read, Zhang, Nie, & Ding, 1984). One group had received *pinyin* instruction, while a second group of older Chinese readers, though also literates in reading the traditional logograms, received no instruction in the alphabetic principle. In phoneme addition or deletion tasks (similar to those used with Portuguese subjects), all 12 alphabetic subjects got at least 70% correct, whereas only 2 of 18 nonalphabetic subjects did better than 55%. Unlike literate and illiterate adults, who differ in written language experience, both alphabetic and nonalphabetic subjects encounter written language daily. It can be assumed that their language experience is

nearly comparable. These results suggest that alphabetic reading instruction is a critical factor in developing phonological segmentation abilities (or, perhaps, in preserving those abilities) (see Mann, 1986).

Implications of literacy training

Taken together, the findings with beginning readers, poor readers, and (alphabetically) illiterate adults suggest that all of the subjects find it difficult to penetrate the internal structure of words to recover their phonemic structure. These individuals are language users, but their experience with the spoken language, in itself, has not provided them with explicit conscious awareness of phonemic structure. Morais and colleagues (1979) concluded that the differences between illiterates and ex-illiterates were tied to instruction and experience in an alphabetic system and, quite specifically, to tasks involving phonemes rather than syllables, rhymes, or alliteration. While reading instruction brings about improvement in all segment and sound-based abilities, they argued that a phonemic analysis capability seems particularly reliant on the experience gained through specific instruction. (Most often, this instruction occurs in the context of teaching to read, but it may be taught independently; Byrne & Fielding-Barnsley, 1991, 1995; Lundberg et al., 1988.) Presumably, when instruction makes explicit the relationship between sounds and graphemes (grapheme-phoneme correspondence rules or connections), the beginning reader becomes aware of the phonological structure of utterances – the reader has grasped the alphabetic principle (Liberman, Shankweiler, & Liberman, 1989; Mattingly, 1972, 1980).

A number of writers, including Morais and his colleagues, have maintained that this is not a one-way relationship, but a complex interaction. With the acquisition of an alphabetic orthography there ensues a rapid development in phonological segmentation skills; reciprocally, an advanced level of phonological awareness improves reading and writing abilities (Ehri, 1984; Liberman et al., 1974). For the present purposes, we choose to emphasize only that the rapidity of the development seems to depend crucially on language. That is to say, phonological segmentation skills should develop more thoroughly and earlier in languages whose orthography is phonologically precise.

The link between phonological awareness and literacy is supported by the failures of illiterate Portuguese adults and nonalphabetic Chinese readers on phoneme segmentation tasks. However, it should be noted that their failure was not complete: in phoneme segmentation, 20% of the illiterates matched or exceeded the performance of 23% of the literates in Morais et al. (1979) and 62% of the poor readers in Morais et al. (1986). The more successful illiterates were those who had some early schooling or who had been taught to identify letters by their children; they performed somewhat better than those who had received no instruction at all (Morais et al., 1979). Similar anomalies can be found in the data from the readers of Chinese. Of the nonalphabetic subjects, 11% matched or exceeded the per-

formance of 25% of the alphabetic subjects in Read et al. (1984). While it is possible that these levels of performance mean that segmentation skill in some people can occur outside the context of alphabetic literacy training, it is reasonable to suppose that the illiterates in question gained some degree of familiarity with sound-to-letter correspondence (perhaps through incidental reading instruction from their children or, in the case of the Chinese, from noticing the *pinyin* transcriptions of logographic signs provided for foreigners in Beijing). This interpretation would suggest that a rather minimal alphabetic exposure – not necessarily enough to read whole words – is sufficient to develop phonemic awareness in linguistically mature adults, given a shallow phonology and orthography. This possibility has conceptual and empirical implications. Conceptually, it suggests that the literacy-illiteracy distinction should be viewed as poles of a continuum rather than as distinct categories. Empirically, it implies the need for control of the factor of alphabetic familiarity to allow a clean evaluation of the link between phonological awareness and literacy.

Other empirical issues are also germane. In addition to an explicit assessment of adult illiterates' degree of alphabetic familiarity, the tendency for good readers to be superior to poor readers in all tasks demands an evaluation of subjects' general verbal abilities. It is possible that the differences between literate and illiterate groups might reflect more general differences in their capacity (due to pre-existing analytic skills or intellectual or motivational level) to benefit from literacy instruction or language experience. For example, ex-illiterates could be successful in the segmentation tasks not because they acquired literacy, but because they had segmentation skills before they acquired literacy. On the other hand, illiterates (or low-literacy adults who have attended literacy courses but have not attained the level of proficiency required to earn a certificate) may be unable to benefit from instruction because they lack even the most rudimentary awareness of phonemic segmentation. The comparison between illiterate and ex-illiterate subjects, in and of itself, therefore, does not allow firm conclusions about the relationship between literacy training and phonological segmentation abilities to be posited.

Expectations of adult illiterate speakers of Serbo-Croatian

In Serbo-Croatian, the phonology of the spoken language is closely transcribed by its orthography – partly a result of spelling reform by V. Karadžić in the early 1800s. If we assume that phonemic awareness is stimulated by encounters with the alphabet, then we could expect more rapid acquisition in a language which maintains a one-to-one correspondence between graphemes and phonological units. Indeed, comparisons of beginning readers of English and Italian bear this out. Like Serbo-Croatian, Italian is relatively shallow, with few morphophonological alternations. Italian children are better at both syllable and phoneme segmentation tasks than their English-speaking American counterparts, and they probably advance more rapidly in early reading acquisition (Cossu et al., 1988; Cossu, Shankweiler,

Liberman, & Gugliotta, 1995). Such differences suggest that Serbo-Croatian provides a revealing comparison with other languages that have a deeper orthography such as English or, to a lesser extent, Portuguese. The question is, should the metalinguistic abilities of Serbo-Croatian speakers differ from other populations whose languages do not have such a straightforward relationship to their orthographies? The present study set out to explore the metalinguistic word-segmentation abilities of Yugoslav adult illiterate subjects, drawing comparisons, wherever possible, to beginning readers and illiterate adults from other linguistic environments.

Special care was taken in the selection and categorization of illiterate subjects, restricting individual characteristics such as age, profession, geographic setting, and cause of illiteracy. They were Yugoslavian adult speakers of Serbo-Croatian who have been exposed to minimal, if any, reading instruction. Although they differed in their familiarity with their Cyrillic alphabet, their daily routine did not include reading, and therefore they did not "tune up" their phonological awareness. Subjects' analytic metalinguistic abilities were assessed with segmentation tasks similar to those used with Portuguese illiterates (Morais et al., 1979) and with American children (Liberman et al., 1974): syllable counting, phoneme counting, and deletion of the initial consonant. Because failure on the metalinguistic tasks could reflect a general analytic deficiency rather than a deficiency specifically for the phonological level, two nonlinguistic control tasks were introduced: counting tones and counting sticks. Subjects' verbal IQ and short-term memory span (a limitation associated with poor readers) were also assessed.

There were three major expectations. First, in light of the intimate connection between literacy and phonemic awareness, truly illiterate adults should be unable to perform phonemically analytic tasks. Second, consistent with previous results with children and adults of low literacy, it was expected that syllable tasks would be easier than phoneme tasks. Third, given the nature of the letter-sound relationship in Serbo-Croatian, it was expected that familiarity with the alphabet would establish fairly secure phonemic awareness. The first prediction concerns what would constitute evidence for a close relationship between segmentation abilities and reading skill. The second prediction derives from our understanding of the syllable as a less abstract segment, closer to the basic unit of articulation. The final prediction stands in contrast to what has been found with English-speaking adults of low literacy and children who are beginning readers - that is, knowing the names of letters per se did not contribute much to segmental skills.

METHOD

Subjects

The study was carried out in a rural area of Serbia which was, at that time, a republic of Yugoslavia. The subjects, 23 adult females between the ages of 55 and 76 were tested in three villages (Selevac, Krcecin, and Nova

Pazova) within a 200 km radius of Belgrade. Although two alphabets are in use in Yugoslavia (see note 1), in rural Serbia all printed matter (street and shop signs, packaging) is in Cyrillic. Exposure to the Roman alphabet would be considerably less.

All of the subjects were active farm workers; none of them had ever been employed outside the home. They were paid for participation in this study. Most of them were identified and introduced to the experimenter by local educational personnel (teachers and school directors). No subject had ever attended a regular school. The reason for that in all cases was poverty, combined with a traditional attitude that girls do not benefit from schooling. Some of the subjects had, as adults, attended the obligatory elementary reading instruction course instituted throughout the whole of Yugoslavia after World War II. None of the subjects had completed the course, spending between several days and one month in attendance; in all cases, their drop-out was for economic reasons and reasons related to culturally defined gender roles. From questioning each of the subjects, it was ascertained that they withdrew because they could not be spared from farm and household chores (in conjunction with the prevailing village attitude that women do not need to be literate). Nevertheless, some of the subjects had learned the alphabet, presumably with help from their children and grandchildren. The subjects who knew the alphabet are identified in all analyses.

Literacy assessment

Literacy was assessed by testing each subject on her reading and writing abilities at three levels: letters, words, and sentences. First, each subject was presented all 30 letters from the Cyrillic alphabet and asked to identify them. If a subject could identify a majority of the letters, she was then asked to read individual words, all of which were concrete, frequent nouns. To conclude the reading test, a subject was given sentences and paragraphs from a second-year reading text book.

The writing test resembled the reading test. A subject was asked to write individual letters, then words, and finally sentences. We found that subjects who could read some of the letters often could not write them.

Tasks and procedures

The subjects were tested on three metalinguistic tasks that tested their ability to segment speech: (a) phoneme counting, (b) syllable counting, and (c) deletion of the initial consonant.

Phoneme counting. The test contained 40 items: 30 were words and 10 were single phonemes. There were equal numbers of 1-, 2-, 3-, and 4-phoneme items. The single-phoneme items included all the vowels in Serbo-Croatian (*a, o, e, i, u*) and some consonants (*z, ž, s, š, f*). Among the 2-phoneme items, half were pronouns and half were nouns. All 3- and 4-phoneme items

were concrete, high frequency nouns. The structure of most test words was alternating consonant-vowel (CV) sequences. The test began with four sets of training items (each set containing 1-, 2-, 3-, and 4-phoneme items ordered successively); these items offered the subject an opportunity to deduce the nature of the unit being counted.

The test, modeled after that designed by Liberman et al. (1974), required the subjects to count the phonemes of auditorily presented items. The examiner demonstrated the task by performing the first training set: she said the word with normal speed and intonation, and then she repeated the word slowly, tapping once with a wooden dowel for each spoken phoneme. After the demonstration, the subject was invited to imitate the examiner and participate in the practice trials. The demonstration continued through three practice sets. The test items were ordered randomly with respect to the number of phonemes. Subjects responded by repeating the item and tapping the answer without the examiner's help.

Syllable counting. The test contained 40 items. There were an equal number of 1-, 2-, 3-, and 4-syllable words. All of the words were concrete, high frequency nouns. All of the syllables had either the CV or CVC structure.

The design of this task was identical to that for phoneme counting except that the items varied the number of syllables instead of the number of phonemes. The task was to count syllables in an auditorily presented word. The procedure was the same as for phoneme counting, starting with four sets of training items.

Consonant deletion. The items were pseudowords whose initial consonants were either [p], [s], or [m]. After correct deletion of the initial consonant, half of the items (experimental and practice) would become words and half would remain pseudowords. All of the items were of the CVCV or CVCVC structure.

The subject had to delete the first phoneme from the auditorily presented items provided by the experimenter. Initially the subject was told that her task was to delete the first "sound" of the item presented by the examiner, but because this instruction was rather difficult for some to follow, a special example was given using the subject's name. For example, if the subject's name was Zora, she was asked to say what she would be called if she lost the first "sound" of her name (__ora). If the subject could not provide the answer, the examiner would do so and then continue the instruction by using the name of another family member. The examiner started with 10 demonstration trials and provided the response if necessary. After the practice trials were completed, 20 test items were presented with no feedback.

Control tasks. In order to assess verbal intelligence, a Serbo-Croatian form of the Peabody Picture Vocabulary Test (PPVT) was administered. Short-term memory was examined by means of forward and backward digit span subtests of the Wechsler Adult Intelligence Scale. Verbal short-term memory is known to have a phonological component but, in contrast to the

experimental tasks, it is not segmental. Counterparts to the Liberman et al. (1974) tapping test required the subjects to count musical tones and sticks. It should be emphasized that tone counting is, in fact, quite challenging, given that the speed of presentation was intended to mimic speech.

RESULTS

Literacy assessment

In spite of their almost total lack of schooling, most of the subjects managed to develop measurable literacy skills. (Table 1).

Alphabet identification. Knowledge of the alphabet, even in subjects who could recognize a majority of the letters, was not necessarily complete. Thus, the percentage of letter identification provided a convenient continuous measure of alphabet familiarity. Subjects were divided into three groups according to their ability to identify single letters of the alphabet. The poor letter recognition (PLR) group consisted of 7 subjects, ranging in age from 60 to 70 years (mean = 68), who identified fewer than 50% of the letters; this group included 2 subjects who could not identify any letters. The medium letter recognition (MLR) group consisted of 9 subjects, ranging in age from 55 to 76 years (mean = 65), who could identify up to 95% of the letters. Finally, the good letter recognition (GLR) group, included 7 subjects, ranging in age from 55 to 65 years (mean = 61), who could identify all of the letters.

Reading achievement. In general, reading achievement was predicted by the subjects' letter recognition success. A qualitative description of each subject's performance is provided in Table 1, next to their letter recognition scores.

Women in the PLR group could not read. The one who recognized 50% of the letters could make letter-by-letter sounds for words up to 3 letters, but she could not combine those sounds into a single word unit. Women in the MLR group read letter-by-letter for words between 3 and 8 letters (mean = 4.3). That is to say, they made a sound for each letter and, in many cases, were then able to blend those sounds into a single word. In a number of cases, however, the blended sound was a nonword. Women in the GLR group could read all the words, sentences, and paragraphs. They were slow, and most made a large number of errors. In view of the fact that the material was from a second grade reading text, it must be noted that the best subjects were near-literates.

Writing achievement. For every skill level, writing ability lagged behind reading ability. Figure 1 shows some writing samples and demonstrates the difficulties the subjects had, even those with the highest alphabet familiarity. A qualitative description of subjects' performance is provided in Table 1, next to their reading achievement scores.

Table 1. Letter recognition scores (in %), reading achievement, writing achievement, and literacy scores on each subject

Letter recognition	Reading achievement	Writing achievement	Literacy score ^a
Poor Letter Recognition			
0	does not read	does not write	0
0	does not read	does not write	0
25	reads single letters	does not write	1
30	reads single letters	does not write	1
50	letter-by-letter, up to 3 letters	few letters	4
40	does not read	few letters	1
40	does not read	does not write	0
Medium Letter Recognition			
80	letter-by-letter, up to 4 letter words	does not write	4
90	letter-by-letter, up to 5 letter words	does not write	5
80	letter-by-letter, up to 3 letter words	few letters, with effort	4
95	letter-by-letter, up to 5 letter words	short words, many errors	9
90	letter-by-letter, up to 4 letter words	20% of letters, no words	6
90	letter-by-letter, up to 6 letter words	50% of letters, 3-letter words	10
60	only letters, no words	no letters	1
70	letter-by-letter, up to 4 letter words	no letters	4
90	letter-by-letter, up to 8 letter words	50% of letters	11
Good Letter Recognition			
100	reads paragraphs, slowly, with errors	words, many errors	13
100	reads paragraphs, slowly, with errors	words, few errors	14
100	reads paragraphs, slowly, fluently	sentences, many errors	15
100	reads paragraphs, slowly, with errors	words, many errors	13
100	reads paragraphs, slowly, with errors	words, many errors	13
100	reads paragraphs, slowly, with errors	words, many errors	13
100	reads paragraphs, slowly, fluently	sentences, few errors	16

^aEach increment in reading or writing achievement adds 1 point.

Only 2 women in the PLR group could write any letters at all. In the MLR group, 7 women could write no more than 6 letters (despite recognizing 18–29 of them), 2 could write half of the letters, and only 1 of those could write some 3-letter words. For the GLR group, those who did not make reading errors were the best at writing to dictation, even attempting sentences (one with many errors, the other with few errors). The other GLR subjects could, with many errors, write words to dictation.

Estimated literacy score. For subsequent analyses, these reading and writing achievements were assigned a score, beginning with 0, for those who could not read or write any letters, up to 16, for those who could read paragraphs fluently. Each increment on the reading and writing sides was worth one point. These improvised literacy scores are provided in the far right column of Table

% ID	Target	Sample	Translation
60	СА	GO	/s/ /a/
40	АОМ	40M	/a/ /o/ /m/
50	СИР	С N Q	/s/ /i/ /r/
	БОР	♂ СР	pine
80	МИШ	W И E	mouse
	СОБА	♂ О б А	room
90	Радомила	Радомила	Radmila
80	ДАРИНКА	Д Р П А У А	Darinka
100	НЕ КИТИ СЕ	НЕКИТИЈЕ	(a proverb)
	МИШ	МИШ	mouse
100	КРОМПИР	КОПР	potato
	ЦРВ	СРВ	worm
100	ДАНАС	ДОНО	today

Figure 1. Writing samples from subjects at different levels of letter recognition skill (indicated as % ID). Note that, even among those with relatively high letter recognition, letters are wrong (W for M and E for Ш in mouse), many letters are flipped (P in Radmila's signature, И in Darinka's signature), letters are missing (P, П, and И in potato), and word boundaries are missing (in the proverb).

1. A one-way analysis of variance (ANOVA) performed on these reading scores as a function of letter recognition group revealed a significant effect of group, $F(2, 20) = 54.18, p < .0001$ (PLR = 1.0, MLR = 6.0, GLR = 13.9). Post-hoc tests found all comparisons to be significant ($p < .05$).

Experimental and control tasks

All of the subjects achieved a 100% success on stick counting. The subjects had great difficulty with backward digit span, averaging only 1.2 digits (the groups did not differ in a one-way ANOVA, $F < 1$). These two tasks

Table 2. *Subjects' age and performance (in %) on experimental and control tasks*

Age	Letter recognition	Syllable counting	Phoneme counting	Phoneme deletion	PPVT	Tone counting	Forward digit span
Poor Letter Recognition							
72	0	77	13	0	89	57	71 ^a
61	0	72	25	0	90	60	57
74	25	67	47	0	87	74	86
68	30	0	66	0	84	65	43
70	50	67	77	0	86	52	43
69	40	77	0	0	89	50	43
60	40	80	47	0	91	75	86
Medium Letter Recognition							
76	80	55	85	25	86	80	71
78	90	70	87	40	90	70	71
68	80	77	80	0	86	72	57
60	95	72	77	75	90	52	57
62	90	72	57	45	88	52	71
55	90	95	82	50	91	88	71
54	60	72	57	20	90	67	86
76	70	80	67	0	90	60	71
60	90	58	77	60	92	65	71
Good Letter Recognition							
63	100	60	92	90	88	80	86
	100	95	100	85	85	77	86
58	100	82	100	100	99	70	100
58	100	92	92	85	92	52	86
64	100	85	92	70	97	94	86
60	100	85	95	85	92	67	71
65	100	70	97	80	93	90	71

^aForward digit span is expressed as a percentage of the maximum performance obtained with this population, which was seven items.

were not considered in subsequent analyses. The scores on each of the experimental and remaining control tasks are shown in Table 2. The data were evaluated in a number of ways. Because particular control tasks were not logically paired with particular experimental tasks, separate analyses were conducted. For the experimental tasks, a 3 (Good, Medium, Poor Letter Identification) \times 3 (Syllable Counting, Phoneme Counting, Phoneme Deletion) ANOVA addressed whether people of varying alphabetic familiarity differed with respect to phonemic awareness. The main effect of group, $F(2, 20) = 70.11, p < .0001$, indicates that skill at letter identification is associated with better overall performance on the tasks (GLR = 87%, MLR = 61%, PLR = 34%). The main effect of task, $F(2, 40) = 20.96, p < .0001$, indicates that the subjects performed better on syllable counting (72%) and phoneme counting (70%) than on phoneme deletion

(40%). The interaction of group with task was significant, $F(4, 40) = 6.46, p < .0004$, thus qualifying both of these interpretations. In particular, planned comparisons between letter recognition groups on each of the tasks revealed no group differences on syllable counting, but all comparisons (GLR-MLR, MLR-PLR, and GLR-PLR) were significant for both phoneme counting and phoneme deletion (Tukey $p < .05$).

In order to assess whether such differences simply reflect general intellectual skills, a parallel 3×3 ANOVA for the control tasks (PPVT, tone counting, and digit span) was conducted; to be comparable to the other tasks, which were all percentages, forward digit span was scaled to the maximum performance in this population. The main effect of group, $F(2, 20) = 6.96, p < .01$, again indicates that skill at letter identification is somewhat associated with better overall performance on the tasks (GLR = 84%, MLR = 75%, PLR = 70%). The main effect of task, $F(2, 40) = 33.30, p < .0001$, indicates that the subjects performed better on PPVT (90%) than on tone counting (68%) or forward digit span (72%). The interaction of group with tasks was not significant, $F(4, 40) = 1.72, p > .15$. Nonetheless, planned comparisons were carried out and revealed no significant group differences on PPVT or tone counting and only one difference (GLR-PLR) for forward digit span (Tukey $p < .05$). It has been shown that verbal short-term memory limitations have a phonological basis (Baddeley, 1966) and are associated with differences in reading ability (Conrad, 1972; Shankweiler et al., 1979). The differences among the letter recognition groups as a function of experimental and control tasks are shown in Figure 2.

A second analysis focused on the counting tasks in a 3 (Good, Medium, Poor Letter Identification) $\times 2$ (Syllable vs. Phoneme) $\times 4$ (Number of Segments) ANOVA on the errors. The main effect of group $F(2, 18) = 7.13, p < .01$, again indicates that better letter identification is associated with better performance in the form of fewer errors (PLR = 3.6, MLR = 2.6, GLR = 1.3). While there was a main effect of number of segments, $F(3, 54) = 6.11, p < .01$, there was no overall difference between the tasks, $F(1, 18) < 1$. These effects are best seen in interactions. The Group \times Task interaction, $F(2, 18) = 4.39, p < .03$, revealed that the group difference was attributable wholly to the phoneme-counting task (Figure 3), with simple effects tests showing significance for phonemes, $F(2, 36) = 10.82, p < .0001$, but not for syllables $F < 1$. The Group \times Segments interaction, $F(6, 54) = 4.74, p < .001$, indicates that number of segments mattered for PLR (by simple effects), $F(2, 54) = 10.20, p < .0001$, and MLR, $F(2, 54) = 4.30, p < .01$, but not for GLR ($F \approx 1$). The Task \times Segments interaction, $F(3, 54) = 18.62, p < .0001$, found number of segments to matter for both tasks but in opposite directions: there were more errors with more phonemes, $F(3, 54) = 19.20, p < .0001$, but fewer errors with more syllables, $F(3, 54) = 6.4, p < .001$.

The marginal Group \times Task \times Segments interaction, $F(6, 54) = 2.11, p < .07$, pinpoints this reversal and provides a dramatic contrast between the syllable and phoneme tasks. The flip is largely due to the MLR group,

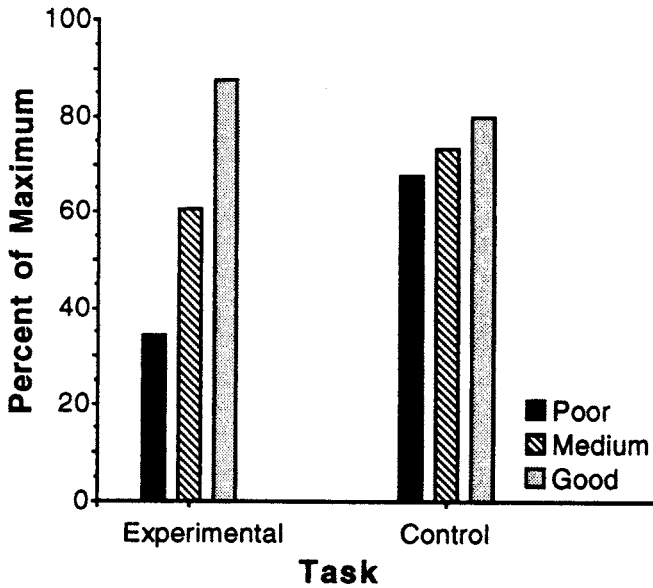


Figure 2. Performance on experimental and control tasks (individual tasks of each type were combined) for the different letter recognition groups.

who encountered special difficulty in counting the number of syllables in 1-syllable words, averaging almost 7 errors out of a possible 10 (upper panel, Figure 4). The simple effect of number of syllables was not significant for either the GLR or PLR group. Systematic group differences were apparent in phoneme counting (lower panel, Figure 4). The number of segments increased errors slightly for GLR ($p < .01$), moderately for MLR ($p < .001$), and sharply for PLR ($p < .0003$).

These group differences were repeated in the analyses of the phoneme deletion scores. Letter recognition group was significant, $F(2, 20) = 43.75$, $p < .0001$, with average scores of PLR = 0 ($SD = 0$), MLR = 35 ($SD = 25.9$), and GLR = 85 ($SD = 9.1$). All paired comparisons were significant. In parallel with other studies testing illiterate adults (Morais et al., 1979; Read et al., 1984) and children (Stanovich et al., 1984), this task was the most difficult for our adult illiterate subjects.

Interrelatedness of tasks

A correlation matrix of the eight measures makes apparent the interrelationships among tasks (Table 3). In particular, phoneme counting, phoneme deletion, letter recognition, and the literacy score were highly correlated with one another and less so with other variables. Syllable counting

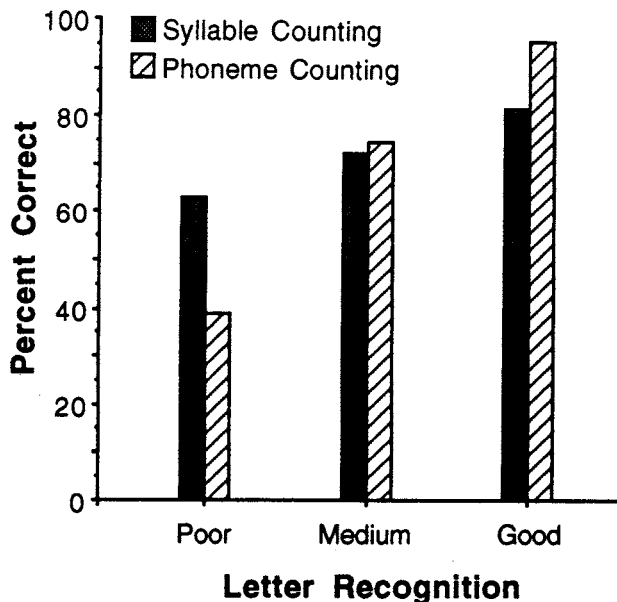


Figure 3. Performance on syllable- and phoneme-counting tasks for the different letter recognition groups.

was not correlated significantly with either of the phoneme tasks, nor was it correlated with the literacy score. A stepwise regression of the literacy score against the tasks entered only phoneme deletion and phoneme counting as significant ($r^2 = .92, p < .0001$). The pattern of results points to (a) a difference between the abilities to segment syllables and phonemes and (b) a relationship between literacy level and phonemic segmentation abilities.

The possibility of constitutional literacy deficits

We should address the possibility that our sample may have included individuals whose reading deficit is due to neurobiological factors, and that these factors may have contributed to the observed group differences. Such a possibility is suggested by the fact that some of the subjects dropped out of reading instruction courses, although the reason given during the individual interviews pertained to socioeconomic factors rather than reading difficulties. Moreover, developmentally language-impaired individuals would be expected to have other language-related difficulties, such as naming common pictorial objects (Katz, 1985; Wolf & Goodglass, 1986). However, the PPVT scores did not differ across letter recognition groups, and performance by all individuals was uniformly strong. Finally, a case for neurologic causation could be made for individuals who had good knowl-

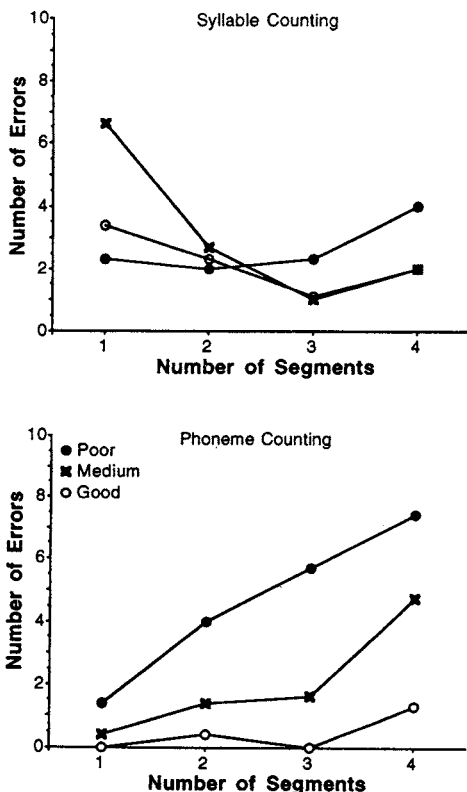


Figure 4. Number of errors for syllable counting (top) and phoneme counting (bottom) as a function of number of segments and letter recognition group.

edge of the alphabet (which does not require sophisticated phonological skills) coupled with poor performance on phonologically taxing tasks. But a reexamination of Table 2 reveals no instances of such a dissociation in the GLR group: those who identified 100% of the letters of the alphabet performed well on both phoneme counting and phoneme deletion. One PLR individual and one MLR individual could be considered discrepant on phoneme counting (40% letters with 0% phoneme counting; 90% letters with 57% phoneme counting), and two MLR individuals could be considered discrepant on phoneme deletion (both of whom scored 0% on phoneme deletion after identifying 70% and 80% of the letters). These two types of discrepancies do not identify the same individuals, as would be expected if their reading deficits were primarily constitutional in origin. Moreover, eliminating these individuals from the analyses (either collectively or as pairs) does not alter the pattern of significances, including the Group \times Task interaction.

Table 3. *Correlation matrix for experimental and control tasks*

	Letter recognition	Syllable counting	Phoneme counting	Phoneme deletion	PPVT	Tone counting	Digit span	Literacy score
Letter recognition	—							
Syllable counting	.32	—						
Phoneme counting	.85***	.10	—					
Phoneme deletion	.83***	.32	.73***	—				
PPVT	.36	.44*	.24	.52**	—			
Tone counting	.35	.09	.49*	.30	.24	—		
Digit span	.39	.45*	.39	.53**	.52**	.46*	—	
Literacy score	.85***	.34	.79***	.95***	.51**	.40	.45*	—

* $p < .05$; ** $p < .01$; *** $p < .0001$.

DISCUSSION

We found that native speakers of Serbo-Croatian who are adept at identifying the letters of their alphabet are also adept at performing tasks that tap phonological abilities – particularly those involving phoneme awareness. They are far superior to ostensibly comparable groups who identify letters less well. It should be emphasized that the women in this study had no formal schooling. The only reading instruction they may have had lasted no longer than a month and occurred over 40 years prior to the testing. Nonetheless, those who succeeded, on the basis of such minimal exposure, in establishing a link between graphemes and phonemes achieved impressive phonemic awareness abilities. Indeed, alphabetic familiarity seems to be a useful index of the lower end of the literacy continuum in Serbo-Croatian.

Against this background, the results can be evaluated with respect to our predictions: namely, (a) minimal phonemic awareness among the truly illiterate, (b) better performance on the syllable task than on the phoneme tasks, and (c) a strong link between alphabetic familiarity and phonemic awareness in Serbo-Croatian. Consistent with (a), it was found that the truly illiterate adults – those in the PLR group – were unable to do the phoneme deletion task at all. This task has been found to be the most difficult for beginning readers as well (Stanovich et al., 1984). Table 4 allows a comparison of the phoneme deletion task used in the present study with that used in Morais et al. (1979) in their study of Portuguese illiterates. Note the gradation in performance as a function of alphabet familiarity by the Serbo-Croatian subjects. The best performed at ceiling, whereas the worst performed at floor. The third group was in between. This result suggests that the discreteness implied by the categories literate versus illiter-

Table 4. *Percent correct phoneme deletions by Portuguese^a and Serbo-Croatian speakers on targets requiring word or nonword responses*

Language	Literacy	Response	
		Word	Nonword
Portuguese	Illiterates	26	19
	Literates	87	73
Serbo-Croatian	Poor letter recognition	0	0
	Medium letter recognition	62	51
	Good letter recognition	94	91

^aData are taken from Morais et al. (1979).

ate is somewhat misleading. The superior performance of the Portuguese illiterates relative to the Yugoslav PLR group suggests that the Portuguese group probably included subjects with some alphabetic ability. The poorer performance by the Portuguese recent literates relative to the Yugoslav GLR group, especially on nonwords, probably reflects the fact that the Portuguese group included subjects who were not firmly established in their literacy skills. In other words, the finer gradation that appears when the subjects are divided on the alphabetic familiarity dimension reinforces the idea that literacy is a continuum.

The PLR group also had considerable difficulty with phoneme counting, averaging 39% correct. If we consider 25% to be chance performance (given that all of the counting tasks involved up to 4 entities), 3 people were at or below chance, including the 2 subjects who could not recognize any letters of the alphabet. It should be noted, however, that two of the PLR subjects achieved modest success, scoring 66% and 77% correct. Nonetheless, it seems clear that phonemic awareness and literacy go hand in hand – a conclusion that is buttressed by developmental and cross-language data (e.g., Ball & Blachman, 1991; Bradley & Bryant, 1983; Byrne & Fielding-Barnsley, 1991; Cossu et al., 1988; Lundberg et al., 1980; Lundberg et al., 1988; Morais et al., 1986).

In support of (b), the PLR group was better at syllable counting than phoneme counting, but the opposite was true of the GLR group, although the GLR subjects did better than the MLR subjects on both tasks. This pattern is reminiscent of the Italian children for whom the initial advantage of syllables over phonemes reversed for first and second graders (Cossu et al., 1988). In contrast, for American children, the syllable advantage shrinks with age (nursery school, kindergarten, and first grade), but does not disappear (Liberman et al., 1974). The similar pattern for Italian children and Yugoslav adult illiterates is noteworthy given that, relative to English, both languages are phonologically shallow. Again, across ages and across orthographies, language users with minimal phonemic awareness have considerably less difficulty with syllables – that is, segments closer to

the basic unit of articulation. Whether a syllable advantage persists (or, perhaps, reverses with literacy experience) seems to be language specific, however.

The corroboration of (c) provides what is perhaps the most striking feature of the results – how closely associated letter knowledge and phonemic awareness were for the unschooled Yugoslavs. The low literacy English-speaking adults of Liberman et al. (1985) and Read and Ruyter (1985) had considerably more schooling than our Yugoslav subjects – presumably their exposure to printed materials was far greater – and yet the MLR (74%) and GLR (95%) groups exceeded the phoneme-counting scores of their English-speaking counterparts (39–58%). Interestingly, the syllable-counting scores of the English-speakers (77%) (Read & Ruyter, 1985) were comparable to those of the MLR (72%) and GLR (81%) Yugoslavs. Amplifying this point, the lower panel of Figure 4 shows that, with increasing ability to identify letters, subjects made fewer errors and were less bothered by multiple segments in counting phonemes. An obvious source of this cross-language difference is the shallow phonology of the Serbo-Croatian language, which lends itself to a correspondingly shallow orthography, with its set of one-to-one mappings between phonemes and graphemes. One consequence of the difference between the two orthographies, which may be important in understanding these results, is the matter of the letter names. In Serbo-Croatian, letters are named by their sounds (/ah/, /buh/, /kuh/) rather than by non-corresponding names, as in the English (“ay,” “bee,” “see”). Reading instruction emphasizes this, so that knowing the letters is, in effect, knowing their phonemic correspondences. In English, some letter names refer to only one of the possible phonemic interpretations for that letter (e.g., “gee” identifies the soft consonant /dz/ but not the hard /g/, while the names of others are actually misleading (e.g., “aitch,” “double u”). These differences help to explain why the link between alphabetic familiarity and phonemic awareness is language specific.

Phonemic awareness and literacy achievement

The groups distinguished by letter recognition ability differed most clearly on the phoneme-counting and phoneme deletion tasks, but differed minimally, if at all, on the syllable-counting and the control tasks. Both syllable tasks and phoneme tasks have been studied as measures of phonological awareness (e.g., Lundberg et al., 1980, 1988; Mann & Liberman, 1984); they have been found to make unequal contributions in predicting subsequent reading success (e.g., Cossu et al., 1988; Liberman et al., 1974; Mann, 1984). Moreover, data sets with a sufficiently large sample size to permit a factor analysis have shown these tasks to load onto different underlying factors, whether for low literacy English-speaking adults (Read & Ruyter, 1985), Swedish 7-year-old kindergartners (Wagner & Torgesen's [1987] reanalysis of data from Lundberg et al., 1980),² or Danish kindergarten children (Lundberg et al., 1988). Thus, across languages there is an

impressive consistency in the nature of the metaphonological measures that show the highest relations with literacy.

It is clear that whatever modest reading abilities adult illiterate Yugoslavs have attained covary dramatically with their degree of phonemic awareness. Indeed, the association between phonemic segmentation and literacy measures appears to be, if anything, more direct in shallow orthographies than in deeper ones. For English-speaking persons, we have reason to believe that phonological awareness and letter knowledge are each necessary but not sufficient conditions for word recognition in reading. As Byrne and Fielding-Barnsley demonstrated (1989, 1991, 1995), these abilities do not account for all of the variance in the reading scores of children studied during the acquisition phase. Moreover, as we noted, the association between individual differences in letter knowledge and phoneme segmentation skill, which is well-nigh total in the present study, appears to be far weaker for beginning readers of English and Danish. Training studies have shown how dissociable these abilities can be. In English, Ball and Blachman (1991) found that training in letter names and letter sounds alone did not significantly improve the segmentation skills or the reading skills of kindergarten children. Conversely, Lundberg and his colleagues showed that training Danish kindergartners to segment spoken words phonemically did not enhance their ability to identify letters beyond that of a control group. Certainly the present findings are very different from these. They fit with other indications (which are reviewed elsewhere, e.g., Carello, Turvey, & Lukatela, 1992; Lukatela & Turvey, 1990a, 1990b, 1991) that the Serbo-Croatian orthography is highly phonologically penetrable.

Conclusion

Our research found that, with Serbo-Croatian speakers at least, a little (letter) knowledge goes a long way. Some almost totally unschooled speakers penetrated remarkably far into the orthography, armed only with phonological awareness and alphabetic knowledge. We suggest that, for a Serbo-Croatian speaker, knowing the letter units is the entry point into the alphabetic principle because letters and phonemes are so straightforwardly related. Knowing the letters is not as helpful for speakers of English, as discussed earlier. In all events, the present research lends support to the claim that literacy is a continuum. Just as differences in phonological awareness have been found between good and poor literates, so too we found differences in phonological awareness between good and poor illiterates. How easily one moves along that continuum is dependent on language-specific features.

ACKNOWLEDGMENTS

Preparation of this article was supported in part by National Institutes of Child Health and Human Development Grants HD-01994 and HD-08495 to Haskins Laboratories and the University of Belgrade, respectively.

Until the time of her death in July 1990, Isabelle Y. Liberman contributed importantly to each phase of this research.

NOTES

1. Although Serbo-Croatian is phonologically precise – a given letter has a single pronunciation – there is a complication. It happens to be phonologically precise in two largely distinct but partially overlapping alphabets, Roman and Cyrillic (children are expected to be fluent in both by the second grade). The nature of the overlap is such that a few shared letters are pronounced the same way in the two alphabets (e.g., E, A, T are pronounced /e/, /a/, and /t/, respectively), and a few shared letters are pronounced differently, depending on which alphabet they are read in (e.g., B is /b/ in Roman but /v/ in Cyrillic; P is /p/ in Roman but /r/ in Cyrillic). Letter strings composed of a mix of these shared letters are phonologically ambiguous. For example, BETAP read in Cyrillic is /vetar/, the word for “wind.” Read in Roman, it is /betap/, a nonword. Phonologically unique versions of these same letter strings can be constructed in one or the other alphabet (Feldman & Turvey, 1983). For BETAP, the phonologically unique control is VETAR, which can only be pronounced /vetar/. The standard result with adult readers (Lukatela, Feldman et al., 1989; Lukatela, Turvey et al., 1989) is that they take longer to name a phonologically ambiguous letter string than its phonologically unique counterpart.
2. Wagner and Torgesen (1987) nonetheless concluded (on the basis of “confirmatory factor analyses”) that tasks involving syllables and tasks involving phonemes tap a single latent ability.

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