Read Writ (2010) 23:359–384
DOI 10.1007/s11145-009-9204-8

Universal and language-specific constraints on phonemic awareness: evidence from Russian–Hebrew bilingual children

Elinor Saiegh-Haddad · Nadya Kogan · Joel Walters

Published online: 17 October 2009

Abstract The study tested phonemic awareness in the two languages of Russian (L1)–Hebrew (L2) sequential bilingual children ($N = 20$) using phoneme deletion tasks where the phoneme to be deleted occurred word initial, word final, as a singleton, or part of a cluster, in long and short words and stressed and unstressed syllables. The experiments were designed to test the effect of four linguistic factors on children's phoneme deletion: phoneme position (initial, final), linguistic context (singleton, cluster), word length and stress. The results indicated that word length and stress confirmed previous findings in other languages demonstrating the universal validity of these factors. However, phoneme position and linguistic context gave rise to novel findings in the languages studied and provided evidence for language-specific effects on phonemic awareness reflecting onset-rime versus body-coda syllable structure differences. The results are discussed within the framework of universal versus language-specific constraints on phonemic awareness performance in different languages.

Keywords Body-coda · Hebrew · Linguistic constraints · Onset-rime · Phoneme position · Russian · Stress · Word length

Introduction

It is agreed that phonemic awareness, the insight that spoken words may be segmented into discrete-point phonemes and the ability to manipulate the phonemic structure of spoken words, is a reading universal and plays a fundamental role in the acquisition of reading in all languages (Adams, 1990; Goswami & Bryant, 1990; National Reading Panel, 2000; Ziegler & Goswami, 2005). Yet, phonemic

E. Saiegh-Haddad (✉) · N. Kogan · J. Walters
English Department: Linguistics Division, Bar-Ilan University, Ramat-Gan 52900, Israel
e-mail: saieghe@mail.biu.ac.il

awareness is a complex psychological construct and demonstrating this ability on a phonemic awareness testing task is subject to a variety of cognitive universal as well as language-specific linguistic constraints (Saiegh-Haddad, 2007a, b). Though there has recently been a significant upsurge in our understanding of the effect of linguistic factors on children's ability to access phonemes in English (McBride-Chang, 1995; Schreuder & van Bon, 1989; Stahl & Murray, 1994; Stanovich, Cunningham, & Cramer, 1984; Stuart, 2005; Treiman, 1988; Treiman & Weatherson, 1992; Yopp, 1988), we know very little about the effect of these same factors on phonological awareness in other languages, and even less about the consistency or generality of their effect on phonemic awareness in different languages. Hence, one important question remains unanswered: "Does a given linguistic factor affect phonological awareness in the same way in different languages?" Alternatively, "Does the effect of a given linguistic factor on phonological awareness vary in different languages?" These questions are crucial to both reading theory and practice. As such, the extent to which phonological awareness may be characterized as a mechanical ability and, hence, a universal and language independent construct, as against a concept-based, language-specific linguistic ability is a central question in the psycholinguistics of reading (Byrne & Fielding-Barnsley, 1989, 1990, 1993; Saiegh-Haddad, 2007a; Swan & Goswami, 1997; Thomas & Senechal, 2004). Understanding the language-specific demands imposed by the properties of a particular language on phonemic awareness, through systematic comparisons of how phonemic awareness, we well as other basic reading requisites, are accomplished in different languages, helps uncover variations in learning-to-read experiences in diverse languages. The current study contributes to this objective by studying the effect of four linguistic factors on phonemic awareness in the two languages of Russian-Hebrew bilingual children: phoneme position (initial, final), linguistic context (singleton, cluster), word length, and stress. This inquiry into the possible cross-linguistic variations that may exist in phonemic awareness in the two languages contributes to identifying the limits on the transfer of this insight in diverse language and permits a conceptual exploration of how basic reading skills development in different languages is constrained by the linguistic structure of the language involved (Durgunoglu, 2002; Koda, 2007).

Because children's awareness of the phonemic structure of spoken words is affected both by cognitive maturation and schooling (Liberman, Shankweiler, Fischer, & Carter, 1974), and in particular by children's exposure to orthography and their familiarity with the mapping details of their writing system (Perfetti & Liu, 2005), the current study tested phonemic awareness in junior and senior kindergarteners and tested children's informal exposure to print through measures of letter knowledge. The aim was to control for variations among children in degree of exposure to print and for the effect of this factor on phonemic awareness performance.

Linguistic constraints on phonemic awareness

Phonemic awareness underlies the ability of individuals to operate on and manipulate the phonemic structure of spoken words. As languages vary in the nature and the complexity of their phonological systems, children from different linguistic

backgrounds may vary in their familiarity with certain phonological structures and, in turn, in the facility with which they can access various phonological units. The last two decades have witnessed increasing empirical attention and scientific support of this hypothesis (e.g., Bruck, Genesee & Caravolas, 1997; Carroll & Snowling, 2001; De Cara & Goswami, 2003; Seymour, Aro, & Erskine, 2003). For instance, Caravolas and Bruck (1993) compared the development of phonemic awareness in English and in Czech monolingual children and found better performance among Czeck children in the ability to access phonemes from complex onsets. This difference between the two groups was attributed to Czech children's oral language familiarity and experience with complex onsets. Similarly, Durgunoglu and Öney (1999) compared the development of phonological awareness in Turkish and in English-speaking children and found better performance among Turkish children with final consonants. This difference was explained as the result of children's experience with the highly inflected Turkish language.

The role that the oral language experience plays in children's phonological awareness was also demonstrated in studies that addressed the effect of phoneme position (initial versus final) and linguistic context (singleton versus cluster) on phonemic awareness. Research in this area has been largely dominated by the *rime-cohesion hypothesis* (Fudge, 1969, 1987; Goldsmith, 1990). According to this hypothesis, the mental representation of the syllable does not consist of a string of linearly ordered phonemes. Rather, phonemes within the syllable are hierarchically grouped into two constituents: *the onset*, the initial consonant(s), and *the rime*, the nucleus vowel and any following consonant(s), *the coda*. Such a psycholinguistic representation of the syllable makes important predictions about children's ability to access initial onset as against final coda phonemes. It predicts that onset consonants should be easier to access than consonants embedded within the rime (coda consonants), because the coda is an internal constituent of a larger phonological unit, the rime. Treiman (1983, 1985, 1988) was the first to systematically test these predictions. Treiman's work has shown that syllable onset phonemes were easier for both monolingual English children and adults to access than rime-coda phonemes, and that phonemes embedded within a consonantal cluster were harder than singleton phonemes. These results provided behavioral evidence that helped anchor the psycholinguistic reality of the onset-rime structure in the mental representation of phonemes. Subsequent research has provided convergent evidence in support of the cohesiveness of the rime and its salience in phonological analysis in English (e.g., Bryant, Maclean, Bradely, & Crossland, 1990; Kirtley, Bryant, Maclean, & Bradley, 1989. However, for evidence to the contrary, see Booth & Perfetti, 2002; Duncan, Seymour, & Hill, 1997; Geudens & Sandra, 2003; Geudens, Sandra, & van den Broek, 2004; Geudens, Sandra, & Martensen, 2005; Goswami & East, 2000; Lewkowicz & Low, 1979; Savage, Blair, & Rvachew, 2006).

The unique cohesiveness of the rime in English has been argued to be rooted both in the phonological structure of the language and in its orthography. Distributional analysis of the phonological similarity among English simple words has revealed that phonological neighborhood in English is dominated by rime neighborhood (Booij, 1983; De Cara & Goswami, 2002; Luce & Pisoni, 1998), and that "word beginnings distinguish between words more efficiently than word endings"

(Aitchison & Straf, 1981, p. 773). Further, statistical computations of the consistency between the spelling and the sound of English graphemes revealed that the orthographic rime makes the pronunciation of English graphemes significantly more predictable (Goswami, 1986, 1988, 1992, 1998; Stanback, 1992; Treiman, Mullennix, Bijeljac-Babic, & Richmond-Welty, 1995). Thus, it appears that both the phonological structure of English and its orthographic architecture contribute to the psycholinguistic cohesion of the rime. On this ground, it would not be surprising to find cross-linguistic differences in children's ability to access phonemes in languages that differ in their phonological and orthographic structure.

This hypothesis was tested in Semitic Arabic and Hebrew. Saiegh-Haddad (2003, 2004, 2005, 2007a), Share and Blum (2005) and Saiegh-Haddad (2007b) tested phonological awareness in Arabic and in Hebrew, respectively, among native speaking preliterate and early literate children. These studies showed that, in both languages, children's performance reflected a unique cohesiveness of the initial consonant and the following nucleus vowel (C1V), so called the body, rather than the vowel and the following consonant (VC2), so called the rime. These findings were consistent with earlier reports of the phonemic awareness profiles of adults skilled in reading unvoweled Hebrew (Ben-Dror, Frost, & Bentin, 1995). Such unique preferences were argued to be attributed to the predominance of the CV unit in the phonologies of the two languages and to its orthographic cohesiveness. Arguably, the strong cohesiveness of the CV unit variously affects children's ability to access syllable-internal prevocalic as against postvocalic phonemes and supports a body-coda psycholinguistic representation of the Semitic syllable.

There is preliminary evidence showing that the adhesiveness of the consonant with the following vowel may be even stronger in Semitic Arabic than the adhesiveness of consonants within a consonantal cluster. This was reflected in the finding that children found initial clustered phonemes easier to isolate than initial singleton consonants directly followed by a vowel. Further, final consonants were the easiest to isolate both as singleton and cluster, with no difference between the two conditions (Saiegh-Haddad, 2007a). These findings suggest that two factors—phoneme position (initial, final) and linguistic context (singleton, cluster)-affect children's ability to access phonemes. Further, it shows that the effect of these two factors may be language-specific and may reflect differences in the language's syllable structure.

Word length is another linguistic factor. Phonological processing happens within the scope and limitations on working memory (Snowling, 2000; Wagner & Torgesen, 1987). It follows that long multi-syllabic words should be more difficult for children to code and analyze than shorter words because of their phonological and memory processing demands. This prediction was empirically supported and formalized in psycholinguistic theory as the *word-length effect* (Baddeley, Thomson, & Buchanan, 1975). For instance, Schreuder and van Bon (1989), in an examination of Dutch 6-year-old children's initial and final phoneme isolation found higher performance for monosyllabic than for bisyllabic words. Similar results were reported in other languages, including English (Treiman & Weatherson, 1992), Spanish (Jiménez González & Haro García, 1995), and Arabic (Levin, Saiegh-Haddad, Hindi, & Ziv, 2008). Thus, word length appears to be a universal constraint exerting consistent

effects in different languages. The effect of this factor on phonological awareness in the two languages of bilingual children remains to be investigated.

A fourth linguistic constraint is stress. Though the role of stress in phonological awareness has received rather little empirical attention, it is a particularly pertinent factor because it affects the phonetic prominence of word-internal phonemes. The prominence of a stressed syllable is manifested in a number of ways: (1) a stressed syllable is generally louder than surrounding unstressed syllables; (2) it is often longer than the other non-prominent syllables; (3) the constituent sounds within a stressed syllable, especially its onset consonants, are often more clearly or forcefully articulated than those in unstressed ones; finally (4) a stressed syllable is often the locus of pitch movement (accent) and as a result pronounced typically on a particularly high pitch (Spencer, 1998). Research has shown that prosody (stress, rhythm and intonation) is a significant component of a language's phonology and it becomes salient from birth (Jusczyk, Cutler, & Redanz, 1993; Nazzi & Ramus, 2003; Nazzi, Bertoncini, & Mehler, 1998). Further, Chiat (1983) observed that the production of phonemes in the speech of a 6 year-old boy was easier in stressed than in unstressed syllables. Finally, studies comparing stress processing abilities in different languages showed that children's performance varied as a function of acoustic manifestations and lexical functions of prosodic features (Dupoux et al., 1997; Goetry, Wade-Woolley, Kolinsky, & Mousty, 2006). For instance, French-native listeners were shown to display stress "deafness" compared with Spanish or Dutch native listeners (Dupoux et al., 2001). Most importantly, sensitivity to metrical stress was found to account for variance in phonological awareness and in various measures of literacy (Goswami et al., 2002; Muneaux, Ziegler, Truc, Thomson & Goswami, 2004; Richardson, Thomson, Scott & Goswami, 2004; Wood (2004, 2006a, b); Wood & Terrell, 1998).

To our knowledge, the only study that probed the effect of stress on phonological awareness was Treiman and Weatherson (1992). In this study, the researchers examined the ability of English-speaking children to isolate initial phonemes from stressed versus unstressed syllables in bi-syllabic words. Unexpectedly, they found that children found it easier to isolate initial consonants in word-final than word-initial stress. Yet, as the authors rightfully argue, these results must be treated with care since in final-stress words, like "suppose" or "belong", the first syllable had a reduced vowel. Hence, the first syllable of these words happened to be a correct response in the initial phoneme isolation task. In a study of the effect of stress on children's spelling, Treiman, Berch and Weatherson (1993) found that children were more likely to omit phonemes, and to make more spelling errors in unstressed than in stressed syllables.

To sum up, research has addressed the effect of various structural factors on monolingual children's ability to access phonemes. Yet, no study has tested the concurrent effect of these factors on phonological awareness in the two languages of bilingual children. The present study probes the effect of four linguistic factors on phoneme awareness in the two languages of Russian–Hebrew bilingual children. These factors are: (a) phoneme position (initial vs. final); (b) linguistic context (singleton vs. cluster); (c) word length (monosyllabic vs. bi-syllabic); and (d) stress (stressed syllable versus reduced syllable). The study aims to explore the effect of

these factors on phonological awareness in the two languages and to determine whether they exert a consistent effect in different languages. Earlier evidence, albeit limited in scope, has shown that some factors, like word length, have a consistent effect across the languages tested. In line with this evidence, we predict that word length will have a similar effect on phonological awareness in the two languages of children: Russian and Hebrew. Similarly, earlier research has shown that there appear to be a general tendency for increasing facility with singleton than with cluster phonemes. Hence, we predict that singleton phonemes will be easier to access than cluster phonemes in both languages. Yet, it is to be remembered that the two languages tested vary in permissibility and frequency of consonantal clusters (see next section). This may result in cross-linguistic differences in relative difficulty with clustered as against singleton phonemes in the two languages. Finally, due to its role in enhancing the prominence of syllables, stress is predicted to contribute to phoneme accessibility in both Russian and Hebrew.

Unlike the factors discussed above, some linguistic constraints appear to exert a language-specific effect that is highly sensitive to the phonological structure of the particular language involved. For instance, phoneme position appears to make different predictions about children's phoneme accessibility in English, and other languages that follow an onset-rime syllable structure, than in languages that follow a body-coda structure, like Hebrew. In line with earlier evidence (Saiegh-Haddad, 2007b; Share & Blum, 2005), we hypothesize that, in Hebrew, initial phonemes will be easier to access than final phonemes. As no research has directly tested the internal structure of the syllable in Russian (However, see Schwartz, Leikin & Share, 2005; Schwartz, Geva, Share & Leikin, 2007), it is not possible to make strong predictions about the effect of phoneme position on phonemic awareness in this language. However, as the CV unit is a frequent syllabic structure in Russian too (Bondarko, 1969), phonemic awareness may reveal patterns that are similar to those observed in CV-based language like Hebrew. In what follows we briefly consider some of the pertinent differences in the phonological structure of Russian and Hebrew.

The phonologies of Russian and Hebrew

The phonological structure of Russian—a Slavic language, and of Hebrew—a Semitic language, varies in a number of respects. Russian and Hebrew have different, though only partially overlapping phonemic inventories. For instance, while the glottal fricative /h/ is absent from the Russian phonemic inventory, post-alveolar affricate /č/ and post-alveolar fricatives /ž/ and /šč/ are not within the Hebrew phonemic stock (Eviatar, Leikin, & Ibrahim, 1999). Russian and Hebrew also differ in their prosodic structure and in patterns of stress assignment. Russian has lexical stress. Hence, stress is free and unpredictable and is assigned in the lexical entries of words. As a result, stress may be placed on any syllable within the word and may be used contrastively (e.g. /′muka/-"pain" vs. /mu′ka/-"flour"; /′par'it'/-"to stew" vs. /pa´r'it'/—"to hover") (Halle, 1971; Ward, 1965; Vinarskaya et al., 1977). In contrast, stress assignment in Hebrew is both lexically and phonologically determined. Lexical stress is unpredictable and is the product of an

interaction between lexical properties of the stem and lexical properties of the affix (Graf, 2000; Mixdorff & Ami, 2002). In contrast, phonological stress is predictable and is assigned, when no lexical properties are specified for stem and/or suffix, to the rightmost accented syllable. Despite these differences, stress in both languages is closely associated with allophonic vowel lengthening (Bat-El, 1993; Becker, 2003).

Regarding phonological complexity and syllable structure, the open CV syllable is a predominant feature of the Hebrew phonology (Cohen-Gross, 2003). Russian also has a tendency for open syllables (Bondarko, 1969). However, while, in Hebrew, consonantal clusters are very infrequent; phonotactically constrained to word initial positions; and are limited in size to two consonants, e.g., /**st**av/"autumn" (Bolozky, 2006; Graf, 2003), Russian features complex consonantal clusters in both syllable-initial and syllable-final positions (Knyazev, 1999; Vinarskaya et al., 1977; Zaretsky, 2002;). This is partly because of the productive derivational prefixation in Russian which increases the size of complex onsets amounting to a maximum of four segments in length (e.g. /**fsgl'**at/"glance, view" and /**fspl**esk/"splash"). Like onsets, complex codas are also frequent in Russian. Yet, bi-consonantal codas are more frequent than tri-consonantal or quadri-consonantal codas (e.g. /mo**st**/ "bridge", /ho**lst**/"canvas" and /mo**nstr**/"monster") (Zaretsky, 2002).

Method

Participants

Twenty pre-school Russian–Hebrew bilingual children (9 boys and 11 girls) participated in the study; they were divided into two age-groups: Younger (Mean age = 54.1; SD = 2.64) and Older (Mean age = 68.7; SD = 6.58). All children came from middle-class Russian immigrant families from the former Soviet Union, residing in the central region of Israel. All children were early sequential Russian (L1)–Hebrew (L2) bilinguals who spoke Russian at home but were enrolled in Hebrew-speaking kindergartens for at least 1 year at the time of testing.

Materials

The study used two sets of tasks. The first consisted of two tests of phonemic awareness that aimed to address the effect of the linguistic factors targeted in the study on children's phoneme awareness. The second consisted of two tests of letter knowledge that aimed to assess children's informal exposure to literacy in the two languages.

Phonemic awareness

Two versions of the phoneme deletion task were used to measure phonemic awareness: initial and final phoneme deletion (phoneme position) in both Russian and Hebrew. There were 20 items in Russian and 15 items in Hebrew

(See "Appendix A"[1]). Stimuli in both initial and final phoneme deletion tasks were high-familiarity words and classifiable into the following categories, respectively, 5 items per category. Target phonemes appear in boldface.

Initial phoneme deletion

1. Monosyllabic word, Singleton Phoneme (e.g. *мост* /**m**ost/ 'bridge').[2]
2. Monosyllabic word, Clustered Phoneme (e.g. *стул* /**s**tul/ 'chair'; פקק /***p***kak/ 'plug').
3. Bi-syllabic word, Singleton Phoneme, Stressed[3] (e.g. *сахар* /**s**a̲xar/ 'sugar'; סרט /**s**e̲ret/ 'film').
4. Bi-syllabic word, Singleton Phoneme, Unstressed (e.g. *конец* /**k**on'e̲c/ 'end'; חלון /**x**alo̲n/ 'window').

Final phoneme deletion

1. Monosyllabic word, Singleton Phoneme (e.g. *хлеб* /xl'e̲**p**/ 'bread'; כרוב /kru̲**v**/ 'cabbage').
2. Monosyllabic word, Clustered phoneme (e.g. *зонт* /zo̲n**t**/ 'umbrella').[4]
3. Bi-syllabic word, Singleton Phoneme, Stressed (e.g. *билет* /bil'e̲**t**/ 'ticket'; בשר /basa̲**r**/ 'meat').
4. Bi-syllabic word, Singleton Phoneme, Unstressed (e.g. *ветер* /ve̲t'e**r**/ 'wind'; דרך /de̲re**x**/ 'road').

Procedure

All children were tested individually in two separate sessions in a quiet place in their homes. All tasks were administered by the second author, a Russian–Hebrew bilingual. Two independent language sessions were administered: Russian and Hebrew. Instructions and a maximum of 10 practice trails (5 initial and 5 final) were given in Russian or Hebrew depending on the language of the session. Final phoneme deletion, which was predicted to be relatively less challenging to children (Saiegh-Haddad, 2007b), was administered first followed by initial phoneme deletion. The Russian session (L1) was administered first followed by the Hebrew session (L2). Both phoneme deletion tasks required children to remove a phoneme from the initial or the final position of a word and to produce the remainder of the word, which in most cases was a pseudoword. Task administration made use of a puppet and the following instructions were given to children: "This puppet is always

[1] The number of stimulus items in the two languages was different because final clustered phonemes, which hardly exist in Hebrew but are frequent in Russian, were only targeted in Russian but not in Hebrew.

[2] This condition was tested in Russian only.

[3] Cluster versus singleton conditions were manipulated in monosyllabic words only. This is because high familiarity bi-syllabic words with consonantal clusters are rare in the Hebrew lexicon of preschool children.

[4] This condition was tested in Russian only.

in a hurry. He likes to run to all kinds of places and doesn't have enough time. To save time, he made up his own way of speaking. Sometimes he skips over the beginning of the word (initial phoneme deletion)/ the end of the word (final phoneme deletion). I will show you how he speaks. Now I'm going to say the word after I skip over the first/last sound of the word. Try to copy me.

Each child received one point for successfully deleting the target phoneme from the stimulus word, and a zero score for failing to do so. Performance was converted to percentage correct scores.

Informal exposure to literacy

In order to test children's exposure and familiarity with print children were tested on two letter knowledge tasks: letter discrimination and letter naming/identification. The letter discrimination task assessed children's ability to discriminate between pairs of letters by deciding whether letters were same or different (not same). There were four categories of letter pairs: phonologically similar, orthographically similar, orthographically and phonologically similar, same letter presented twice. The letter identification/naming task measured children's knowledge of the sound and/or the name of the letter and consisted of a random sample of 20 letters (including both vowel and consonant letters) from the alphabets of each language (See "Appendix B").

Results

Table 1 provides summary statistics of children's performance on the letter knowledge tasks (letter discrimination and letter naming), which assessed informal exposure to literacy, as a function of language (Russian and Hebrew) and group (younger and older).

Two independent one-way ANOVAs with repeated measures on language (Hebrew and Russian) and with group (younger versus older) as a between subject factor were used to analyze children's performance on the two letter knowledge tasks. This analysis showed a main effect of group on the letter naming task with older children performing significantly higher than younger children,

Table 1 Mean and standard deviation for letter naming and letter discrimination in Russian and Hebrew

		Russian		Hebrew	
		Naming	Discrimination	Naming	Discrimination
Younger	*M*	.16	.95	.29	.99
$N = 10$	SD	(.23)	(.12)	(.26)	(.02)
Older	*M*	.76	1	.70	1
$N = 10$	SD	(.27)	(.01)	(.32)	(0)
Total	*M*	.47	.98	.49	.99
$N = 20$	SD	(.40)	(.09)	(.35)	(.02)

$F(1,14) = 33.19$, $p < .001$. However, the main effect of group on the letter discrimination task did not reach statistical significance, and with children performing at ceiling. On neither of the two letter knowledge task did the effect of language (Hebrew versus Russian) reach satisfactory levels of statistical significance. Neither was the interaction of language by group significant. These results imply comparable levels of informal exposure to literacy in the two languages of children: Russian (L1) and Hebrew (L2). At the same time they indicate a significant advantage in letter naming in favor of the older children in both languages.

While letter knowledge was used as a control measure and aimed to ensure that children had comparable levels of informal exposure to literacy in the two languages, the phonemic awareness tasks were used to assess the effect of four linguistic factors on children's ability to access phonemes in the two languages. These factors were phoneme position (initial versus final), linguistic context (singleton versus cluster), word length (monosyllabic versus bi-syllabic words) and stress (phoneme within a stressed syllable versus phoneme within a reduced syllable). Since languages differ in their phonological structure, it is not always possible to construct structurally equivalent stimuli in the two languages tested. Yet, this should not undermine the validity of cross-linguistic designs that acknowledge and account for such language built-in limitations. In our case, because Hebrew does not allow complex consonantal clusters in the coda of mono-morphemic monosyllabic words, this category was not included in the Hebrew tasks. Hence, the concurrent effect of phoneme position and linguistic context was only examined in Russian, but not in Hebrew. To test the effect of stress on phoneme deletion, singleton phonemes in bi-syllabic words were targeted in both languages. Yet, as singleton phonemes in the initial and final position of monosyllabic words were only targeted in Russian, the concurrent effect of word length and phoneme position was only tested in this language, but not in Hebrew. As a result of the forgoing language built-in gaps in the design of the study, the impact of the linguistic factors targeted was investigated using a series of independent ANOVAs. These are described below.

Table 2 summarizes children' overall performance on the initial and final phoneme deletion tasks in both languages (Russian and Hebrew) and by both groups (younger and older).

To test the effect of phoneme position on phoneme deletion in Russian and Hebrew, a $2 \times 2 \times 2$ ANOVA with repeated measures on language (Russian vs. Hebrew) and phoneme position (initial vs. final), and with group as a between-subject factor was used to analyze children's performance for monosyllabic and bi-syllabic words. The results showed a significant main effect of language, $F(1,18) = 10.32$, $p < .01$, with children obtaining significantly higher scores in Hebrew (L2) than in Russian (L1). The main effect of group was also significant, $F(1,18) = 10.71$, $p < .01$, with older children outperforming younger children. Finally, the main effect of phoneme position was significant, $F(1,18) = 49.03$, $p < .001$, with initial phonemes in both languages being significantly more difficult for children to delete than final phonemes.

Table 2 Mean and standard deviation for phoneme deletion by group, language, and phoneme position

		Russian			Hebrew		
		Initial	Final	Combined	Initial	Final	Combined
Younger	*M*	.26	.64	.43	.31	.80	.56
$N = 10$	SD	(.27)	(.19)	(.23)	(.33)	(.23)	(.28)
Older	*M*	.57	.89	.73	.62	.93	.78
$N = 10$	SD	(.19)	(.12)	(.16)	(.23)	(.13)	(.18)
Total	*M*	.42	.77	.58	.47	.87	.67
$N = 20$	SD	(.23)	(.16)	(.20)	(.28)	(.18)	(.23)

To test the effect of linguistic context on initial and final phoneme deletion we used separate ANOVAs in the two languages. This is because Hebrew word-final consonantal clusters were not targeted in Hebrew. Note that only monosyllabic words were included in this analysis. Table 3 summarizes children's initial and final phoneme deletion in Russian by linguistic context (singleton versus cluster) and group (younger versus older).

The concurrent effect of linguistic context and phoneme position on phoneme deletion in Russian was tested using a $2 \times 2 \times 2$ ANOVA with repeated measures on linguistic context (singleton vs. cluster) and phoneme position (initial vs. final), and with age-group as a between-subject factor. Like the previous analysis, the main effect of age-group and the main effect of phoneme position were both significant, Age-group: $F(1,18) = 44.46$, $p < .001$; Phoneme position: $F(1,18) = 27,74$, $p < .001$, with older children scoring significantly higher than the younger children and with final phonemes yielding greater facility than initial phonemes. Also, the two-way interaction of linguistic context by age-group: $F(1,18) = 4.44$, $p < .05$, and linguistic context by phoneme position, $F(1,18) = 34.27$, $p < .001$, and the three-way interaction of linguistic context by phoneme position by age-group $F(1,18) = 9.09$, $p < .01$, were all significant. Scheffe post hoc analyses showed that, in the younger group, while final singleton phoneme deletion was significantly

Table 3 Mean and standard deviation for phoneme deletion by group, phoneme position, and linguistic context

		Russian			
		Initial		Final	
		Cluster	Singleton	Cluster	Singleton
Younger	*M*	.08	.44	.36	1
$N = 10$	SD	(.14)	(.48)	(.29)	(.0)
Older	*M*	.52	.82	.94	.96
$N = 10$	SD	(.41)	(.17)	(.10)	(.08)
Total	*M*	.30	.63	.65	.98
$N = 20$	SD	(.55)	(.33)	(.20)	(.04)

easier than initial singleton phoneme deletion, there was no difference in phoneme deletion between initial cluster and final cluster phonemes. However, in the older group, there was no difference between initial and final phoneme deletion in either singleton or cluster conditions.

The concurrent effect of phoneme position and linguistic context was tested, in both languages, by comparing children's initial phoneme deletion for clustered phonemes in monosyllabic words against their performance on singleton phonemes in bi-syllabic words. No such analysis was possible for final phoneme deletion or for initial phoneme deletion within each of the categories of monosyllabic or bi-syllabic words separately, as these manipulations were not possible in Hebrew. Repeated measure ANOVA revealed a significant main effect of language, $F(1,18) = 5.46$, $p < .05$, with children achieving higher scores in Hebrew than in Russian, and a main effect of age-group, $F(1,18) = 13.67$, $p < .01$, with the older participants achieving higher scores than the younger ones. The main effect of linguistic context (singleton versus cluster) was not significant. The same analysis was conducted on final phoneme deletion scores in Russian. Again, the results revealed no main effect of linguistic context. However, the two-way interaction of linguistic context by age-group was significant, $F(1,18) = 9.95$, $p < .01$. Scheffe post-hoc analysis showed that younger children performed significantly higher on final singleton than final cluster phonemes. This difference was not significant in the older children.

Table 4 summarizes younger and older children's initial and final phoneme deletion in Russian as a function of word length (monosyllabic vs. bi-syllabic), and Hebrew final phoneme deletion only as a function of word length (monosyllabic vs. bi-syllabic).

The effect of word length on children's phoneme deletion was tested by conducting a repeated measure ANOVA on final singleton phoneme deletion in Russian and Hebrew separately. Word length (monosyllabic vs. bi-syllabic), and language (Russian vs. Hebrew) were used as within-subject factors and age-group (younger vs. older) as a between subject factor. This analysis showed that the main effect of word length and language were both significant, Word length: $F(1,18) = 16.11$, $p < .01$; Language, $F(1,18) = 5.24$, $p < .05$, with scores higher

Table 4 Mean and standard deviations for phoneme deletion in Russian and Hebrew as a function of phoneme position and word length

		Russian				Hebrew	
		Initial		Final		Final	
		Bisyl	Monosyl	Bisyl	Monosyl	Bisyl	Monosyl
Younger	*M*	.25	.44	.58	1	.73	.94
$N = 10$	SD	.34	.48	.35	0	.38	.13
Older	*M*	.48	.66	.72	.96	.92	.95
$N = 10$	SD	.33	.30	.27	.08	.19	.11
Total	*M*	.37	.55	.65	.98	.83	.95
$N = 20$	SD	.34	.39	.31	.04	.29	.12

for monosyllabic than for bi-syllabic words and in Hebrew than in Russian. The main effect of group did not reach satisfactory levels of statistical significance ($p > .05$). Neither was the three-way interaction of word length by language by group significant ($p > .05$).

The effect of word length on initial phoneme deletion was tested in Russian using a 2 × 2 ANOVA with repeated measures on word length (monosyllabic vs. bi-syllabic) and with group as a between-subjects factor. This analysis revealed again a main effect of word length, $F(1,18) = 14.76$, $p < .01$, with bi-syllabic words being more difficult than monosyllabic words. The results also showed a significant main effect of age-group, $F(1,18) = 5.26$, $p < .05$, with the older participants outperforming their younger counterparts. The interaction of word length by group was not significant ($p > .05$).

To test the effect of syllable stress position on phoneme deletion a 2 × 2 × 2 × 2 repeated measure ANOVA was used to analyze children's initial and final phoneme deletion from bi-syllabic words. Stress position (syllable initial stress vs. syllable final stress), language (Russian vs. Hebrew), and phoneme position (initial vs. final phoneme) were used as within subject factors. Group (older vs. younger) was used as a between-subject variable. Table 5 summarizes younger and older children's initial and final phoneme deletion by stress. As expected, though the main effect of stress position was not significant ($p > .05$), the results showed that the two-way interaction of phoneme position by stress position was significant, $F(1,18) = 18.98$, $p < .001$. Post hoc analysis confirmed that initial phoneme deletion was easier when the initial syllable was stressed than unstressed, and final phoneme deletion was easier when the final syllable was stressed than unstressed: Initial phoneme deletion, $F(1,18) = 7.81$, $p < .05$; Final phoneme deletion, $F(1,18) = 13.86$, $p < .01$. The analysis also showed again a significant main effect of phoneme position, $F(1,18) = 18.27$, $p < .001$, with final phonemes being easier to delete than initial phonemes. Finally, the main effect of language and age-group were both significant, Language: $F(1,18) = 7.05$, $p < .05$; Group: $F(1,18) = 6.28$, $p < .05$, with scores in Hebrew higher than those in Russian and with older children performing better than younger children.

Table 5 Mean and standard deviation for phoneme deletion as a function of language, phoneme position, and stress

		Russian				Hebrew			
		Initial		Final		Initial		Final	
		−Stress	+Stress	−Stress	+Stress	−Stress	+Stress	−Stress	+Stress
Younger	*M*	.16	.34	.52	.64	.38	.28	.66	.80
$N = 10$	SD	(.23)	(.41)	(.34)	(.37)	(.49)	(.34)	(.42)	(.33)
Older	*M*	.40	.56	.72	.94	.86	.97	.86	.97
$N = 10$	SD	(.27)	(.39)	(.27)	(.10)	(.25)	(.08)	(.25)	(.08)
Total	*M*	.28	.45	.62	.79	.62	.63	.76	.89
$N = 20$	SD	(.25)	(.40)	(.31)	(.24)	(.37)	(.21)	(.34)	(.21)

Discussion

The aim of the present study was to examine the effect of four linguistic factors on phonological awareness in the two languages of Russian (L1)–Hebrew (L2) bilingual children. Phoneme deletion was used to measure older and younger children's phoneme awareness in Russian and Hebrew as a function of four linguistic factors: phoneme position, linguistic context, word length, and stress position. The first factor tested was the position of the target phoneme: initial versus final. Earlier research has shown that the effect of phoneme position may be language specific and different in English, which utilizes an onset-rime structure, than in Hebrew or Arabic, which follow a body-coda structure (Saiegh-Haddad, 2007a, b; Share & Blum, 2005). In line with earlier evidence, we hypothesized that bilingual children would also find final phonemes easier to delete in Hebrew than initial phonemes. No such strong predictions were possible for Russian as the psycholinguistic representation of the syllable in Russian has not yet been directly examined (However, see Schwartz et al, 2005; Schwartz et al, 2007). Nonetheless, two factors led to the following prediction. The first is reported distributional tendency in the Russian phonology for the open CV unit (Bondarko, 1969). The second is behavioral evidence reported in a study by Vinarskaya et al., (1977), in which Russian children's syllabification of isolated multi-syllabic words containing consonant clusters was tested. This study showed that 4-year-old children tended to split words into open syllables, e.g. *п*у-***ст****ой* (/pu-**st**oj/ empty), *ко-ше-**чка*** (/ko-ši-**čk**a/ a cat, diminutive), while five-year-olds opted for both open and closed syllables, e.g. *ба-бу-**шка*** (/ba-bu-**šk**a/, grand mother) or *ба-буш-ка* (/ba-buš-ka/), ма-**льчи-шк**а (/ma-**l'či-šk**a/, a boy) or *маль-чиш-*ка (/mal'-čiš-ka/). Based on these observations it was predicted that children would reveal patterns of phoneme deletion in Russian that are similar to those in Hebrew. In line with this prediction, the results of the study showed that, in both languages, children found initial phonemes harder to delete than final phonemes. Further, from a developmental perspective, the challenging task of deleting initial phonemes was found to be significantly more difficult for 4-year olds than 5-year olds, in both languages. These findings provide evidence for a consistent effect of phoneme position on phonological awareness in the two languages tested: Hebrew and Russian. Yet, these findings are at odds with the patterns reported in other languages, and mostly English (e.g., Stanovich et al., 1984; Treiman, 1991; Treiman & Zukowski, 1991).

The observed facility that children were shown to have with final phoneme deletion in contrast with initial phoneme deletion in Hebrew accords with earlier evidence in this language involving monolingual children and adults (Ben-Dror et al., 1995; Saiegh-Haddad, 2007b; Share & Blum, 2005). They are also in harmony with similar reports of Arabic, another Semitic language (Saiegh-Haddad, 2003, 2004, 2007a). Nonetheless, the results are at odds with a large body of evidence, mostly from English speaking children and adults, which demonstrate greater facility with initial phonemes ((Stanovich, Cunningham & Cramer, 1984; Treiman, 1991; Treiman & Zukowski, 1991). These conflicting findings have led researchers to suggest that the mental representation of the syllable may be language-specific and may in some languages, such as Hebrew and Arabic, take the form of a body-coda (CV-C), rather than an onset-rime structure (C-VC). It is noteworthy, that there are

now additional reports of an internal structure of the syllable that does not conform with the onset-rime dichotomy (e.g., Geudens & Sandra, 2003; Kim, 2007; Yoon, Bolger, Kwon, & Perfetti, 2002). Cross-linguistic differences in syllable structure and, in turn, in phonological awareness patterns are argued to reflect language-specific phonological and orthographic properties (Koda, 2007; Share, 2008).

The finding that in Russian children found deletion of final phonemes easier than that of initial phonemes is harder to interpret, however. This finding appears to provide preliminary evidence in favor of a body-coda structure of the Russian syllable. As such, children found final phonemes easier to delete than initial phonemes because the structure of the Russian syllable, like that of the Hebrew syllable, follows a body-coda dichotomy. Such a CV/C hierarchical structure, which is in sharp contrast with the onset-rime structure C/VC, results in greater accessibility of final as against initial phonemes because it implies a stronger cohesiveness of the CV body and hence more difficulty in breaking down this phonological unit into its segmental constituents. This proposal remains tentative, however, and calls for future research involving monolingual Russian speakers and a larger sample.

Yet, it is possible that observed facility with final phonemes in Russian has been transferred from Hebrew, the dominant language of children. Hence, the question that follows from the finding that bilingual children found final phonemes easer to delete than initial phonemes in both languages is whether this consistent effect of phoneme position observed in the two languages is due to cross-linguistic transfer, or is due to a similar syllabic structure utilized in the two languages tested. In other words, did children find initial phonemes in both languages more difficult to delete because they were making use of similar underlying processes in both language? Alternatively, is the consistent effect of phoneme position on phoneme deletion in the two languages reflective of a similar syllable structure. To address this question, two further comparisons are called for. One comparison should involve monolingual Russian and Hebrew speakers. Another should involve bilinguals with a language combination of Russian and Hebrew plus another language like English, with a clearly onset-rime syllable structure and in which relative facility with final as against initial phonemes has clearly been demonstrated. These additional comparisons will enable us to determine whether the pattern observed in the present study implies transfer of a phonological process across the two languages, or shared phonological structures in the two languages. At a broader level, these additional studies will allow us to bring bilingual phonological processing to bear on questions of universal versus language-specific processes.

The second question of the study concerned the effect of linguistic context (singleton vs. cluster) on phoneme deletion. Based on earlier research (McBride-Chang, 1995; Bruck and Treiman, 1990; Caravolas and Bruck, 1993; Treiman and Weatherson, 1992), it was hypothesized that singleton phoneme deletion would be easier than deletion of a phoneme from a cluster. In accordance with previous research, we found that in Russian it was more difficult to delete phonemes in a cluster than in singleton contexts in both initial and final positions. This was true for all children, and especially so for the younger ones. Furthermore, clustered phonemes in the initial position were the most challenging, and especially for younger children. In contrast, clustered and singleton phonemes in the final position were of equal

difficulty for all children. These latter results are similar to those reported for Arabic speaking children and they support the unique cohesiveness of simple and complex bodies in these languages (Saiegh-Haddad, 2007a). At the same time, these findings reaffirm the hypothesis that young children perceive of consonantal clusters as cohesive phonological units and as a result find them difficult to break down into smaller phonemic segments (Caravolas and Bruck, 1993; Bruck and Treiman, 1990; Treiman, Zukowski, & Richmond-Welty, 1995; Treiman and Weatherson, 1992).

The effect of the linguistic context on phoneme deletion in Hebrew did not reach satisfactory levels of statistical significance. This is probably because initial clustered phonemes in monosyllabic words were compared with initial singleton phonemes in bisyllabic words and, hence, the two factors, word length and linguistic context, could not be teased apart. This is one limitation in the design of the current study that should be addressed in future research. Another way to account for the absence of a significant effect of linguistic context (singleton versus cluster) on phoneme deletion in Hebrew is to propose that CV bodies may be more cohesive that clusters. As the CV body is a cohesive phonological unit that children find difficult to segment, it is not unreasonable that children would find it equally, if not more difficult to delete a phoneme from this unit than from a cluster. Evidence in support of a stronger cohesiveness of the CV body as against clustered consonantal units has been demonstrated in Arabic (Saiegh-Haddad, 2007a), where it has been shown that, initial singleton phonemes were the hardest to isolate among all other three conditions. To sum up, the results pertaining to the effect of the linguistic context on phoneme deletion suggest that the effect of this factor may be language-specific. The relative difficulty with accessing singleton versus clustered phonemes and with breaking down clusters into their constituent segments does not appear to be uniform within the same language or consistent in different languages. Rather, it interacts with the position of the singleton or the clustered phoneme (prevocalic onset or postvocalic coda) and with the syllable structure of the specific language (onset-rime or body-coda).

The third research question addressed the effect of word length on initial and final phoneme deletion. In line with earlier evidence, it was hypothesized that phoneme deletion from longer words would be harder than that from shorter words (Baddeley et al., 1975; Schreuder & van Bon, 1989; Treiman & Weatherson, 1992; Jiménez González & Haro García, 1995; Levin, Saiegh-Haddad, Hindi, & Ziv, 2008). In line with this research, the findings from the final phoneme deletion task showed that, in both languages, deleting phonemes from bi-syllabic words was harder than that from monosyllabic words. Phoneme deletion from bi-syllabic words was also significantly more challenging for younger children in both languages. These findings are consistent with the well established hypothesis that, by virtue of their phonological and memory processing demands, longer words are harder for children to manipulate than short words. The effect of word length on initial phoneme deletion was only addressed in Russian. The results in this domain are consistent with the previous findings involving other languages. Taken together, these findings imply that word length is a universal factor that exerts a consistent effect on phonemic awareness in different languages.

The fourth research question addressed the effect of stress position (initial vs. final) on initial and final phoneme deletion. This analysis was naturally restricted to

bi-syllabic words and compared initial and final phoneme deletion in both languages. The results showed a clear effect of stress on the ability of both younger and older children to access phonemes in both languages. Both initial and final phonemes were easier to delete when they were embedded within stressed than within unstressed syllables. This was true for both younger and older children and in both Hebrew and Russian. Both Russian and Hebrew are stress-timed languages. That is, they display rhythmic alternation between stressed and unstressed syllables, and the vowels become reduced in unstressed syllables in both languages. This alternation is associated with different levels of intensity, duration, and amplitude modulation for different syllables. The results of the study accord with previous evidence from other languages (Treiman, Berch & Weatherson, 1993) and support the universality of the effect of stress on phonological manipulation.

In summary, the results of the present study show that, while the four linguistic factors that the study addressed were all found to impact on bilingual children's phoneme deletion performance in both languages, two of the factors, stress and word length, appear to be universal and to exert a consistent effect of phonemic awareness in different languages. In contrast, two other factors, phoneme position and linguistic context, appear to be language-specific and their impact on phonemic awareness directly affected by the language's suprasegmental syllabic structure.

In addition to the specific linguistic findings discussed above, the performance of children in this study revealed two general patterns. The first concerns developmental patterns. We found that 5-year old children consistently outperformed 4-year old children on all phonological awareness tasks and under all conditions. Older children also had better command of early literacy skills in both languages, as reflected in their letter naming ability. The concurrent advantage that older children have revealed in both phonological awareness as well as level of literacy exposure implies that it is not possible to attribute phoneme deletion ability in the older children to cognitive maturation only. The advantage that older children have revealed probably reflects the combined effect of cognitive maturation and exposure to literacy (Ben-Dror et al., 1995; Bradley & Bryant, 1983; Liberman et al., 1974). The current research was not designed to resolve this issue.

The second pattern pertains to the finding that children had consistently obtained higher phoneme deletion scores in Hebrew (L2) than in Russian (L1), despite the fact that they had similar letter naming scores in both languages. Such an unexpected finding, given the predominance of Russian in the homes of children, calls into question the validity of qualifying these children as Russian L1 speakers and of the claim that Russian is the children's first and best language just because it is the language of the home and was acquired sequentially first. It appears that Hebrew, the societal language and the language used in communication with their preschool teachers and their peers has become the children's dominant language. As the study did not use a measure of oral language proficiency, the possibility that an advantage in spoken Hebrew proficiency has contributed to phonological awareness in this language, compared with the weaker Russian, remains unanswered. Whether oral language proficiency has a facilitative effect on phonological awareness remains a contested issue. For instance, based on a systematic review, Geva (2006) concludes that it is possible to obtain a reliable estimate of phonological awareness before

children have developed satisfactory levels of oral language proficiency. This implies that at a general level oral language proficiency should not have a substantial effect on phonological processing. Yet, recent research has demonstrated a *lexicality effect* in phonological awareness (Seymour et al., 2003). As such, when the stimulus word is familiar to candidates, phonological analysis is more successful than when it is unfamiliar (Metsala, 1997). This is probably because of the availability of the *redintegration* mechanism—the use of lexical processes in phonetic encoding and maintenance in working memory (Snowling, 2000). Indeed, the lexicality effect constraint on phonological analysis may be a cross-linguistic universal (Seymour et al., 2003). On the other hand, the extent to which children find it necessary to rely on lexical feedback in phonological analysis may be language-specific and may interact with the language's phonological complexity and orthographic depth (Saiegh-Haddad, 2004). Children's higher phoneme deletion scores in Hebrew than Russian may also be related to wider experience with phonological awareness games in Hebrew that children might have received at the kindergarten in Hebrew but not in Russian. This may have contributed directly to children's awareness of the phonological structure of Hebrew, or indirectly by broadening the Hebrew lexicon of children, hence facilitating phonological processing of familiar Hebrew words. Although there were differences among children in age and also probably in oral language proficiency in the two languages, the results showed that the nature of the effect of the four linguistic factors that the study targeted was similar in the two age-groups. This implies that cognitive maturation and oral language proficiency does not undermine the effect of a given linguistic factor on children's phonemic awareness, neither does it alter its qualitative effect. In both languages, the difference between the two age-groups was noted in the intensity of the effect of a given linguistic factor rather than in the nature of its effect on phoneme deletion.

To sum up, the current study contributes to identifying universal versus language-specific constraints on phonemic awareness in the two languages of bilingual children. Through systematic comparisons of how phonemic awareness is accomplished in the two languages studied, and with reference to previous studies in other languages, the current study unravels the language-specific factors that are imposed by the properties of a particular language and their effect on phonemic awareness and, in turn, uncovers possible variations in basic reading skills development in diverse languages. In identifying the language-specific versus universal constraints on phonemic awareness in different languages, the current study has contributed to identifying the limits on the transfer of phonemic awareness in diverse language and has permitted a conceptual exploration of the way in which reading development in different languages may be constrained by the linguistic structure of the language involved (Koda, 2007).

Thus, phonemic awareness is not an all-or-none phenomenon. Phonemic awareness performance is constrained by a variety of linguistic factors: universal and language-specific. As we have shown in this study, aspects of the phonological structure of language, and in particular the syllable structure, affect the ease with which children can access phonemes in different positions (initial or final) and in different linguistic contexts (singleton versus cluster). As languages vary in their syllable structure, the effect of this factor is language-specific. This sets a serious

limit on the transferability of phonemic awareness in languages that vary in their phonological structure and, as a result, warrants a careful consideration of the phonological structure of the items employed in different languages.

At the same time, other factors appear to have a consistent effect on phonemic awareness in different languages. We have shown that stress and word length may be such factors. While they are linguistic factors in nature, their effect is universal. That is, their effect is consistent across languages and does not interact with the linguistic structure of the particular language involved. The consistent effect of these factors across languages should make the transferability of phonemic awareness more straightforward and less dependent on the specific linguistic and orthographic architecture of the particular language. In the current state of affairs, where there is general acceptance of the mechanism of transfer, yet "little consensus as to what constitutes transfer and how it transpires" (Koda, 2007, p. 3; Genesee & Geva, 2006) research into the linguistic and orthographic constraints on transfer in different languages is the way forward. This investigation will inform a theory of the impact of language and literacy experiences in L1 and L2 on reading development in diverse languages.

Appendix A

Phonological awareness tasks

Russian

Stimulus words for initial phoneme deletion

Practice trials: локоть, мороз, рукав, кусок, десять, ладонь, камень, ковёр, номер.

Experimental trials: халат, сахар, ло*ш*адь, внук, вечер, *б*ант, мост, стул, куст, дверь, гость, диван, носок, конец, лист, друг, ножик, цвет, малы*ш*, выход.

Stimulus words for final phoneme deletion

Practice trials: сосед, восемь, север, горох, память, лю*б*овь, сироп, песок, запах.

Experimental trials: торт, смех, ветер, дождь, свет, месяц, глаз, петух, живот, девять, *б*илет, город, хле*б*, рост, зонт, дурак, салат, вход, парк, голос.

Hebrew

Stimulus words for initial phoneme deletion

Practice trials: ורד, סדר, סכ'ן, גבר, כסף, סד'ן, ר'קוד, סרט, פנס

Experimental trials: חדר, צמח, מלון, פקק, צחוק, לשון, חתן, זמן, גשר, פרס, חודש, חלב, מלך, ס'פור, חלון, קצת

Stimulus words for final phoneme deletion

Practice trials: דלת, בצל, מרק, גזר, סוכר, גשר, ספר, בגד, בשר, חלום, מפ'ת

Experimental trials: כרוב, סתו, כב'ש, ת'נוק, לחם, כפר, כדור, בוקר, דבשה דרך, בטן, כר'ת, כלב, בלו

Appendix B

Russian letter discrimination

Practice trials			
1	Г	Г	Same
2	Н	И	Dif
Experimental trials			
1	З	Э	Dif
2	Ш	С	Dif
3	Щ	Ч	Dif
4	З	З	Same
5	П	Ц	Dif
6	Г	Г	Same
7	Э	Е	Dif
8	Ж	К	Dif
9	Б	Г	Dif
10	Я	Я	Same
11	Д	Т	Dif
12	И	У	Dif
13	О	У	Dif
14	А	Л	Dif
15	Ш	Щ	Dif
16	А	Я	Dif
17	Д	Д	Same
18	Р	В	Dif
19	В	З	Dif
20	Б	Б	Same

Russian letter identification/naming

Practice trials	
1	В
2	Л
Experimental trials	
1	Ф
2	Ё
3	Р
4	Ц
5	Г
6	Н
7	Ж
8	С
9	З

10	Ч
11	У
12	А
13	К
14	П
15	Х
16	Э
17	Ш
18	Щ
19	Ы
20	Б

Hebrew letter discrimination

Practice trials		
1	ג	ז
2	ן	ן
Experimental trials		
1	ר	ד
2	ק	ק
3	ח	ב
4	ה	ה
5	ס	ם
6	ק	ח
7	ז	ב
8	ג	ג
9	נ	ג
10	ז	ר
11	ח	ת
12	ס	ס
13	ן	ך
14	פ	ט
15	ה	פ
16	ס	שׁ
17	ך	ך
18	ת	ה
19	פ	ה
20	פ	ר

Hebrew letter identification/naming

Practice trials	
1	ם
2	שׁ
Experimental trials	
1	ג
2	ט
3	י
4	ר
5	ה
6	א
7	ז
8	ך
9	ק
10	ס
11	שׂ
12	ד
13	ן
14	פ
15	ג
16	ח
17	ס
18	נ
19	ם
20	פ

References

Adams, M. J. (1990). *Beginning to read: Thinking and learning about print*. London: MIT Press.

Aitchison, J., & Straf, M. (1981). Lexical storage and retrieval: A developing skill? *Linguistics, 19*, 751–795.

Baddeley, A. D., Thomson, N., & Buchanan, M. (1975). Word length and the structure of short-term memory. *Journal of Verbal Learning and Verbal Behavior, 14*, 575–589.

Bat-El, O. (1993). Parasitic metrification in the modern Hebrew stress system. *The Linguistic Review, 10*, 189–210.

Becker, M. (2003). Hebrew stress: Can't you hear those trochees? In Kaiser & Arunachalam (Eds.) *Proceedings of PLC 26* (Vol. 9.1, pp. 45–58).

Ben-Dror, I., Frost, R., & Bentin, S. (1995). Orthographic representation and phonemic segmentation in skilled readers: A cross-language comparison. *Psychological Science, 6*, 176–181.

Bolozky, S. (2006). A note on initial consonant clusters in Israeli Hebrew. *Hebrew Studies, XLVII*, 227–235.

Bondarko, L. V. (1969). The syllable structure of speech and distinctive features of phonemes. *Phonetica, 20*, 1–40.

Booij, G. E. (1983). Principles and parameters in prosodic phonology. *Linguistics, 21*, 249–280.

Booth, J. R., & Perfetti, C. A. (2002). Onset and rime structure influences naming but not early word identification in children and adults. *Scientific Studies of Reading, 6*, 1–23.

Bradley, L., & Bryant, P. (1983). Categorizing sounds and learning to read: A causal connection. *Nature, 313*, 419–421.

Bruck, M., Genesee, F., & Caravolas, M. (1997). A cross-linguistic study of early literacy acquisition. In B. Blachman (Ed.), *Foundations of reading acquisition and dyslexia: Implications for early intervention* (pp. 145–162). London: Lawrence Erlbaum Associates Publishes.

Bruck, M., & Treiman, R. (1990). Phonological awareness and spelling in normal children and dyslexics: The case of initial consonant clusters. *Journal of Experimental Child Psychology, 42*, 156–178.

Bryant, P. E., MacLean, M., Bradley, L. L., & Crossland, J. (1990). Rhyme and alliteration, phonemic detection, and learning to read. *Developmental Psychology, 26*, 429–438.

Byrne, B., & Fielding-Barnsley, R. (1989). Phonemic awareness and letter knowledge in the child's acquisition of the alphabetic principle. *Journal of Educational Psychology, 81*, 313–321.

Byrne, B., & Fielding-Barnsley, R. (1990). Acquiring the alphabetic principle: A case for teaching recognition of phoneme identity. *Journal of Educational Psychology, 28*, 805–812.

Byrne, B., & Fielding-Barnsley, R. (1993). Evaluating a program to teach phonemic awareness to young children: A 1-year follow-up. *Journal of Educational Psychology, 85*, 104–111.

Caravolas, M., & Bruck, M. (1993). The effect of oral and written language input on children's phonological awareness: A cross-linguistic study. *Journal of Experimental Child Psychology, 55*, 1–30.

Carroll, J. M., & Snowling, M. J. (2001). The effects of global similarity between stimuli on children's judgment of rime and alliteration. *Applied Psycholinguistics, 22*, 327–342.

Chiat, S. (1983). Why Mikey's right and my key's is wrong: The significance of stress and word boundaries in a child output system. *Cognition, 14*, 275–300.

Cohen-Gross, D. (2003). Hamivne hahavarti shel ha_ivrit hexadasha [Syllable structure in Modern Hebrew. In O. Schwarzwald, S. Blum-Kulka, & E. Olshtein (Eds.), *A tribute to Raphael Nir: Studies in communication, linguistics, and language teaching* (pp. 359–369). Jerusalem, Israel: Carmel (in Hebrew).

De Cara, B., & Goswami, U. (2002). Statistical analysis of similarity relations among spoken words: Evidence for the special status of rimes in English. *Behavioural Research Methods and Instrumentation, 34*, 416–423.

De Cara, B., & Goswami, U. (2003). Phonological neighbourhood density effects in a rhyme awareness task in 5-year-old children. *Journal of Child Language, 30*, 695–710.

Duncan, L. G., Seymour, P. H. K., & Hill, S. (1997). How important are rhymes and analogy in beginning reading? *Cognition, 63*, 171–208.

Dupoux, E., Pallier, C., Sebastián, N., & Mehler, J. (1997). A destressing "deafness" in French? *Journal of Memory and Language, 36*, 406–421.

Dupoux, E., Peperkamp, S., & Sebastián-Gallés, N. (2001). A robust method to study stress 'deafness'. *Journal of the Acoustical Society of America, 110*, 1606–1618.

Durgunoglu, A. Y. (2002). Cross-linguistic transfer in literacy development and implications for language learners. *Annals of Dyslexia, 52*, 189–204.

Durgunoğlu, A. Y., & Öney, B. (1999). A cross-linguistic comparison of phonological awareness and word recognition. *Reading and Writing: An Interdisciplinary Journal, 11*, 281–299.

Eviatar, Z., Leikin, M., & Ibrahim, R. (1999). Phonological processing in second language phonemes: A selective deficit in bilingual aphasic. *Language Learning, 49*, 121–141.

Fudge, E. C. (1969). Syllables. *Journal of Linguistics, 5*, 193–320.

Fudge, E. C. (1987). Branching structure within the syllable. *Journal of Linguistics, 23*, 359–377.

Genesee, F., & Geva, E. (2006). Cross-linguistic relationships in working memory, phonological processes, and oral language. In D. August & T. Shanahan (Eds.), *Developing literacy in second language learners: A report of the national literacy panel on language minority children and youth* (chapter 7, pp. 175–184). Mahwah, NJ: Erlbaum.

Geudens, A., & Sandra, D. (2003). Beyond implicit phonological knowledge: No support for an onset-rime structure in children's explicit phonological awareness. *Journal of Memory and Language, 49*, 157–182.

Geudens, A., Sandra, D., & Martensen, (2005). Rhyming words and onset-rime constituents: An inquiry into structural breaking points and emergent boundaries in the syllable. *Journal of Experimental Child Psychology, 92*, 366–387.

Geudens, A., Sandra, D., & van den Broek, W. (2004). Segmenting two-phoneme syllables: Developmental differences in relation with early reading skills. *Brain and Language, 90*, 338–352.

Geva, E. (2006). Second-language oral proficiency and second-language literacy. In D. August & T. Shanahan (Eds.), *Developing literacy in second-language learners: A report of the national literacy panel on language-minority children and youth* (chapter 5, pp. 123–140). Mahwah, NJ: Lawrence Erlbaum Associates.

Goetry, V., Wade-Woolley, L., Kolinsky, R., & Mousty, P. (2006). The role of stress processing abilities in the development of bilingual reading. *Journal of Research in Reading, 29*, 349–362.

Goldsmith, J. (1990). *Autosegmental and metrical phonology*. Oxford: Blackwell.

Goswami, U. (1986). Children's use of analogy in learning to read: A developmental study. *Journal of Experimental Child Psychology, 42*, 73–83.

Goswami, U. (1988). Orthographic analogies and reading development. *Quarterly Journal of Experimental Psychology, 40A*, 239–268.

Goswami, U. (1992). *Analogical reasoning in children*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Goswami, U., & Bryant, P. (1990). *Phonological skills and learning to read*. East Sussex: Lawrence Erlbaum Associates.

Goswami, U., & East, M. (2000). Rhyme and analogy in beginning reading: Conceptual and methodological issues. *Applied Psycholinguistics, 21*, 63–93.

Goswami, U., Thomson, J., Richardson, U., Stainthorp, R., Hughes, D., Rosen, S., et al. (2002). Amplitude envelope onsets and developmental dyslexia: A new hypothesis. *Proceedings of the National Academy of Science, 99*, 10911–10916.

Graf, D. (2000). Stress assignment in the nominal system of Modern Hebrew (MH). In A. Z. Wyner (Ed.), *The proceedings of the 15th annual conference of IATL*, Israel (Vol. 7).

Graf, D. (2003). Prosodic control: Consonants clusters in Modern Hebrew. In *The Proceedings of the 11th Manchester Phonology Meeting*, Manchester, England.

Halle, M. (1971). *The sound pattern of Russian*. The Hague: Mouton & Co.

Jiménez González, J. E., & Haro García, C. R. (1995). Effects of word linguistic properties on phonological awareness in Spanish children. *Journal of Educational Psychology, 87*, 193–201.

Jusczyk, P., Cutler, A., & Redanz, N. (1993). Infants' preference for the predominant stress patterns of English words. *Child Development, 64*, 675–687.

Kim, Y.-S. (2007). Phonological awareness and literacy skills in Korean: An examination of the unique role of body-coda units. *Applied Psycholinguistics, 28*, 69–94.

Kirtley, C., Bryant, P. E., MacLean, M. J., & Bradley, L. L. (1989). Rhyme, rime and the onset of reading. *Journal of Experimental Child Psychology, 48*, 224–245.

Knyazev, S. V. (1999). O kriteriyah slogodeleniya v sovremennom russkom yazike: Teoriya volni, sonornosti i teoriya optimalnosti. *Voprosi Yazikoznaniya (The criteria of syllabifications in Modern Russian language: Wave Theory, Sonority Theory, and Optimality Theory). Issues on Linguistics, 1*, 84–102.

Koda, K. (2007). Reading and language learning: Crosslinguistic constraints on second language reading development. *Language Learning, 57*, 1–44.

Levin, I., Saiegh-Haddad, E., Hindi, N., & Ziv, M. (2008). Early literacy in Arabic: An intervention study among Israeli Palestinian kindergartners. *Applied Psycholinguistics., 29*, 413–436.

Lewkowics, N., & Low, L. (1979). Effects of visual aids and word structure on phonemic segmentation. *Contemporary Educational Psychology, 4*, 238–252.

Liberman, I. Y., Shankweiler, D., Fischer, F. W., & Carter, B. (1974). Explicit syllable and phoneme segmentation in the young child. *Journal of Experimental Child Psychology, 18*, 201–212.

Luce, P. A., & Pisoni, D. B. (1998). Recognizing spoken words: The neighborhood activation model. *Ear and Hearing, 19*, 1–36.

McBride-Chang, C. (1995). What is phonological awareness? *Journal of Educational Psychology, 87*, 179–192.

Metsala, J. L. (1997). An examination of word frequency and neighborhood density in the development of spoken word recognition. *Memory and Cognition, 25*, 47–56.

Mixdorff, H., & Ami, N. (2002). The prosody of Modern Hebrew—a quantitative study. In *Proceedings of SP-2002 conference* (pp. 511–514).

Muneaux, M., Ziegler, J. C., Truc, C., Thomson, J., & Goswami, U. (2004). Deficits in beat perception and dyslexia: Evidence from French. *NeuroReport, 15*, 1255–1259.

National Reading Panel. (2000). *Report of the national reading panel teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction*. Washington, DC: National Institute of Child Health and Human Development.

Nazzi, T., Bertoncini, J., & Mehler, J. (1998). Language discrimination by newborns: Towards an understanding of the role of rhythm. *Journal of Experimental Psychology: Human Perception and Performance, 24*, 756–766.

Nazzi, T., & Ramus, F. (2003). Perception and acquisition of linguistic rhythm by infants. *Speech Communication, 41*, 233–243.

Perfetti, C. A., & Liu, Y. (2005). Orthography to phonology and meaning: Comparisons across and within writing systems. *Reading and writing: An Interdisciplinary Journal, 18*, 193–210.

Richardson, U., Thomson, J. M., Scott, S. K., & Goswami, U. (2004). Auditory processing skills and phonological representation in dyslexic children. *Dyslexia, 10*, 215–233.

Saiegh-Haddad, E. (2003). Linguistic distance and initial reading acquisition: The case of Arabic diglossia. *Applied Psycholinguistics, 24*, 115–135.

Saiegh-Haddad, E. (2004). The impact of phonemic and lexical distance on the phonological analysis of words and pseudo words in a diglossic context. *Applied Psycholinguistics, 25*, 495–512.

Saiegh-Haddad, E. (2005). Correlates of reading fluency in Arabic: Diglossic and orthographic factors. *Reading and Writing: An Interdisciplinary Journal, 18*, 559–582.

Saiegh-Haddad, E. (2007a). Linguistic constraints on children's ability to isolate phonemes in Arabic. *Applied Psycholinguistics, 28*, 607–625.

Saiegh-Haddad, E. (2007b). Epilinguistic and metalinguistic awareness may be subject to different constraints. *First Language, 27*, 385–405.

Savage, R., Blair, R., & Rvachew, S. (2006). Rimes are not necessarily favoured by pre-readers: Evidence from meta- and epi-linguistic phonological tasks. *Journal of Experimental Child Psychology, 94*, 183–205.

Schreuder, R., & van Bon, W. H. J. (1989). Phonemic analysis: Effects of word properties. *Journal of Research in Reading, 12*, 59–78.

Schwartz, M., Geva, E., Share, D., & Leikin, M. (2007). Learning to read in English as a third language: The cross-linguistic transfer of phonological processing skills. *Written Language and Literacy, 10*, 25–52.

Schwartz, M., Leikin, M., & Share, D. L. (2005). Bi-literate bilingualism versus mono-literate bilingualism: A longitudinal study of reading acquisition in Hebrew (L2) among Russian-speaking (L1) children. *Written Language and Literacy, 8*, 179–207.

Seymour, P. H. K., Aro, M., & Erskine, J. M. (2003). Foundation literacy skills in European orthographies. *British Journal of Psychology, 94*, 143–174.

Share, D. (2008). On the Anglocentricities of current reading research and practice: The perils of overreliance on an "outlier" orthography. *Psychological Bulletin, 134*, 584–615.

Share, D. L., & Blum, P. (2005). Syllable splitting in literate and preliterate Hebrew speakers: Onsets and rimes or bodies and codas? *Journal of Experimental Child Psychology, 92*, 182–202.

Snowling, M. J. (2000). *Dyslexia* (2nd ed.). Oxford: UK, Blackwell.

Spencer, A. (1998). *Phonology*. UK: Blackwell.

Stahl, S. A., & Murray, B. A. (1994). Defining phonological awareness and its relationship to early reading. *Journal of Educational Psychology, 86*, 221–234.

Stanback, M. L. (1992). Syllable and rime patterns for teaching reading: Analysis of a frequency-based vocabulary of 17, 602 words. *Annals of Dyslexia, 42*, 196–221.

Stanovich, K. E., Cunningham, A. E., & Cramer, B. B. (1984). Assessing phonological awareness in kindergarten children: Issues of task comparability. *Journal of Experimental Child Psychology, 38*, 175–190.

Stuart, M. (2005). Phonemic analysis and reading development: Some current issues. *Journal of Research in Reading, 28*, 39–49.

Swan, D., & Goswami, U. (1997). Phonological awareness deficits in developmental dyslexia and the phonological representations hypothesis. *Journal of Experimental Child Psychology, 66*, 18–41.

Thomas, E., & Senechal, M. (2004). Long-term association between articulation quality and phoneme sensitivity: A study from age 3 to age 8. *Applied Psycholinguistics, 25*, 513–541.

Treiman, R. (1983). The structure of spoken syllables: Evidence from novel word games. *Cognition, 15*, 49–74.

Treiman, R. (1985). Onsets and rimes as units of spoken syllables: Evidence from children. *Journal of Experimental Child Psychology, 39*, 161–181.

Treiman, R. (1988). The internal structure of the syllable. In G. Carlson & M. Tanenhaus (Eds.), *Linguistic structure in language processing* (pp. 27–52). Norwell, MA: Kluwer Academic.

Treiman, R. (1991). Children's spelling errors on syllable-initial consonant clusters. *Journal of Educational Psychology, 83*, 346–360.

Treiman, R., Berch, D., & Weatherson, S. (1993). Children's use of phoneme-grapheme correspondences in spelling: Roles of position and stress. *Journal of Educational Psychology, 85*, 466–477.

Treiman, R., Mullennix, J., Bijeljac-Babic, R., & Richmond-Welty, E. D. (1995a). The special role of rimes in the description, use, and acquisition of English orthography. *Journal of Experimental Psychology: General, 124*, 107–136.

Treiman, R., & Weatherson, S. (1992). Effects of linguistic structure on children's ability to isolate initial consonants. *Journal of Educational Psychology, 84*, 174–201.

Treiman, R., Zukowski, A., & Richmond-Welty, E. D. (1995b). What happened to the "n" of sink? Children's spellings of final consonant clusters. *Cognition, 55*, 1–38.

Vinarskaya E. N., Lepskaya N. I., & Bogomazov, G. M. (1977). Pravila slogodeleniya i slogovye modeli (ne materiale detskoy rechi). Problemi teoreticheskoy i eskperemental'noj fonetiki. Publikacii otdeleniya strukturnoy i prikladnoj lingvistiki MGU. The rules for syllabification and syllable models (the analysis of children's speech). The problems of theoretical and experimental phonetics. Publications of the department of structural and applied linguistics of Moscow State University. Issue 8. Moscow.

Wagner, R. K., & Torgesen, J. K. (1987). The nature of phonological processing and its causal role in the acquisition of reading skills. *Psychological Bulletin, 101*, 192–212.

Ward, D. (1965). *The Russian language today: System and anomaly*. Chicago: University of Chicago Press.

Wood, C. (2004). *Speech rhythm processing in young children and its relation to phonological awareness*. Paper presented at the annual meeting of the society for the scientific studies of reading, Amsterdam.

Wood, C. (2006a). *Sensitivity to speech rhythm and the development of reading. Trends in cognitive psychology research*. New York: Nova Science.

Wood, C. (2006b). Metrical stress sensitivity in young children and its relationship to phonological awareness and reading. *Journal of Research in Reading, 29*, 270–287.

Wood, C., & Terrell, C. (1998). Poor readers' ability to detect speech rhythm and perceive rapid speech. *British Journal of Developmental Psychology, 16*, 397–413.

Yoon, H. K., Bolger, D. J., Kwon, O. S., & Perfetti, C. A. (2002). Subsyllabic units in reading. A difference between Korean and English. In L. Verhoeven, C. Elbo, & P. Reitsma (Eds.), *Precursors of functional literacy*. Amsterdam/Philadelphia: John Benjamins Publishing Company.

Yopp, H. K. (1988). The validity and reliability of phonemic awareness tests. *Reading Research Quarterly, 23*, 159–177.

Zaretsky, E. (2002). Effects of oral language on sound segmentation skills: Cross linguistic evidence. In W. Fay & K. M. Louise (Eds.), *Investigations in clinical phonetics and linguistics* (pp. 201–212). Mahwah, NJ: Lawrence Erlbaum Associates.

Ziegler, J. C., & Goswami, U. (2005). Reading acquisition, developmental dyslexia, and skilled reading across languages: A psycholinguistic grain size theory. *Psychological Bulletin, 131*, 3–29.