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ORIGINAL ARTICLE

The internal structure of the syllable in Russian and in Hebrew: Evidence from monolingual kindergarteners

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Abstract

Notwithstanding remarkable phonological differences, the CV syllable is the most frequent syllable type in both Russian and Hebrew. This led to the prediction that the internal structure of the CVC syllable in the two languages, as reflected in phonological awareness tasks, might be similar. The study tested phonological awareness in two groups of monolingual kindergarteners: Hebrew-speaking ($N = 35$) and Russian-speaking ($N = 20$) in order to shed light on the underlying structure of the CVC syllable in the two languages. Phonological awareness tasks targeted awareness of the sub-syllabic structure (structured and unstructured) and phoneme awareness (initial and final). A linear mixed model analysis revealed that children in both groups showed greater facility with body-coda CV-C than with onset-rime C-VC syllable splitting and higher scores on final than on initial phoneme isolation tasks. The unstructured tasks also reflected the cohesion of the CV body in both languages. The findings demonstrate a similar internal representation of the CVC syllable in Russian and in Hebrew speakers as reflected in phonological awareness among preschoolers.

Keywords: body-coda; onset-rime; Russian; Hebrew; phonological awareness

Literature review

It has been widely shown that phonological awareness, the ability to access and manipulate the sounds in spoken words, plays a pivotal role in the acquisition of literacy skills in L1 and in L2 (Adams, 1990; August & Shanahan, 2006; Goswami & Bryant, 1990; Wagner & Torgesen, 1987). Research shows that the development of phonological awareness follows universal trajectories and progresses from large units to small units (Goswami & Bryant, 1990; Ziegler & Goswami, 2005). At the same time, language-specific typological differences, such as phonological structure and complexity, affect patterns of phonological awareness in speakers of different languages. As such, speakers from different linguistic backgrounds vary in their familiarity and experience with certain phonological structures and, in turn, in the facility with which they represent these structures and access them in phonological awareness tasks (e.g., Bruck et al., 1997; Caravolas & Landerl, 2010; Carroll & Snowling, 2001; Cossu et al., 1988; De Cara & Goswami, 2003; Durgunoglu & Öney, 1999; Gottardo et al., 2016; Zaretsky, 2002). Along the lines of this research, the aim of the current study is to test whether hypothesized linguistic structures are empirically real, namely, play a role in the mental activity of real speakers (Derwing & Eddington, 2014), and to test this question in Russian and in Hebrew young speakers. Specifically, the study aimed (a) to investigate the internal sub-syllabic structure of the syllable in Hebrew and in Russian by probing, through the use of phonological awareness tasks, the phonological units that are more accessible to children, and (b) to compare the performance of the two monolingual groups, Russian and Hebrew, across tasks that target various sub-syllabic and phonemic units that can inform the internal structure of the syllable in the two languages.

The internal structure of the syllable: a cross-linguistic perspective

In addition to informing theories of phonological awareness and literacy development, patterns of phonological awareness in different languages have been used to forge claims about the underlying psycholinguistic sub-syllabic structure of the syllable in different languages (e.g., Chen, 2011; for a discussion, see Derwing & Eddington, 2014; Russak & Saiegh-Haddad, 2011, 2017; Saiegh-Haddad, 2003, 2007a, 2007b; Share & Blum, 2005; Treiman, 1983, 1985, 1986). Two contrasting sub-syllabic structures have been suggested: *the onset-rime* structure and *the body-coda* structure, both of which propose a hierarchical organization of two major sub-syllabic phonological constituents (Venneman, 1988). Phonological awareness tasks in English-speaking children and adults (De Cara & Goswami, 2003; Treiman, 1983, 1985, 1986; Yoon et al., 2002) appear to support *the onset-rime structure,* alternatively called *the rime-cohesion hypothesis,* according to which the syllable is made up of two major constituents: the first is *the onset*, and this includes all prevocalic consonant(s); the second is *the rime,* and this includes the vowel (the nucleus of the syllable) together with all postvocalic consonant(s) (VC_2), the coda, (Fudge, 1987; Goldsmith, 1990; Kurylowicz, 1973; Selkirk, 1982). In contrast, phonological awareness patterns in speakers of Hebrew, Arabic, Dutch, and Korean (Ben-Dror et al., 1995; Russak and Saiegh-Haddad, 2017, Saiegh-Haddad, 2007b; Hebrew: Share and Blum, 2005; Arabic: Saiegh-Haddad, 2003, 2004, 2007a; Dutch: Geudens & Sandra, 2003; Geudens et al., 2004; Geudens et al., 2005; Korean: Kim, 2007; Yoon, 1997; Yoon et al., 2002; Yoon & Derwing, 2001) appear to support *the body-coda hypothesis* according to which the onset consonant(s) together with the vowel (C_1V) form *the body* unit of the syllable, whereas the final consonant(s) form the second unit, *the coda* (Iverson & Wheeler, 1989; McCarthy, 1979).

Unlike hierarchical hypotheses, Lee and Goldrick (2008) suggest an integrative alternative between hierarchical theories and flat models arguing that the syllable structure may be represented as a simple, linear string of phonemes governed by the phonotactic probabilities of the language (Clements & Keyser, 1983; Frisch et al., 2000; Jusczyk et al., 1994; Vitevitch et al., 1997). According to this view, native speakers of a language are sensitive to the frequency with which individual units within the syllable co-occur together, as well as to the general patterns of association

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over all syllables within a given language. In turn, it is argued that the development of sub-syllabic units is influenced to a great extent by the phonological structure of the stored vocabulary and is the product of the general way consonants and vowels combine within words in a language. In support of this argument, in English, for instance, onset-vowel versus vowel-coda sequences are subject to phonological distributional restrictions. In particular, there are relatively fewer constraints on the combination of onsets and vowels, than on vowels and codas than expected by chance, and phonological neighborhood in English is dominated by rime neighborhood (De Cara & Goswami, 2002; Kessler & Treiman, 1997; Luce & Pisoni, 1998). Moreover, in English, the cohesion of the rime is reinforced by the English orthography which is more predictable at the level of the rime than the individual grapheme (Goswami, 1986, 1988, 1992, 1998; Stanback, 1992; Treiman et al., 1995). Such patterns of phonological and orthographic associations might exert an influence on phonological representations and processing in different languages and orthographies.

The idea that the phonological representation of words stored in memory is dynamic and affects access to various phonological units within words is captured by *the Lexical Restructuring Model* (Metsala & Walley, 1998; Walley et al., 2003). According to this model, vocabulary growth in children exerts pressure on the restructuring of lexical items stored in memory, and this influences access to individual phonological units within words. The lexical restructuring model plays a central role in Chen's (2011) developmental *theory of intra-syllabic structure preference*. Chen (2011) argues that, at least early in language development, a core-CV unit may be a universally preferred sub-syllabic unit. In this core-CV unit, any consonant that "is not immediately preceding the nucleus vowel … [is] extrasyllabic" (p. 339). For instance, in a C_1C_2V syllable, the C_2V consists of a core-CV, whereas C_1 is an extrasyllabic unit. Chen (2011) argues that if we are to define the nature of the body (CV) unit properly, we need to distinguish between "a special case of an all-inclusive body unit" (p. 338), which would include a nucleus and an immediately preceding consonant or group of consonants (consonant clusters, e.g., CCV, CCCV) and a "core syllable" consisting of a nucleus and the immediately preceding consonant only. Chen (2011) further argues that the tendency to treat the core syllable as a cohesive unit is reinforced when the language has a simple syllabic structure like Chinese or Korean. However, when the language has a complex syllabic structure, like English, vocabulary growth exerts pressure on speakers to restructure their phonological representations. Moreover, it is argued that a change in preferred sub-syllabic phonological units may also be affected by the acquisition of alphabetic literacy (e.g., Geudens & Sandra, 2003; Savage et al., 2006).

Different views on the internal structure of the syllable lead to different predictions about phonological processing in children (e.g., Bradley & Bryant, 1983; MacKay, 1987; Stahl & Murray, 1994; Stanovich et al., 1984; Stemberger, 1983; Treiman, 1983, 1985, 1991, 1995; to mention just a few). For instance, *the rime-cohesion hypothesis* predicts that onset phonemes will be easier to access than phonemes embedded within the coda, since the coda is further embedded within a larger phonological unit, the rime. Studies of phonological awareness in English-speaking children, as well as adults, have corroborated this prediction, hence supporting the psychological reality of the onset-rime structure of the English

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syllable. For instance, in a series of studies, Trieman provided support for the cohesion of the CV unit in English (Treiman, 1983, 1985, 1986). Similarly, Stahl and Murray (1994) showed that the isolation and deletion of initial phonemes from CVC monosyllabic words were significantly less challenging than the isolation and deletion of final phonemes among kindergarten and first-grade children. Similar results were obtained from phoneme recognition tasks (Bruck & Genesee, 1995; Bruck et al., 1997; Vandervelden & Siegel, 1995).

Support for the onset-rime structure was also demonstrated in other languages including Dutch, French, and German suggesting a possible universality of this structure (Dutch: De Graaff et al., 2008; De Graaff et al., 2011; German: Wimmer et al., 1994; French: Ziegler & Goswami, 2005). At the same time, some researchers have argued that CV-C (body-coda) splitting and C-VC (onset-rime) splitting may represent the preferred divisions at different developmental stages. CV-C patterns may be the preferred units at a younger age because the vocabulary acquired by very young children is comprised mostly of CV syllables, whereas with vocabulary growth and with literacy instruction children become more sensitive to the statistical characteristics of their language, and cohesion patterns may change to represent the onset-rime C-VC sub-syllabic structure (Geudens & Sandra, 2003; Geudens et al., 2005; Geudens et al., 2004).

The body-coda structure has been used to account for the internal syllable structure of Korean. Both young and adult speakers were found to treat the body as a cohesive phonological unit as reflected on tasks of word blending and segmentation, sound similarity judgments, odd word out, reading by analogy, and grapheme substitution (Kim, 2007, 2008; Yoon, 1997; Yoon et al., 2002; Yoon & Derwing, 2001). Moreover, body-coda awareness was shown to make a unique contribution to pseudo word reading and spelling in Korean (Kim, 2007, Exp. 1). In line with this evidence, an analysis of the distributional properties of Korean words has demonstrated the prevalence of the CV syllable (Kim, 2007, Exp. 2; Lee & Goldrick, 2008).

Research into Semitic Arabic also offers evidence for the cohesion of the CV body unit (Saiegh-Haddad, 2003, 2004, 2007a). Saiegh-Haddad (2003, 2004) examined initial and final phoneme isolation from monosyllabic CVC and bi-syllabic CVCVC words and pseudo words in kindergarten and first-grade children. The results showed that initial phonemes were consistently more difficult to isolate than final phonemes. Saiegh-Haddad (2007a) examined the same question in simple CVC as against complex CCVC and CVCC pseudo words. The results showed again that initial consonants were harder than final consonants across all syllable types. These results were used to support the psycholinguistic reality of the body-coda structure in Arabic, and this has been argued to be probably attributed to the high frequency of the CV syllable (Saiegh-Haddad & Spolsky, 2014) and also to the CV-based *abjad* writing system of Arabic (Daniels,1992; Saiegh-Haddad, 2005, 2017; Saiegh-Haddad & Henkin-Roitfarb, 2014). It is noteworthy that this study did not distinguish between a core-CV unit and an all-inclusive body unit. Yet, a comparison between the isolation of initial consonants from CVC versus CCV words revealed that the former was more difficult than the latter. This difference, however, was not statistically significant when final consonants in CVC and CVCC were compared, a finding that might be used to support the cohesion of a core-CV unit (Chen, 2011).

Hebrew and Russian: phonological structure compared

The phonologies of Russian, a Slavic language, and of Hebrew, a Semitic language, vary in several ways. First, Russian and Hebrew have different and only partially overlapping phonemic inventories. For instance, while the Hebrew glottal fricative /h/ is absent from the Russian phonemic inventory, Russian post-alveolar affricate /č/ and post-alveolar fricatives /ž/ and/šč/ are not within the Hebrew phonemic stock (Eviatar et al., 1999). Another phonological difference consists of the phonemic distinction between soft (palatalized) and hard consonants, a fundamental characteristic of the Russian consonantal system that discriminates between words, for example, вес (/ves/ "weight") and весь (/ves^j/ "whole"), нос (/nos/ "nose") and нёс (/n^{j}os/ "he carried," 3rd person, singular, past tense).

Moreover, Russian and Hebrew differ in their prosodic structure and in patterns of stress assignment. Russian has lexical stress. Hence, stress is free, 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., /ˈmuka/- "pain" vs. /muˈka/- "flour"; /ˈpar'it'/- "to stew" vs. /paˈr'it'/ - "to hover") (Halle, 1971; Ward, 1965; Vinarskaya et al., 1977). In contrast, stress assignment in Hebrew is both lexically and phonologically determined (Graf, 2000; Mixdorff & Ami, 2002). Nonetheless, in both languages, stress is closely associated with allophonic vowel lengthening (Bat-El, 1993; Becker, 2003).

Russian and Hebrew also diverge in phonological complexity. Russian has a more complex syllabic structure than Hebrew, and it features a variety of complex onsets. The productive derivational prefixation in Russian greatly increases the number of possible complex clusters, allowing for up to four segments in the onset position (e.g., /**str**ah/ "fear," /**vzgl**jat/ "glance, view" and /**fspl**esk/ "splash"). Complex codas, however, are relatively rare in Russian though the language does permit up to four consonants in the coda position (e.g., /mo**st**/ "bridge," /ho**lst**/ "canvas" and /gra**fstf**/ "earldom" in genitive case) (Kochetov, 2002; Zaretsky, 2002). Quantitative distributional studies also demonstrated that, like many Slavic languages, Russian exhibits a clear preference for initial clusters over final clusters (Kučera & Monroe, 1968). Unlike in Russian, however, syllables with complex onset are rare in Hebrew (1%) and syllables with complex coda are even less frequent (Ben-David, 2020; Ben-David & Bat-El, 2016). Hebrew only allows two consonants in the onset (e.g., /gvul/ "border") and no complex codas unless in specific verb conjugations, such as /katavt/ "you wrote" (2nd person, singular, past tense) (Cohen-Gross, 2003; Saiegh-Haddad et al., 2010).

Although the phonological structure of Russian and Hebrew is apparently very different, the two systems share three critical and inter-related features which converge on the prediction that the syllable CV body may be an equally salient phonological unit of representation and processing in both languages.[1] The first feature is the frequency of the CV syllable. The CV syllable is the most frequent syllable type in Hebrew with a 47% overall percentage of occurrence in the language (Asherov & Bat-El, 2019; Ben-David, 2020).[2] The prominence of open syllables in Russian phonology is even greater with CV and CCV types making up more than two-thirds of all syllable types in Russian (Bogomazov, 2001, as cited in Kerek & Niemi, 2012; Bondarko, 1998; Bondarko et al., 1977; Yolkina & Yudina, 1964).

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The second feature is the high frequency of multisyllabic words in both languages resulting from various morpho-phonological processes including the use of word-pattern templates in Hebrew (all of which are multisyllabic) and various inflectional and derivational affixational processes in Russian (Bogomazov, 2001, as cited in Kerek & Niemi, 2012; Bondarko, 1969, 1998; Bondarko et al., 1977; Grigorenko, 2006; Kerek & Niemi, 2012; Cohen-Gross, 2003; Share & Bar-On, 2018). The last feature that the phonologies of Russian and Hebrew share is the rather limited repertoire of vowel phonemes (five basic vowels /a, o, u, e, i/) reducing hence the scope of monosyllabic words that the language can allow.[3] These three phonological properties contrast, for instance, with the phonology of English, which is notorious for its complex syllabic structure (Seymour et al., 2003) and the large number of vowel phonemes. This, together with the sparse morphology of English, allows for the configuration of many monosyllabic yet phonologically complex words in this language. Moreover, VC rimes are salient in English monosyllabic words, and phonological neighborhood in English appears to be dominated by rime neighborhood (Cole et al., 1999; Kessler & Treiman, 1997).

Several studies tested phonological awareness in monolingual Hebrew-speaking children. The results of these studies consistently showed that it was significantly easier for participants to operate on final than on initial phonemes (Saiegh-Haddad, 2007b; Share & Blum, 2005; Tolchinsky et al., 2012; Wesserstein & Lipka, 2019). For instance, Share and Blum (2005) used unstructured CVC syllable splitting tasks (unstructured vs. structured) among Hebrew-speaking preschoolers and showed that children found the syllable body (CV) a more accessible biphonemic unit than the syllable rime (VC). Moreover, this effect was more pronounced in high-literacy preschool children than low-literacy ones suggesting an important role of the Hebrew orthography in promoting the salience of the syllable body among literate Hebrew speakers (Ben-Dror et al., 1995; Russak & Saiegh-Haddad, 2017). Saiegh-Haddad (2007b) tested phonological awareness in junior kindergarten, senior kindergarten, and first-grade Hebrew-speaking children using initial and final phoneme recognition and isolation tasks. The results revealed children having greater facility in isolating final than initial phonemes. These findings were used to support the reality of the body-coda structure in explicit phonological awareness in children. Wasserstein and Lipka (2019) examined phonological awareness among monolingual Hebrew-speaking kindergarten children at the syllabic and the phonemic levels. The results showed the predictable pattern of final phonemes being easier to delete than initial phonemes, yet only from CVC words, while no significant difference was found between initial and final phoneme isolation from bi-syllabic words. Yet, these results should be treated with caution as the study did not systematically match or manipulate different syllable structures (only syllable length) or phoneme identity within syllables.

With respect to Russian, Kerek and Niemi (2012, Exp. 2) studied phonological awareness among monolingual Russian first graders using two unstructured segmentation tasks: syllable segmentation and phoneme segmentation. In both segmentation tasks, the participants demonstrated a pronounced tendency to leave CV units intact (the syllable body), yet with just a few cases of syllabic segmentation into VC units (the syllable rime). This led to the conclusion that the "body-coda is a more natural representation of sub-syllabic structure than the onset-rime in the

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phonological awareness of Russian first graders" (p. 104). As the children tested in this study were exposed to literacy and were learning how to read, it was not possible to tease apart the role of the Russian phonology from the role of orthography or from reading instructional methods on the observed patterns of phonological segmentation.

Kavitskaya and Babyonyshev (2011) examined the role of syllable complexity on pseudo word repetition in monolingual Russian-speaking typically developing and language-impaired children aged 4,7–10,7. Error analysis revealed a strong tendency to preserve the CV unit when repeating pseudo words by deleting consonant(s) in the coda position or by deleting the first consonant of a complex onset regardless of whether the sonority sequence was rising or falling. Saiegh-Haddad et al. (2010) examined phonological awareness in Russian-Hebrew preliterate bilingual children using phoneme deletion from monosyllabic and bi-syllabic words. The study revealed again that kindergarteners had greater facility with final phonemes as against initial phonemes in the two languages of the bilingual sample.

As the studies explicated above show, earlier research on phonological processing in Hebrew and in Russian appears to support the cohesion of the CV unit and by extension the CV-C body-coda sub-syllabic structure of CVC words. At the same time, earlier research does not allow definitive conclusions because of various confounding issues, such as the effect of reading instruction, orthographic/literacy exposure, or bilingualism. Moreover, previous studies tested phonological awareness either at a sub-syllabic or at a phonemic level, and they did not control for the internal phonological structure of the syllable or the phoneme identity of target phonemes. To account for these methodological issues, the current study targeted two independent samples of Hebrew and Russian-speaking monolingual preschool children with no prior exposure to literacy and compared their performance on parallel phonological awareness tasks in the two languages, in a real and in a pseudo word conditions, by designing phonological awareness tasks that are matched phonemically in the two languages. This was done by (1) carefully equating items across all the tasks on syllabic structure (using only simple CVC monosyllabic words and pseudo words) and (2) matching initial and final phonemes on phonological properties with the same phonemes appearing once in the onset position and once in the coda position (Treiman, 1986).

The aim of the current study was twofold. The first aim was to investigate the internal sub-syllabic structure of the syllable in Hebrew and in Russian by probing the phonological units that are more accessible to children as reflected in performance on phonological awareness tasks. Two specific hypotheses about the internal structure of the syllable were tested: the rime-cohesion and the body-coda hypotheses. Structured CVC syllable splitting tasks (onset-rime splitting and body-coda splitting) as well as initial and final phoneme isolation tasks were used to test these hypotheses. If the structure of the syllable aligned with the rime-cohesion structure, children were predicted to find structured onset-rime splitting easier than body-coda splitting. Similarly, unstructured syllable splitting was predicted to yield many more C-VC spontaneous divisions. Moreover, children were predicted to find initial phonemes easier to isolate than final phonemes. Opposite patterns were predicted if the body-coda hypothesis was to be supported. Hebrew and Russian are an interesting test case for a cross-linguistic investigation of the sub-syllabic structure in phonological processing. As was explicated earlier, the two languages belong to different language families and their phonologies vary greatly. Nevertheless, they converge on three features that can make the syllable's CV an equally salient unit of representation and processing in both languages, namely the prevalence of open syllables, the high frequency of multisyllabic words, and the relatively small inventory of vowels. Therefore, we predicted that children in both language groups would show phonological awareness patterns that would align with the cohesiveness of the CV unit. Specifically, we predicted that (1) structured body-coda splitting would be easier than structured onset-rime splitting; (2) final phonemes would be easier to isolate than initial phonemes; and (3) unstructured syllable splitting would yield a larger number of CV-C spontaneous division of the syllable. The second aim of the present study was to compare the performance of the two monolingual groups, Russian and Hebrew, and probe whether they reveal differences in phonological awareness across the different tasks that might inform the internal structure of the syllable in the two languages.

Method

Participants

Two groups of kindergarteners participated in the study. The first group consisted of 35 Hebrew-speaking monolinguals (16 boys and 19 girls, *mean* age = 69.59; *SD* = 4.07) sampled from four municipal kindergartens in the central region of Israel. The second group comprised of 20 monolingual Russian-speaking children (13 boys and 7 girls; *mean* age = 66.44; *SD* = 4.85) enrolled in a public kindergarten in the city of Yaroslavl, Russia. All the participants came from a middle SES. Authorization to conduct the study and signed written consent forms from the parents of all the children recruited for the study were obtained.

Children in both data collection sites were tested on phonological memory using the digit span task and on phonological naming speed using the Rapid Automatized Naming (RAN) for objects and colors. The children in the two sites were not found to differ significantly on these cognitive measures: Forward Digit Span: $t(53) = 0.35$, $p = .73$; Backward Digit Span, $t(53) = 2.18$, $p = .03$; RAN Objects: $p = .06$; RAN Numbers: $p = .14$ (See Appendix A). In order to confirm that the children in the two data collection sites were preliterate and could not read in Hebrew or in Russian, we used two literacy tasks: First, a *Letter Naming* task which required the Hebrew-speaking and the Russian-speaking children to name all twenty-seven printed Hebrew and all thirty-three Russian upper-case letters, respectively. Letters were printed each on a separate white card and were presented one at a time in a randomized order. Both letter name and letter sound responses were accepted as a correct response. The score was the total number of correct responses out of the total number of letters in each language. The second literacy task, *Familiar Word Reading task,* asked children to read eight very familiar words (e.g., mother, father, hello) in each language: Hebrew or Russian. An analysis of performance on the two literacy tasks revealed that while the Hebrew-speaking children were able to name, on average, 8 more letters than the Russian-speaking children, $t(53) = 4.75$, $p < .001$, no significant difference between the two groups in familiar word reading was found, $t(53) = 0.05$, $p = .96$ (See Appendix A).

Materials and procedure

Phonological awareness in Russian and Hebrew was assessed using three CVC syllable splitting tasks: two structured CVC splitting tasks (onset-rime syllable splitting and body-coda syllable splitting) and an unstructured CVC splitting task. In addition, two phoneme isolation tasks were used: initial phoneme isolation and final phoneme isolation. Two types of CVC items were used: real and pseudo words (*N* items per task = 20: 10 real and 10 pseudo).

The use of pseudo words enabled us to control for the identity of the phonemes within syllables and to match onset and codas on the identity of the embedded consonants. This is critical as research has shown that some phonemes (like liquids and nasals) tend to be more cohesive with the nucleus vowel than other phonemes. Pseudo words were matched and created according to the phonotactic constraints of Russian and Hebrew, by changing one consonant from within the same phonetic class in real words. Single target phonemes (the onset or the coda) that were to be detached from CVC syllables in the syllable splitting and the phoneme isolation tasks included phonemes from the following manner of articulation categories: plosives, fricatives, nasals, and liquids and were matched across tasks. Within each language, the same target phoneme was once in a prevocalic (onset) and once in a postvocalic (coda) position (e.g., in Hebrew, */**d**uv - vu**d**/; in Russian, /**m**of - fo**m**/*). Note, however, that in Russian, due to final devoicing, it was not possible to have pairs with the same voiced consonant in both the initial and the final position. Therefore, in the final (coda) position, voiced consonants were replaced by their voiceless counterparts (e.g., */b/* => */p/* as in */**b**otʃ - tʃo**p**/*).

The test items were pronounced one at a time and repeated once more if necessary. To ensure accurate perception of the target stimulus, children were asked to repeat each stimulus word (real and pseudo), and manipulation was performed only after the child had correctly produced the target word. Repetition was necessary to ensure that the children's performance on the tasks was not confounded by perceptual or articulatory problems. Experimental trials were preceded by four practice trials, except for the unstructured syllable splitting task. No feedback besides general encouragement was provided during administration of the experimental trials. The administration of all the tasks and conditions (real and pseudo) within tasks was counterbalanced. Written parental consent for all children participating in the study was obtained, and proper ethics approvals from the schools and the Ministries of Education in the two data collection sites were secured.

Structured syllable splitting

Onset-rime splitting

The structured onset-rime syllable splitting task required the children to divide a CVC syllable into the *onset* and the *rime* units (C-VC). For example, in Hebrew the real word **כד** */kad/* "jug" had to be divided into */k/* (onset) and */ad/* (rime); the pseudo word **ניג** */nig/* was to be split into */n/* (onset) and */ig/* (rime); In Russian, the real word **лес** */l'es/* "forrest" had to be divided into */l'/* (onset) and */es/* (rime); the pseudo word **мос** */mos/* was to be split into */m/* (onset) and */os/* (rime).

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Body-coda splitting

In body-coda syllable splitting task, the children were asked to break a syllable into the *body* and the *coda* units (CV-C). For example, in Hebrew the real word **סוס** */sus/* "horse" had to be split into */su/* (body) and */s/* (coda); the pseudo word **לוץ** */luts/* was to be divided into */lu/* (body) and */ts/* (coda). In Russian, the real word **суп** */sup/* "soup" was supposed to be divided into */su/* (body) and */p/* (coda), while the pseudo word **дош** */dosh/* had to be split into */do/* (body) and */sh/* (coda).

A score of one was assigned when the children succeeded in splitting a target real/pseudo word according to the required division: onset-rime or the body-coda, and a score of zero was assigned otherwise. The training items were not included in the overall means used for data analysis.

Error analysis

After calculating the percentage of correct responses on each task, we performed an analysis of errors in order to probe if they show patterns that are indicative of the cohesion of the rime or the body. All erroneous responses in both tasks were grouped into three categories depending on the biphonemic unit (i.e., the *rime* or the *body*) that was left intact after the splitting. The first category was *the Rime* category, and it consisted of divisions in which the participants preserved the biphonemic rime (**VC**) unit, although they did not correctly split the syllable into the onset and the rime (e.g., CVC-**VC**). The second category is *the Body* category, and it consisted of divisions in which the biphonemic body (**CV**) unit was left intact, although the children did not split the stimulus into the body and the coda (e.g., C-**CV**; **CV**-**CV**; **CV**-CVC; **CV**-V, CVC-**CV**). The third category is *the Others* category, and it consisted of all other erroneous responses that could not be aligned with either a body or a coda error (e.g., CV-VC; CV-V-VC) or neither of them (e.g., C_1VC_2-C1; C-C; C-CVC, C_1-V; C_1VC_2-C_2; C-V-C). After assigning all the erroneous responses to categories, we calculated the percentage of errors per category.

Unstructured syllable splitting tasks

In the unstructured syllable splitting task, the children were required to divide CVC words and pseudo words into two parts. No demonstration, instruction, or feedback was provided as to how the syllable should be broken down. Modeled after Share and Blum (2005), to introduce the idea of splitting, the experimenter tore a piece of paper into two not necessarily equal pieces. This was followed by a linguistic example of breaking up a compound word into two components (in Hebrew: **כדורסל** */kadur-sal/* "basketball" was divided into */kadur/* "ball" and */sal/* "basket"; in Russian: **пароход** */parakhod/* "steamship" was divided into */par/* "steam" and */khod/* "move"*)*. Then, a bi-syllabic word was divided into two syllables (in Hebrew: the word **פרפר** */parpar/* "butterfly" was broken down into */par/* and */par/*; in Russian: **фонтан** */fantan/* "fountain" was broken down into */fan/* and */tan/*). Following this demonstration, children were presented with the testing items and were asked to break them down into two units. Stimulus items were presented one at a time. Items were repeated if this was solicited by the participant.

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Responses in the unstructured syllable splitting task were analyzed as follows. We first calculated the mean frequency of occurrence (expressed as a percentage out of all responses) of the different types of divisions produced by the participants. In addition, to determine the mean frequency of divisions that preserved the *rime* or the *body* unit, we assigned all the responses to four categories. The first category was *the Rime* category, in which the splitting of the syllable left the rime unit intact, for example, C-**VC** (onset-rime division) and CVC-**VC** (where the participants repeated the entire CVC stimulus and then isolated the rime unit). The second category was *the Body* category, where the body unit was preserved in the splitting of the syllable, for example, **CV**-V (body-coda), **CV**-CVC, and **CV** divisions. The third category was the *CV-VC*. This category was found to occur a lot in the responses and hence merited a separate category (CV-VC). The last category was *the Others* category, which included the rest of divisions (i.e., CV-V-VC, C_1-C_2, C-CVC, or CV_1C-CV_2C).

Phoneme isolation

Initial phoneme isolation

Initial phoneme isolation asked children to isolate the first phoneme from each CVC stimulus and produce it. For example, children were requested to isolate the initial phoneme */n/* from the real Hebrew word **נר** */ner/* "candle" and */g/* from the pseudo word **גוז** */goz/*. Similarly, they had to isolate the initial phoneme */z/* from the Russian real word **зуб** */zup/* "tooth" and the initial phoneme */n/* from the pseudo word **нек** */n'ek/*.

Final phoneme isolation

Final phoneme isolation required children to isolate the final phoneme from the CVC stimulus and produce it. For instance, children had to isolate the final phoneme */s/* from the real Hebrew word **כוס** */kos/* "glass" and */ts/* from the pseudo word **תוץ** */tuts/*. In the same way, they were asked to isolate final phoneme */l'/* from the Russian real word **пыль** */pyl'/* "dust" and */f/* from the pseudo word **чоф** */tʃof/*.

The following instructions were given: "We are going to play a game with words. I'll say a word/a funny word (for pseudo words), and I want you to tell me just the FIRST/LAST sound you hear in the beginning/end of this word. I will do the first one for you." Four trials were given to each child. Children were assigned one score for isolating the correct target phoneme (initial or final depending on the task) and a zero score for producing an incorrect phoneme, or the correct phoneme in a CV unit.

Error analysis

Error analysis of initial and final phoneme isolation tasks was conducted after computing the percentage of correct responses. All the erroneous answers were coded, and their percentage was calculated.

Data analysis

All analyses were conducted in R. To test the effects of Language, Condition (Real/Pseudo), and Task (body-coda, onset-rime, initial phoneme isolation, and final

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Table 1. Percentage of correct responses in phonological awareness tasks by condition (Real words vs. Pseudo words) and by language (Hebrew vs. Russian)

Task		Hebrew-speaking	Russian-speaking
		M (*SD*)	*M (SD)*
Onset-rime splitting	Real words	7.43 (19.15)	0.00
	Pseudo words	5.14 (9.81)	1.00 (3.08)
	Both	6.29 (14.48)	.05 (1.58)
Body-coda splitting	Real words	67.14 (41.34)	86.00 (31.19)
	Pseudo words	64.57 (42.17)	87.00 (30.28)
	Both	65.86 (41.76)	86.5 (30.74)
Initial phoneme isolation	Real words	28.00 (37.87)	37.50 (36.54)
	Pseudo words	28.29 (36.98)	31.50 (36.02)
	Both	28.15 (37.43)	34.50 (36.28)
Final phoneme isolation	Real words	65.14 (35.51)	66.50 (41.58)
	Pseudo words	62.00 (35.22)	64.00 (37.75)
	Both	63.57 (35.37)	65.25 (39.67)

phoneme isolation) on the percentage of correct responses, we ran a linear mixed model (LMM) analysis using the *lme4* package (Bates et al., 2014). The fixed factors were Language, Condition, Task, and their interactions. Participants entered the model as the random intercept. We also tested the random slopes for task; however, the model failed to converge, and finally, only the random intercept was included. To establish the significance of each fixed factor, likelihood ratio tests were carried out. The package *emmeans* (Lenth, 2019) was used to interpret interaction effects, and the package *sjPlots* (Lüdecke, 2021) was used to plot the significant interactions.

Results

Structured syllable splitting and phoneme isolation in Hebrew and in Russian

For the purposes of the analysis, raw scores were converted into percent correct scores. Table 1 presents Descriptive Statistics of performance on the phonological awareness structured splitting and phoneme isolation tasks by group (Hebrew- and Russian-speaking children) and condition (real words vs. pseudo words).

A LMM analysis was conducted with the percentage of correct responses as the dependent variable. The first model included only the random intercept for participants, and then in each model, we were adding the following fixed factors in this order: Language, Task, Language*Task, Condition, Language*Condition, Task*Cognition, and Language*Task*Cognition. Likelihood ratio tests were used to assess the significance of each factor. Estimates of all fixed factors and the results of the likelihood ratio tests are presented in Appendix B. The following fixed factors came out significant: Task and the Language*Task interaction, and the final optimal

Table 2. Estimates of LMM predicting the percentage of correct responses in the structured phonological awareness tasks

Predictors	Estimates	*CI*	*p*
(Intercept)	65.86	57.05–74.67	<**0.001**
LG	20.64	6.04–35.25	**0.006**
Task [FPI]	−2.29	−11.02–6.45	0.607
Task [IPI]	−37.71	−46.45–-28.98	<**0.001**
Task [OR]	−59.57	−68.31–-50.84	<**0.001**
LG * Task [FPI]	−18.94	−33.43–-4.45	**0.011**
LG * Task [IPI]	−14.29	−28.77–0.20	0.053
LG * Task [OR]	−26.43	−40.91–-11.94	<**0.001**
Random effects			
σ^2	691.32		
$\tau_{00\ ID}$	357.26		
ICC	0.34		
N_{ID}	55		
Observations	440		
Marginal R^2/Conditional R^2	0.430/0.624		

Note. BC (body-coda syllable splitting) is the reference category for task; FPI-final phoneme isolation; IPI = initial phoneme isolation; OR = onset-rime syllable splitting.

model included only these factors. Table 2 presents the model's estimates. The fixed factors explained 43% of variance.

For Task, post hoc analyses using the *emmeans* function from the *emmeans* library (Lenth, 2019) with Tukey corrections revealed that the structured Body-Coda syllable splitting task had significantly higher percent of correct responses than the structured Onset-Rime syllable splitting task as well as initial and final phoneme isolation tasks ($p < .001$). Moreover, differences between all the tasks were statistically significant. For the Language*Task interaction, we used the plot model function from the sjPlot library (Lüdecke, 2021) to plot the interaction. Next, we conducted the post hoc analysis using the emmeans library with the Kenward-Roger method for the degrees of freedom which revealed that the difference between Hebrew and Russian was significant only in the body-coda task ($p = .01$) but not in other tasks. Figure 1 shows the values predicted by the interaction.

Unstructured syllable splitting in Russian and in Hebrew

Table 3 presents descriptive statistics (mean frequency of occurrence) of response type on the unstructured CVC syllable splitting task in the Hebrew-speaking and in the Russian-speaking samples, by condition (real vs. pseudo).

As may be seen in Table 3, the most frequent response among the monolingual Hebrew and monolingual Russian speakers was the body-coda splitting pattern in

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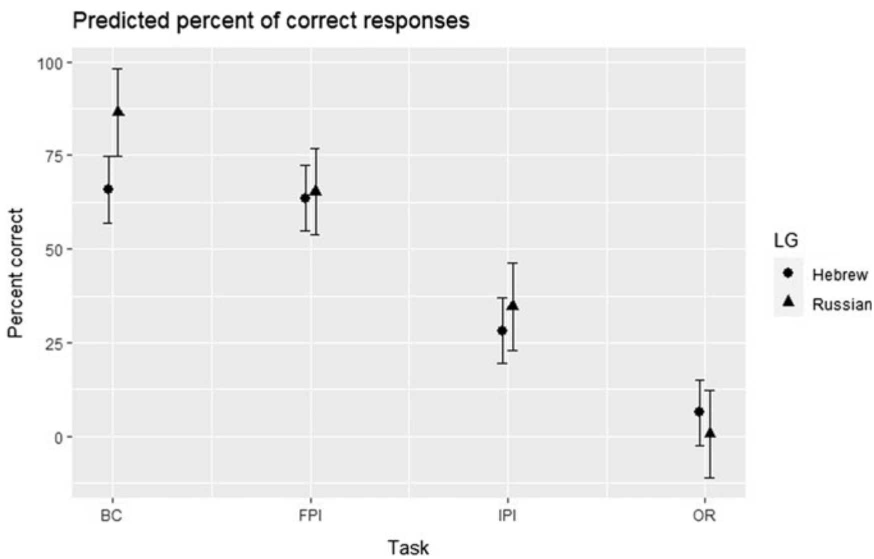

Figure 1. Predicted Percentage of Correct Responses in Phonological Awareness Tasks by Condition (Real words vs. Pseudo words) and by language (Hebrew vs. Russian). BC = Body-Coda Syllable Splitting; FPI = Final Phoneme Isolation; IPI = Initial Phoneme Isolation; OR = Onset-Rime Syllable Splittings.

both languages (Hebrew and Russian) and both conditions (real and pseudo). Body-coda responses were followed by CV-VC responses in both languages and conditions. Onset-rime splitting responses which preserve the cohesion of the rime unit were very rare in the Hebrew-speaking sample and no onset-rime splitting at all occurred in the spontaneous divisions of the Russian-speaking children. Another type of splitting that was only observed among Hebrew monolinguals was a C-C division pattern, where the vowel was left out altogether. The remaining natural division responses were all rather infrequent and included CV-CVC, where the initial CV unit was isolated first, and then, the entire CVC word or pseudo word was repeated, as well as divisions that left the CVC unit undivided.

Next, the responses provided by the participants were grouped into major categories (see Table 4). The first two categories consisted of divisions that left intact one of the target sub-syllabic units: *Rime* (VC) or *Body* (CV). The other two categories comprised divisions that preserved both units or neither of them: *CV-VC* and *Others*. (For a more detailed description of each of the categories, see the Method section.) The distribution of the responses into the above categories showed that the *Body* category was the largest in both languages across the two conditions: real and pseudo. In Hebrew, it was followed by the *CV-VC* category and two other categories: *Rime* and *Others* included only a very small number of responses. In Russian, however, *CV-VC* and *Others* categories had a rather equal number of splitting, and no responses fell into the *Rime* category in the real word condition, and a negligible percentage in the pseudo words condition.

To test the effect of Language (Hebrew vs. Russian), Condition (Real vs. Pseudo), and Categories (Rime vs. Body vs. CV-VC vs. Others) on the types of division in

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Table 3. Frequency of occurrence of division types in unstructured cvc syllable by condition (Real words vs. Pseudo words) and by language (Hebrew vs. Russian)

			Type of division						
Languagegroup	Condition		B-C	O-R	CV-VC	C-C	CV-CVC	CVC	No reply
Hebrew	Real words	*M* (*SD*)	56.29 (43.79)	0.86 (2.84)	38.00 (43.97)	1.43 (8.45)	2.86 (16.90)	0.29 (1.69)	–
	Pseudo words	*M* (*SD*)	54.86 (40.10)	2.00 (10.23)	39.14 (42.31)	1.42 (5.50)	0.57 (2.36)	–	0.29 (1.69)
	Both	*M* (*SD*)	55.58 (41.95)	1.43 (6.54)	38.57 (43.14)	1.43 (6.98)	1.72 (17.63)	0.15 (.85)	0.15 (.85)
Russian	Real words	*M* (*SD*)	56.50 (41.20)	–	21.00 (36.40)	–	–	12.00 (25.45)	9.5 (29.29)
	Pseudo words	*M* (*SD*)	51.00 (40.90)	–	19.00 (34.78)	–	0.50 (2.24)	13.50 (22.77)	14.00 (34.40)
	Both	*M* (*SD*)	53.75 (41.05)	–	20.00 (35.59)	–		12.75 (24.11)	11.75 (31.85)

Note. BC = body-coda; OR = onset-rime.

Table 4. Frequency of occurrence of division types (categories) in unstructured cvc syllable splitting by condition (Real words vs. Pseudo words) and by language (Hebrew vs. Russian)

			Types of division (Categories)			
Language group	Condition		Body	Rime	CV-VC	Others
Hebrew	Real words	*M* (*SD*)	59.14 (43.28)	1.14 (3.23)	38.00 (43.98)	1.71 (8.57)
	Pseudo words	*M* (*SD*)	55.43 (40.39)	3.14 (6.31)	39.14 (42.31)	2.00 (5.84)
	Both	*M* (*SD*)	57.29 (41.84)	2.14 (4.77)	38.00 (43.54)	1.86 (7.21)
Russian	Real words	*M* (*SD*)	57.00 (42.31)	0.00 (0.00)	21.50 (36.88)	21.50 (36.89)
	Pseudo words	*M* (*SD*)	52.50 (40.77)	.05 (2.23)	19.00 (34.77)	28.00 (36.94)
	Both	*M* (*SD*)	54.75 (41.54)	0.25 (1.12)	20.25 (36.94)	24.75 (36.92)

Table 5. Estimates of GLMM predicting the frequency of occurrenceof division types in the unstructured cvc splitting task by condition (Real words vs. Pseudo words) by language (Hebrew vs. Russian)

Predictors	Incidence rate ratios	*CI*	*p*
(Intercept)	5.73	5.19–6.32	<**0.001**
LG	0.96	0.81–1.13	0.627
categories [CV-VC]	0.67	0.58–0.79	<**0.001**
categories [OR]	0.04	0.02–0.07	<**0.001**
categories [Others]	0.03	0.02–0.06	<**0.001**
LG * categories [CV-VC]	0.54	0.40–0.73	<**0.001**
LG * categories [OR]	0.11	0.02–0.86	**0.036**
LG * categories [Others]	13.88	7.61–25.32	<**0.001**

Note. BC (body category) is the reference category for the category; OR-rime category.

the unstructured syllable splitting task, generalized LMM analysis with Poisson distribution was performed (used for count frequencies). The initial model included only the random intercept for participants, adding the following fixed factors in this order: Language, Condition, Language*Condition, Categories, Language*Categories, and Categories* Condition. Only the Language*Categories interaction came out significant. The results of likelihood ratio tests for each factor are presented in Appendix C. The estimates of the final optimal model which included only the Language*Categories interaction are presented in Table 5. The fixed factors explained 91% of variance.

Figure 2 plots the interaction. The post hoc analysis which was performed using the emmeans library revealed that the difference between Hebrew and Russian was significant in the following categories of division types: *CV-VC* ($p < .001$), *Rime* ($p < .001$), and *Others* ($p < .001$), but not in the *Body* category ($p = .63$).

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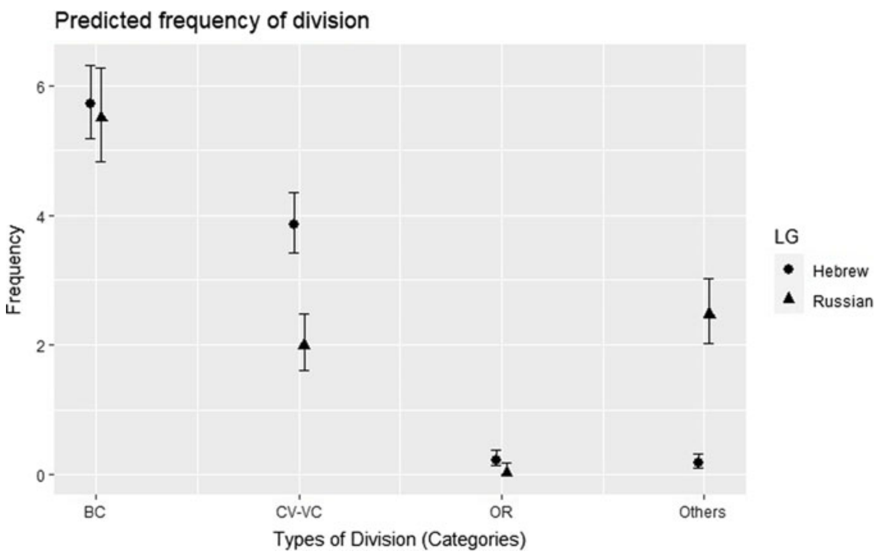

Figure 2. Predicted Frequency of Occurrence of Division Types (Categories) in Unstructured CVC Syllable Splitting by Condition (Real words vs. Pseudo words) and by language (Hebrew vs. Russian). BC = Body Category; OR = Rime Category.

Error analysis in structured tasks in Russian and in Hebrew

Erroneous responses in the structured syllable splitting tasks (onset-rime and body-coda) in both conditions (real and pseudo words) were categorized into one of the following three categories, depending on the biphonemic unit (i.e., the rime or the body) that was left intact in the sub-syllabic divisions: *Rime*, *Body,* and *Others* (where the divisions preserved both units or neither of them) (See Appendix D).

In the structured onset-rime syllable splitting task, no erroneous divisions fit into the *Rime* category in either the real or the pseudo word conditions in the Hebrew or in the Russian-speaking samples. The most frequent error category was the *Body* category in both languages making up about three-quarters of all observed errors. All remaining responses fell within the *Others* category both in Hebrew and in Russian, and they made up about one-quarter of the total errors. In the structured body-coda syllable splitting task, most of the erroneous responses fell into the *Others* category in both Hebrew and Russian. The *Body* or the *Rime* errors were very rare in Hebrew and they did not occur at all in Russian.

The analysis of the errors in the initial and final phoneme isolation tasks revealed the predominance of the C_1V error in both languages and across real and pseudo word conditions, making up between 80% and 90% of the total number of initial phoneme isolation errors and between 50% and 60% of the total number of final phoneme isolation errors.

Discussion

The current study tested the internal sub-syllabic structure of the CVC syllable as reflected in phonological awareness task performance in two independent samples

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of Hebrew-speaking and Russian-speaking preschool children. Specifically, we tested the predictions that derive from two contrasting hypotheses regarding the psycholinguistic representation of the syllable: the onset-rime and the body-coda hypotheses. Though limited in scope, earlier psycholinguistic research in Hebrew and its Semitic sister language Arabic (Arabic: Saiegh-Haddad, 2003, 2004, 2007a; Hebrew: Saiegh-Haddad, 2007b; Saiegh-Haddad et al., 2010; Share & Blum, 2005) led to the prediction that Hebrew-speaking children in our study would show evidence for a body-coda structure. In contrast with Hebrew, psycholinguistic research on the sub-syllabic structure of the syllable in Russian is rare, and because of various methodological issues, it did not allow strong predictions about the children's phonological representations or processing (Kerek & Niemi, 2012). Despite vast phonological differences between the two languages, a close analysis of the phonological structure of Hebrew and Russian revealed three common phonological features that might converge on the prediction that children in both language groups would show a preference for the cohesion of the CV unit and accordingly evidence for the body-coda sub-syllabic structure of CVC words. These features include the frequency of CV syllables in both languages, the abundance of multi-syllabic words, and the rather small vowel phonemic inventory.

To address the question of the underlying sub-syllabic structure in young kindergarten speakers of Hebrew and of Russian, we used structured and unstructured tasks that targeted various relevant sub-syllabic and phonemic units within words: body CV, rime VC, initial phoneme, and final phoneme. The results showed that the Hebrew-speaking sample revealed evidence for a body-coda structure in both structured tasks: syllable splitting and phoneme isolation. This was reflected in higher scores when the splitting task requested a body-coda splitting than an onset-rime splitting and in higher scores on final than on initial phoneme isolation. The results from the unstructured syllable splitting task converged on the same pattern of results with children showing a clearly more natural preference for a body-coda than an onset-rime division. These results support earlier evidence (Saiegh-Haddad, 2007b; Saiegh-Haddad et al., 2010; Share & Blum, 2005; Tolchinsky et al., 2012; Wesserstein & Lipka, 2019), and they corroborate the hypothesis that CVC syllables are represented in the memories of Hebrew-speaking children as CV bodies and codas. This, as has been argued elsewhere, may be attributed to the predominance of the CV unit in the phonological structure of Hebrew (Saiegh-Haddad, 2017; Share & Blum, 2005). In our study, the children tested were kindergarten children with negligent experience with the Hebrew orthography. The clear and consistent patterns of a body-coda cohesion across all tasks and conditions support the argument that these effects stem initially from phonological factors, rather than from orthographic factors, specifically the CV-based orthographic structure of the Hebrew script. At the same time, these early phonologically triggered preferences are expected to be consolidated with exposure to the Hebrew orthography and with reading skill development as earlier research with Hebrew speakers skilled in reading the unpointed orthography has already shown (Ben Dror et al., 1995).

A similar pattern of results was observed among the Russian-speaking sample, with performance on both the syllable splitting and the phoneme isolation tasks supporting the body-coda structure. Yet, interestingly, the results showed that, in

Russian, and more prominently than in Hebrew, onset-rime divisions on the unstructured syllable splitting task were very rare and sometimes non-existent. This finding offers particularly strong evidence that the onset and the rime units are not naturally accessible units among monolingual Russian-speaking children. Further support for the body-coda syllable structure in Russian comes from the results obtained from the initial and final phoneme isolation tasks with the Russian-speaking children showing greater facility with final than initial phonemes. This enhanced accessibility of final phonemes replicates earlier research with Russian-Hebrew bilingual children (Saiegh-Haddad et al., 2010). At the same time, the current results consolidate these earlier findings from bilinguals; especially, it was not possible based on research with bilinguals to determine whether the patterns observed implied transfer from Hebrew or a genuine tendency among speakers of Russian. The current results provide unequivocal evidence that the body unit is a more accessible phonological unit in Russian-speaking children and that this effect is not attributed to the Russian orthography or to Russian reading instructional methods. This does not mean that these two factors cannot play a role in strengthening the salience of the CV units (Goretsky et al., 1988; Kerek & Niemi, 2009; Kornev, 1997).

The analysis of errors supports the hypothesized body-coda representation and processing tendencies in both the Hebrew and the Russian-speaking samples. In other words, even when children were instructed and trained to split CVC syllables into the onset and the rime, they kept the CV body undivided in their erroneous responses. Similarly, the overwhelming majority of erroneous responses observed on the initial phoneme isolation task constituted CV errors reflecting the psycholinguistic unity of the CV body.

It is noteworthy that the results of the current study supporting the body-coda sub-syllabic structure in Hebrew and in Russian can also be conceptualized within Chen's (2011) developmental hypothesis of a core-CV unit. According to this view, at least early in the linguistic development, syllable structure is universally represented by a core-CV syllable, and other constituents are treated as appendixes unless subject to a further influence of a specific language's phonological and statistical properties. However, the current study cannot shed light on this hypothesis because only CVC stimuli were used.

The second research question of the current study examined whether different tasks would reveal differences between the two language groups and what this would imply about any possible differences between Hebrew and Russian in sub-syllabic representation. Before we delve into this question, it is to be remembered that the pattern of results in the two language groups was rather similar as we have explicated above. At the same time, a comparison between the two languages did reveal some interesting differences. The first one was related to the body-coda structured syllable splitting task on which Russian-speaking participants had significantly higher scores than their Hebrew-speaking counterparts. We believe that this discrepancy between the two language groups might be related to differences in the relative frequency of open syllables in Hebrew and in Russian. Although both languages feature many open syllables, in Russian open syllables are more frequent than in Hebrew, 68%[4] versus 47% (Hebrew: Asherov & Bat-El, 2019; Ben-David, 2020; Russian: Yolkina & Yudina, 1964). As a result, the cohesiveness of the

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syllable's CV in Russian might be perceptually stronger than in Hebrew. Consequiently, Russian-speaking participants might have outperformed their Hebrew-speaking counterparts on the body-coda structured syllable splitting task.

Another noticeable difference between Hebrew and Russian was related to the unstructured syllable splitting task, namely in the frequency of occurrence of the Rime, the CV-VC, and the Others types of divisions, with the Rime and the CV-VC splitting being significantly more frequent in the Hebrew-speaking children than in their Russian-speaking peers, yet with the reversed pattern for the Others types of splitting. The fact that the Rime category consisting of divisions that left the syllable's *Rime* (VC) intact was significantly more frequent in Hebrew monolinguals than in their Russian counterparts may provide additional support for the greater perceptual salience of the syllable's *Body* (CV) in Russian than in Hebrew. In addition, a close inspection of the data reveals that the difference between the languages in frequency of the CV-VC types of divisions is attributed to the "no answer" and "left unsplit" types of responses provided by the Russian-speaking children. We think that this difference may be related to differences between the two language groups in degree of school-based training in phonemic awareness in kindergartens which may be undertaken more heavily and systematically in Israel than in Russia.

To sum up, the current study is the first to directly test the internal psycholinguistic representation of the syllable in Russian by systematically comparing the facility with which different phonological units within CVC syllables are accessed by Russian-speaking kindergarten children. It also uses comparable tasks to address the same question among Hebrew-speaking monolingual children who speak a language that shares critical phonological features with Russian supporting the cohesion of the CV unit. The results show that both Hebrew-speaking and Russian-speaking children represent CVC sub-syllabic phonological units as cohesive CV bodies and consonantal codas following them and that these patterns emerge before children are exposed to the orthography and are, thus, independent of any specific reading instructional method or of exposure to literacy and written language.

Notes

1 In addition to the shared phonological properties, both Hebrew and Russian have transparent, CV-based orthographies and employ CV-based initial reading instructional methods which, in turn, further strengthens the salience of the CV unit with the onset of reading and writing. However, these characteristics of Hebrew and Russian go beyond the scope of the present paper as the present study tests preliterate children.

2 Statistics is given for the noun stems.

3 There is still an ongoing controversy among scholars regarding the status of the phoneme [ɨ]. Some regard it as a separate phoneme (Bondarko, 1998; Halle, 1971); others argue it acts as an allophone of the phoneme [i] (e.g., Avanesov, 1974; Cubberley, 2002)

4 In some sources this number is as high as 78% (Bondarko 1998; Bogomazov 2001, as cited in Kerek & Niemi, 2012).

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Appendix A
Mean, standard deviation (in parenthesis), and t-tests for differences between the groups in background variables and control early literacy measures

	Hebrew	Russian	
	Mean (SD)	Mean (SD)	$t(53)$
Background Variables			
Cognitive Measures:			
RAN Objects[a]	0.01 (0.00)	0.01 (0.00)	1.95, p=.06
RAN Numbers[a]	0.01 (0.00)	0.01 (0.00)	1.50, p =.14
Digit Span (Forward)	0.33 (0.09)	0.34 (0.08)	0.35, p=.73
Digit Span (Backw.)	0.37 (1.18)	1.56 (2.86)	2.18, p=.03
Control Early Literacy Measures			
Letter Naming	0.76 (0.21)	0.4 (0.35)	4.75, p<.001
Familiar Word Reading	0.28 (0.24)	0.27 (0.35)	0.05, p=.96

[a]Presented as time per item.

Appendix B
Estimates of LMM Analysis Predicting the Percentage of Correct Responses in the Structured Phonological Awareness Tasks

Fixed factors	AIC	BIC	logLik	deviance	Chisq	Df	p
Language	4542.6	4559	−2267.3	4534.6	0.9337	1	0.334
Task	4242	4266.5	−2115	4230	305.54	3	<**.001**
Language*Task	4235.6	4276.5	−2107.8	4215.6	14.379	4	**0.006**
Condition	4237.1	4282.1	−2107.6	4215.1	0.529	1	0.467
Language*Condition	4237.1	4282.1	−2107.6	4215.1	0.529	1	0.467
Task*Cognition	4243	4300.2	−2107.5	4215	0.0832	3	0.994
Language*Task*Cognition	4250.4	4324	−2107.2	4214.4	0.6683	7	0.999

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Appendix C
Estimates of LMM Analysis Predicting the Frequency of Occurrence of Division Types in the Unstructured CVC Splitting Task by Condition (Real Words vs. Pseudo Words) by Language (Hebrew vs. Russian)

Fixed factors	AIC	BIC	logLik	deviance	Chisq	Df	*p*
Language	3071.4	3083.7	−1532.7	3065.4	0	1	>0.99
Condition	3071.4	3083.7	−1532.7	3065.4	305.54	3	>0.99
Language*Condition	3071.4	3083.7	−1532.7	3065.4	14.379	4	>0.99
Categories	2190.8	2211.2	−1090.4	2180.8	884.64	3	<**.001**
Language*Categories	2028.4	2065.2	−1005.2	2010.4	170.39	4	<**.001**
Categories*Condition	2191.2	2228	−1086.6	2173.2	0	0	>0.99

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Appendix D

Tasks (Body vs. Rime Syllable Splitting and Initial vs. Final Phoneme Deletion) by Condition (Real Words vs. Pseudo Words) and Error Types Expressed as a Percentage of All Responses in Monolingual Hebrew- and Russian-speaking Children

				Hebrew	Russian
	Task	Error types	Stimulus type	M (SD)	M (SD)
Syllable Splitting	Rime	Body	Real words	57.43 (42.93)	76.00 (37.61)
			Pseudo words	59.14 (36.81)	78.50 (36.02)
			Both	58.29 (39.87)	77.25 (36.82)
		Others	Real words	35.14 (39.95)	23.50 (37.87)
			Pseudo words	35.43 (35.59)	20.50 (36.49)
			Both	35.29 (37.77)	22.00 (37.18)
	Body	Body	Real words	2.57 (13.58)	–
			Pseudo words	2.00 (11.83)	–
			Both	2.29 (12.71)	–
		Rime	Real words	1.14 (4.04)	–
			Pseudo words	2.00 (7.19)	–
			Both	1.57 (5.62)	–
		Others	Real words	28.86 (39.61)	14.00 (31.19)
			Pseudo words	32.43 (40.80)	12.50 (28.81)
			Both	29.43 (40.21)	13.25 (30.00)
Phoneme Isolation	Initial	C_1V	Real words	60.29 (4.10)	41.00 (4.01)
			Pseudo words	54.57 (3.93)	46.00 (3.97)
			Both	57.43 (4.02)	43.5 (3.99)
		C_2	Real words	5.43 (1.31)	3.5 (0.59)
			Pseudo words	8.86 (1.81)	4.00 (0.60)
			Both	7.15 (1.61)	3.75 (0.60)
		$C\ _1V(ə)$	Real words	1.14 (0.40)	–
			Pseudo words	–	–
			Both		
		C_1VC_2	Real words	2.57 (1.52)	–
			Pseudo words	–	–
			Both		–

(*Continued*)

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(*Continued*)

Task	Error types	Stimulus type	Hebrew M (SD)	Russian M (SD)
Final	C_1	Real words	5.71 (1.12)	11.00 (2.15)
		Pseudo words	9.14 (1.87)	13.50 (2.43)
		Both	7.43 (1.50)	12.25 (2.29)
	C_1V	Real words	20.00 (3.02)	11.50 (2.76)
		Pseudo words	19.43 (2.85)	15.00 (3.09)
		Both	19.72 (2.94)	13.25 (2.93)
	VC_2	Real words	3.14 (0.90)	–
		Pseudo words	2.86 (0.62)	–
		Both	3.00 (0.76)	–
	C_1VC_2	Real words	0.57 (0.34)	–
		Pseudo words	0.57 (0.34)	–
		Both	0.57 (0.34)	–
	No answer	Real words	0.86 (0.37)	0.50 (0.22)
		Pseudo words	0.29 (0.17)	0.50 (0.22)
		Both	0.58 (0.27)	0.5 (0.22)
	C_2V(a)	Real words	0.57 (0.39)	–
		Pseudo words	0.57 (0.24)	–
		Both	0.57 (0.32)	–

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