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Does reading in an alphasyllabary affect phonemic awareness? Inherent schwa effects in Marathi-English bilinguals

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The extent to which speakers of alphasyllabaries develop phonemic awareness is unclear. In alphasyllabaries, diacritics are used to mark all vowels following consonants, except for the schwa vowel, which is inherent in every consonant, and is marked or unmarked depending on its position within a word. We used Marathi as an example alphasyllabary language to explore schwa awareness. We tested the awareness shown by Marathi-English bilinguals for the schwa vowel compared with awareness for marked vowels and with vowel awareness in English. In Marathi, participants were significantly more accurate at identifying initial schwas (expressed by a graph) than medial (unexpressed) or final schwas (expressed by a diacritic) and were more accurate at identifying other vowels in the medial or final positions than the schwa. Across languages, participants were significantly more likely to omit medial and final schwa vowels in Marathi than in English. The results suggest that biliterate speakers of alphasyllabaries have general awareness of phonemes but not inherent vowels. More generally, the results suggest that phonemic awareness depends specifically on the expression of the phoneme in writing, in alignment with previous research that shows literacy effects on phonemic awareness.

Keywords: Alphasyllabary; Inherent vowel; Bilingual; Schwa; Devanagari; Phonemic awareness.

The extent to which speakers of alphasyllabaries develop phonemic awareness is unclear. Previous research has shown that learning to read an alphabetic orthography promotes phonemic awareness, whereas learning to read morphosyllabic (logographic) Chinese may not. Pre-literate children (and illiterate adults) generally can identify and manipulate syllables, but not phonemes. Literacy in an alphabetic script supports an ability to identify

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and manipulate phonemes (Morais, Cary, Alegria, & Bertelson, 1979; Read, Zhang, Nie, & Ding, 1986). However, orthography-specific features can cause problems for literates on phonemic awareness tasks; for example, people will correctly report that ‘rich’ has three phonemes but incorrectly report that ‘pitch’ has four phonemes since they “perceive” the silent <ɾ> (Ehri & Wilce, 1980). Less is known about the extent to which reading an alphasyllabary promotes phonemic awareness.

Alphasyllabaries, which express languages spoken in South Asia as well as in Ethiopia and Eritria, are so called because their writing systems combine features of alphabets and syllabaries. True syllabaries have unique symbols for each syllable that do not represent the constituent phonemes of the syllable. For example, the graphs for <ku> and <ka> may not share visual features despite sharing the phoneme /k/, in contrast to alphabetic writing where each graph represents a phoneme (the letter <k> represents the sound /k/). Alphasyllabaries have symbols that represent the syllables of the language, but the subcomponents within these symbols represent phonemes, e.g., the graphs for <ku> and <ka> share a subcomponent that represents /k/; <ku> and <pu> share another subcomponent that represents /u/.

In South Asian alphasyllabaries, all graphs (called *akshara*) have both primary and secondary forms. A vowel’s primary form is used only when the vowel does not follow a consonant, typically at the beginning of a word. When a vowel follows a consonant, a diacritic on the consonant indicates the vowel. Consonants are typically in their primary form and are in their secondary form only when they are ligatured together to form a consonant cluster.

The primary form of a consonant includes an inherent schwa. In some South Asian languages, such as Hindi and Marathi, both of which use the Devanagari script and are derived from Sanskrit, the schwa is always suppressed (not pronounced) when the consonant is marked with a diacritic or is an initial or medial position within a ligatured consonant cluster. Although most single consonants are pronounced with a schwa, this schwa is sometimes suppressed, as when a word ends with a consonant or when the consonant occurs at a syllable boundary (schwa syncopation rule). Because schwas typically are suppressed after final consonants, a diacritic called an *anuswara* is placed over the final consonant if the schwa is to be pronounced (see Figure 1).

The inherent schwa is a property of the writing system and all consonantal *akshara* have an inherent schwa. For the purposes of this paper, when a schwa *is* pronounced in a word, but there is no orthographic marker to denote its presence, the schwa will be called *unexpressed* (in the spelling). For example, अलगद (gently) would be fully transcribed as /əlgəḍə/ but would be pronounced as /əlgəḍ/. The /g/, /l/, and /ḍ/ have inherent schwas, but there is only one unexpressed schwa, following the /g/. The schwas at the syllable boundary and at the end of the word are not pronounced. A *halanta* or *virama* is used in Sanskrit to indicate that the schwa is not to be pronounced, but it is rarely used in modern languages; native speakers have an intuitive understanding of when to pronounce the schwa (Salomon, 2000). When transcribing South Asian languages using Roman letters, the letter <a> is used to represent the schwa sound and is often inserted after every consonant which does not have a diacritic, regardless of whether the schwa is pronounced. For example, अलगद would be transcribed as <alagada>. Although the inherent schwas following the /l/ and /ḍ/ are not pronounced, they are included in the transcribed word. This phenomenon raises the question, “Are native speakers consciously aware of whether or not the schwa is pronounced?”

Here we explore this question through a study of Marathi, a language written in an alphasyllabary. Marathi is the official language of the Indian state Maharashtra, and there were 96 million speakers of Marathi worldwide as of 2006 (Wali, 2006). It is derived from Sanskrit and written in the Devanagari script. Marathi has 38 consonants and eight vowels,

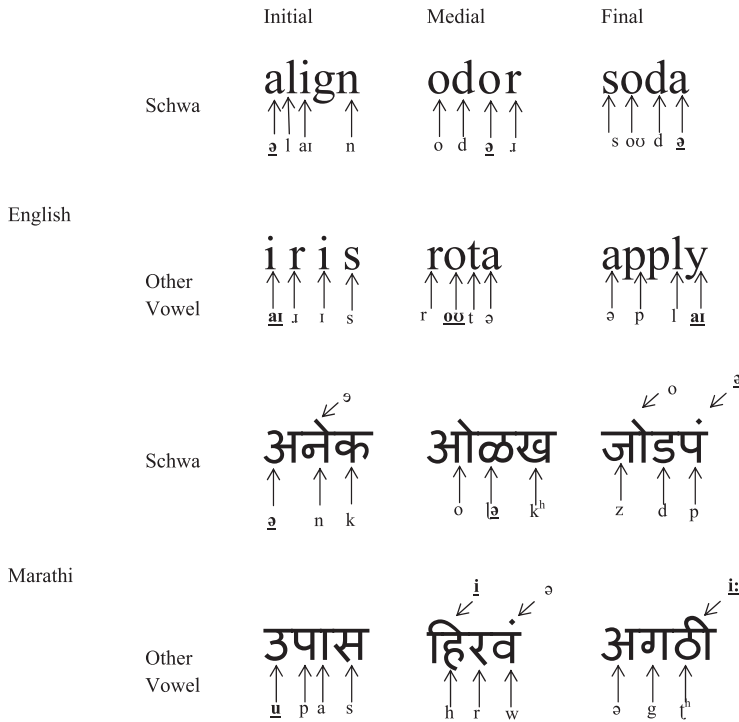


Figure 1. Examples of schwas and other vowels in all three word positions. Note that both schwas and other vowels are written with an entire akshara in the initial position. Other vowels are represented with diacritics in medial and final word positions and schwas are represented with diacritics in word final positions. Schwas are not expressed in the orthography in word medial positions. Also note how the medial and final schwas are not pronounced at syllable boundaries (अगठी, जोडपं, हिरवं) and when the word ends with a consonant (अनेक, ओळख, उपास). Finally, remember that word final schwas are often written with an /e/ sound in formal writing; जोडपं and हिरवं would be written as जोडपे and हिरवे respectively.

/ə/, /a/, /i/, /u/, /e/, /o/, /əi/, and /əu/. Length differences of the /i/ (/i/ versus /i:/) and /u/ (/u/ versus /u:/) are not phonemic; they are determined by position. However, the orthography does distinguish between the two lengths (Dhongade & Wali, 2009). Nasals (um) and a combination of three phonemes (aha) are also represented using vowel-like diacritics and are taught as vowels in schools, though linguistically speaking they are not considered vowels. All vowels can occur in word initial, medial, and final positions (Dhongade & Wali, 2009).

To summarise, in Marathi, initial schwas are represented with their own akshara, medial schwas are unexpressed in the orthography and final schwas are marked with an anuswara. Some words which historically ended with an /ə/ are pronounced with an /ə/ in modern Marathi, and this change is expressed in the orthography by using an anuswara instead of the diacritic for /ə/ (Pandharipande, 1997). However, in formal writing, the original spelling and pronunciation are often preserved (see Figure 1).

Several studies have suggested that, though phonemes are grouped syllabically in South Asian writing systems, adult biliterates who speak both a South Asian language and English read South Asian scripts phonemically, similar to an alphabet. Reading the script one phoneme at a time would imply that the participants have phonemic awareness. For example, Vaid and Gupta (2002) found that adults (students at the University of Delhi, presumably biliterate) were slowed by vowel diacritics that are written to the left of the consonant (though they are pronounced after the consonant). This would be the case only if

the adults were reading the words alphabetically, rather than each akshara as a whole unit. Similarly, Kandhadai and Sproat (2010) reported that biliterate speakers of Hindi and English find it more difficult to delete consonants in a phoneme-deletion task when their diacritics are found either to the left of or below them.

The nonlinear display of the vowel diacritics may create spatial demands beyond those made on alphabetic reading. Kumar et al. (2010) found that, in Hindi-English bilinguals, the right caudate nucleus (a subcortical structure within the basal ganglia, has a role in learning and memory) was activated while reading Hindi but not English. Another study has shown that the right caudate nucleus becomes more activated as participants are trained in mirror reading, suggesting that it is involved in visuo-spatial skill learning (Poldrack, Desmond, Glover, & Gabrielei, 1998). Since the right caudate nucleus is activated in Hindi but not English reading, Hindi presumably is more spatially complex and requires more visual-spatial skills during decoding. However, Hindi is only spatially complex if one is reading phonemically, first pronouncing the consonant and then the diacritic which can be placed on all four sides of the consonant. If one is processing the script as a syllabary, Hindi is not spatially complex. Again, these findings support the hypothesis that the components comprising an akshara are read one at a time, rather than as a single unit. Reading alphabetically should promote phonemic awareness. However, these studies focused on vowels expressed with diacritics and not on the inherent vowel. It is possible that people may have awareness for vowels expressed in the orthography, but not for unexpressed vowels.

A study by Prakash, Rekha, Nigam, and Karanth (1993, experiment 2) found that monoliterate adult speakers of Hindi have greater phonemic awareness than illiterates, suggesting that literacy in an alphasyllabary does promote limited phonemic awareness. Monoliterates were significantly better than illiterates at the phoneme-deletion task (46% and 8% accuracy rates respectively). The literate adults showed a strong influence of the unique orthographic features of Hindi; they found it easy to delete the /d/ from /d̪oʃi:/, since the /o/ is represented by a diacritic, but hard to delete the /n/ from /nəɖi:/, because the schwa is unexpressed. The most common answer was /ɖi:/. However, another experiment (Prakash et al., 1993, experiment 3) found that Kannada-English biliterates have high levels of phonemic awareness (99% accuracy). (Though Hindi and Kannada are written in different scripts, they are both alphasyllabaries with similar phoneme-grapheme mapping systems.) Prakash et al. (1993) argue that monoliterate speakers of alphasyllabaries have limited phonemic awareness but biliterates have fully developed phonemic awareness and that “learning an alphabetic code can alter the processing of the non-alphabetic system that one might have already acquired” (p. 68).

One shortcoming of the Prakash et al. (1993) study was that its stimulus selection did not allow for the testing of inherent vowels. It had 24 stimuli, and, of those stimuli, only the three stimuli that involved deleting initial consonants which were followed by vowels were capable of demonstrating difficulty with inherent vowels. Furthermore, this stimulus type is only capable of demonstrating difficulty with an inherent vowel if the initial consonant is followed by a schwa, rather than another vowel (similar to deleting the /n/ from /nəɖi:/ in Hindi). Probably only one stimulus met this criterion, though it is possible that two met this criterion, or none at all. Therefore, the materials used in the Prakash et al. (1993) study do not allow us to conclude that biliterates show more awareness for inherent vowels.

The present study examined Marathi-English bilinguals’ phonemic awareness for vowels in both languages using a phoneme dictation task (asking them to decompose words into their constituent phonemes). This task generates rich data with observations on every phoneme in a stimulus. The stimuli were chosen in such a way that awareness of the

schwa vowel could be fully examined, in contrast to the Prakash et al. (1993) study. Given the findings that orthography-specific features can affect phonemic perception (Ehri & Wilce, 1980), we hypothesised that participants would show awareness of all initial vowels, since they are represented with an akshara. Participants would also show awareness of all medial and final vowels, except the schwa, since they are represented with diacritics. In contrast, participants should struggle with medial schwas, since those are unexpressed in the orthography. Participants may or may not have awareness for the final schwa; it is orthographically represented with an anuswara but not in many formal texts, so participants may have less familiarity with the anuswara than with other diacritics. It is also taught later in schooling, so heritage Marathi speakers with limited Marathi schooling may not have learned it. We also expected the participants to show awareness of all vowels, including the schwa, in English, since they are always represented with a vowel.

Although we hypothesised that our Marathi speakers would omit the medial and, perhaps, the final schwas in Marathi, there is another possibility. Perhaps they would know that all Marathi consonants have an inherent schwa, but would not be aware when it is not pronounced. The Marathi speakers then may add schwas after every consonant that does not have a diacritic, even when it does not belong there, similar to how the letter <a> is added after every consonant which is not followed by another vowel when transcribing Marathi into English.

Notice that finding more difficulty with medial schwas than with other vowels in the same position does not require an orthographic explanation based on the schwa being unexpressed. Because the schwa is a minimal vowel, it may be phonologically less salient than the other vowels. A phonological explanation is possible even if initial schwas (expressed with an akshara) produce better performance than (unexpressed) medial schwas. Because phonemes occurring at an edge are more salient, this could again be a phonological difference. We addressed this problem by including the English stimuli. In both Marathi and English, schwas can occur in all word positions and in both stressed and unstressed positions (we considered both the /ə/ and /ʌ/ in English to be schwas to more closely match Marathi's phonology). We predict that in both languages people will struggle with medial schwas since they are not phonologically salient. However, this difference will be larger in Marathi due to orthographic influences.

METHODS

Participants

Participants were 23 Marathi-English bilinguals recruited from the Pittsburgh and New Jersey communities (11 males, mean age = 35 years, range = 18–81 years). The participants were recruited based on their ability to fluently understand and speak both languages. The ability to fluently read and write was not a criterion, allowing us to examine whether written fluency interacted with phonemic awareness. Nineteen participants were born in India, three in the United States, and one in Canada. Of the participants born in India, one was visiting relatives in the United States and one had moved to the United States as a child. Eight of the participants born in India were between the ages of 22 and 30 and had been in the United States for a few months to four years (the majority were graduate students). Nine of the participants born in India were over the age of 35 and had been in the United States for an average of 21 years (range: 10–44). The participants born in North America were between the ages of 18 and 24 and were studying either at the undergraduate or postgraduate level. The experiment was approved by the University of Pittsburgh IRB. All participants signed an informed consent form and were paid for their participation.

Procedure

Participants were tested individually in a quiet room by the first author, a native American English and heritage Marathi speaker. The participants completed oral fluency, speeded reading and spelling tasks in both Marathi and English¹ to test their language skills. They also completed the phoneme dictation task in both languages and a language background survey. The language skill assessments for a given language were given prior to the phoneme dictation task in that language to help participants get into that languages' mindset. To further help participants get into the mindset, the experimenter and the participant spoke only in the language being tested. The order of the presentation of the two languages was counterbalanced across participants. The language background survey was given either at the start of the session, in between the two languages, or at the end of the session, depending on convenience. After the testing session, participants self-reported their strategies for the phoneme dictation task. The participants were not told the purpose of the study.

Materials

Oral fluency task

Participants named as many animals as they could in one minute.²

Speeded reading

The Test of Word Reading Efficiency (TOWRE) version A (Torgesen, Wagner, & Rashotte, 1999) was used to measure English reading. Since there are no standardised Marathi reading measures, we created one to be similar to the TOWRE ([Appendix A](#)). The words were ordered from easiest to hardest based on orthographic features; diacritics were not introduced till the sixth word, ligatured consonants were not introduced till the 26th word, and three consonants ligatured together were only present in the last word.

Spelling

Twelve words from the Wide Range Achievement Test (WRAT) spelling test (blue version) were chosen for the English spelling test (Jastak & Wilkinson, 1984).³ Twelve Marathi spelling words were chosen to approximately match the English words in difficulty (see [Appendix B](#)). The words were ordered in terms of orthographic complexity; consonant ligatures were not introduced till the eighth word and three consonants ligatured together were only present in the last word. The participants wrote and orally defined⁴ the words that the experimenter read aloud.

Phoneme dictation

There were 79 words per language (see [Appendix C](#)). Two random orders of both the Marathi and English stimuli were created and counterbalanced across the participants. The words were pre-recorded, the English by a native American English speaker and the Marathi by a native Marathi speaker. If a participant indicated trouble hearing a word, the experimenter either replayed the recording or said the word. The participants were asked to "listen to the sounds in the word and then say those sounds slowly". The following

¹The tests can only be used for comparing participants within a language because we cannot confirm that the English and Marathi versions were equated for difficulty.

²Scoring was very lenient, both males and females of the same species (e.g. lion and lioness) and names and examples of a category (e.g. snake and python) were counted as correct.

³The words were not homonyms, so context was not needed to spell them correctly.

⁴Definitions were accepted in either English or Marathi, or the participants could use the words in a sentence.

examples were provided because they are very similar across languages: English: “pretty is /p-r-i-t-i-/, Marathi: “प्रीती is /p-r-i:-t-i:/”. In each case, the phonemes were spoken as separate sounds by the experimenter. The minimal voicing needed to pronounce the consonant was kept as short as possible. If a vowel followed that consonant, the participants were then expected to pronounce that vowel in isolation as well. As this study was mainly concerned with vowels, only the vowel responses were scored. Each vowel (either a schwa⁵ or another vowel) in one of three positions (initial, medial or final) was scored as correct, mispronounced, or omitted.⁶ It was considered omitted if it was not spoken in isolation. If a participant inserted a vowel in between consecutive consonants or after a final consonant, the consecutive consonants/final consonant was scored as incorrect (otherwise it was correct). There were at least 18 examples of each of these categories within each language. The participants also rated how well they knew each word on a scale of 1–5⁷ immediately after repeating it back phoneme-by-phoneme.

The English and Marathi words were matched for CV structure, with the exception of schwa-final words, which could not be matched. For example, the word आठवणी /a^hwəɳi:/ was matched with ‘injury’ /ɪndʒə.ɪ/ because they both have the structure VCCəCV. There were at least 15 examples of each category within the English-Marathi pairs.

Because we were primarily concerned with vowel awareness, none of the Marathi stimuli contained any consonants that could be confused. There were no ligatured consonants, nasals marked with an anuswara,⁸ or akshara that represent two phonemes (e.g., क्ख /kʃə/). The two diphthongs, /əi/ and /əu/, also were not present in the stimuli.

The Marathi section was scored by the first author and the English section by the third author. Though they were aware of the purpose of the experiment, the scoring rubric was objective so their knowledge could not affect the scores given.

Language history questionnaire

A slightly edited version of the Language History Questionnaire (Tokowicz, Michael, & Kroll, 2004) was used to assess the participants’ language background.

RESULTS

We report first results for participants’ Marathi- and English-language skills and familiarity with the Marathi and English words used in the study, then report the results for the main experimental task, the phoneme dictation task.

Language skills

All participants were fluent in English but their Marathi skill varied greatly. This wide range can be seen in [Table 1](#), which shows quartile scores on the oral fluency, reading and spelling tasks and various self-report language abilities for both languages. On balance, the participants who were born in India (who tended to be older than the participants born in North America) were better at Marathi. Marathi skill had no effect on performance on the

⁵Both ə and ə were counted as schwas.

⁶Diphthongs were scored as correct if they were pronounced as one vowel or as two.

⁷5-knew the meaning, used the word frequently; 4-knew the meaning, rarely used the word; 3-had a vague idea of what the word meant; 2-did not the meaning but the word sounded familiar; 1- never heard the word before

⁸An anuswara on a final consonant indicates that the consonant is followed by a schwa; these stimuli were included. An anuswara above an initial or medial akshara indicates that the akshara is followed by a nasal; these stimuli were excluded.

TABLE 1
Participants' fluency in both languages

<i>Language</i>	<i>Fluency Measure</i>	<i>Minimum</i>	<i>25th Percentile</i>	<i>Median</i>	<i>75th Percentile</i>	<i>Maximum</i>
English	Oral Fluency	10	17.5	21	23.5	39
	Reading Attempted	87	93.5	102	104	104
	Reading Correct	87	92.5	100	103.5	104
	Spelling	8	9	9	10	12
	Reading*	7	9	10	10	10
	Writing*	6	9	9	10	10
	Conversational Fluency*	7	8	9	10	10
	Speech Comprehension*	7	8.5	9	10	10
	Oral Fluency	4	8.5	14	19	27
Marathi	Reading Attempted	11	59	78	84.5	104
	Reading Correct	6	53	78	81.5	100
	Spelling	1	7.5	12	12	12
	Reading*	2	8	9	10	10
	Writing*	1	6	8	10	10
	Conversational Fluency*	6	8	9	10	10
	Speech Comprehension*	7	9	10	10	10

Note: The * indicates that the value was self-reported (scale of 1–10). The maximum scores on the reading and spelling tasks were 104 and 12 respectively. Note that seven participants finished the English reading task in less than 45 seconds, but none of the participants had time remaining on the Marathi version.

phoneme dictation task. All participants had had some exposure to languages besides English and Marathi, and 17 were fluent in a third language, the most common being Hindi. Some interference from their other languages was seen on the oral fluency task; for example, three participants named at least one animal in Hindi instead of Marathi.

Familiarity with materials

Although the average rated familiarity was high for both Marathi and English, it was higher for the Marathi than for the English stimuli, 4.4 and 4.1 respectively; 2-tailed paired *t*-test $t(22) = 2.92, p = .008$. If familiarity is important in the task, more errors should occur in English. If more errors occur in phoneme dictation with the Marathi stimuli, this strongly suggests that any differences between the languages are due to orthography rather than familiarity.

Phoneme dictation task

The results—the mean proportion of correct, omitted and mispronounced responses for vowel stimuli—are shown in Table 2. The key result for the question of orthographic effects between the languages was that Marathi produced both more omissions of schwa vowels in the medial and final positions of words, and more insertions of schwa vowels in between consecutive consonants and after final consonants than did English. These results were in addition to effects that were shared across the languages—medial schwas produced more errors than other medial vowels and also more errors than schwas in other positions. The statistical analyses that support these conclusions are detailed in the following paragraphs.

The presentation order of the languages did not have an effect of accuracy, therefore the following analyses collapse across order of presentation. The proportions of omitted and mispronounced responses for the vowel stimuli were analysed in two separate three-factor analyses of variance: Language (2 levels: Marathi and English) x Vowel Identity (2 levels:

TABLE 2
Performance on the phoneme dictation task

Language	Response type	Initial schwa	Medial schwa	Final schwa	Initial vowel	Medial vowel	Final vowel	Consecutive consonants	Final consonant
English	Correct	.97 (.05)	.42 (.25)	.16 (.27)	.69 (.24)	.60 (.19)	.80 (.19)	.97 (.05)	.88 (.14)
	Mispronounced	.02 (.04)	.21 (.14)	.74 (.31)	.30 (.24)	.28 (.15)	.06 (.06)	–	–
	Omitted/ Incorrect	.01 (.02)	.37 (.27)	.12 (.22)	.01 (.03)	.13 (.19)	.13 (.21)	.03 (.05)	.12 (.14)
Marathi	Correct	.92 (.16)	.20 (.36)	.35 (.41)	.69 (.36)	.91 (.18)	.93 (.10)	.83 (.32)	.83 (.34)
	Mispronounced	.08 (.16)	.01 (.01)	.01 (.02)	.30 (.36)	.01 (.01)	.01 (.02)	–	–
	Omitted/ Incorrect	0 (0)	.79 (.36)	.64 (.42)	0 (.02)	.09 (.18)	.06 (.10)	.17 (.32)	.17 (.34)

Note: The mean and (*SD*) of the proportions are shown.

Examples of Response Types:

Language	Stimulus	Correct	Mispronounced	Omitted	Incorrect consecutive consonants	Incorrect final consonant
English	unravel	ʌ-n-ɪ-æ-v-ə-l	ʌ-n-ɪ-æ-v-i-l	ʌ-n-ɪ-v-ə-l ʌ-n-ɪæ-v-ə-l ʌ-n-ɪ-æv-ə-l	ʌ-n-ɪ-ɪ-æ-v-ə-l	ʌ-n-ɪ-æ-v-ə-l-i
Marathi	अडणिवर	ə-d-ŋ-i-w-ə-r	ə-d-ŋ-i-w-ə-r	ə-d-ŋ-w-ə-r ə-d-ŋj-w-ə-r ə-d-ŋ-iw-ə-r	ə-d-i-ŋ-i-w-ə-r	ə-d-ŋ-i-w-ə-r-i

TABLE 3
Pairwise comparisons between English and Marathi

<i>Vowel identity</i>	<i>Vowel position</i>	<i>Error type</i>	<i>Mean difference</i>	<i>Significance</i>
Schwa	Initial	Mispronounced	-.057	.108
		Omitted	.009	.030*
	Medial	Mispronounced	.205	< .001*
		Omitted	-.415	< .001*
	Final	Mispronounced	.728	< .001*
		Omitted	-.537	< .001*
Other Vowel	Initial	Mispronounced	-.005	.952
		Omitted	.005	.426
	Medial	Mispronounced	.269	< .001*
		Omitted	.040	.204
	Final	Mispronounced	.057	< .001*
		Omitted	.074	.018*

Note: The Bonferroni-Sidak method was used to correct for multiple comparisons. A positive difference indicates that the proportion in English was greater than the proportion in Marathi. * indicates p -value < .05.

schwa or other vowel) x Vowel Position (3 levels: initial, medial and final). For both analyses, the three-way interactions were significant, $F(2, 44) = 25.700, p < .001$ and $F(2, 44) = 47.474, p < .001$ for omitted and mispronounced, respectively. The 2-way interactions between Vowel Identity and Vowel Position were also significant, English omitted: $F(2, 44) = 24.244, p < .001$, Marathi omitted: $F(2, 44) = 50.315, p < .001$, English mispronounced: $F(1.390, 30.586) = 109.805, p < .001$, and Marathi mispronounced: $F(1.012, 22.273) = 11.453, p = .003$.⁹ The differences reflected in these interactions are shown in Tables 3, 4, and 5. Table 3 shows the comparisons between Marathi and English, Table 4 shows the Vowel Identity comparisons and Table 5 shows the Vowel Position comparisons.

Medial schwas were difficult for participants in both languages, suggesting some effects of phonology. They were significantly more likely to be omitted than other medial vowels in both English and Marathi. They were also more likely to be omitted than were initial and final schwas in English and Marathi (marginal for comparison with Marathi final schwas, significant for rest). However, consistent with our hypothesis, they were significantly more likely to be omitted in Marathi than in English, suggesting effects of orthography above

TABLE 4
Pairwise comparisons of vowel identity in English and Marathi

<i>Error Type</i>	<i>Vowel Position</i>	<i>English</i>		<i>Marathi</i>	
		<i>Mean Difference</i>	<i>Significance</i>	<i>Mean Difference</i>	<i>Significance</i>
Mispronounced	Initial	-.281	< .001*	-.228	.003*
	Medial	-.065	.034*	.000	.878
	Final	.674	< .001*	.002	.665
Omitted	Initial	.000	.977	-.005	.162
	Medial	.248	< .001*	.703	< .001*
	Final	-.026	.383	.585	< .001*

Note: The Bonferroni-Sidak method was used to correct for multiple comparisons. A positive mean difference indicates that the proportion is greater for schwas than for other vowels. * indicates p -value < .05.

⁹The Greenhouse-Geisser correction was used because the sphericity assumption was violated.

TABLE 5
Pairwise comparisons of vowel position in English and Marathi

Error Type	Vowel identity	Vowel position #1	Vowel position #2	English		Marathi	
				Mean difference	Significance	Mean difference	Significance
Mispronounced	Schwa	Initial	Medial	-.192	< .001*	.071	.147
		Initial	Final	-.718	< .001*	.067	.116
		Medial	Final	-.527	< .001*	-.003	.878
	Other Vowel	Initial	Medial	.025	.898	.299	.002*
		Initial	Final	.237	< .001*	.298	.002*
		Medial	Final	.212	< .001*	-.001	.990
Omitted	Schwa	Initial	Medial	-.365	< .001*	-.790	< .001*
		Initial	Final	-.097	.098	-.643	< .001*
		Medial	Final	.268	< .001*	.146	.085
	Other Vowel	Initial	Medial	-.118	.013*	-.082	.125
		Initial	Final	-.123	.018*	-.054	.052
		Medial	Final	-.006	.979	.028	.468

Note: The Bonferroni-Sidak method was used to correct for multiple comparisons. A positive mean difference indicates that the proportion is greater for Vowel Position #1 than #2. * indicates p -value < .05.

and beyond those of phonology. Final schwas were difficult only in Marathi. They were more likely to be omitted than other final vowels in Marathi, but not in English, and were more likely to be omitted than initial schwas only in Marathi. Consistent with our hypothesis, there was a significant difference between the languages in terms of final schwa omission. In contrast, participants were significantly more likely to omit initial schwas in English than in Marathi. Furthermore, in Marathi, participants were just as likely to omit initial schwas as other vowels in the initial position. These data show that, in Marathi, people do not struggle with the schwa vowel in general. Rather, difficulty with the schwa vowel interacts with vowel position, and hence orthographic saliency.

In English, participants were significantly more likely to mispronounce both schwas and other vowels in the medial and final positions than in Marathi. This could be due to Marathi's greater transparency, making the orthographic representations more useful in completing the task. Although it is possible that some of these mispronunciations were due to accent, others were clearly due to orthography (e.g., for the word 'odor', pronounced /odər/, responding /o-d-o-r/).

We also tested for the insertion of vowels in the phoneme dictation task. Participants were less likely to insert vowels in English than in Marathi and this difference was greater for vowels inserted in between consecutive consonants than for vowels inserted after final consonants, $F(1, 22) = 6.088, p = .022$. Participants tended to insert vowels in English due to orthography; 60% of vowels inserted after final consonants were in words containing silent <e's> at the end (e.g., for 'arise' answering /ə-r-ar-z-i/). In contrast, people tended to add vowels in Marathi because they knew that all consonants have inherent schwas, but were unaware of when the schwa was not pronounced. Ninety-seven percent of the vowels people inserted in Marathi were schwas whereas only 59% of the vowels that people inserted in English were schwas, confirming that they were inserting these vowels in Marathi because they were unaware of which consonants had inherent schwas.

Since each Marathi word was paired with an English word with the same structure (except for the words which end with schwa), we analysed the pairs using McNemar's test. Unlike the previous analysis, this analysis controls for the environment around the vowel

TABLE 6
Percentage of correct responses to Marathi stimuli by subgroup

Subgroup number	Subgroup name	<i>n</i>	Medial schwas	Final schwas	Consecutive consonants	Final consonants
1	Medial and Final Schwa Omission	15	3.9	7.0	95.1	96.8
2	Medial Schwa Omission	4	8.3	83.8	96.3	86.8
3	Schwa Insertion	3	97.2	88.3	4.9	5.3
4	High Accuracy	1	87.5	100	82.4	84.2

in question (e.g., length of word, exact sequence of consonants and vowels, etc.). It combined the correct and mispronounced items to test for awareness of the *presence* of the vowels irrespective of correct pronunciation. The words were paired by participant and by structure of the words, simultaneously controlling for individual differences and the environment surrounding the vowel in question (e.g., length of the word). Consistent with the results reported above, in Marathi participants showed *less* awareness of medial schwas, $\chi^2(1) = 109.4, p < .001$ and incorrectly inserted schwas in between consecutive consonants: $\chi^2(1) = 52.3, p < .001$ and after final consonants: $\chi^2(1) = 7.2, p = .007$. Furthermore, participants showed more awareness of other vowels in the medial and final positions in Marathi than in English, medial vowels: $\chi^2(1) = 5.8, p = .016$ and final vowels: $\chi^2(1) = 15.6, p < .001$. They also showed more awareness of initial schwas in Marathi: $\chi^2(1) = 5.0, p = .025$, but not for other vowels in the initial positions, $p = .41$.

The results so far do not capture the individual variability that we observed. Some participants tended to omit all of the medial schwas but did not insert schwas inappropriately, whereas other participants never omitted schwas but regularly inserted schwas inappropriately. In fact, four unique subgroups could be observed: (1) medial and final schwa omission pattern: participants who omitted both medial and final schwas and did not incorrectly insert schwas; (2) medial schwa omission pattern: participants who omitted medial schwas and did not incorrectly insert schwas; (3) schwa addition pattern: participants who did not omit schwas, but added schwas in between consecutive consonants and after final consonants; and (4) high-accuracy pattern: participants who had high accuracy with all schwas (see Table 6). The third subgroup knew that all consonants in Marathi had an inherent schwa, but were not aware of when it was deleted.

We examined whether these subgroup profiles in Marathi phoneme dictation performance were associated with other measures of the study.¹⁰ The subgroup profile was not associated with English fluency (includes scores on the oral fluency, reading, and spelling tasks and their self-reported fluency measures), Marathi fluency, or trilingual status, all $ps \geq .27$. Nor was it associated with the proportion of omitted or mispronounced responses in the English phoneme dictation task, both $ps \geq .48$. However, subgroup was a significant predictor of the likelihood of adding a vowel in between consecutive consonants or after a final consonant in English, $F(2, 19) = 13.238, p < .001$. Specifically, participants in subgroup 3 (schwa addition pattern) when responding to English stimuli were more likely to add vowels in between consecutive consonants and after final consonants than were participants in subgroups 1 (medial and final schwa addition pattern) and 2 (medial schwa

¹⁰Group four was not included in the following analyses because it only had one member.

addition pattern), all $ps \leq .045$. Thus this group of participants added vowels incorrectly in both Marathi and English.

One interesting qualitative observation was that when a Marathi word started with an initial vowel other than the schwa, (for example, /a/), many participants produced two vowels, beginning with a schwa; for example, producing /ə-a/ instead of just /a/. This could be because in schools people are taught “अ ला काना आ” which means “add a line after /ə/ to form /a/”. Just as one forms क /ka/ by adding a line after the base क /kə/, people saw आ /a/ as being formed by adding a line after the “base” अ /ə/. Of the mispronunciations that people made on initial vowels excluding schwas, 82.7% were due to this pattern.

Some participants seemed to know about the anuswara, but were not aware of what it represented phonemically. For example, when one woman got to the first Marathi word containing a final schwa, she explicitly asked, “I know there is an anuswara there, but I don’t know what sound it makes.” The experimenter demonstrated the schwa sound for her benefit, and after that she got every final schwa correct. Another participant told the experimenter repeatedly, whenever he heard a word with a final schwa, that “it’s only said like that but it would be written with an /ə/ sound”. Thus, he clearly had some awareness of the final schwa. However, when he was asked to break up the word phonemically, he never produced the final schwa sound as a separate phoneme. Another participant put more emphasis on the final consonant in words that had an anuswara, because he thought that the anuswara indicated emphasis, and not a phoneme. A fourth explicitly asked about the inherent schwas before the experiment began. He also gave an example in which the word ended with a consonant and asked if he should say schwa after that consonant. The experimenter told him to pronounce them when he heard them (and gave an example) and to omit them when he did not, such as in the example he gave. However, during the experiment, he added schwas in between nearly every pair of consecutive consonants and following nearly every final consonant. Although he was explicitly told that some consonants are not followed by a schwa, he did not have enough awareness of the vowel to hear the difference.

DISCUSSION

Our results are that Marathi-English bilinguals do, in general, show phonemic awareness in Marathi, but they struggle specifically with medial and final schwas. This is because medial schwas are not orthographically represented in the script and, although final schwas are represented with an anuswara, our participants seemed to be unaware of the phoneme it signifies. They either omitted these schwas or inserted schwas after every consonant that did not have a diacritic, regardless of whether the schwa was present or not. These effects are orthographic, not phonological, because if they were phonological, one should see a similar pattern of results in English. Some phonological effects were seen; for example, medial schwas were difficult in both languages. But, they were more likely to be mispronounced in English but omitted in Marathi, suggesting orthographic influences as well.

These results contrast with Prakash et al.’s (1993) findings that biliterate speakers of alphasyllabaries, but not monoliterate speakers, showed awareness for all phonemes (including, presumably, inherent vowels). Although this contrast in results might be due to task (phoneme deletion vs. phoneme dictation) or language differences, it is more likely a reflection of the greater opportunity in the present study to observe effects on medial schwa vowels. The present results suggest some limits on the extent to which learning an alphabetic language transfers awareness of phonemes to a bilingual’s alphasyllabary language. The alphasyllabary’s distinctive orthographic structure can exert its own influence on phonemic representations.

Although our participants varied greatly in terms of their Marathi literacy skills, we did not see any significant differences between the highly skilled and the less skilled participants on their Marathi phoneme dictation performance. None of our participants were illiterate in Marathi, suggesting that even low levels of literacy can affect phonemic awareness. A study that compares Marathi-English bilinguals who are literate only in English with biliterate bilinguals would be useful to verify that it is literacy in an alphasyllabary that is uniquely responsible for these phonemic awareness patterns. Illiterates in Marathi may imagine the Marathi stimuli written in Roman letters and thus would not have trouble with the medial and final schwas. In fact, the participant with the lowest level of skill in Marathi did report using this strategy to a limited extent. She got the final schwas correct because she was imagining the words in Roman letters, ending with the letter <a>. However, her limited Marathi schooling did have an effect, as she tended to miss medial schwas.

Although the participants could be divided into distinct subgroups based on their performance on the Marathi phoneme dictation task, the group profiles were not very predictive of other individual differences. The specific profiles could reflect unmeasured variables, such as instructional practices in the schools they attended or knowledge of other languages. For example, the only participant with high accuracy across the board reported using her knowledge of Sanskrit to help her; since Sanskrit marks consonants which do not have a schwa, she had greater awareness for the vowel.

The extent to which our participants were misled by English's lack of transparency was surprising given their skill level in English. Many participants pronounced the vowel used to spell the word rather than the vowel sound they heard and added vowel sounds in words that have silent <e's>. Although one might wonder about the phonetic difference between the participants' English pronunciation and the American English of the stimuli they heard, the pattern of errors suggests that such a difference was not a cause of the error patterns. For example, speakers with an Indian accent do not pronounce the medial <o> in 'odor' as /o/, nor do they pronounce 'arise' as /əraɪzi/. Perhaps learning a transparent first language made it difficult for participants to understand that they could not rely solely on orthography to complete the task. This finding does raise the question whether people who are bilingual in another transparent first language (e.g., Finnish, Korean) and English would find phonological awareness tasks especially difficult in English as well.

Our main conclusion concerns the effect of literacy on phonemic awareness. The specificity of our results—the pattern of errors was specific to the conventions of written Marathi compared with written English—demonstrates again that generalisations about phonemic awareness, once literacy has been attained, are constrained by how phonemes are expressed in the orthography. Thus, the question of whether alphasyllabaries, compared with alphabets, promote or inhibit awareness of phonemes has a two-part answer, at least for adult bilinguals who are literate in both an alphabet and an alphasyllabary. An alphasyllabary enables phonemic awareness through its alphabetic component, while selectively inhibiting the ability to demonstrate awareness for phonemes whose representations are not reliably expressed in the orthography.

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APPENDIX A: Marathi Reading Task

Practice (this page) and test (next page) words shown

आठ

कड

ताई

गोड

वळसा

साबण

धसका

प्रवास

आई	सांग	उपाशी	प्रेमपुष्प
एक	वस्तू	रुमाल	हुंदडणे
कर	शीर्ष	घाणेरडा	वज्रलेप
बस	गोष्ट	पाठीवर	लेकुरवाळी
वय	सुई	हमखास	वज्रहात
दे	सूर्य	क्षयतिथि	मुखचर्या
तो	नाच	गडबडणे	वनस्पति
हो	खांब	कृपया	मुहुर्तमणि
मी	सुष्ट	कारकीर्द	कामचेष्टा
घे	खुर्ची	लांबोडा	वल्हवणे
केस	उघड	मल्हारी	पुण्यक्षेत्र
काच	वक्र	चिड्डी	सर्वकालीन
तू	उचल	रंगवणे	वत्सलता
बाळ	दूध	संतोष	हस्तगत
खा	बदल	गुलहौशी	पुरस्कर्ता
हात	मूर्ती	मृगजळ	काथ्याकूट
काल	मांजर	उभयान्वयी	वक्रदृष्टी
थांब	पंचा	नास्तिक	जन्माष्टमी
बोट	भुवई	चित्रफलक	गतभर्तृका
बास	प्रवास	विल्हेवाट	मूत्राशय
लाल	पुष्कळ	मुशाहिरा	पुष्पवृष्टी
वाच	भिकारी	आकर्षण	ज्ञानमार्ग
तूप	कुत्रं	चरितार्थ	उत्कृष्टता
पैसे	सुंदर	मूल्यवान	वर्ज्य
नाक	चेंडू	संप्रदाय	महावस्त्र
प्रेम	स्वभाव	जबरदस्ती	पुंस्त्व

APPENDIX B: English and Marathi spelling tasks

1. in	1. ये
2. make	2. गाल
3. must	3. बेटा
4. explain	4. बडीशोप
5. material	5. पंचवीस
6. advice	6. कोशिंबीर
7. executive	7. शिक्षा
8. decision	8. वास्तपुस्त
9. lucidity	9. स्वरूप
10. medieval	10. धर्मात्मा
11. malfeasance	11. तृष्णा
12. vicissitude	12. स्वास्थ्य

Details about test administration: The words in the spelling test were ordered in terms of difficulty and the difficulty level of the spelling test was titrated according to a person's score on the speeded reading task. For every column of words that a participant attempted to read, he/she could skip three words on the spelling test. If the participant misspelled a word, the unadministered words were administered in reverse order until the participant spelled three consecutive words correctly or question #1 was administered. At that point, the normal order resumed. The task ended when the participant misspelled 3 consecutive words or #12 was administered. The participants were given credit for all of the unadministered words at the beginning of the test.

APPENDIX C: Phoneme dictation stimuli

Item Number	Marathi Word	English Translation	IPA of Marathi Word	Consonant-Vowel Structure	Initial schwas	Medial schwas	Final Schwas	No schwa at syllable boundary	Final consonants	Initial vowels	Medial vowels	Final vowels	English Word	IPA of English word
1	जोडपं	a couple, a married pair	zɔdʱə	CVCCə			1	1			1			
2	घुसळपं	churning	gʱusəʎɳə	CVCəCCə	1	1	1				1			
3	घसरडं	a slippery spot	gʱəsərdʱə	CəCəCCə	2	1	1							
4	गाळपं	a sieve, a strainer, a filter	gəʎɳə	CVCCə			1	1			1			
5	गळतं	a leak	gəʎtə	CəCCə	1	1	1							
6	खेळपं	a toy	kʰəʎɳə	CVCCə			1	1			1			
7	खोबरं	coconut	kʰəbrə	CVCCə			1	1			1			
8	कारलं	bitter gourd	karlə	CVCCə			1	1			1			
9	घेतलं	(he) took	gʱətʎə	CVCCə			1	1			1			
10	आडवं	sideways	adʱvə	VCCə			1	1		1				
11	सापडलं	(he) found it	sapəʎlə	CVCəCCə	1	1	1				1			
12	हरवलं	(he or it) lost	ɦərəvlə	CəCəCCə	2	1	1							
13	चुकीचं	incorrect	ʧukiːtʃə	CVCVCə			1				2			
14	हिरवं	green	ɦirvə	CVCCə			1	1			1			
15	कोरडं	dry	korɖə	CVCCə			1	1			1			
16	मागचं	behind	maɡtʃə	CVCCə			1	1			1			
17	माणसं	men, people	maɳsə	CVCCə			1	1			1			
18	घरभाडं	house rent	gʱərbʱadʱə	CəCCVCə	1	1	1				1			
19	जानवं	the sacred thread	zəɳvə	CVCCə			1	1			1			
20	धुपाटपं	a vase for holding incense	ɖʱupətɳə	CVCVCCə			1	1			2			
21	आजोबा	grandfather	azɔbə	VCVCV						1	1	1	alleyway	æliweɪ
22	आकाशी	sky-blue	akəʃiː	VCVCV						1	1	1	ideally	aɪdiəli
23	आवाज	sound	əwəz	VCVC					1	1	1		iris	aɪrɪs
24	आधीच	already	ədʱiːtʃ	VCVC					1	1	1		eyelid	aɪlɪd
25	अकरा	eleven	əkɾə	əCCV	1		1				1		undo	ʌndu
26	उलटी	1) vomit 2) upside down	ulʈiː	VCCV			1			1	1		elbow	ɛlboʊ
27	अनाथ	orphan	ənəʈʰ	əCVC	1				1		1		alive	əlaɪv
28	अशोक	boy's name	əʃok	əCVC	1				1		1		arise	əraɪz
29	अपराजित	one who is undefeated	əpərəʃɪt	əCəCVCVC	1	1			1		2		unabated	ʌnəbeɪtɪd
30	अनेक	many	ənək	əCVC	1				1		1		align	əlaɪn

31	अलगद	gently	əlgəḍ	əCCəC	1	1	1	1			ulcer	ʌlsər
32	अडणिवर	on top of a shell-holder	əḍḡḡwər	əCCVCəC	1	1	1	1	1		unravel	ʌnɹævəl
33	अखिल	all-encompassing	əkʰil	əCVC	1			1		1	anneal	ənɪl
34	अकारण	without any reason, unprovoked	əkərən	əCVCəC	1	1		1		1	aligner	əlɪnər
35	अठरा	eighteen	əḥṭrə	əCCV	1		1			1	ulnae	ʌlni
36	अतोनात	a lot	ətənəṭ	əCVCVC	1		1		2		alluded	əludɪd
37	अदित्ती	girl's name	ədɪtɪ:	əCVCV	1					1	abaci	əbækər
38	अगणित	countless, innumerable, incalculable	əgənɪt	əCəCVC	1	1		1		1	unaware	ʌnəweər
39	अजित	boy's name	əjɪt	əCVC	1		1			1	about	əbaʊt
40	अमोहा	girl's name	əmofɪə	əCVCV	1					1	awearly	əweərli
41	अनुरा	girl's name	ənʊrə	əCVCV	1					1	agouty	əgʊti
42	अलीकडे	recently	əlɪ:kəḍə	əCVCəCV	1	1				1	anomaly	ənɒməli
43	उघडणे	to open	uḡḡəḍḡṇə	VCəCCV		1	1	1		1	energy	enədʒi
44	उसळ	lentil soup	usəl	VCəC		1		1	1		opal	oʊpəl
45	उपास	fasting	ʊpəs	VCVC				1	1	1	opine	oʊpaɪn
46	आपण	1) us 2) you (respectful tense)	apən	VCəC		1		1	1		onus	oʊnəs
47	इकड्या	of this side, of this place	ɪkəḍɪsə	VCəCCV		1	1	1		1	agency	enɪdʒənsi
48	आरती	incantation	ərɪ:	VCCV			1	1		1	Alfie	ælfɪ
49	ओरडणे	to yell	orəḍḡṇə	VCəCCV		1	1	1		1	evenly	ɪvənli
50	आखुडणे	to contract, to shrink	əkʰuḍḡṇə	VCVCCV			1	1	1	1	acidly	æsɪdli
51	आघाडी	the front, the vanguard	əḡḡəḍɪ:	VCVCV						1	O'Leary	oʊləri
52	आजारी	unwell, ill, sick	əzəri:	VCVCV				1	1	1	amity	æmɪti
53	आठवणी	memories	ətʰwənɪ:	VCCəCV		1	1	1		1	injury	ɪnɟʊəri
54	ओळख	acquaintance, slight knowledge; recognition	oḷəkʰ	VCəC		1		1	1		odor	oḍər
55	दरवाजा	doorway	ḍərɹəzə	CəCCVCV		1	1			1	dirtyly	ḍərtɪli
56	अगठी	warming fire	əḡṭi:	əCCV	1		1			1	apply	əplai
57	अकडणे	to swagger, to be stiff; to walk affectedly; to strut; to be proud	əkəḍḡṇə	əCəCCV	1	1	1			1	utterly	ʌtərli
58	अपराध	crime	əpərəḍʰ	əCəCVC	1	1	1			1	unakin	ʌnəkɪn
59	आजकाल	at present, in these times, nowadays	əzkal	VCCVC			1	1	1	1	argyle	ɑrɟaɪl
60				CVCCə			1	1		1	dogma	ḍɔgmə

61				VCCVCə			1	1		1	1		adenoma	ædnoomə
62				əCCCə	1		1	1					ultra	ʌltrə
63				əCVCə	1		1				1		Anita	ənitə
64				əCVCə	1		1				1		amoeba	əmibə
65				əCVCə	1		1				1		Elana	ələnə
66				CVCəCVCə		1	1				2		Carolina	kærəlɪnə
67				CVCə			1				1		Lina	lɪnə
68				CVCə			1				1		yoga	yoʊgə
69				CVCə			1				1		soda	sodə
70				CVCə			1				1		soma	soʊmə
71				CVCə			1				1		rota	roʊtə
72				CVCə			1				1		llama	lɑmə
73				CCVCə			1				1		flora	flɔrə
74				CVCə			1				1		Tina	tɪnə
75				əCVCə	1		1				1		Evita	əvɪtə
76				əCəCCə	1	1	1	1					alumna	əlʌmnə
77				əCVCə	1		1				1		arena	ərɪnə
78				əCVCə	1		1				1		aroma	əroʊmə
79				CCVCə			1				1		drama	dɾəmə
Examples of the Category in English Stimuli					28	18	20	19	19	19	46	20		
Examples of the Category in Marathi Stimuli					20	24	20	34	19	19	45	20		
Examples of the Category in English-Marathi Pairs					20	16	0	15	19	18	27	20		