Published in final edited form as:
J Phon. 2013 November ; 41(6): 393–406. doi:10.1016/j.wocn.2013.07.004.

The effects of native language on Indian English sounds and timing patterns

Hema Sirsa and **Melissa A. Redford***
University of Oregon, OR 97403-1290, USA

Abstract

This study explored whether the sound structure of Indian English (IE) varies with the divergent native languages of its speakers or whether it is similar regardless of speakers' native languages. Native Hindi (Indo-Aryan) and Telugu (Dravidian) speakers produced comparable phrases in IE and in their native languages. Naïve and experienced IE listeners were then asked to judge whether different sentences had been spoken by speakers with the same or different native language backgrounds. The findings were an interaction between listener experience and speaker background such that only experienced listeners appropriately distinguished IE sentences produced by speakers with different native language backgrounds. Naïve listeners were nonetheless very good at distinguishing between Hindi and Telugu phrases. Acoustic measurements on monophthongal vowels, select obstruent consonants, and suprasegmental temporal patterns all differentiated between Hindi and Telugu, but only 3 of the measures distinguished between IE produced by speakers of the different native languages. The overall results are largely consistent with the idea that IE has a target phonology that is distinct from the phonology of native Indian languages. The subtle L1 effects on IE may reflect either the incomplete acquisition of the target phonology or, more plausibly, the influence of sociolinguistic factors on the use and evolution of IE.

1. Introduction

Indian English (IE) refers to those varieties of English that developed on the Indian subcontinent. IE is currently the co-official language of India with Hindi, and it is the primary medium of education, law, media, and business throughout India. IE is also used for social interactions and in pan-Indian literature. A small minority of Indians are members of a community that has IE as a native language. However, most speakers of IE are native speakers of an indigenous Indian language such as Hindi or Telugu. These non-native speakers of IE are first exposed to the language in English medium schools. Children are educated in English from primary school onwards (age 6), or from secondary school or even higher secondary school onwards (age 12 or 15, respectively).

In the 1970s, a number of investigations revealed strong influences of different indigenous Indian languages on the variety of English spoken in India (e.g., Bansal, 1970;

*Correspondence to: Linguistics Department, University of Oregon, Eugene, OR 97403-1290, USA. Tel.: +1 541 346 3789. redford@uoregon.edu (M.A. Redford).

Balasubramanian, 1972; Chaswal, 1973; Thundy, 1976). Around this time, IE was standardized in a monograph issued by the Central Institute of English and Foreign Languages so that there would be a consistent variety for use in primary and secondary education (CIEFL, 1972). The standardized variety was called General Indian English (GIE), and it has several salient phonological features such as a reduced vowel inventory compared to the Received Pronunciation (RP) of British English, the substitution of retroflex stops for RP British English alveolar stops, and the omission of some fricative sounds (Bansal, 1976; Wells, 1982). Although suprasegmental features were not standardized in the CIEFL monograph, the rhythms of (G)IE are notably different from those of most other Englishes. For example, whereas British English is a canonical stress-timed language, IE has most often been characterized as syllable-timed (Gargesh, 2004) or nearly syllable-timed (Babu (1971), cited in Pingali, 2009:34).

Today, IE is the second language spoken by many millions of educated Indians across different regions of the country.[1] One specific question that we address in this study is whether the sound patterns of IE, though standardized as GIE, nonetheless differ as a function of the native languages of its speakers. An alternative is that IE has a distinct target phonology that is perfectly attained by speakers with similar educational backgrounds even if these speakers come from different language backgrounds. Another question we address is whether or not sound pattern similarities in the native languages of different speakers can account for sound pattern similarities in IE produced by these speakers.

1.1. Previous investigations of L1 influences on IE

Early investigations of native language influences on IE phonology often compared English spoken by a particular group of Indians (L1 Hindi speakers or L1 Telugu speakers) to British English (e.g., Bansal, 1970; Dhamija, 1976; Vijayakrishnan, 1978). These studies have inevitably found that IE has absorbed many features from the indigenous languages of India. The studies have also documented the many similarities of IE across speakers with different L1 backgrounds. More recently, a number of studies have directly compared the effects of different native languages on specific phonological characteristics of IE (Maxwell & Fletcher, 2009, 2010; Pickering & Wiltshire, 2000; Wiltshire & Moon, 2003; Wiltshire & Harnsberger, 2006). The cumulative evidence from such comparisons largely supports the idea that speakers from different native language backgrounds produce a similar variety of IE, though some L1-dependent differences are also documented.

Maxwell and Fletcher (2009, 2010) investigated the acoustic–phonetic characteristics of IE vowels in L1 speakers of Punjabi and Hindi. Although Maxwell and Fletcher noted that both Punjabi and Hindi are Indo-Aryan languages, they were careful to document differences in the vowel inventories and suprasegmental features of the two languages based on phonological descriptions of these languages. Although very few differences were observed in the IE vowels produced by the two groups, Punjabi speakers produced IE diphthongs with more phonetic variation than Hindi speakers. Maxwell and Fletcher concluded that Punjabi

[1]The 16th edition of Ethnologue reports a 1961 census figure of 11 million L2 users of English in India. Pinjali (2009) cites a 1991 census figure of 64 million L2 users of English India. The Times of India (3/14/10) reported a 2001 census figure of 125 million L2 and L3 users of English in India.

and Hindi speakers shared vowel categories for IE monophthongs, but that native language phonology may influence the representation of IE diphthongs.

Although the differences observed between the Punjabi and Hindi speakers of IE may indicate persistent L1 influences on IE, Maxwell and Fletcher's (2010) methods leave room for an alternative explanation. In particular, 2 of the 4 Punjabi speakers began English medium education in secondary school. All other speakers were educated in English from primary school onwards. Thus, variability in age-of-acquisition may account for the larger degree of phonetic variation observed in Punjabi speakers' productions of IE diphthongs compared to Hindi speakers' productions of IE diphthongs (for age of acquisition effects on pronunciation see, e.g., Flege & Fletcher, 1992; Long, 1990). This possibility is further supported by Maxwell and Fletcher's acknowledgment that the differences between the groups did not conform to predictions based on differences in the phonologies of Punjabi and Hindi.

Two studies on the realization of prominence in IE have documented only similarities across speakers with different language background, and so provide no further evidence for persistent effects of L1 on IE (Pickering & Wiltshire, 2000; Wiltshire & Moon, 2003). The larger of the two studies (Wiltshire & Moon, 2003) investigated the effect of Indo-Aryan (Hindi and Gujarati) and Dravidian (Tamil and Telugu) on the production of English noun/verb pairs that differed only in canonical stress placement. There were 10 speakers in each group, and all speakers had been educated in English from primary school onwards. Multiple acoustic correlates of prominence (duration, amplitude, and *F*0 changes) were measured and no significant differences between Indo-Aryan and Dravidian speakers' productions were found. IE productions did however differ significantly from American English productions of the same words. In particular, duration differences between stressed and unstressed syllables were much smaller in IE productions than in American English productions, consistent with the characteristic timing patterns of these two varieties of English. IE productions also differed from American English in the direction of pitch change from prominent to non-prominent syllables.

In contrast to the Wiltshire and Moon (2003) study, Wiltshire and Harnsberger (2006) reported some L1-dependent differences in the production of IE rhotics, voiceless stops, and pitch accents. Five Gujarati (Indo-Aryan) and 5 Tamil (Dravidian) speakers of IE produced English word lists, isolated sentences, and a read passage for later acoustic–phonetic analysis of vowels, glides, rhotics, and stops, and for the transcription-based analysis of intonation. The measures indicated many similarities across the categories examined, but also a few differences across groups. For example, Gujarati and Tamil speakers of English produced the high and mid back vowels differently from one another and from the canonical descriptions of GIE back vowels. One of the differences between Gujarati English and descriptions of GIE, namely the near merger of /u/ and /æ/ in Gujarati English, was attributed to the absence of a short, high back vowel in Gujarati. The other differences observed could not be explained with reference to the L1 of the speaker.

Consonantal and intonational differences were also noted in the English produced by Gujarati and Tamil speakers. Specifically, there was substantial variation in the production

of rhotics across speakers, but unlike Gujarati speakers, Tamil speakers also produced a Tamil-style fricativized approximant in this category. Tamil speakers of English also produced longer VOTs than Gujarati speakers of English. And while both Tamil and Gujarati speakers of English produced many more accents per utterance than would be typical in American or British English, there were L1 related differences in proportion of rising vs. falling pitch accents. The sum of these segmental and suprasegmental differences led Wiltshire and Harnsberger conclude that the effects of L1 on IE may "supersede GIE norms (p. 103)." This conclusion is consistent with the view that IE representations are persistently influenced by the L1 of its speakers, and so may lack a stable phonology that is characteristic of a dialect.

Although the Wiltshire and Harnsberger (2006) study is comprehensive, their conclusion that IE is strongly influenced by L1 might be called into question for two reasons. First, like Maxwell and Fletcher (2010) who found some subtle L1 effects on IE, Wiltshire and Harnsberger's study included speakers who were first exposed to English at different ages. Three of the five Tamil speakers were educated in English from the beginning of primary school onwards. The other two were first exposed to English later: one began English medium education in the 3rd standard (age 9), and one in higher secondary school (age 15). The Gujarati speakers were more homogeneous in that all had been educated in English from primary school onwards. The variability in age of acquisition could account for the differences observed between groups, and especially for why Tamil speakers were found to occasionally use a Tamil-style fricativized approximant for the English rhotic.

The second reason that we might call into question Wiltshire and Harnsberger's (2006) conclusion that L1 influences supersede GIE norms is that no comparable L1 data are presented. Here, a number of similarities between the groups are at issue. Although some of these were interpreted as consistent with similarities between Tamil and Gujarati when different than GIE, no empirical data is offered to support this interpretation. In fact, with the exception of the Pickering and Wiltshire (2000) study, none of the acoustic–phonetic investigations of L1 influences on IE compare the segmental and suprasegmental characteristics of L1 and IE in the same speakers. The Pickering and Wiltshire (2000) study does however support Wiltshire and Harnsberger's idea that similarities across indigenous Indian languages may account for similarities in the IE produced by speakers with different language backgrounds. In particular, Pickering and Wiltshire found that the variable of interest in that study, prominence realization, was the same in the IE and across the different L1s of their 3 speakers.

1.2. The current study

If both the similarities and differences in IE sound patterns across groups can be attributed to the native languages of the speakers, then the acquisition of IE sound patterns may simply involve the selective transference of L1 categories to L2. An alternative hypothesis is that Indians acquire a common IE phonology that is distinct from their native language phonology. This latter hypothesis does not contradict the idea that IE phonology reflects indigenous Indian languages influences; it merely suggests that these influences are historical in nature. To test between these competing hypotheses, we investigated the

perceptual and acoustic similarities and differences of IE produced by native Hindi and native Telugu speakers, all of whom had been educated in English from primary school onwards. We also investigated acoustic similarities and differences between the native languages of the speakers.

We focused on native Hindi and Telugu speakers' production of IE because Hindi has the most speakers among the Indo-Aryan language family and Telugu among the Dravidian language family. Hindi is the official language of 11 states, and its speakers account for 41.03% of total population of India. Telugu is an official language of Andhra Pradesh, and its speakers account for 7.19% of the total population of India. Hindi and Telugu are also known to be phonologically distinct: Hindi has a larger phonemic inventory than Telugu (Maddieson, 1984). The Hindi vowel inventory includes tense-lax distinction and a quantity difference as well as a central vowel /i, iː, eː, ɛ, æ, ə, a, ɔ, oː, u, uː/ (Ohala, 1999), whereas the Telugu vowel inventory includes just 5 vowels and a phonemic length contrast /iː, i, eː, e, aː, a, oː, o, uː, u/ and a low-front vowel /æː/ in borrowed English words (Krishnamurti, 1972). Although Hindi and Telugu consonantal inventories are roughly similar in size, as shown in Appendix A, the Telugu set is functionally smaller than the Hindi set because the contrasts due to voicing and aspiration are strictly features of written or literary Telugu in the retroflex, palatal, and velar series (Krishnamurti, 1972:5). Also, there is some indication that Hindi and Telugu may vary in the degree of retroflexion for particular speech sounds (Ladefoged & Bhaskararao, 1983). Finally, Hindi and Telugu are both described as quantity sensitive languages, but default stress is on the last syllable in Hindi and on the first in Telugu (Ohala, 1999; Srinivas, 1992). Hindi has been described as a syllable-timed language (Crystal, 1995; Dauer, 1983), and Telugu as mora-timed (Murty, Otake, & Cutler, 2007).

We investigated the similarities and differences in IE as a function of native language using global perceptual analyses, and specific acoustic measurements. Naïve and experienced listeners provided perceptual judgments on IE sentences produced by different speakers. The listeners had to determine whether the speakers had the same or different native languages. The naïve listeners were native speakers of American English with little exposure to IE; the experienced listeners were native Hindi or Telugu speakers and fluent IE speakers. We expected that naïve listeners would only be able to distinguish between IE produced by native Hindi and Telugu speakers if speakers' native language strongly influences IE production. We expected that experienced listeners might be able to distinguish between IE produced by Hindi and Telugu speakers if native language effects on IE are subtle.

The acoustic measurements focused on vowel and obstruent production as well as on temporal patterns that contribute to the perception of language rhythm, which reportedly differs in Hindi and Telugu. We reasoned that if IE involves the transference of native language categories, then IE sound patterns produced by Hindi and Telugu speakers should parallel the native language sound patterns produced by the same speakers. If IE phonology is acquired separately from native language phonology, then there should be little to no measurable differences in the IE sound patterns produced by Hindi and Telugu speakers, and measurable differences in the native language sound patterns produced by the same speakers.

2. Methods

2.1. Participants

Fourteen IE speakers provided speech samples for the present study. Seven speakers had Hindi as their native language and 7 had Telugu as their native language. Three of the Hindi speakers were female and 4 were male. Five of the Telugu speakers were female and 2 were male. All speakers were between the ages of 20 and 35 years old. All speakers were exposed to English education from the 1st standard onwards (age 6), and all continued to be educated in English through college. Five of the native Hindi speakers and 5 of the native Telugu speakers were residing in India at the time of the study. The remaining 4 IE speakers were residing in Oregon (Eugene or Portland), but had been in the United States for less than 6 months at the time of recording. All Hindi speakers were from Delhi and all Telugu speakers were from Hyderabad.

Ten naïve listeners and 10 experienced listeners participated in the perceptual judgment task that compared IE produced by native Hindi and Telugu speakers. Ten additional naïve listeners participated in a perceptual judgment task that compared Hindi and Telugu. The naïve listeners were American-English speaking undergraduates from University of Oregon, who received course credit for their participation. The experienced listeners were 4 native speakers of Hindi and 6 native speakers of Telugu, who were residing in Eugene, Oregon, and had been in the United States for at least one year. None of the experienced listeners were acquainted with any of the Indian speakers who provided the spoken material for the study.

2.2. Material

The language samples were sentences from different language versions of a story familiar to all Indians; that of Lord Ganesha and his adventurous ride on his mouse at night on Ganesha Puja. The English version was obtained on-line from http://pz26.com (accessed summer 2009). The story was then translated, sentence-by-sentence, into Hindi and Telugu by native speakers of these languages. The translations were then checked against the intuitions of the first author, a multilingual speaker with native-like fluency in Hindi, Telugu, and English.

Each story consisted of 13 sentences that varied in length from 11 to 49 syllables in English, from 12 to 43 syllables in Hindi, and from 15 to 53 syllables in Telugu. Appendix B provides the text for each language. The English, Hindi, and Telugu sentences were printed on separate cards in native orthographies (Roman, Devanagari, and Brahmi scripts, respectively). The cards were then shuffled to randomize sentence order before being presented to speakers. The randomization process was used to avoid storytelling prosody.

2.3. Production task

The participants were given a stack of cards that were either in their native language (Hindi or Telugu) or in English. If participants were given cards with sentences in their native language, they were then instructed either in Hindi or Telugu to look through the cards to familiarize themselves with the text. If they were given cards with sentences in English, they were instructed to do so in English. Participants were then asked to read the sentences on

each card at a comfortable speed. Participants read through the entire stack in one language, and then the process was repeated for the other language with instructions given in the language that corresponded to the language of the cards. Participants then took a break before returning to the first stack to repeat the process. Participants alternated between stacks (languages) in this way until 3 repetitions of all the sentences had been obtained for each of the languages. The cards were shuffled between each re-reading so that the sentences were read in a new random order every time they were read. Participants were recorded in a quiet room using a Shure professional unidirectional microphone and a Marantz Professional PMD660 portable solid-state recorder. All measures reported in this paper were taken from either the second or third repetition of the sentences. The third repetition was used if the second repetition was not fluently spoken.

2.4. Perceptual judgment task

On each trial, naïve and experienced listeners were presented with the most fluent IE renditions of two different sentences produced by different IE speakers (sentences 5 and 8, see Appendix B).[2] A second group of naïve listeners were also presented with the most fluent native language renditions of these same two sentences on every trial. The same pair of different speakers was never repeated for a particular sentence order (5, 8 or 8, 5) in either language task. In half of the stimuli, the different speakers had the same native language background. In the other half, the different speakers had different native language backgrounds. The same and different stimuli were amplitude normalized and presented in random order over headphones to listeners, who were seated in front of a computer in a quiet experimental room. Listeners were instructed that they would hear speech samples from native Hindi speakers and native Telugu speakers. They were then told that their job was to listen to each pair of sentences and judge whether the different speakers had the same language background or different language backgrounds. Judgments were to be made on a 5-point scale, where “1” equaled a confident “same” judgment and “5” equaled a confident “different” judgment. The scale was presented on a computer monitor, and the listeners indicated their response by clicking on the box with the number that corresponded to their judgment. We expected that only experienced listeners might be able to tell the difference in IE produced by speakers with different language backgrounds if the differences were subtle. We expected that naïve listeners would be able to distinguish between Hindi and Telugu, since these languages are reported to differ phonologically.

Perceptual judgments on the paired sentences took approximately 25 minutes to complete. Preliminary analyses indicated that 1 of the 10 naïve listeners who made judgments on IE defaulted to a single judgment and then did not complete the task as required. The judgments from this listener were therefore excluded from further analysis. In addition, listener feedback suggested that it took some time to accommodate to the task. For this reason, presentation order was included as a covariate in the analyses of listener ratings (see below for further detail). The ratings were z-transformed within each listener in order to obtain a normally distributed dependent measure that was comparable across listeners.

[2]Different IE and L1 sentences were used as stimuli so that judgments would be made on the basis of abstract properties of the languages rather than on the basis of point-to-point comparisons.

2.5. Acoustic measurements

Acoustic measurements were also used to investigate group differences in the production of IE as well as the similarities and differences between Hindi and Telugu. A number of segmental and suprasegmental characteristics were chosen for analysis including vowel quality, degree of retroflexion for /ʈ/ and /ɖ/, extent of aspiration for voiceless stops, the spectral characteristics of /s/, and temporal patterns associated with lexical stress, phrase-final lengthening, language rhythm, as well as a measure of speech rate. The measurement procedures are described in more detail next.

Vowels—Using the Praat speech processing software (Boersma & Weenink, 2011), utterances were displayed and segmented into consonantal and vocalic intervals. *F*1 and *F*2 values were extracted automatically at the midpoint of every vowel using formant tracking and a script. Every measure was also visually inspected and when a mismatch between the tracks and the formant band in the spectrogram was detected, script parameters were changed until a proper match was obtained. Formant values were then normalized using the Lobanov method (Erik & Kendall, 2007) to control for variability due to speaker vocal tract characteristics. Normalized *F*1 and *F*2 and the ratio of *F*1 to *F*2 were used as dependent variables in the analyses of vowel quality.

Consonants—Six words with post-vocalic retroflex consonants were chosen from the IE, Hindi, and Telugu sample (see Table 1) to investigate the degree of retroflexion across languages. Retroflexion was quantified as the difference between *F*3 and *F*2 at vowel offset, which was meant to characterize the degree of *F*3 depression due to retroflexion (Wiltshire & Harnsberger, 2006). As with the vowel measures, values at *F*2 and *F*3 offset were extracted automatically, but the formant tracks for every measure were visually inspected and parameters were adjusted if there was a mismatch between the tracks and the visible formant bands on the spectrogram.

Six words with syllable-initial voiceless stops were chosen from the IE, Hindi, and Telugu sample (Table 1) to investigate aspiration across languages. Aspiration was quantified using VOT With regards to this measures, 3 of the Hindi speakers and 6 of the Telugu speakers produced at least one stop with multiple bursts. When this occurred, VOT was measured from the last burst to voicing onset.

Finally, three additional words were chosen from the IE, Hindi, and Telugu sample (Table 1) to compare non-final syllable /s/ production across the 3 languages. Some studies have shown that spectro-temporal properties of /s/ varies with language contact (Erker, 2012). An effect of first language on the production of /s/ in IE might be anticipated based on the differences in the phonemic inventories of Hindi and Telugu: Hindi has /s/ in contrast to /ʃ/ and /z/, whereas Telugu has /s/ in opposition to //ʃ/ and to /ʂ/. The spectral characteristic of /s/ across the 3 languages was captured by a center of gravity (COG) measurement.

Suprasegmentals—Twelve disyllabic words were selected to investigate temporal patterns associated with lexical prominence, which help to define language rhythm (Dauer, 1983). The English words were further categorized according to their dictionary-defined prominence pattern (trochaic or iambic). We attempted to match the prominence patterns of

the English words with prominence patterns in Hindi and Telugu words following the quantity-sensitive stress rules for the different languages and the first author's intuition on prominence placement. Table 2 provides the list of words selected for this analysis.

Lexical prominence was captured as the ratio of first vowel duration to second vowel duration in the disyllabic word (V1:V2) since duration represents the best correlate of lexical prominence in English (Huss, 1978) and since the temporal pattern corresponded best with our interest in rhythm.

Phrase final lengthening also contributes to the perception of language rhythm (Nooteboom, 1997). Final lengthening in IE, Hindi, and Telugu was assessed by dividing the final vowel duration by the average vowel duration in the sentence for each of the 13 sentences.

Finally, we calculated several global rhythm metrics based on interval duration and speech rate. These measures have all been used to distinguish between languages from different rhythm classes (Dellwo, 2010; Grabe & Low, 2002; Ramus, Nespor, & Mehler, 1999). Although we acknowledge the controversy surrounding the hypothesis that interval duration measures adequately convey language rhythm (see, e.g., Arvaniti, 2009), we also note that the measures provide an objective description of vocalic and consonantal durations, and these are at least in part correlated with long-established notions of rhythm.

The interval duration measures used in the current study were as follows: the proportion of vowel duration to total speech duration in a sentence (%*V*, Ramus et al., 1999); the standard deviation of consonant duration for each sentence (Δ*C*, Ramus et al., 1999); and the normalized weighted summed difference of sequential vowel durations across a sentence minus the final syllable (nPVI, Deterding, 2001; Grabe & Low, 2002). Speech rate was calculated as the number of vowel intervals (=syllabic nuclei) per second of speech for each sentence, following one of the measures used by Dellwo (2010).

2.6. Analyses

Linear mixed effects modeling was used to investigate the effect of native language on IE as well as on the similarities and differences of the sound patterns of the native languages involved. A first set of analyses focused on the perceptual judgments. These analyses investigated the fixed effects of listener experience (naïve vs. experience) and speaker background (same vs. different) on similarity ratings, as well as the fixed effects of language task (IE or Hindi/Telugu=L1) and speaker background on naïve listeners' similarity ratings. In both analyses, item and listener were treated as random factors with item nested within listener. Order of presentation was entered as a random covariate, and also nested within listener. A second set of analyses investigated the fixed effects of speaker background (native Hindi or Telugu speakers) and language task (IE or L1) on the various acoustic measures. Segment identity was an additional fixed factor in the analysis on retroflexion and aspiration. The English lexical prominence pattern was an additional fixed factor in the analysis on V1:V2 duration. Again, item (word or sentence) and speaker were treated as random factors with item nested within speaker. All results are given with the denominator degrees of freedom rounded to the nearest whole number.

3. Results

American-English speaking listeners were less able to distinguish between English sentences produced by native Hindi and Telugu speakers than native Hindi and Telugu speaking listeners, but the naïve listeners easily distinguished between Hindi and Telugu sentences. Moreover, naïve listeners were better able to differentiate between Hindi and Telugu than experienced listeners were able to differentiate between English produced by Hindi and Telugu speakers. The acoustic measures were consistent with the perceptual results. Although Hindi and Telugu differed on almost every measure, the English produced by native Hindi and Telugu speakers differed on only 3 measures. These results are presented in detail below.

3.1. Perceptual judgments

The analysis of similarity ratings on IE sentences as a function of listener experience and speaker language background revealed a significant interaction between experience and background, $F(1, 3041)=47.54$, $p<.001$, and a simple effect of speaker background, $F(1, 3041)=8.86$, $p=.003$. The significant interaction is shown in Fig. 1.

Analyses on ratings split by listener experience indicated that the effect of background was significant for both naïve American-English speaking listeners and for experienced Hindi and Telugu speaking listeners [naïve listeners, $F(1, 1383)=10.14$, $p=.001$; experienced listeners, $F(1, 1549)= 59.04$, $p<.001$]; however, it was only experienced listeners who could accurately differentiate English sentences produced by native Hindi speakers from those produced by native Telugu speakers. Naïve listeners appear to have judged English produced by speakers with the same language background as more different than English produced by speakers with different language backgrounds. That said, the result for naïve listeners was fairly weak. The mean normalized judgment score for “different” stimuli was −.07, but .06 for “same” stimuli (non-normalized means were 2.84 and 3.06, respectively). Although weak, the result is entirely unexpected. Further investigations revealed no immediate explanation: the effect was not driven by a particular listener nor by significant differences in the “same” or “different” stimuli. (We considered whether there were important differences in the proportion of stimuli with same gender pairings of speakers within each type; there were not.) Naïve listeners clearly attended to something in the productions, but that something was not related to the language background of the speakers.

The analysis of naïve listeners' similarity ratings on IE and L1 sentences also revealed a significant interaction, but this time it was between language task and speaker background, $F(1, 3341)=82.99$, $p<.001$. It is clear from Fig. 2 that the interaction was due to the fact that naïve American-English speaking listeners were very clearly able to appropriately differentiate Hindi from Telugu sentences, so much so that the simple effect of background on the difference ratings was also in the right direction and significant, $F(1, 3341)=28.11$, $p < .001$.

Visual inspection of the results shown in Figs. 1 and 2 suggests that one other comparison between the groups may be interesting: a comparison of naïve listeners' difference ratings of Hindi and Telugu compared to experienced listeners' different ratings of English produced

by native Hindi and Telugu speakers. An analysis of the effect of language task and speaker background on the normalized ratings from the different groups of listeners confirms the impression derived from inspection of the figures; namely, that naïve listeners were better at differentiating Hindi and Telugu than experienced listeners were at differentiating English produced by speakers with different language backgrounds, $F(1, 3509)=7.55$, $p<.006$.

Taken together, the similarity ratings on IE sentences by naïve and experienced listeners indicate perceptible effects of L1 on IE, albeit fairly subtle ones that are only identified by experienced listeners. Note that the results on ratings of Hindi vs. Telugu show that naïve listeners' are very good at picking up on phonological differences when these are sufficiently robust.

3.2. Acoustic measurements

The next set of analyses addressed the effect of language task and speaker background on the production of specific segmental and supra-segmental attributes. The results on vowel production are presented first, followed by those on retroflexion, aspiration, /s/ production, lexical stress, final lengthening, and rhythm, in that order.

The IE and L1 vowels are plotted in Fig. 3 according to their normalized *F*1 and *F*2 values and shown as a function of speaker background. A qualitative comparison of the different vowel spaces depicted in the figure suggests that IE does vary somewhat with speaker background, but the differences between IE and the native languages are more striking. Quantitative analyses were conducted to determine which, if any, of the differences evident in Fig. 3 were systematic enough across speakers to be statistically significant. In particular, the analyses on *F*1/*F*2 and on *F*1 and *F*2 values separately tested for effects of speaker background and (where possible) language task on the production of particular vowels.

Analyses on *F*1/*F*2 revealed a significant effect of speaker background for/u/, $F(1, 21)=5.36$, $p=.031$. The effect of language task was significant for /ɪ/, $F(1, 17)=4.73$, $p=.044$, and for /æ/, $F(1, 24)=22.72$, $p<.001$. A significant interaction between background and task was only observed for /ɑ/, $F(1, 24)=4.85$, $p=.037$. If we interpret these results with reference to the group mean values shown in Fig. 3, we find that the effect of background on /u/ was due to a more fronted articulation by Telugu speakers compared to Hindi speakers, especially in the L1. With regards to the effect of language task, /ɪ/ and /æ/ were both more centralized in IE compared to the L1 across speaker background. The interaction between background and task on /ɑ/ effect appeared to be primarily due to the raising of this vowel by Telugu speakers in Indian English.

Analyses of *F*2 alone, revealed a further significant effects of task on /*e*/, $F(1, 24)= 10.27$, $p=.004$. This vowel was more centralized in IE compared to the L1. Analyses on *F*1 alone revealed a suite of high and mid vowels that were lower in IE compared to L1: /i/, $F(1, 24)=8.02$, $p=.009$; /*e*/, $F(1, 24) = 24.78$, $p<.001$; /ɔ/, $F(1, 24) = 68.89$, $p<.001$; /o/, $F(1, 18) = 35.04$, $p<.001$; /ʊ/, $F(1, 24)=18.44$, $p=.001$. There were also significant effects of background on *F*1 for /i/, $F(1, 24)=4.47$, $p=.045$, and /*e*/, $F(1, 24)=6.87$, $p=.015$, and a significant interaction between task and background for /ɪ/, $F(1, 17)=4.88$, $p=.041$. The main effects were due to Hindi speakers producing more raised front vowels than Telugu speakers

across the language task. The interaction was due to a relatively raised /ɪ/ in Hindi compared to Telugu, but similar productions of /ɪ/ in IE regardless of language background.

With respect to degree of stop retroflexion, an analysis of the difference between *F*3 and *F*2 at vowel offset indicated no significant main effects of background, language task or consonant type, but there was a significant 3-way interaction between these factors, $F(1, 109)=6.83$, $p<.010$. This result, shown in Fig. 4, appears to have been due to similar degrees of retroflexion across consonant types in IE compared to the native language, and a native language difference in the consonant that was produced with more retroflexion (i.e., a smaller difference in *F*2 and *F*3 offset). Hindi speakers, in particular, appeared to have produced /ʈ/ with more retroflexion than /ɖ/, but the reverse may have been true for Telugu speakers. Thus, once again, native language differences were evident, but IE targets were constant across speakers with different language backgrounds.

As for the degree to which voiceless stops were aspirated, the analysis on VOT indicated a main effects of background, $F(1, 158)=6.40$, $p=.012$, and stop identity, $F(1, 158)=46.34$, $p<.001$, but no effect of language task and no interactions between the factors. Fig. 5 shows these results.

In spite of the main effect of group, VOT in Hindi English was not different from VOT in Telugu English. Rather, the group effect seems to have been driven by a significant difference in the production of Hindi and Telugu voiceless velar stops: post-hoc comparisons showed that these were produced with significantly less aspiration in Hindi compared to Telugu ($p=.001$).

In contrast to the measures of retroflexion and aspiration, the frequency measures on /s/ showed a clear effect of native language on IE. Like the results on stop aspiration, the overall analysis of mean frequency indicated a significant effect of group, $F(1, 80)=13.38$, $p<.001$, but no effect of language task or interaction with language task. Unlike the results on stop aspiration, post-hoc comparisons indicated that the difference between groups was significant for IE ($p=.021$) as well as for the native languages ($p<.001$). Fig. 6 shows that Hindi speakers produced /s/ with a lower average frequency in English and in their native language compared to Telugu speakers.

The analyses on suprasegmental temporal patterns indicated a minimal effect of native language on IE, but substantial differences in the sound patterns of Hindi and Telugu. For example, the results on temporal patterns associated with lexical stress in English indicated a significant effects of background, $F(1, 297)=29.84$, $p<.001$, and stress pattern, $F(1, 297)=5.18$, $p=.024$, on the vowel-to-vowel duration ratio. There was also a significant interaction between background and task, $F(1, 297)=9.12$, $p=.003$. When the data were split by language task, the effect of speaker background was significant for native language disyllabic words, $F(1, 140)=39.09$, $p<.001$, but not for IE. Of course, the effect of lexical stress pattern was significant in IE, $F(1, 157)=8.50$, $p=.004$, but not in the native languages. The results are shown in Fig. 7.

We can see in Fig. 7 that trochaically- and iambically-stressed English words were differentiated regardless of the native language, and that the striking differences between

Hindi and Telugu speakers occurred in the native languages where disyllabic words were produced either with a long V2 relative to V1 (Hindi) or a long V1 relative to V2 (Telugu). Thus, the results once again indicated a strong contrast between Hindi and Telugu, but none in the IE produced by Hindi and Telugu speakers.

In contrast to the results on lexical prominence patterns, the results on phrase-final lengthening suggested an effect of native language on IE. The overall analysis indicated a main effect of background on the measure of final lengthening, $F(1, 347)=4.33$, $p=.038$, but no effect of language task or any interaction between the factors. Post-hoc analyses indicated that the effect of group on final lengthening was not significant within each language, so the effect was small (see Fig. 8). Overall, Hindi speakers engaged in more phrase-final lengthening than Telugu speakers regardless of the language they were speaking.

Finally, the analyses on global rhythm metrics and speech rate suggested that IE has a rhythm pattern that is distinct from either Hindi or Telugu, and that the native language has little influence on speakers' production of IE rhythm. Specifically, the analyses indicated an effect of group on Δ*C* $F(1, 166)=3.96$, $p=.048$ and on speech rate, $F(1, 163)=69.28$, $p<.001$, an effect of language task on %*V*, $F(1, 171)=122.11$, $p<.001$, Δ*C*, $F(1, 164)= 11.63$, $p=.001$ and speech rate $F(1, 151)=257.23$, $p<.001$, and an interaction between group and language task on speech rate, $F(1, 151)=148.44$, $p<.001$. Post-hoc comparisons indicated no significant effect of group on any of the measures in IE, but a significant effect of group on native language Δ*C* ($p=011$), and speech rate ($p<.001$). Note that there were no significant main effects or interactions on nPVI. The significant results are shown in Fig. 9.

Although the %*V* value (46.8%) in IE was lower than the values for Hindi (52.3%) and Telugu (51.2%), it was still much higher than that reported for the canonically stress-timed language, British English (41.1%; Grabe & Low, 2002). Similarly, the Δ*C* value for IE (29.7) was marginally higher than the value for Hindi (28.6) and for Telugu (26.4), but much lower than that reported for British English (54; Ramus et al., 1999). Of course, the interval-based measures, including speech rate, are sensitive to a variety of factors that are not strictly rhythmic, and so a cross-study comparison of mean values should be interpreted with caution. The comparison does, nonetheless, support the intuition that timing in IE is significantly different than timing in British English. We have further shown here that the timing of IE is also substantially different from that of two indigenous Indian languages.

In sum, the acoustic measures indicated some effects of native language on IE. In particular, there were L1 effects on IE /i/, /e/, /ɑ/, and /u/, on the articulation of /s/, and on final lengthening. Nonetheless, many more differences were found in the sound patterns of Hindi and Telugu. The degree of stop retroflexion varied by language with Hindi speakers producing /ʈ/ with more retroflexion than /ɖ/ and vice versa for Telugu speakers. Hindi speakers also produced stops with less aspiration and /s/ with a lower mean frequency than Telugu speakers. In addition, Hindi speakers lengthened V2 relative to V1 in disyllabic words, whereas Telugu speakers did the reverse. Finally, Hindi speakers engaged in somewhat more final lengthening than Telugu speakers, and produced phrases with higher %*V* and Δ*C*, but at slower rates than Telugu speakers. Altogether, the results are consistent

with the suggestion that Indians with similar educational backgrounds have similar IE representations that are minimally influenced by their L1.

4. General discussion

The current study investigated native language influences on IE as spoken by Indians with different language backgrounds and educated in English medium schools. This study was undertaken to assess the competing hypotheses that IE represents L1 influenced English or a perfectly acquired pan-Indic variety of English. Although most contemporary linguists likely accept that IE is a distinct variety of English, IE diverges from other major dialects of English in that its speakers are nearly always exposed to the language after they have acquired one or more indigenous Indian languages. It is therefore reasonable to assume that IE phonology may not be stable across speakers in India. The strongest version of this assumption predicts that native language phonologies will account for both the similarities and differences in IE produced by speakers with different language backgrounds. The current findings are consistent with previous findings in contradicting this strong prediction. Specifically, the present results indicate that the sound patterns of IE show minimal variation with native language background even while the sound patterns of the native languages are substantially different from one another.

The present results are not fully consistent with the alternative strong hypothesis, namely, that IE represents a perfectly acquired pan-Indic variety of English with a distinct and stable phonology. Like Maxwell and Fletcher (2010) and Wiltshire and Harnsberger (2006), we found some effects of L1 on IE. Because we controlled for age of acquisition, the L1 effects found in the present study cannot be easily attributed to divergent proficiency levels. This ambiguity raises the following questions: do the L1 effects on IE indicate its incomplete acquisition, which is defined here as partial overlap between speakers' L1 and IE phonology? Or are the subtle L1 effects due to sociolinguistic factors, including identity and/or regional variation? Although the results from the current and previous studies on IE do not provide definitive answers to these questions, we suspect that the noticeable effects of indigenous languages on IE are due to sociolinguistic factors rather than to psycholinguistic ones.

As noted in the introduction, many Indians are first exposed to English at age 6 in primary school. There is evidence to suggest that this is early enough for individuals to acquire an “accentless” variety of a target language (Flege & Fletcher, 1992; Long, 1990). Let us consider what this might mean in the Indian context. English medium school teachers do not speak English natively, nor do they have the same L1 as each other or as their students, and there is also some indication that not all teachers have equal proficiency in English (Annamalai, 2005; Mohanty, 2006). Putting aside the question of how one assesses proficiency in a variety that is not well described and has emerged through use by multilingual speakers, let us assume for the moment that children received highly variable English input. If this is not currently the case (and it may not be), then we can at least assume that it was the case for young English-learning Indians at some point since the adoption of the Three Language Policy in 1968. Under these circumstances, the notion of accentless IE may be the same as that of language emergence. That is, adults who learned IE

from a young age may have come to produce the same IE patterns regardless of their first language if they regularized the variable input that they received.

We know from the example of Nicaraguan Sign Language that young children can regularize highly variable input to create a grammatically structured language within a single generation (Senghas, Sotaro, & Ozyurek 2004). What appears to be critical to the speed at which this process occurs is the size of the community of young people involved, and their motivation for learning the language and using it among themselves (Senghas, Senghas, & Pyers 2005). As noted in the introduction, the community of young people learning English in India is extremely large. Moreover, the language has become a lingua franca for young people of different language backgrounds, who interact regularly in the multilingual urban cities of India. Under these circumstances, it is hard to imagine that IE is anything other than another variety of English, albeit one that may be quickly evolving into multiple varieties (see, e.g., Wiltshire, 2005).

Strong social and regional pressures could drive the evolution of IE into multiple varieties that would keep language-affiliated identities alive. The prevailing political unrest in Northeastern India and the secessionist impulses of many citizens in the region provide an extreme example of these pressures. Wiltshire (2005) notes that such pressures could account for the Tibeto-Burman influenced variety of IE spoken in the region. She also advocates for descriptive work to determine the number of varieties in existence and the extent to which they are based on L1 phonologies. A complementary research program would be to investigate regionally based differences on IE that are independent of L1. For example, we are interested in the possibility that the IE spoken by native Hindi speakers from cities other than Delhi may differ from that spoken by native Hindi speakers in Delhi. Similarly, for the IE of native Telugu speakers living in different cities. A study of this sort would disambiguate psycholinguistic and sociolinguistic factors to some degree. And, if the regional varieties of IE varied in the way that IE varied by language group in this study, then we would have better evidence for sociolinguistic explanations of what otherwise looks like L1 influenced IE.

Acknowledgments

This research was supported in part by Award number R01HD061458 from the Eunice Kennedy Shriver National Institute of Child Health & Human Development (NICHD). The content is solely the responsibility of the authors and does not necessarily reflect the views of NICHD.

Appendix A

A. Consonant inventory of GIE (CIEFL, 1972)

	Labial	Labio-dental	Dental	Alveolar	Post-alveolar	Retroflex	Palatal	Velar	Glottal
Stop	p (p^h)		(t) d t^h			ʈ (ʈ^h)		k (k^h)	
	b					ɖ		g	
Affricate					ʧ (ʧ^h) ʤ				
Nasal	m			n				ŋ	

A. Consonant inventory of GIE (CIEFL, 1972)

	Labial	Labio-dental	Dental	Alveolar	Post-alveolar	Retroflex	Palatal	Velar	Glottal
Fricative		f		s z	ʃ				h
Approximant	ʋ/w			r			j		
Lateral approximant				l		(ɭ)			

B. Consonant inventory of Hindi (Ohala, 1999)

	Labial	Labio-dental	Dental	Alveolar	Post-alveolar/palatal	Retroflex	Palatal	Velar	Uvular	Glottal
Stop	p p^h		t t^h			ʈ $ʈ^h$		k k^h	(q)	
	b b^h		d d^h			ɖ $ɖ^h$		g g^h		
Affricate					tʃ $tʃ^h$					
					dʒ $dʒ^h$					
Nasal	m			n	ɲ	ɳ		ŋ		
Fricative		f		s z	ʃ			(x)		h
								(ɣ)		
Tap or Flap				ɾ		(ɽ)				
						($ɽ^h$)				
Approximant		ʋ		l j						

C. Consonant inventory of Telugu (Krishnamurti, 1972)

	Bilabial	Labio-dental	Dental/alveolar	Retroflex	Post-alveolar/palatal	Velar	Uvular	Glottal
Nasal	m		n	ɳ				
Plosive	p p^h		t d^h	ʈ $ʈ^h$		k k^h		
	b b^h		d	ɖ $ɖ^h$		g g^h		
Affricate					tʃ dʒ			
					$tʃ^h$ $dʒ^h$			
Fricative		f	s	ʂ	ʃ			h
Tap or flap			ɾ					
Approximant	w		l	ɭ j				

Appendix B

A. Story in Indian English

1. Lord Ganesha is very fond of laddoo (modaka, a sweet delicacy).
2. Once upon a day of Ganesh Puja, Ganesha went from house to house and accepted the offering of laddoo.
3. He stuffed himself to the capacity and decided to take a ride on his mouse at night.
4. Along the moonlit road, they got to see a large snake, and the troubled rat stumbled, with the consequence Ganpati fell down.
5. He hit the ground hard and as a result his stomach burst open.

6. All the laddoo came out, but Ganesha again stuffed them into his stomach.
7. He caught the snake and tied it around his belly.
8. Moon witnessed the whole event and laughed heartily.
9. Lord Ganesha lost his temper and furiously looked about for something to throw at his tormentor.
10. Getting nothing, he pulled out one of his tusks and hurled it at the moon.
11. He cursed the moon that no one should look at the moon on the day of Ganesh Puja.
12. If anyone would look at it, he will get a bad name, criticism, or ill reputation.
13. If anyone gets to see the moon by chance he would be free from that bad name or blame after hearing the story of Lord Krishna's clearing his personality in respect of syamantaka jewel.

B. B. Story in Hindi (Standard transliteration, sentences were presented in Devanagari script.)

1. Bhagwan Ganesh ko laddoo bahut pasand hai.
2. Ek baar Ganesh Puja ke din Ganesh ghar ghar gaye, tatha jo laddoo diye gaye veh swikar kiye.
3. Vah baDi mushkil se raat me apne vahan chuhhe par sawar hokar nikle.
4. Chandni raat me unhe ek baDa saanp dikha jise dekh kar vah bhaybhit ho gaye aur Dagmagane ke karan Ganapati niche gir paDe.
5. Vah jese hi sakht zamin par gira, vese hi uska peT faT gaya.
6. Girte sabhi laddoo bahar gir gaye lekin Ganesh ne unhe dubara apne peT me Daal diya.
7. Usne saanp ko pakaD kar apne kamar me bandh liya.
8. Chaand is pure ghaTna kram ko dekhte hue ji bhar kar hasa.
9. Bhagwan Ganesh gusse me aa kar aag babula hote hue kuch fekne ke liye idhar udhar dekha.
10. Jab kuch nahi mila to usne apna ek daant bahar nikaal kar chaand par vaar kiya.
11. Usne chaand ko shrap diya ki Ganesh Puja ke din koi bhi chaand ko nahi dekhega.
12. Agar koi ise dekhega to vah badnaam hoga aur use burai aur badnaami milegi.

13. Agar koi galti se chaand ko dekh le to vah chaand ko dekhne ke bure prabhav se tabhi mukt hoga jab Sri Krishn ka syamantaka maNi ki kahani paDe

C. C. Story in Telugu (Standard transliteration, sentences were presented in Brahmi script.)

1. Ganesha na ku kuDumulu ante chaala ishtam.
2. OkapuDu Ganesha Puji rojuna GaneshaDu intinti ki velli laddoolu tiskone vaaDu.
3. Atanu poTa ninda tini aa raatri eluka pai shikaruki vellaDu.
4. Aa chandrakaanti lo waLLu roddu pai oka pedda pamunu choosaru, daanto yeluka tatar paDindi, daanto Ganapati paDi poyaDu.
5. Aa nelanu gaTTiga taake sariki atana poTTa paglindi.
6. Laddool anni poTTa nunDi baita paDDayi, kani GaneshaDu anni malli poTTa lo peTTesa kunnaDu.
7. Atanu paamunu paTTukoni tana poTTa chuTTu kaTTu kunnaDu.
8. chandruDu antaa choosi manaspoortiga navveDu.
9. Ganeshani ku yento kopam vachchindi, aa kopam to atani pai wisaraDaniki yedaina doruku tundemo ani choosaDu.
10. Emi dorakaka GaneshDu oka dantanni tisi chandruni meeda ki visiri veesaaDu.
11. Ganesha Puja rojuna yevaru chandruni chuDaraadani atanu shapinchaaDu.
12. Atanni yavaaina chooste gani ataniki cheDDa peru, apaninda, leka apavaadu kalugu tayi.
13. Porpaatuna yevraina chandruni chooste vallu apanindala paalayete KrishnuDu syamantaka maNi pondeTappuDu paaleina apanindalu kada chadivite aa apanindalanunDi vimukti pondutaaru.

References

Annamalai, E. Nation-building in a globalised world: Language choice and education in India. In: Lin, Angel; Martin, PeterW, editors. Decolonisation, globalization: Language-in-education policy and practice. Tonawanda, NY: Multilingual Matters; 2005. p. 20-37.

Arvaniti A. Rhythm, timing and the timing of rhythm. Phonetica. 2009; 66(1-2):46–63. [PubMed: 19390230]

Balasubramanian T. The vowels of Tamil and English: A study in contrast. CIEFL Bulletin (Hyderabad). 1972; 9:27–34.

Bansal RK. A phonetic analysis of English spoken by a group of well-educated speakers from Uttar-Pradesh. CIEFL Bulletin (Hyderabad). 1970; 8:1–11.

Bansal, RK. The intelligibility of Indian English. Hyderabad: CIEFL; 1976. monograph 4

Boersma, P.; Weenink, D. Praat: doing phonetics by computer (Version 5.2) [Software]. 2011. Available from http://www.fon.hum.uva.nl/praat/

Chaswal, KK. A comparative study of the intonation of English and Hindi. CIEFL; Hyderabad, India: 1973. research diploma thesis

CIEFL. The sound system of Indian English Monograph 7. Hyderabad: CIEFL; 1972.

Crystal, D. Documenting rhythmical change. In: Lewis, JackW, editor. Studies in general and English phonetics: Essays in honour of Professor JD O'Connor. New York: Routledge; 1995.

Dauer RM. Stress-timing and syllable-timing reanalysed. Journal of Phonetics. 1983; 11:51–69.

Dellwo, V. Influences of speech rate on the acoustic correlates of speech rhythm: An experimental phonetic study based on acoustic and perceptual evidence. Universität Bonn, Bonn University; Bonn, Germany: 2010. Ph.D. dissertation. Electronic publication: ⟨http://hss.ulb.uni-bonn.de:90/2010/2003/2003.htm⟩

Deterding D. The measurement of rhythm: A comparison of Singapore and British English. Journal of Phonetics. 2001; 29:217–230.

Dhamija, PV. A phonological analysis of Rajasthani English. CIEFL; Hyderabad, India: 1976. M.Phil. thesis

Erker D. Of categories and continua: Relating discrete and gradient properties of sociophonetic variation. University of Pennsylvania Working Papers in Linguistics. 2012; 18(2):11–20.

Erik, RT.; Kendall, T. NORM: The vowel normalization and plotting suite. 2007. online resource: ⟨http://ncslaap.lib.ncsu.edu/tools/norm/⟩

Flege JE, Fletcher KL. Talker and listener effects on the perception of degree of foreign accent. Journal of the Acoustical Society of America. 1992; 91:370–389. [PubMed: 1737886]

Gargesh, R. Indian English: Phonology. In: Schneider, EW.; Burridge, K.; Kortmann, B.; Mesthrie, R., editors. A handbook of varieties of English. Berlin: Mouton de Gruyter; 2004. p. 992-1002.

Grabe, E.; Low, EL. Durational variability in speech and the rhythm class hypothesis. In: Gussenhoven, Carlos; Warner, Natasha, editors. Laboratory phonology. Vol. 7. Berlin: Mouton de Gruyter; 2002. p. 515-546.

Huss V. English word stress in postnuclear position. Phonetica. 1978; 35:86–105. [PubMed: 643941]

Krishnamurti, B. Telugu verbal bases. Motilal Banarsidass Publication; New Delhi, India; 1972.

Ladefoged P, Bhaskararao P. Non-quantal aspects of consonant production: A study of retroflex consonants. Journal of Phonetics. 1983; 11:291–302.

Long MH. Maturational constraints on language development. Studies in Second Language Acquisition. 1990; 12:251–285.

Maddieson, I. Patterns of sounds. New York: Cambridge University Press; 1984.

Maxwell O, Fletcher J. Acoustic and durational properties of Indian English vowels. World Englishes. 2009; 28:52–70.

Maxwell O, Fletcher J. The acoustic characteristics of diphthongs in Indian English. World Englishes. 2010; 29:27–44.

Mohanty, AK. Multilingualism of the unequals and predicaments of education in India: Mother tongue or other tongue?. In: Garcia, Ofelia; Skutnabb-Kangas, Tove; Torres-Guzman, MariaE, editors. Imagining multilingual schools. Clevedon: Multilingual Matters; 2006. p. 262-283.

Murty L, Otake T, Cutler A. Perceptual tests of rhythmic similarity: I. Mora rhythm. Language and Speech. 2007; 50(1):77–99. [PubMed: 17518104]

Nooteboom S. The prosody of speech: melody and rhythm. The handbook of phonetic sciences. 1997; 5:640–673.

Ohala M. Hindi. Journal of the International Phonetic Association. 1994; 24:35–38.

Pickering L, Wiltshire C. Pitch accent in Indian-English teaching discourse. World Englishes. 2000; 19:173–183.

Pingali, S. Indian English Edinburgh. University Press; 2009.

Ramus F, Nespor M, Mehler J. Correlates of linguistic rhythm in the speech signal. Cognition. 1999; 73:265–292. [PubMed: 10585517]

Senghas A, Sotaro K, Ozyurek A. Children creating core properties of language: Evidence from an emerging sign language in Nicaragua. Science. 2004; 305:1779–1782. [PubMed: 15375269]

Senghas, RJ.; Senghas, A.; Pyers, JE. The emergence of Nicaraguan sign language: Questions of development, acquisition, and evolution. In: Parker, SueT; Langer, Jonas; Milbrath, Constance, editors. Biology and knowledge revisisted: From Neurogenesis to psychogenesis. Mahwah, NJ: Erlbaum; 2005. p. 287-306.

Srinivas, Ch. Word stress in Telugu and English: A study in contrast. CIEFL; Hyderabad, India: 1992. M.Phil. thesis

Thundy Z. The origins of Indian English. CIEFL Bulletin (Hyderabad). 1976; 12:29–40.

Vijayakrishnan, KG. Stress in Tamilian English: A study within the framework of generative phonology. CIEFL; Hyderabad, India: 1978. M.Phil. thesis

Wells, JC. Accents of English. Cambridge: Cambridge University Press; 1982.

Wiltshire C, Moon R. Phonetic stress in Indian English vs. American English. World Englishes. 2003; 22:291–303.

Wiltshire CR. The ‘Indian English’ of Tibeto-Burman language speakers. English World-Wide. 2005; 26:275–300.

Wiltshire CR, Harnsberger JD. The influence of Gujarati and Tamil L1s on Indian English: A preliminary study. World Englishes. 2006; 25:91–104.

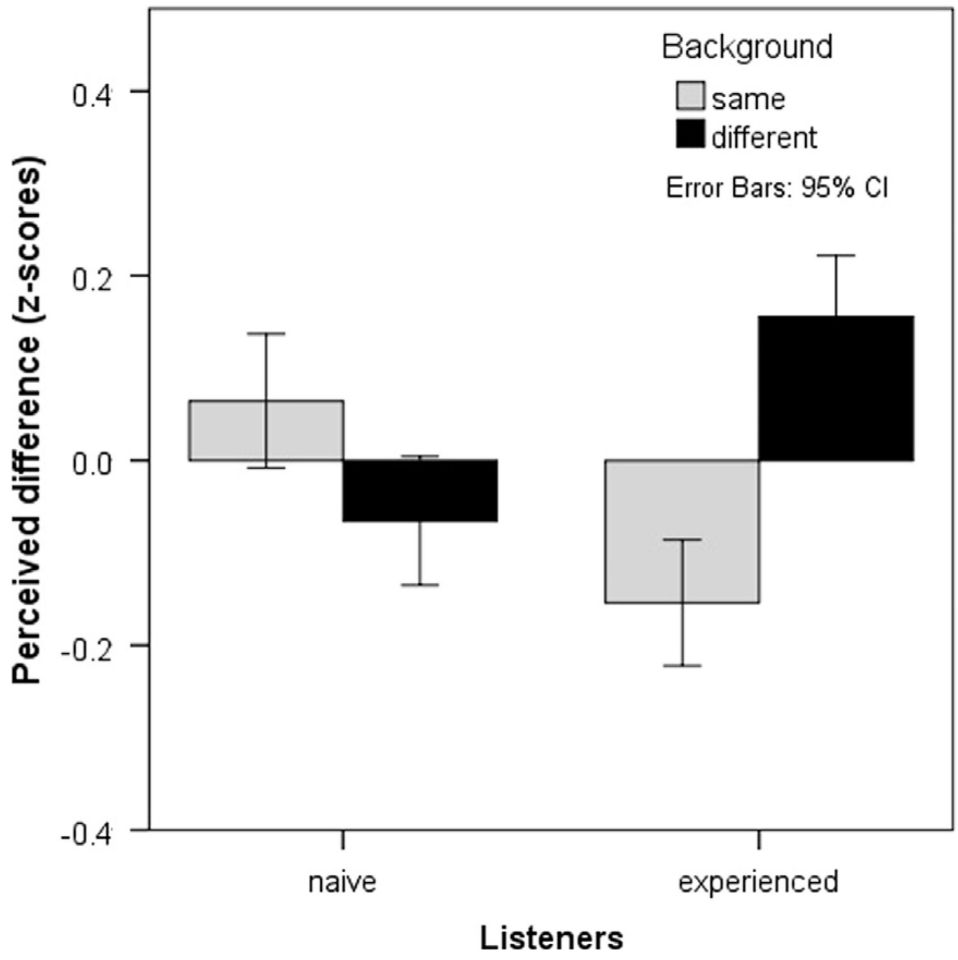

Fig. 1.

Listener difference ratings of IE sentence pairs are shown as a function of the speakers' language background (same vs. different) and listeners' experience (naïve=native American-English speaking, experienced=native Hindi or Telugu speaking).

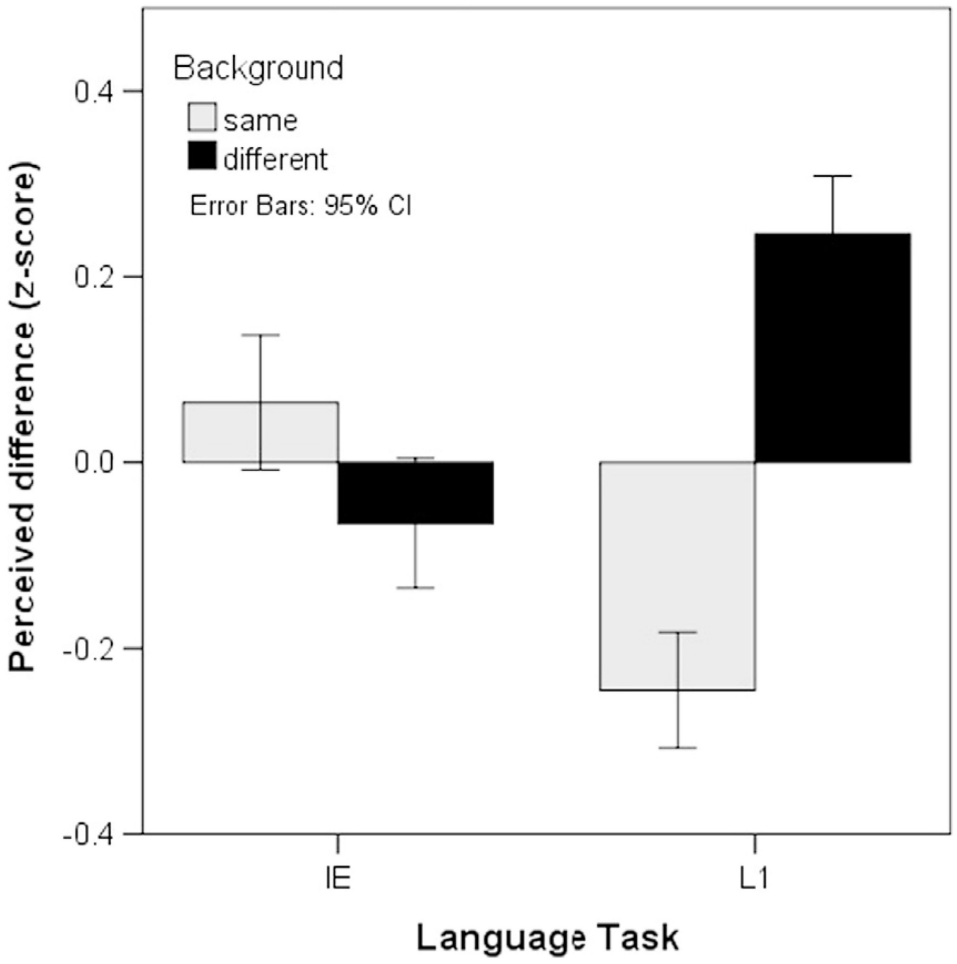

Fig. 2.

Naïve listener difference ratings on IE and L1 sentence pairs are shown as a function of the speakers' language background (same vs. different).

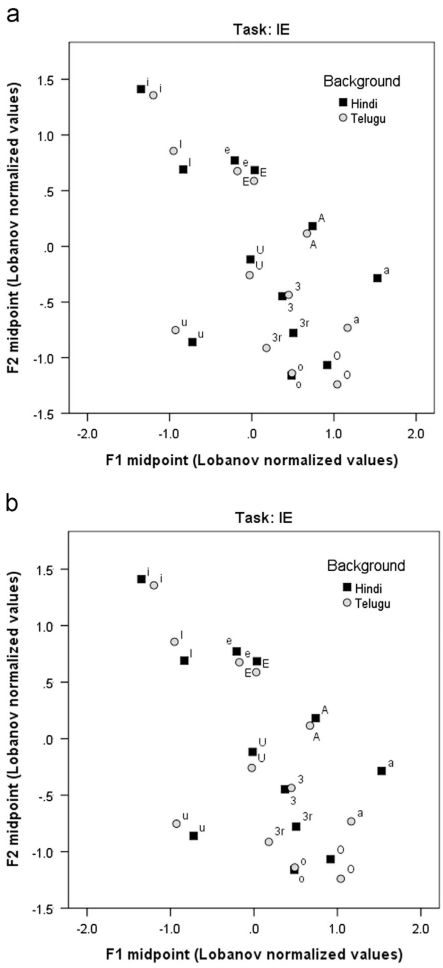

Fig. 3.

The monophthongal vowel space is shown for IE (top) and L1 (bottom) as a function of speaker's language background. Vowel measures were taken at the *F*1 and *F*2 midpoint and normalized using the Lobanov method (*note:* i = /i/ or /iː/, I = /ɪ/ or /i/, e=/e/ or /eː/, E = /ɛ/ or /e/, A = /æ/, a= /ɑ/ or /ɑː/, 3 = /ə/, 3r = /ɚ/, o = /o/ or /oː/, O = /ɔ/ or /o/, u=/ʊ/ or /u/, u = /u/ or /uː/).

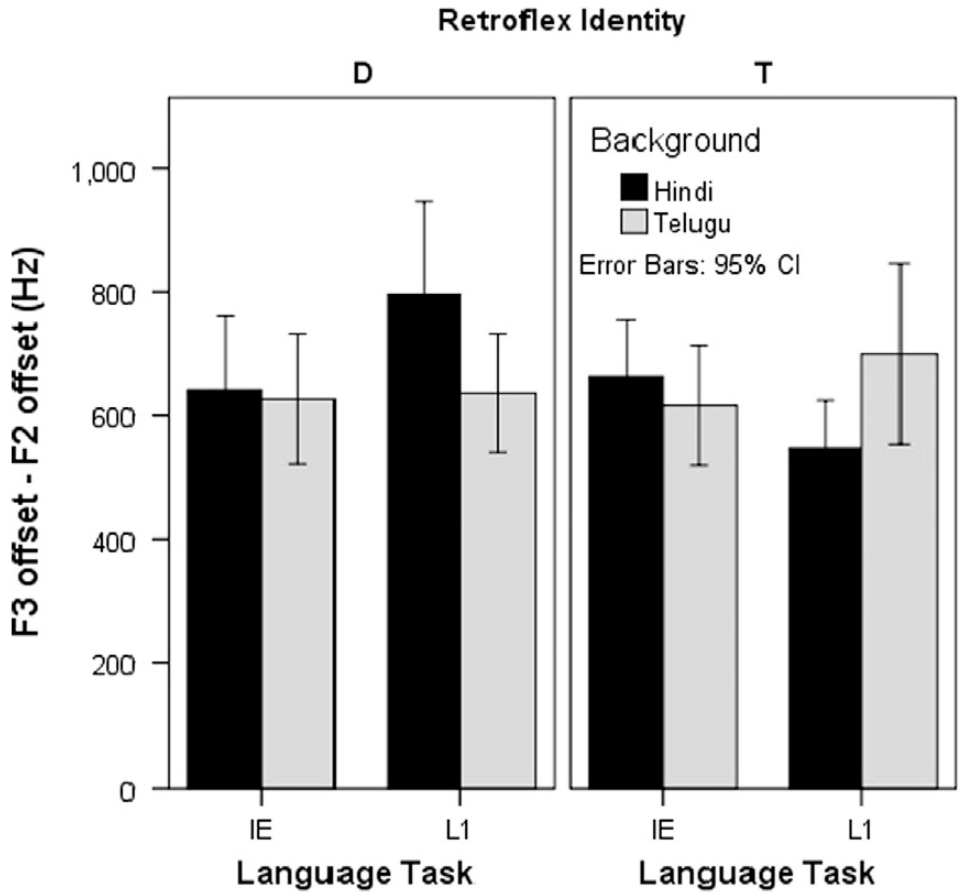

Fig. 4.

Degree of retroflexion of post-vocalic stops is shown for IE and L1 as a function of the speakers' native language background. Retroflexion was measured as the difference between the *F2* and *F*3 offset values in the preceding vowel (*note*: T = /ʈ/, D = /ɖ/).

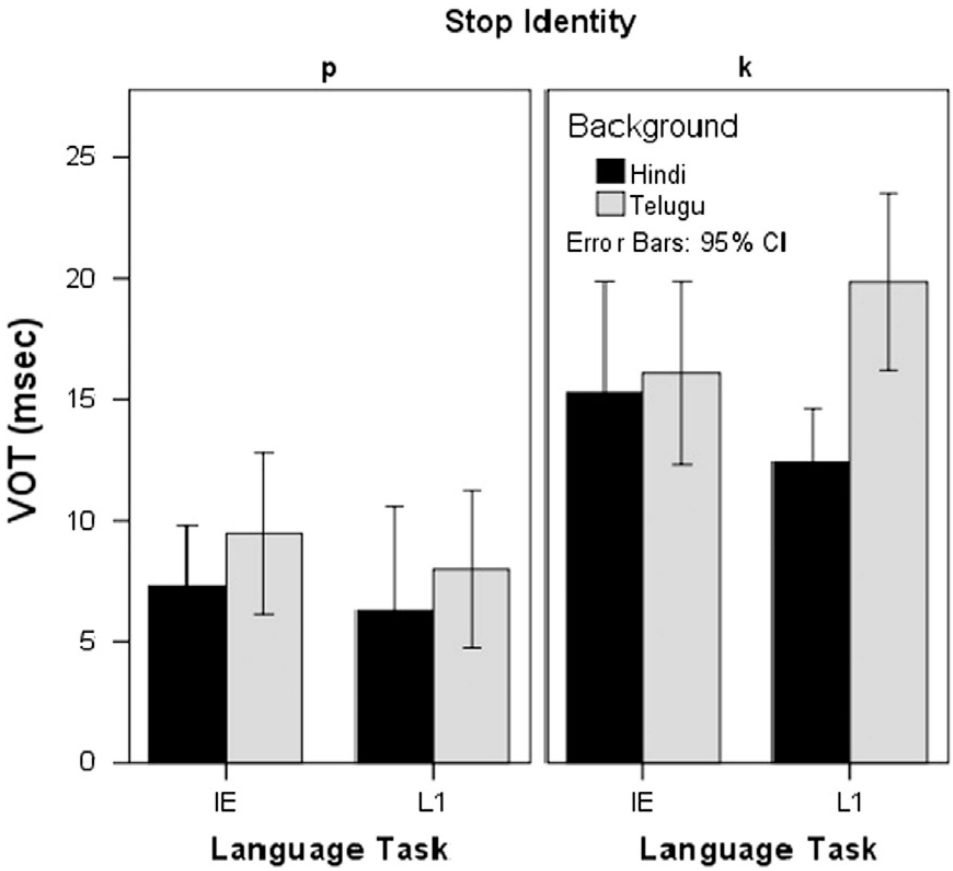

Fig. 5.

Syllable-initial, voiceless bilabial and velar stop voice onset times (VOT) are shown for IE and L1 as a function of the speakers' native language background.

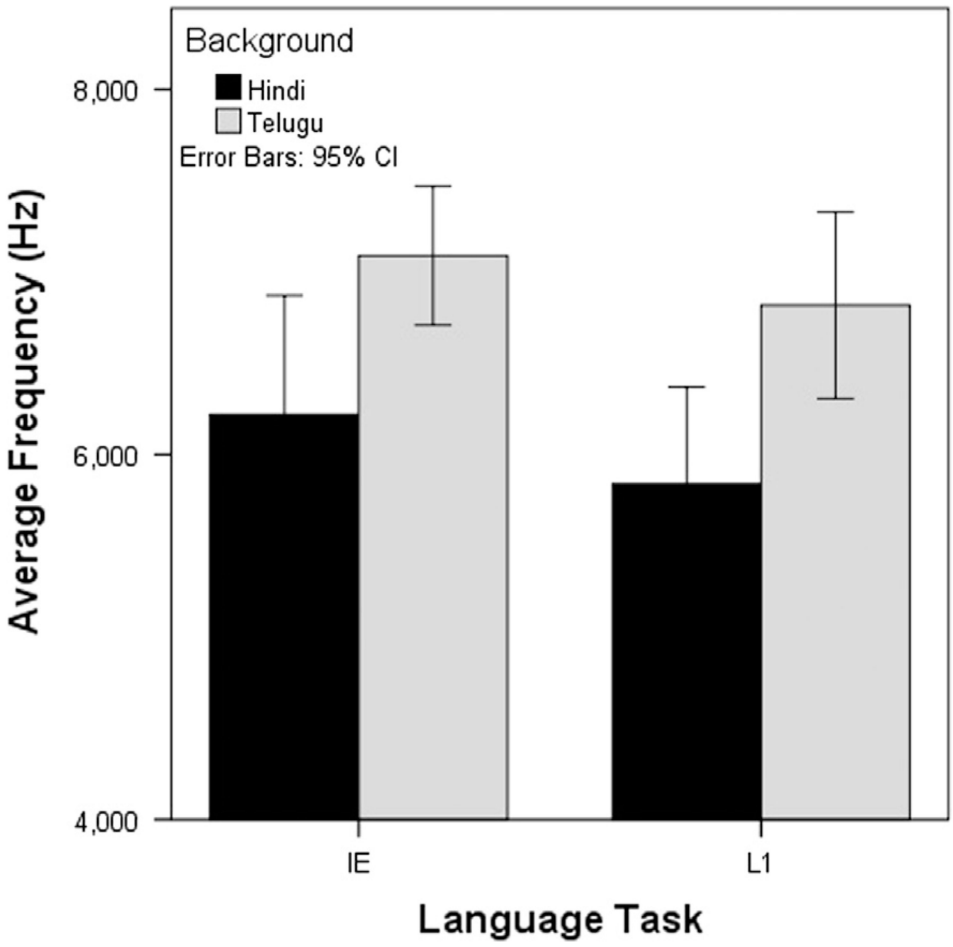

Fig. 6.

The average frequency of syllable-initial /s/ is shown for IE and L1 as a function of the speakers' native languages (L1).

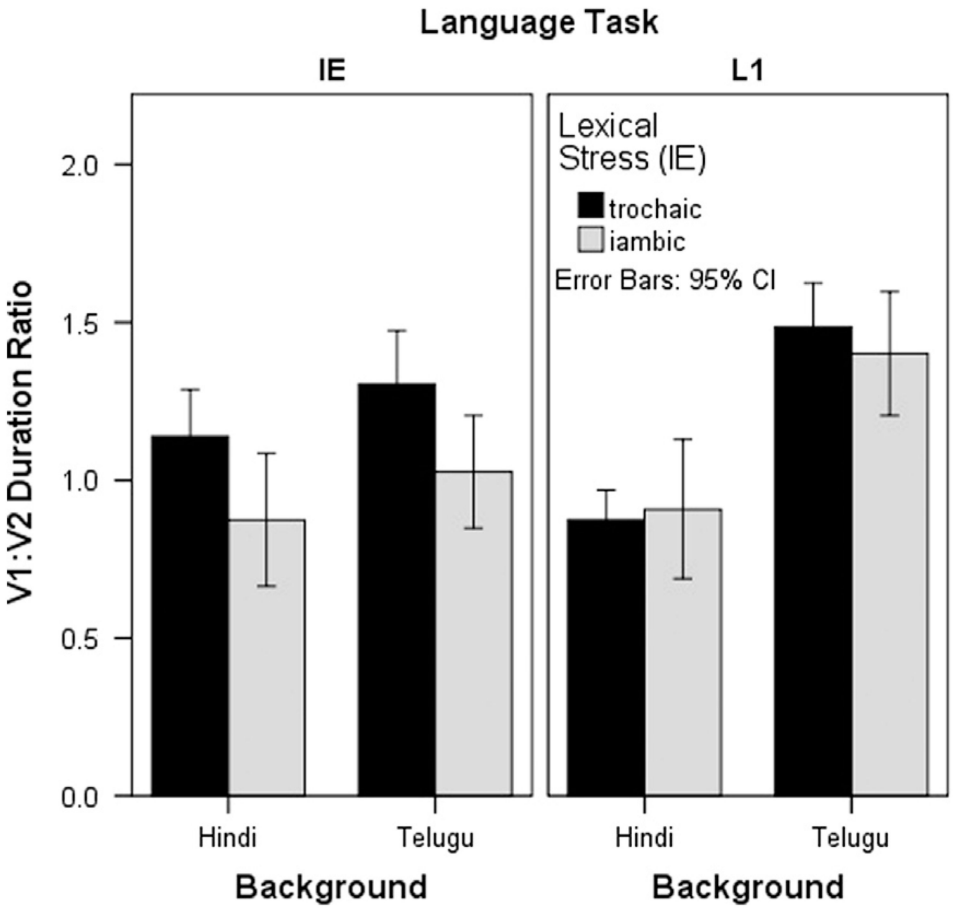

Fig. 7.

IE and native language (L1) lexical stress in disyllabic words, measured as the ratio of the duration of the first vowel to the duration of the second, is shown as a function of speakers' native language (Hindi and Telugu).

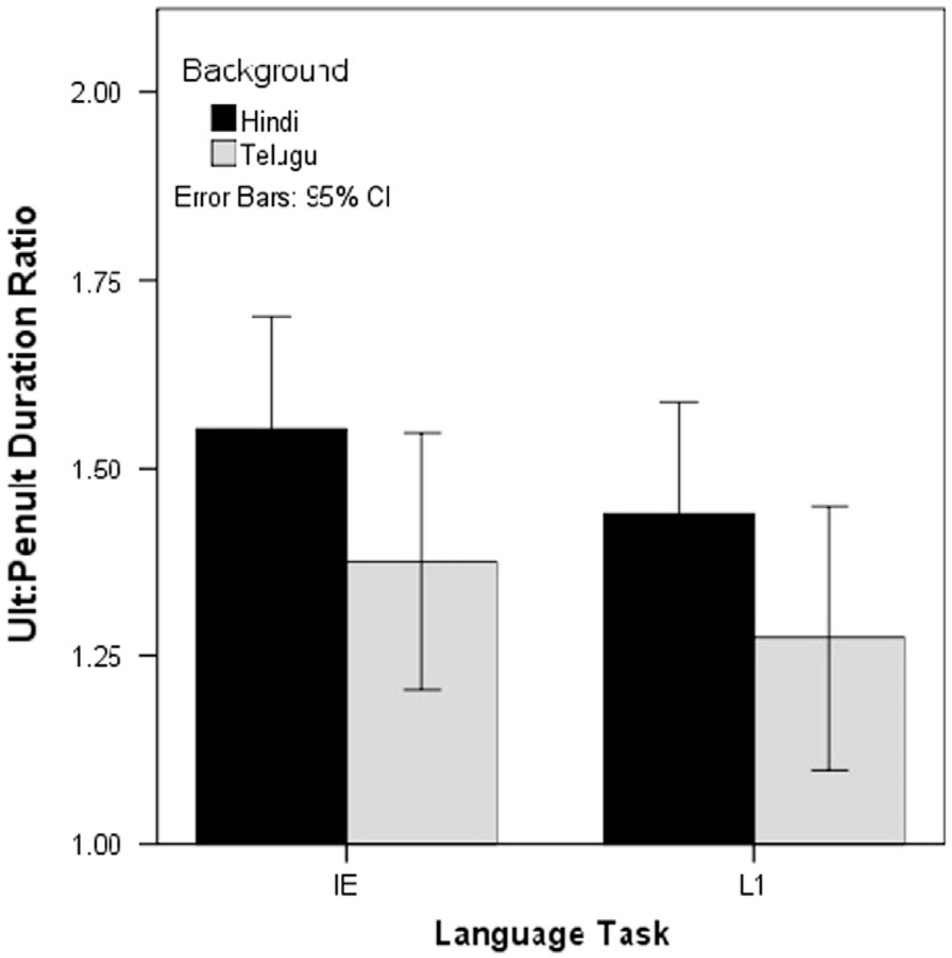

Fig. 8.

Phrase-final lengthening, measured as the ratio of the ultimate vowel duration to the penultimate vowel duration, is shown for IE and the speakers' native languages (L1).

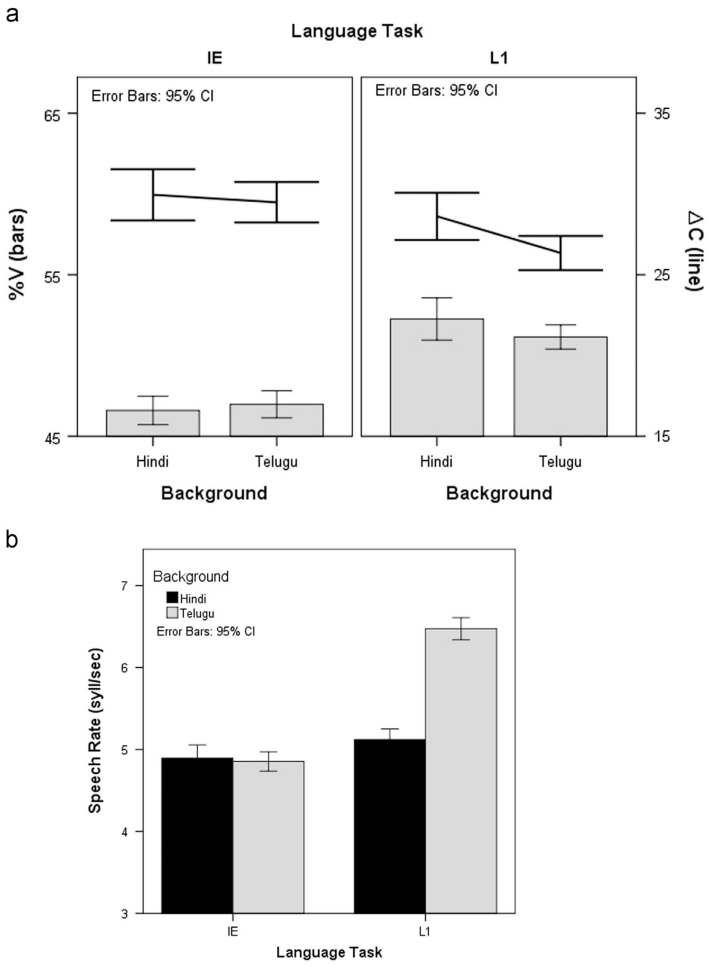

Fig. 9.

Several global measures of language rhythm are shown for IE and L1 as a function of the speakers' native language background. The top panel shows the results for the average percent of vowel duration (bars) and the standard deviation in consonant duration (line) across each phrase. The bottom panel shows the results for speaking rate, also calculated separately for each phrase.

Table 1

List of words with retroflex stops /ʈ, ɖ /, voiceless stops /p, k/ and fricative /s/ in English, Hindi and Telugu.

Obstruent	English	Hindi (=gloss)	Telugu (=gloss)
/ʈ/	/hɪʈ/ “hit”	/peʈ/ (stomach)	/tʃuʈʈu/ (around)
	/kɔʈ/ “caught”	/fəʈ/ (rip off)	/kəʈʈu/ (tie)
	/gɔʈ/ “got”	/ghəʈna/ (event)	/pəʈʈa/ (stomach)
/ɖ/	/lɔrd/ “lord”	/pɑkəɖ/ (hold)	/tʃeɖɖa/ (bad)
	/lɑɖɖu/ “laddoo”	/lɑddu/ (Indian sweet)	/lɑddu/ (Indian sweet)
	/roɖ/ “road”	/bɑɖɑ/ (big)	/roɖɖu/ (road)
/p/	/pɚsnalɪti/ “personality”	/pəsand/ (like)	/pəɖɪndi/ (fell)
	/pʊld/ “pulled”	/puja/ (worship)	/puji/ (worship)
	/əpon/ “upon”	/pure/ (whole)	/apuɽu/ (that time)
/k/	/kəpɛsɪti/ “capacity”	/kaha:ni/ (story)	/kada/ (story)
	/kɔt/ “caught”	/ka:ran/ (reason)	/kaʈʈu/ (tie)
	/kɚsd/ “cursed”	/kar/ (do)	/kalʊgʊ/ (happen)
/s/	/somθɪŋ/ “something”	/sa:np/ (snake)	/sarɪkɪ/ (as a result)
	/tasks/ “tusks”	/uska/ (his)	/tʃuste/ (if sees)
	/si/ “see”	/vese/ (as a result)	/tisi/ (pull out)

Table 2

Disyllabic words selected from English, Hindi, and Telugu texts for analyzing lexical stress.

Language	Trochaic pattern	Iambic pattern
English	*after, nothing, something, stomach, story, temper, very, witnessed*	*event, himself, respect, result*
Hindi	*dekha, galti, gusse, jese, mani, niche, puja, pure*	*ise, laddu, lekin, pakad*
Telugu	*meda, mani, oka, pedda, peru, poṭṭa, puji, velli*	*kopam, laddu, tatar*