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Research Article

Breathy voice during nasality: A cross-linguistic study

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ABSTRACT

In some languages, there is a diachronic correspondence between nasal and breathy sounds, whose origin is often attributed to the acoustic similarities between nasal and breathy vowels. In this study, we test whether nasal consonants and vowels are also produced with breathier voice quality than their oral counterparts in three Yi (Loloish) languages: Bo, Luchun Hani, and Southern Yi. We analyzed oral vs. nasal vowels and consonants using electroglottographic and acoustic measures of phonation. Results indicate that nasal consonants are often breathier than laterals, as are vowels following nasals when compared to vowels following oral consonants. These findings support the assumption that at least some of these nasal-breathy sound changes involve a stage in which the two articulations co-occur. We claim that the production of breathy voice quality during nasals can arise through listener misperception or phonetic enhancement. These findings also contribute to the understanding of nasality as an abstract feature that involves multiple articulations.

1. Introduction

There are several documented cases of sound change involving interactions between nasal and breathy sounds. In one direction, nasalization can be derived diachronically from breathy sounds – notably [h] and other voiceless fricatives (Blevins & Garrett, 1993; Colarusso, 1988, pp. 44–45). For instance, Hindi [sãp] 'snake,' which has a nasal vowel following the voiceless fricative, comes from Sanskrit [sarpa], which has an oral vowel (Ohala & Busà, 1995). Similarly in Nyole, [ŋ] is thought to derive from *p via *h (Schadeberg, 1989). In the other direction, breathy sounds can be derived from nasal ones (Blevins, 2004, Section 6.1.1; Blevins & Garrett, 1993; Ladefoged et al., 1976). For example, intervocalic *n → [h] in some varieties of Basque (Igartua, 2011). These processes are sometimes referred to as 'spontaneous/aspirate nasalization' and 'nasal aspiration', respectively. Together, the bidirectional relationship between nasal and glottal sounds is often called 'rhinoglottophilia' (Blevins & Garrett, 1993; Matisoff, 1975; Rogers, 2011). Researchers generally attribute such changes to perceptual misparsing due to the acoustic similarity between nasality and breathiness. However, there could also be an articulatory basis for such changes. In this paper, we investigate this possibility by focusing on whether nasal sounds are produced with breathy voice quality.

There is strong support from patterns of sound change that listener misperception could be at least partly responsible for interactions between nasal and breathy sounds (Blevins & Garrett, 1993; Matisoff, 1975; Ohala, 1975, 1981; Ohala & Busà, 1995). For example, Ohala and Busà (1995) hypothesize that present-day English 'goose' derives from 'gans-' because listeners misattributed the acoustic characteristics of vowel nasality as belonging to the [s] rather than the [n]. The reasons for this are (1) that a glottal spreading gesture is often part of the phonetic implementation of voiceless fricatives (Löfqvist & McGarr, 1987), which may contribute to the percept of breathiness, and (2) that nasal vowels share some common acoustic correlates with breathy vowels (relative to modal ones). Nasal vowels are differentiated from oral ones by a wide variety of acoustic measures (Beddor, 1993; Carignan, 2014; Carignan, Shosted, Fu, Liang, & Sutton, 2015; Delattre & Monnot, 1968; Delvaux, Demolin, Harmegnies, & Soquet, 2008; Pruthi & Espy-Wilson, 2007; Shosted, Carignan, & Rong, 2012; Styler, 2015). Crucially, these include a weaker first formant relative to the nasal pole (usually the first or second harmonic), which is caused by velopharyngeal coupling (Chen, 1997; Maeda, 1993; Stevens, 2000; Simpson, 2012; Zellou & Tamminga, 2014).

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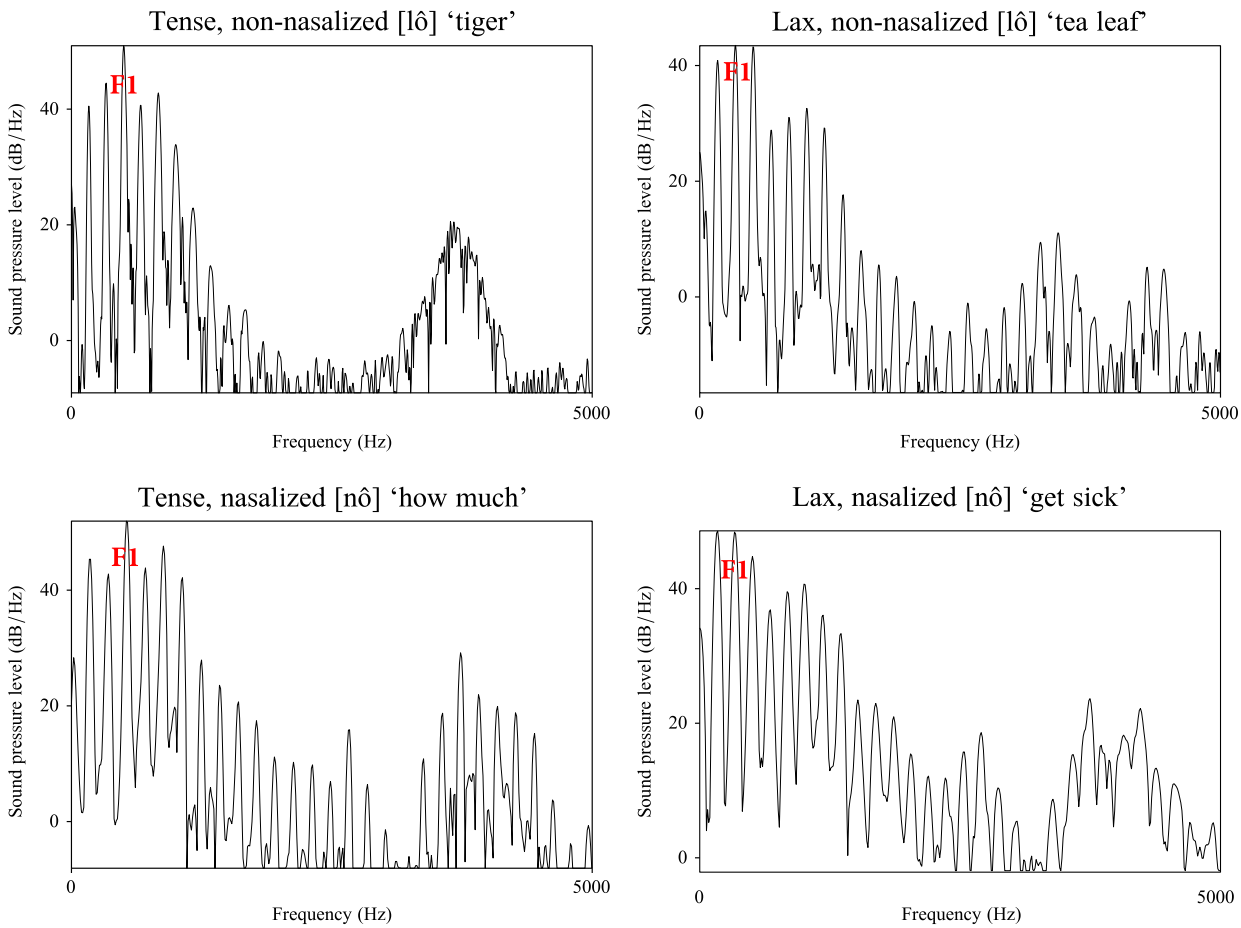

Fig. 1. Sample audio spectra of vowels from a female speaker of Southern Yi. The harmonic most affected by the first formant is indicated by the 'F1' label. Lax vowels have a weaker F1 relative to the first harmonic than tense vowels. Within a given phonation type, nasalized vowels also have weaker F1 than non-nasalized vowels.

Breathy voice is likewise distinguished from modal voice by a weaker first formant and louder first harmonic. Unlike for nasality, the increased spectral tilt for breathy vowels (relative to non-breathy ones) is not caused by coupling of different vocal tract cavities, but instead by the larger open quotient of vocal fold vibrations – that is, a larger proportion of the vibratory cycle during which the glottis is open – as well as by the presence of a posterior glottal gap (Bickley, 1982; Garellek, 2014; Garellek & Keating, 2011; Gordon & Ladefoged, 2001; Hanson, Stevens, Kuo, Chen, & Slifka, 2001; Klatt & Klatt, 1990; Kreiman et al., 2012; Zhang, 2016). Thus, nasal and breathy vowels are acoustically similar, despite the fact that these similarities arise from different articulations. The spectral similarities are illustrated in Fig. 1 using sample audio spectra from Southern Yi, one of the languages investigated in this study. Southern Yi has nasalized vowels that are either tense – more constricted – or lax – more breathy. In these examples, the amplitude of the harmonic closest to F1 (either the second or third harmonic) is lower relative to that of the first harmonic in both nasalized vowels relative to oral ones (regardless of phonation type) and in lax vowels relative to tense ones (regardless of whether the vowel is also nasalized).

1.1. Phonetic enhancement

Listener misperception by itself can account for changes that involved the addition of a novel gesture (as in the change from Sanskrit [sarpa] to Hindi [sãp] 'snake', Ohala & Busà, 1995): the initial vowel in Sanskrit was likely breathy from the glottal spreading during the [s], and listeners misattributed the acoustic characteristics of breathiness as resulting from a nasalized vowel; these listeners would subsequently produce the word with a lowered velum, as well as with breathiness from the preceding [s].

On the other hand, changes that involve the *replacement* of one articulatory gesture for another likely require an additional intermediate stage. Take, for instance, the change in some varieties of Basque, in which intervocalic *n → [h] (Igartua, 2011). In this case, it is highly unlikely that listeners misperceived [n] as [h], because the two segments differ along many acoustic dimensions: compared with intervocalic [h], intervocalic [n] is voiced and has both coronal and nasal cues leading into and out of the consonant. Therefore, under a listener-misperception account, such a change should require an intermediate stage in which the nasal is also breathy, before nasality is lost: *n → *n̤ (listeners misperceive nasals as being breathy nasals) → [h] (listeners misperceive breathy nasals as breathy but non-nasal). The last stage could also be due to gestural reduction, which is a common process in sound change (Garrett & Johnson, 2013).