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An Acoustic and Theoretical Analysis of the Nasal Vowels of Mẽbêngôkre and Panará

This presentation intends to explore the vowel systems of Mẽbêngôkre and Panará, two very divergent languages from the Northern branch of the Jê family, with a particular focus on an analysis of their nasal vowel systems and an extension towards a broader theoretical analysis of nasal vowel systems. The author will present original data collected over the spring of 2015 during fieldwork in the villages of Djudjêkô (Mẽbêngôkre) and Nãsepotiti (Panará), both situated in the state of Pará, in the Amazon region of Brazil.

Mẽbêngôkre has ten oral vowels and seven nasal vowels, for a total of 17 contrastive vowel qualities (Salanova, 2001). Panará has 15 different vowel qualities, of which nine are oral and six are nasal vowels (Dourado, 2001). In addition, recent fieldwork data suggests that Panará contrasts long and short vowels for all of these vowel qualities, which results in a total of 30 vowel phonemes, placing it among the largest inventories reported. Although these languages' strikingly large vowel inventories make them particularly interesting to examine in order to better shape our linguistic knowledge of vowel systems, the phonetics and phonology of both Mẽbêngôkre and Panará are highly understudied, and, to date, no phonetic study has yielded data on either of them.

Acoustic data was collected from a total of 24 participants (all male), of which 12 are native speakers of Mẽbêngôkre and 12 are native speakers of Panará. A carrier sentence was selected in each language, as well as a target word for each vowel quality. Participants were instructed to produce the carrier sentences, which were presented on a computer screen alongside a picture depicting the target word. Each target word was presented ten times and the presentation order of the stimuli was semi-randomized.

A preliminary analysis of the acoustic data reveals that, in both languages, the nasal vowels are centralized when compared to the oral vowels, which results in a general contraction of the acoustic space for nasal vowels. This contraction, which is most prominent in the F1 dimension, manifests itself quite differently in the two sets of data. While the data from Mẽbêngôkre suggests that high and mid-high nasal vowels are lowered (F1 is raised), the data from Panará suggests that the low nasal vowel is raised (F1 is lowered).

This contraction of the nasal vowel space has been observed in a number of other languages, such as European and Canadian French (Carignan, 2014; Martin et al., 2001), European and Brazilian Portuguese (Dos Santos, 2013), Karitiana, (Demolin & Storto, 2002) and Paicĩ, (Gordon & Maddieson, 2004), among many others. Thus, this contraction is not arbitrary, and previous research (Beddor et al., 1986; Beddor, 1993; Maeda, 1993) suggests that it is motivated by a cross-linguistic perceptual constraint (explained below).

Unlike the oral cavity, which can be modified in a great number of ways by the articulators, the nasal cavity cannot be modified. For this reason, the nasal formants that result from the coupling of the oral and nasal cavities are stable for every individual. The anatomical configuration of the nasal cavity varies greatly among individuals, but the value of the first nasal formant (N1, which is most relevant here) is generally found around 400 Hz to 500 Hz. N1, then, is of a higher frequency than the F1 of high vowels and of a lower frequency than the F1 of low vowels. When N1 is in the vicinity of F1, they become perceptually merged, and F1 appears to have a wider bandwidth. The center of gravity of this area of high amplitude in the vowel spectrum is shifted toward N1. Experimental evidence suggests that this seemingly cross-linguistic acoustic-perceptual constraint on nasal vowels can be the trigger of sound change (Beddor et al., 1986). Specifically, this interaction of acoustics and perception causes high vowels to raise F1 and low vowels to lower F1. This results in a general contraction of the acoustic vowel space that is most prominent in the F1 dimension, just as in the case of Mẽbêngôkre and Panará's nasal vowel inventories.

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While this centralization of nasal vowels within the acoustic space is well-known and has been attested in a large number of languages, current theories of vowel systems fail to predict the organization of nasal vowel systems. Major theories of vowel systems predict, among other things, a dispersion of vowels within the acoustic space. However, the proponents of these theories recognize that nasal vowels behave differently. For instance, the proponents of the Dispersion-Focalization Theory of Vowel Systems recognize that "the nasal feature […] leads to significant changes in the formant space and is likely to be processed on another dimension than the oral one" (Schwartz et al., 1997b), but they do not make separate predictions for the organization of nasal vowel systems (Schwartz et al., 1997a).

I suggest that the acoustic space of phonologically nasal vowels is inherently reduced in the F1 dimension. This being so, one can maintain that maximal dispersion applies normally in nasal vowels, albeit in a reduced space. This prediction is consistent with data from natural languages, in which we observe a larger number of contrasts among the F2 dimension than the F1 dimension for nasal vowels.

Furthermore, the reduced size of nasal vowel inventories as compared to oral vowel inventories appears to be a natural consequence of contracted nasal vowel acoustic space. Indeed, Kingston (2007) reports that half of the languages observed in the UPSID database had the same number of nasal and oral vowels, while the other half had fewer nasal vowels. Specifically, no language had more nasal vowels than oral vowels.

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