Three degrees of vowel nasality in Kawaiwete (Tupi-Guarani)

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This talk presents novel data from Kawaiwete (Tupi-Guarani, Brazil, ISO: kyz) supporting a distinction between three degrees of vowel nasality: Kawaiwete vowels can be categorized as fully nasal, partially nasal, or fully oral. These different vowel categories arise from a phonemic contrast in vowel nasality /V, Ṽ/ (1-2), and a phonological process whereby oral vowels are partially nasalized next to nasal consonants (/V/→[V̰]/{N_,_N}, where [V̰] represents a partially nasal vowel) (3). We provide airflow data showing that the three vowel types exhibit significantly different degrees of nasalization.

(1) a. [pɨrapep] 'stingray'
b. [avasi] 'corn'
c. [kuɾuɾu] 'frog'

(2) a. [tukum**ã**] 'type of palm'
b. [aɾus**ĩ**] 'rice'
c. [avam**ũ**] 'now'

(3) a. [faɨɾ**ṵ**m] 'ring'
b. [kaʔaɾ**a̰**n] 'leaf, book'
c. [**a̰**n**ḭ**ra] 'bat'

Previous literature has claimed, but not demonstrated, that some languages exhibit three distinct degrees of vowel nasality (e.g. Palantla Chinantec [2]). Instrumental evidence suggests that these differences in vowel nasality lie in the *time point* at which velum lowering is initiated during the production of the vowel, and not in the *amount* of nasal airflow [1]. Kawaiwete provides the first documented case of vowels that differ in *amount* of nasal flow.

We present airflow data collected from 5 Kawaiwete speakers (n male=3) using an EGG-D800. Participants produced trisyllabic words falling into one of four categories: (i) words containing only oral vowels and consonants; (ii) words containing only oral vowels and one or more nasal consonants; (iii) words containing one phonemically nasal vowel and only oral consonants; and (iv) words containing one phonemically nasal vowel and one or more nasal consonants. The 24 target words were presented verbally, in isolation, and participants produced four repetitions of each word in semi-randomized blocks.

We parsed all vowels in the trisyllabic target words and divided each vowel into three time windows, each equivalent to a third of the vowel's duration. We normalized oral and nasal airflow values from 0 to 1 for each speaker, and we calculated the percentage nasal airflow for each or the three time windows in each vowel using the formula in (4). We calculated a slope between the percentage nasal airflow value for the first third and the last third of each vowel type, and then calculated the area under the curve (AuC) for percentage nasal airflow for each vowel type. Figure 1 summarizes the pooled experimental results, showing the realization of Kawaiwete vowels in various phonotactic environments.

(4) $\%nasal\ airflow = \frac{nasal\ airflow}{nasal\ airflow + oral\ airflow}$

Figure 1 summarizes our findings. Oral vowels between two oral consonants are realized as fully oral with a low flat plateau of nasal airflow over the course of their duration (1D, mean AuC=0.07, SD=0.36). Partially nasal vowels are realized with a cline in nasal airflow throughout the vowel's duration: Oral vowels between an oral and a nasal consonant are realized with a cline-like increase (1B, mean AuC=0.41, SD= 0.39), whereas oral vowels between a nasal and an oral consonant are realized with a cline-like decrease (1C, mean AuC=0.57, SD= 0.19). Phonemically nasal vowels are likewise realized with a cline-like increase throughout the vowel's duration (1A, mean AuC=0.64, SD= 0.52). The percentage nasal airflow is significantly greater in phonemically nasal vowels than in partially nasal vowels ($p<.001$) when preceded by an oral consonant, which in turn, have a significantly greater percentage nasal airflow than oral vowels ($p<.001$). Figure 2 shows that this pattern holds when pooling across vowel qualities (left) and when subsetting for the vowel quality /a/ (right). Table 2 presents detailed results of Welch's t-test for pairwise comparisons.

In sum, Kawaiwete provides the first documented case of vowels that differ in *amount* of nasal airflow, which has important consequences for phonological and phonetic typology. We believe that partially nasal vowels are cross-linguistically rare because (i) a partially open velum is not a possible gestural target, and (ii) spectral differences between partially and fully nasal vowels are not salient enough to maintain phonological contrasts.

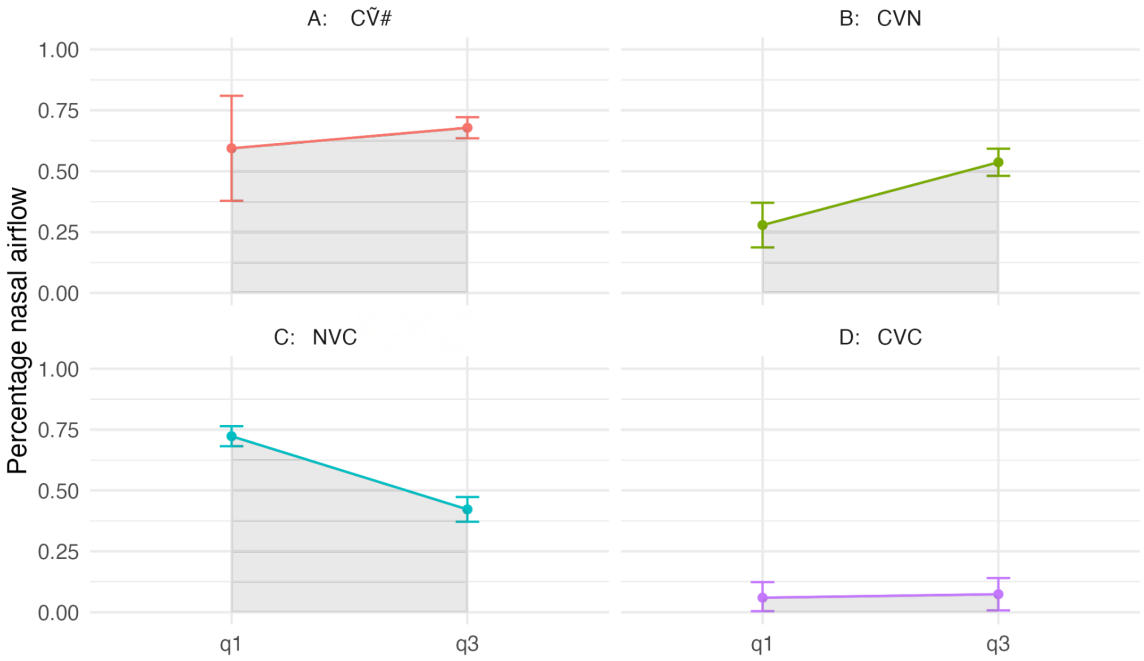

Figure 1. Percentage nasal airflow (with 95% confidence intervals) for vowels in specific phonotactic environments: (A) /CṼ#/; (B) /CVN/; (C) /NVC/; and (D) /CVC/, where q1 represents the first third of vowel duration and q3 represents the last third of vowel duration.

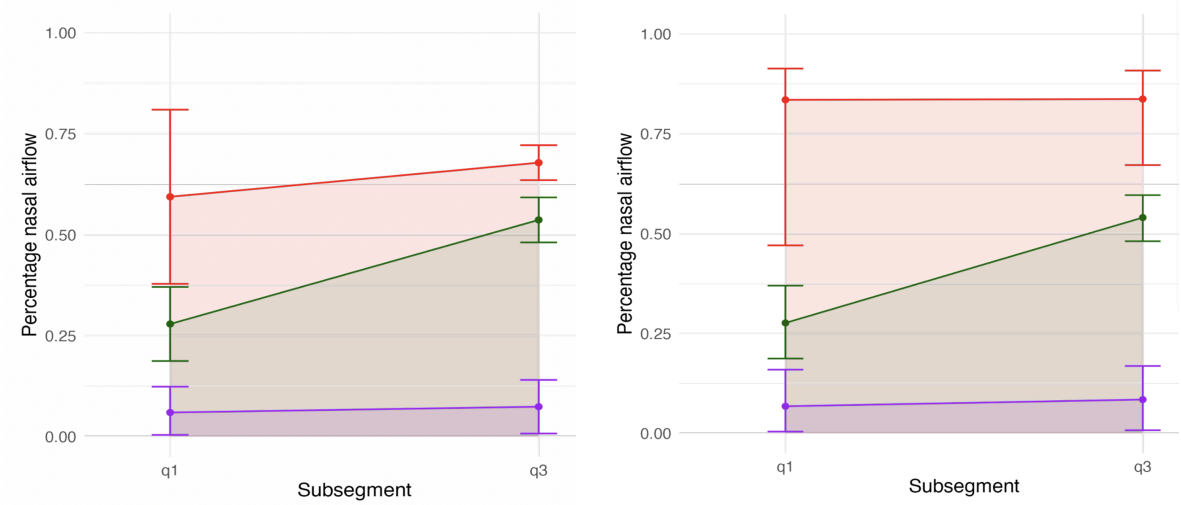

Figure 2. Percentage nasal airflow, pooled for all vowel qualities (left) and subset for the vowel quality /a/ (right), (with 95% confidence intervals) for /CṼ#/ (red), /CVN/ (green), and /CVC/ (purple) environments, where q1 represents the first third of vowel duration and q3 represents the last third of vowel duration.

	Pooled across all vowel qualities				**Subset for the vowel quality /a/**			
Vowel Env. Pair	***t***	***df***	**95% CI**	***p***	***t***	***df***	**95% CI**	***p***
/CṼ#/ vs. /CVC/	9.0668	101.79	0.44 - 0.69	<0.001 ***	9.4433	71.23	0.33 - 0.52	< 0.001 ***
/CVN/ vs. /CVC/	8.5278	270.78	0.26 - 0.42	<0.001 ***	7.4141	86.78	0.23 - 0.39	<0.001 ***
/NVC/ vs. /CVC/	16.839	321.73	0.45 - 0.56	<0.001 ***	9.4803	128.52	0.30 - 0.46	<0.001 ***
/CṼ#/ vs. /CVN/	3.4094	125.98	0.10 - 0.36	<0.001 ***	4.075	35.63	0.08 - 0.24	<0.001 ***
/CVN/ vs. /NVC/	1.781	120.64	-0.01 - 0.10	0.077, n.s.	-2.1667	50.73	-0.13 - -0.01	<0.05 *.
/CṼ#/ vs. NVC/	-0.839	95.56	-0.17 - 0.07	0.403, n.s.	2.4564	37.45	0.02 - 0.17	<0.05 *

Table 1. Welch's t-test results for differences between vowel environments.

References

[1] Ladefoged, P. and Ian M. (1996). *The sounds of the world's languages*. Oxford: Blackwell.
[2] Merrifield, W. R. (1963). Palantla Chinantec syllable types. *Anthro. Ling.* 5, 1-16.