An Agreement-by-Correspondence Analysis of Máíhɨ̃ki Nasalization Harmony*

John Sylak-Glassman
University of California, Berkeley

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1 Overview of Máíhɨ̃ki

- Western Tukanoan, spoken in Peruvian Amazon NE of Iquitos
- Name of language: In orthography, Máíjɨ̀kì; in IPA, with only H tone marked [máíhɨ̃ki]
  Previous names (now considered pejorative): Orejón, Coto
- ∼100 speakers out of ∼400 ethnic Maijuna
- Endangerment Status: Most speakers are 50+ years-old; may still be some acquisition in Tótoya
- Spoken in 4 main communities: Puerto Huamán, Nueva Vida, Sucusari, Tótoya
- Slight dialectal variation: All data here from Nueva Vida

2 Phonological Profile

	Bilabial	Alveolar	Postalveolar	Velar	Glottal
Voiceless Stop	p	t		k, k^w	
Voiced Stop	b [b, β, m]	d [d, ɾ, n]		g [g, ɣ], g^w	
Affricate			tʃ [tʃ, ʃ], dʒ [dʒ, j, ɲ]		
Fricative		s [s, ts]			h

Table 1: Máíjɨ̀kì Phonemic Consonant Inventory

	Front	Central	Back
High	i [i, ĩ]	ɨ [ɨ, ɨ̃]	u [u, ũ]
Mid	e [e, ẽ]		o [o, õ]
Low		a [a, ã]	

Table 2: Máíjɨ̀kì Phonemic Vowel Inventory

- Nasalization is contrastive and treated as a morpheme-level feature: /gá/ ‘a water snail’ vs. /gã́/ ‘meat’
  - Nasal consonants and vowels are not underlying
- No velar nasal [ŋ], no voiceless nasals, no (voiced or voiceless) prenasalized stops
- Contrastive level tones on surface: H = ́v, L = ̀v

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2.1 Distribution of Oral and Nasal Syllables

- Relevant classes of surface segments for nasalization harmony:
  - T : p, t, k, k^w, g, g^w, tʃ, s, h
  - D : b, d, dʒ
  - N : m, n, ɲ
  - V : i, ɨ, u, e, o, a
  - $\tilde{V}$: ĩ, ɨ̃, ũ, ẽ, õ, ã
- Syllable structure is strictly (C)V
- Only one nasal segment per syllable

attested oral	attested nasal	unattested nasal
TV	T$\tilde{V}$	
DV	NV	*D$\tilde{V}$, *N$\tilde{V}$
V	$\tilde{V}$	

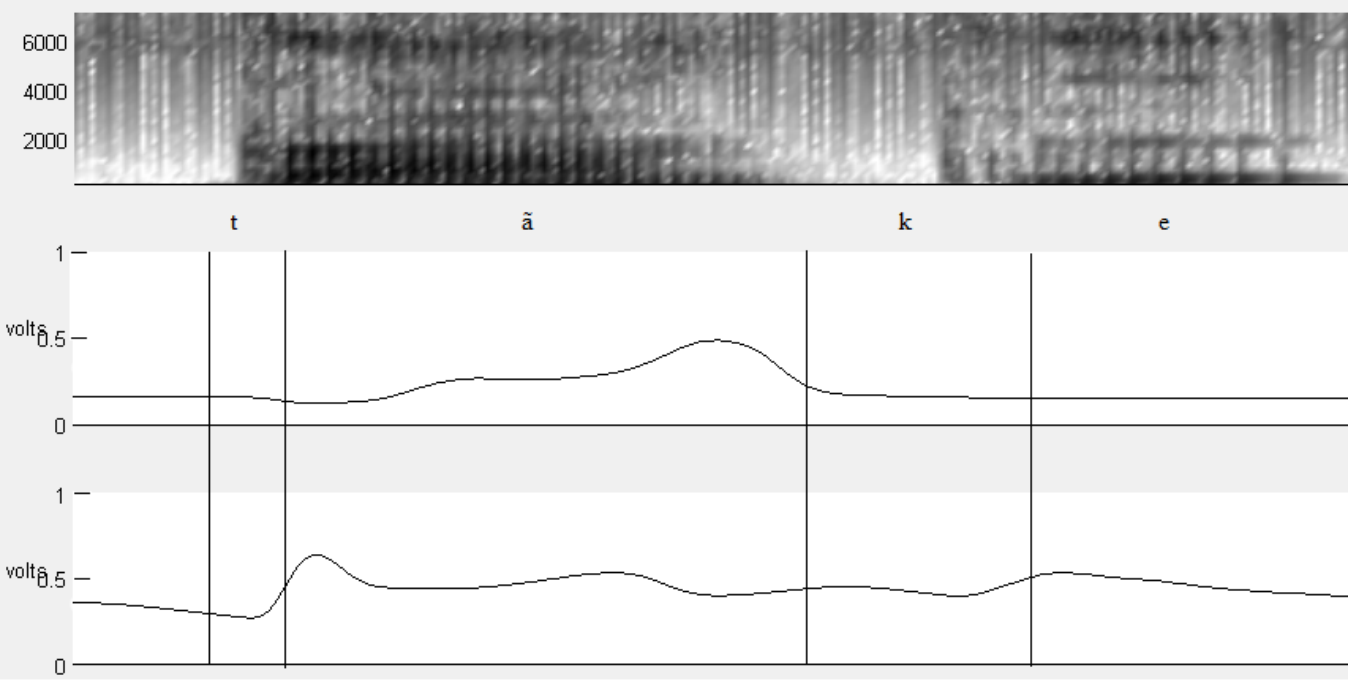
Table 3: Distribution of oral and nasal syllables

- Non-attestation of *D$\tilde{V}$ and *N$\tilde{V}$ is explained by DV nasalizing to NV
- Are there really no N$\tilde{V}$ syllables as in other Tukanoan languages?

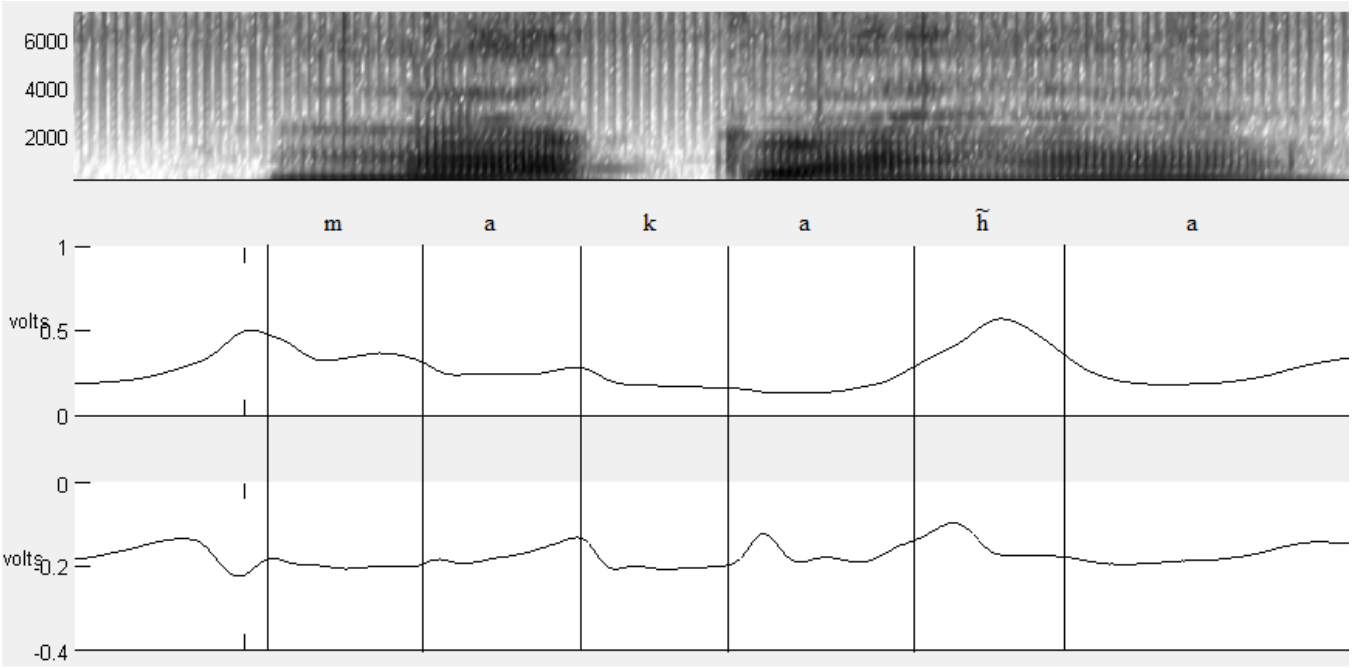
2.2 Instrumental Evidence for *N$\tilde{V}$ Gap

- After surface nasal consonants, no phonological contrast in nasality on vowels
  - No minimal or near-minimal pairs
  - Our judgments and speakers' judgments on vocalic nasality following surface nasal consonants were inconsistent
- Phonetic nasality of these vowels matters for phonological analysis:
  - If vowels after surface nasal consonants are nasal, there is Spreading
  - If they are oral, there is Consonant Harmony
- Stephanie Farmer and Lev Michael brought a pneumotachograph assembled by Ronald Sprouse to the field this past summer (2012)
- The pneumotachograph set-up:
  - Dual-chamber Rothenberg mask attached to a transducer that converted airflow measurements into electrical signals
  - Signals were processed through an analog-to-digital converter and sent to a laptop
- *The Question*: Do vowels after surface nasal consonants look more like unambiguously oral vowels or more like unambiguously nasal vowels?
  - Vowel nasalization is unambiguous in TV syllables
- Took uncalibrated measurements, since only relative airflow was needed

- An unambiguously nasal vowel, [ã], in *tã́ké* ‘monkey’:
  (Spectrogram on top, nasal airflow in the middle, oral airflow on the bottom)



- The vowel /a/ after a surface nasal consonant in *máká hã́* ‘it’s jungle’:



- Slight co-articulatory nasal airflow on vowels after surface nasal consonants, but much less nasal airflow than unambiguously nasal vowels
- Conclude that vowels after surface nasal consonants are phonologically *oral*
- *Sidenote*: /h/ is always realized with significant nasal airflow (as is /s/), but it patterns with the T segments
  - Minimal pair differentiated only by nasality of the vowel after /h/: *hèbɨ̀* ‘type of fish’ vs. *hɛ̀bɨ̀* ‘leg’
  - Confirmed by pneumotachograph investigation

2.3 Distribution of Oral and Nasal Morphemes

- Of the 9 combinatorial possibilities for (bisyllabic) oral morpheme shapes, all 9 are realized: TVTV, TVDV, DVTV, DVDV, TVV, DVV, VTV, VDV, and VV.
- Of the 25 combinatorial possibilities for nasal morpheme shapes, however, only 9 are realized: TṼTV, TVNV, NVTV, NVNV, TṼṼ, NVV, ṼTV, VNV, and ṼṼ.

	$\sigma_2 =$ TV	$\sigma_2 =$ DV	V	$\sigma_2 =$ TṼ	$\sigma_2 =$ NV	Ṽ
$\sigma_1 =$ TV	túkù 'star'	túbɨ́ 'tree stump'	tóà 'cooking fire'	∅	tɨ́nó 'heal (tr.)'	∅
$\sigma_1 =$ DV	békɨ́ 'tapir'	bíbé 'eagle'	báò 'sister-in-law'	∅	∅	∅
$\sigma_1 =$ V	ókó 'water'	ódá 'palm sp.'	éó 'plant sp.'	∅	áŋà 'snake'	∅
$\sigma_1 =$ TṼ	tã́kè 'monkey sp.'	∅	∅	∅	∅	gɨ̃́ɨ̃̀ 'foot'
$\sigma_1 =$ NV	násó 'monkey sp.'	∅	máí 'person'	∅	náŋà 'hair'	∅
$\sigma_1 =$ Ṽ	ɛ̃́kè 'toad sp.'	∅	∅	∅	∅	ã́ɔ̃́ 'food'

Table 4: Attested words showing licit combinations of oral and nasal syllables in morphemes

- These data suggest a 1-to-1 correspondence between oral and nasal morphemes, given in the table below:

oral morpheme	TVTV	TVDV	DVTV	DVDV	TVV	DVV	VTV	VDV	VV
nasal morpheme	TṼTV	TVNV	NVTV	NVNV	TṼṼ	NVV	ṼTV	VNV	ṼṼ

Table 5: Correspondence between oral and nasal morphemes

3 Pre-Theoretical Description

- [NAS] is underlyingly a floating, morpheme-associated feature that triggers nasalization harmony
- Floating [NAS] docks to the leftmost suitable host
  - T segments never nasalize
  - Voiced obstruents (D segments) are preferred over vowels (V) as hosts
  - If there is a voiced consonant in the second syllable of the morpheme, it nasalizes instead of the leftmost vowel, i.e. /[NAS] tada/ → [tana], not *[tãda]
- When [NAS] docks to a voiced obstruent (D), that voiced obstruent surfaces as a nasal consonant.
  - The next voiced obstruent to the right, if there is one, also surfaces as a nasal consonant
- Morpheme boundaries block the "spread" of nasality to voiced obstruents to the right, e.g. ɲíá-dàì 'visit' (lit. see-come)
  - Maximal morpheme seems to be bisyllabic for harmony purposes
  - Morphemes that seem to be longer usually involve frozen morphology which is respected by harmony
- When [NAS] docks to a vowel, it docks to the leftmost vowel
- If the leftmost vowel is directly adjacent to another vowel, that other vowel also nasalizes (i.e. /[NAS] VV/ → *[ṼV] → [ṼṼ])
- An intervening consonant always blocks the spread of vowel nasalization

4 Agreement-by-Correspondence Analysis

- Agreement by Correspondence, henceforth ABC, was originally developed by Walker (2000a,c, 2001) and Hansson (2001) to analyze systems of non-local consonant harmony with unaffected intervening material
- Central insight: Processes of segmental harmony should be viewed as *agreement* rather than spreading
- Agreeing segments are in a formal correspondence relationship, which is predicated on phonetic similarity
- This analysis uses a version of ABC by McCarthy (2010) called MAX ABC that does not use the CORR family of constraints
- *Roadmap*: Introduce framework by analyzing Máíhɨ̃ki nasal consonant harmony, then proceed to vowel nasalization harmony, then integrate the two in one analysis and tie up loose ends

4.1 Analyzing Máíhɨ̃ki Nasal Consonant Harmony

- MAX ABC: IDENT constraints capture the similarity basis of correspondence relationships and also promote harmony with respect to a particular feature
- Features used to establish the similarity basis of correspondence are called α features (Shih 2013)
- In Máíhɨ̃ki, voiced obstruents correspond, so α feature is [voi]
- Constraints that enforce that similarity basis are IDENT-CC[F_α] and IDENT-IO/OI[F_α] constraints
  - IDENT-CC[voi] : For every [voi] feature in a consonant with a corresponding consonant, that corresponding consonant must realize an identically-valued [voi] feature
  - IDENT-IO/OI[voi] : For every [voi] feature in the input, a corresponding [voi] feature must exist in the output, and for every [voi] feature in the output, a corresponding [voi] feature must exist in the input
  - IDENT constraints (in ABC analyses, at least) must be evaluated in a strictly local, pairwise way to avoid typologically bizarre majority rule effects (Hansson 2007)
- While IDENT-CC[F_α] and IDENT-IO/OI[F_α] constraints enforce correspondence, MAX-CC *establishes* it
- MAX-CC is indexed to the morpheme (à la Archangeli and Pulleyblank 2002) to capture the morpheme-boundedness of nasal consonant harmony in Máíhɨ̃ki[1]
  - MAX-CC_μ : Assign a violation mark for every consonant that is not in the domain of a CC correspondence relation within a morpheme (adapted from McCarthy 2010:3)
- MAX-CC_μ ranked below IDENT-CC[F_α] and IDENT-IO/OI[F_α] constraints to force consonants that disagree with respect to the α features to be excluded from the correspondence relation
- The ranking so far:

IDENT-CC[voi], IDENT-IO/OI[voi]
|
MAX-CC_μ

(1)

	/dada/$_\mu$	IDENT-CC[voi] IDENT-IO/OI[voi]	MAX-CC_μ
→	d_1ad_1a		
	dada		2!

(2)

	/tada/$_\mu$	IDENT-CC[voi] IDENT-IO/OI[voi]	MAX-CC_μ
→	tada		2
	t_1ad_1a	1!	
	d_1ad_1a	1!	

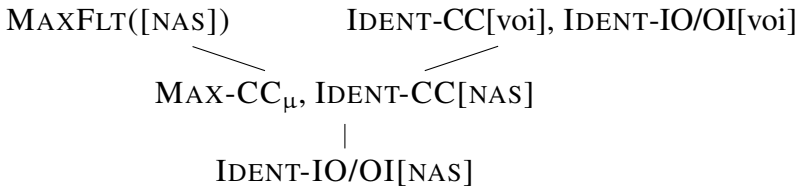
[1] In constraint names, μ should always be read as "morpheme."

- The feature that corresponding segments agree with respect to is called the β feature (Shih 2013)
- The β feature in Máíhɨ̃ki is [NAS]
- IDENT-CC[NAS] is ranked together with MAX-CC$_\mu$ to promote harmony
  - IDENT-CC[NAS] : For every [NAS] feature in a consonant with a corresponding consonant, that corresponding consonant must realize an identical [NAS] feature
- IDENT-CC[NAS] ranked above IDENT-IO/OI[NAS] to allow corresponding segments to become nasal

(3)

	/[NAS] dada/$_\mu$	MAX-CC$_\mu$	IDENT-CC[NAS]	IDENT-IO/OI[NAS]
→	n$_1$an$_1$a			2
	n$_1$ad$_1$a		1!	
	nana	2!		

- Need a constraint to force floating [NAS] feature to be realized
  - MAXFLT([NAS]) : Assign one violation mark for every floating feature [NAS] in the input that is not realized in the output (adapted from Wolf 2005:370)
- The ranking for Máíhɨ̃ki nasal consonant harmony:



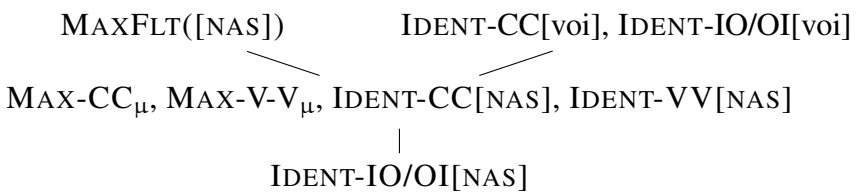
4.2 Analyzing Máíhɨ̃ki Vowel Nasalization Harmony

- Máíhɨ̃ki vowel nasalization harmony can be analyzed parallel to nasal consonant harmony
- Only basis of similarity is status as vowel, so no IDENT-VV[F$_\alpha$] or IDENT-IO/OI[F$_\alpha$] constraints needed
- MAX-VV$_\mu$ must be scaled by proximity (Hansson 2001:296-300) so that correspondence will only be enforced between strictly adjacent vowels
  - MAX-V-V$_\mu$: Assign a violation mark for every vowel that is not in the domain of a VV correspondence relation between immediately adjacent vowels within a morpheme
- IDENT-VV[NAS] ranked together with MAX-VV$_\mu$, which are ranked above IDENT-IO/OI[NAS]
  - IDENT-VV[NAS] : For every [NAS] feature in a vowel with a corresponding vowel, that corresponding vowel must realize an identically-valued [NAS] feature

(4)

	/[NAS] ao/$_\mu$	MAX-V-V$_\mu$	IDENT-VV[NAS]	IDENT-IO/OI[NAS]
→	ã$_1$õ$_1$			2
	ã$_1$o$_1$		1!	
	ãõ	2!		

- These constraints can be folded into the schema devised for nasal consonant harmony:



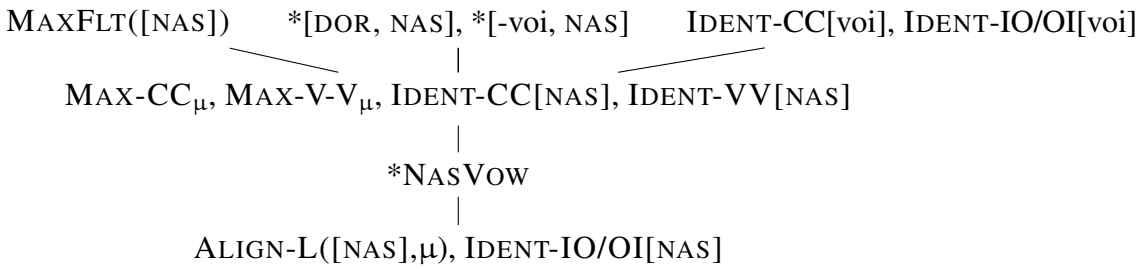
4.3 Tying Up Loose Ends: Inventory, Alignment, and Preferred Hosts

- Undominated inventory constraints:
  - *[DOR, NAS] : Assign one violation mark for each occurrence of a dorsal nasal segment (such as ŋ)
  - *[-voi, NAS] : Assign one violation mark for each occurrence of a voiceless nasal segment
- In a form like TVTV, only the leftmost vowel will bear nasality
  - ALIGN-L([NAS],μ) : Assign one violation mark for every segment that intervenes between the feature [NAS] and the left edge of the morpheme (adapted from McCarthy and Prince 1993 via McCarthy 2011)
- Nasalized vowels must be explicitly ruled out when there is a voiced obstruent (D segment) available (must prevent forms like *[tãda] from /[NAS] tada/$_{\mu}$)
  - *NASVOW : Assign one violation mark for each vowel that bears the feature [NAS] (Walker 2000b:39)
- *NASVOW must be ranked above ALIGN-L([NAS],μ) to ensure that alignment does not force vowels to be nasalized instead of voiced obstruents

(5)

	/[NAS] tada/$_{\mu}$	*NASVOW	ALIGN-L([NAS],μ)
→	tana		2
	tãda	1!	1

- The final constraint ranking for analyzing Máíhĩki nasalization harmony is:



5 Conclusions

- Máíhĩki has non-local consonant harmony in complementary distribution with local vowel harmony for the same feature: nasality ([NAS])
- The ABC framework was built to handle non-local harmony, but can also handle local harmony
  - ABC's original architecture invited extensions to the theory, which has led to analyses of vowel harmony (Rhodes 2010) and CV interactions (Shih 2013)
- ABC's ability to handle different types of harmonies at the same time allow it to account for Máíhĩki nasalization harmony when conventional approaches fail
  - ABC is powerful, but not too powerful
- Typologically, the Máíhĩki nasalization harmony system is a rare (possibly even unique) kind of harmony system globally
- Within Tukanoan, the Máíhĩki system is unique:
  - Most other Tukanoan languages have pervasive nasal spreading that spreads through both consonants and vowels in the same morpheme (e.g. Barasana in E. Tukanoan)
- The Máíhĩki system points to interesting historical changes, for example:
  - Vowels after nasal consonants stopped being realized as phonetically nasal

  - If voiceless segments in Proto-Tukanoan were transparent to nasal vowel harmony (as in Barasana), they have become opaque in Máíhɨ̃ki (or else they became transparent in Barasana)
- It is possible that other Tukanoan languages have systems similar to Máíhɨ̃ki, but detailed phonetic and phonological fieldwork has yet to reveal them

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John Sylak-Glassman
University of California, Berkeley
Department of Linguistics
1203 Dwinelle Hall # 2650
Berkeley, CA 94720-2650
sylak@berkeley.edu
http://linguistics.berkeley.edu/∼sylak/