

Acoustic Opacity and Acoustic Transparency in Chinantec

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Outline

- (0) A. Acoustic opacity and acoustic transparency
- B. Inherent acoustic opacity
 - i. Chinantec voiceless nasals
 - ii. Vowels, phonation, and tone
 - a. Vowels and non-modal phonation
 - b. Laryngeally simplex languages
 - c. Laryngeally complex languages
 - d. Chinantec ballistic syllables
- C. Contextual acoustic opacity--Chinantec tone sandhi
- D. Coarticulation and acoustic transparency--Chinantec pronominal phonology

A. Acoustic Opacity and Acoustic Transparency

- (1) Phonological systems do not always possess contrasts that lend themselves to maximal perceptual salience

phonological representation (unordered):

ejective "p":

[-cont, -son]

/ \

[labial] [constricted]

- (2) unattested phonetic realization:

labial: _____

constricted: _____

= *[p]

potential obscuring of contrastive information: **acoustic opacity**

- (3) the revealing of otherwise opaque gestures: **acoustic transparency**

actual phonetic realization:

labial: _____
 constricted: _____
 = [p']

B. Inherent Acoustic Opacity: the intrinsic quality of the contrastive information may result in acoustic opacity.

- (4) transparent gesture: supralaryngeal laryngeal
opaque gesture: supralaryngeal laryngeal
supralaryngeal **ejective stops**
laryngeal

Chinantec phonology and morphology -- data from Anderson, Martinez, and Pace 1990, and Pace 1990. Comaltepec Chinantec spoken by approximately 1400 people in Comaltepec, Sate of Oaxaca, Mexico. Otomanguenan, VSO.

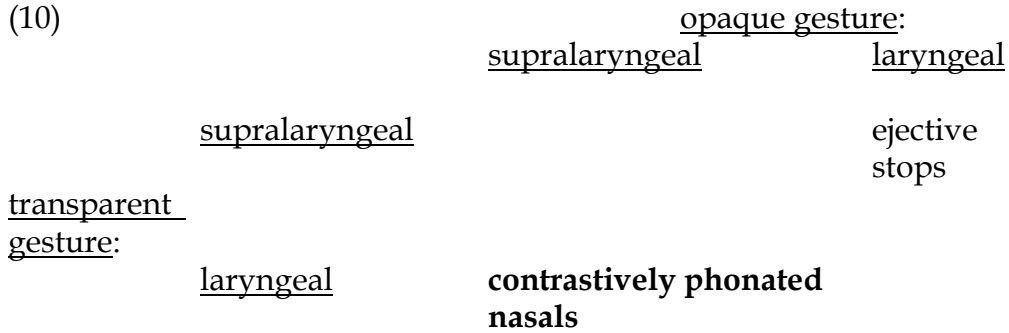
- (5) p t c k ii u
 b d z g ee o
 s æ a
 r
 m n η
 l
 y w
 h,?
 (c = tS, z = dZ, r = z/)

- (7) H, L, LH, H, _

- (8) maximal syllable: C(G)V(:)(N)(?)

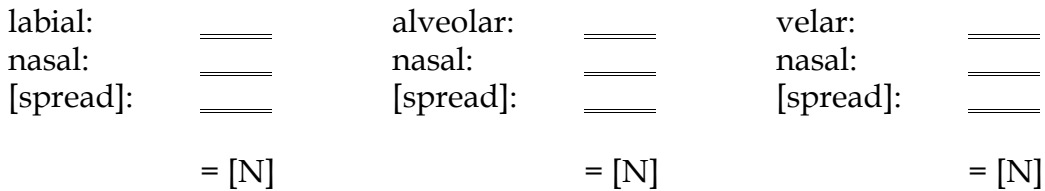
- (9) morphology: monosyllabic roots. Inflection consists primarily of stem modification: tone, length, ablaut, phonation, consonantism.

i. Chinantec Voiceless Nasals



voiceless nasals: Aspiration co-occurring with nasality greatly reduces intensity, dramatically obscuring the nasal formant structure (Dantsuji 1984,86,87). Nasal place of articulation might not be discernible.

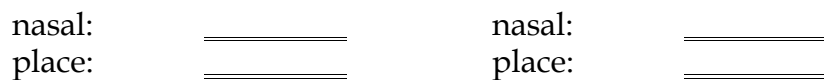
(11) voiceless portion of Burmese voiceless nasals



Ladefoged and Maddieson 1994: the reduced energy associated with voiceless nasals may obscure formant transitions between the nasal and a neighboring vowel. Voiced transition is preferred.



(13) unattested phonetic realizations:



spread: _____ constricted: _____
 = [] = [N]

(14) actual phonetic realizations:

nasal: _____ nasal: _____
 place: _____ place: _____
 spread: _____ constricted: _____

(15) Chinantec preaspirated nasals.

hmi: ^L	[m̥mi: ^L]	water
hniu: ^L	[n̥nju: ^L]	green beans
hŋan? ^{HL-r}	[ŋ̥an? ^{HL}]	he kills

(16) actual phonetic realizations:

nasal: _____ nasal: _____
 place: _____ place: _____
 spread: _____ constricted: _____

(17) In breathy syllables with a post-vocalic nasal element: "tendency to loss of voicing of post-vocalic elements" (Merrifield 1963:3). Comaltepec identically described (Anderson, Martinez, and Pace 1990)

vowel: _____
 [spread] _____
 nasal: _____

Why is post-nuclear nasal fully devoiced? It does not contrast for place features.

(18) "(a) The postnuclear nasal is(...)alveolar preceding /n/ within the word, or preceding any alveolar consonant across a word boundary.

ka ^L huén? ^{LM} ne?	the animal was
	frightened
hiú:n ^{LH} ja ^{HL}	this child
hiú:n ^{LH} ze? ^{HM}	sick child

- (b) Preceding a labial consonant, within the word or across a word boundary, the postnuclear nasal is labial.

pin ^{?Hb}	[pim ^{?H}]	he is tiny
hiú:n ^{LH} pin ^{?H}	[Iyú:m ^{LH} pin ^{?H}]	small child

- (c) Preceding a velar or laryngeal consonant, or pause, the postnuclear nasal is velar.

hiú:n ^{LH} ken ^{?HM}	[Iyú:ŋ ^{LH} ken ^{?HM}]	big children
hiú:n ^{LH} ?uín ^{?H}	[Iyú:ŋ ^{LH} ?wín ^{?H}]	black child
hiú:n ^{LH} han ^{?HM}	[Iyú:ŋ ^H Aaŋ ^{?HM}]	perverse child

- (d) Preceding /r/ within a word, the postnuclear nasal assimilates the /r/ and actualizes as a fronted velar with a nonsyllabic high front vocoid onglide.

ni ^L hlén ^{Mr}	[ni ^L Lléiŋ ^M]	he will tremble
?én ^{LMr}	[?éiŋ ^{LM}]	he pulls (him)"

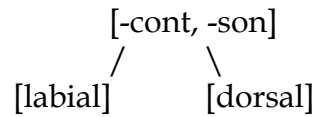
Post-nuclear nasal does not possess a contrastive place specification, it is not crucial for its formant structure to be encoded in the speech signal.

(19)		<u>opaque gesture:</u>	
		<u>supralaryngeal</u>	<u>laryngeal</u>
	<u>supralaryngeal</u>	labiovelar stops	ejective stops
	<u>transparent gesture:</u>		
	<u>laryngeal</u>	contrastively phonated nasals	

- (20) Ewe complex labiovelar stop. Maddieson (1993)

phonological representation:

labiovelar stop:



unattested phonetic realization:

labial: =====

dorsal: =====

actual phonetic realization:

labial: =====

dorsal: =====

ii. vowels, phonation, and tone
a. Vowels and non-modal phonation

(21) With maximum sonority, contain enough acoustic energy so that contrastive laryngeal features may be phonetically simultaneous with the supralaryngeal constriction. Breathy vowels: Oriya (Dhall 1966), Gujarati (Fischer-Jorgensen 1970). Creaky vowels: Sedang (Smith, 1968).

(22) Oriya aspirated vowels

^H ri	shame
^H pi	each (also "fee" (<English "fee"))
^H cu	gone
^H to	place, v. Imp.

(23) phonetic realizations:

place: =====	place: =====
spread: =====	constricted: =====
= [V]	= [V]

b. laryngeally simplex languages: languages with possess both tonal and phonation contrasts, but not cross-classificatorily

Hmong (Lyman 1974, Smalley 1976, Huffman 1987)

(24)	High	tau ⁵⁵	pumpkin
	Rising	tau ³⁵	to dam up (water)
	Low	tau ²²	axe
	Mid (normal)	tau ³³	to be able
	Falling (normal)	tau ⁴²	sp. of grass
	Creaky	tau ³¹	bean
	Breathy	tau ³²	to follow

Vietnamese (Nguyen 1965)

(25)	Level tone	la	(no gloss)
	Rising tone	la	(no gloss)
	Falling tone	la	(no gloss)
	Falling rising tone	la	(no gloss)
	Low rising tone	la	(no gloss)
	Low constricted tone	la	(no gloss)

b. laryngeally complex languages: languages which possess both tone and phonation contrasts which cross-classify, e.g. Chinantec

		<u>opaque gesture:</u>	
		<u>supralaryngeal</u>	<u>laryngeal</u>
	<u>supralaryngeal</u>	labiovelar stops	ejective stops
<u>transparent gesture:</u>	<u>laryngeal</u>	contrastively phonated nasals	vowels with both tone and non-modal phonation

c. Ballistic syllables--Chinantec syllables may possess vowels with a [spread] feature. Aspiration is sequenced so that both tone and phonation achieve acoustic transparency.

(26) Perception:

Dominant region for pitch perception is roughly between 400 and 1000 Hz. (roughly the third through fifth harmonics; approximately the first formant region)(Remez and Rubin 1984,1993).

During breathy voice, harmonic structure may be weakened due to added noise (Silverman, Blankenship, Kirk, and Ladefoged, in prep.).

During creaky voice, the glottal vibration may be a- or quasi-periodic, resulting in a non-salient or unstable harmonic structure.

Pitch (i.e., tone) perception may be obscured during non-modal phonation.

(27) Production:

Respiratory muscular activity, glottal aperture, vocal fold tension, larynx height interact in complex ways to influence pitch.

Reaching and maintaining pitch (tonal) targets during non-modal phonation is thus articulatorily difficult.

tone with breathy phonation:

<u>phonology:</u>	H	L	[spread]	
<u>primary features:</u>				
vocal fold tension	↑	↓	glottal aperture	↑
<u>enhancing features:</u>				
glottal aperture	↓	↑	vocal fold tension	↓
subglottal pressure	↑	↓	subglottal pressure	↑
larynx height	↑	↓	larynx height	-

tone with creaky phonation:

<u>phonology:</u>	H	L	[constricted]	
<u>primary features:</u>				
vocal fold tension	↓	↑	glottal aperture	↓

enhancing features:

glottal aperture	↓	↑	vocal fold tension	↑
subglottal pressure	↑	↓	subglottal pressure	↑
larynx height	↑	↓	larynx height	-

(28) When tone cross-classifies with non-modal phonation, these features are sequenced to avoid acoustic opacity:

Tone is most reliably produced and perceived when realized with modal voice

What is the domain of association of the [spread] feature?
 Syllable? Rime? Mora? Coda? Vowel? Distributional evidence points to the nuclear vowel.

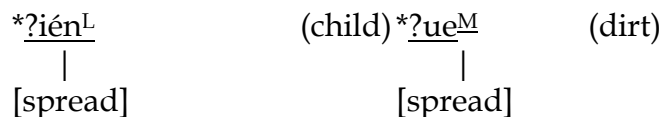
(29) The Syllable



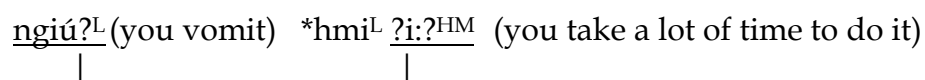
Predicts no subcomponent of the syllable may contrast in aspiration, as the phonological simultaneity of identical features results in neutralization. Yet Chinantec freely allows such contrasts.



Predicts that ballistic syllable onsets may not contain any [constricted] specifications. This would involve the phonological simultaneity of [spread] and [constricted].



Predicts the nonexistence of ballistic checked syllables, as these too involve the phonological simultaneity of [spread] and [constricted]. However, glottally checked ballistic syllables freely occur.



[spread] [spread]

(30) The Rime

CGV:N?
|
[spread]

But rimes may contain glottal checking (see 25)

(31) The Coda (phonologically ordered to precede /?/).

CGV:N?
|
[spread]

Would not explain the reported "fortis release" of ballistic syllable onsets. Why should a coda segment have such an effect on its tautosyllabic onset?

Predicts that the sequencing of these two segments could be reversed: /h?/, but also /?h/. Appeals to the sonority hierarchy could not preclude this ordering contrast, as /?/ and /h/ do not differ along this scale.

Results in very marked coda structure, involving two distinct laryngeal gestures.

(32) The Mora

CGV:N? CGV:N?
| |
μ μ
| |
[spread] [spread]

Predicts that contrasts between preaspirated and postaspirated syllables should be possible. Such contrasts are unattested.

(33) The Segment (the vowel)

CGV(:)N?
|

[spread]

Allows for further laryngeal contrasts in both onsets and codas.

Onsets may possess [spread] or [constricted], and syllables may be checked, both independently of ballisticsity.

[constricted] does not phonologically associate with vowels (i.e., there are no creaky vowels), no feature co-occurrence violation is encountered.

Correctly predicts the unacceptability of moraic aspiration contrasts in bimoraic syllables.

(34) [spread] in ballistic syllables is phonologically associated with the nuclear vowel. To achieve acoustic transparency, tone and [spread] are sequenced

(35) hi:^{LH} (edible tuber) hwi^H (horn of an animal)

<u>phonology</u>	<u>phonetic realization</u>	<u>phonology</u>	<u>phonetic realization</u>
hi: ^{LH}	[hi: ^{LMh}]	hwi ^H	[hwi ^{Hh}]
[spread]		[spread]	

(36) Acoustic Display for form pairs which minimally or near-minimally contrast in ballisticsity (see following pages).

- window A: waveforms
- window B: energy contours
- window C: wideband spectrograms
- window D: narrowband spectrograms

- (41) a. phonetic sequencing (e.g. aspirated stops)
- b. temporal truncation (e.g. contrastively phonated nasals)
- c. temporal expansion (e.g. round harmony systems)

C. Contextual acoustic opacity--Chinantec tone sandhi

Sometimes, a contrastive value may possess intrinsic phonetic salience. However, due to a neighboring gesture, acoustic opacity may result.

(42)	<u>input:</u> vowels: _____ _____	<u>output:</u> vowels: _____ _____	
	H-tone: _____ L-tone: _____	H-tone: _____ L-tone: _____	

(43)	<u>Rime</u> → <u>Tone</u> ↓	VV	V:V	:	V?V	?
	L	x	x	x	x	x
	—		x		x	x
	H	(x)	x	x	(x)	x
	HL	x	x		x	x
	LH	x	x		x	

(44) All LH syllables are triggers

(45) Pitch rises take much longer to implement than pitch falls (Ohala and Ewen 1973, Sundberg 1973)

	<u>L to H</u>	
	<u>H to L</u>	
H tone:	_____	_____
L tone:	_____	_____

(46)	<u>supralaryngeal:</u> consonant: _____ vowel: _____	_____	
	<u>laryngeal:</u> H tone: _____ L tone: _____	_____	

- (47) supralaryngeal:
 consonant: = =
 vowel ===== =====
- laryngeal:
 H tone: =====
- L tone: =====

D. Coarticulation and acoustic transparency--Comaltepec
 Pronominal Phonology

<u>person/ number</u>	<u>full form:</u>	<u>reduced forms:</u>
1s	hna ^{LH}	R
1px	hna ^{?H}	na?, R?
1pi	hna: ^{LHR?}	
2s	?niu ^L	?
2p	?niu ^{?L} , na?	
3	?i ^L r	r
animal	?i ^L ri?	ne?

- (49) The 1s reduced form: syllabic alveolar nasal when immediately preceded by a post-nuclear nasal.

ni ^L ?i:hn ^{LHR}	[ni ^L ?i:h ^{LH} n ^L]	I will sweat
ka ^L kian ^{?MR}	[ka ^L kyan ^{?M} n ^L]	I slept

- (50) Elsewhere, the suffix is realized as a full copy of the stem vowel.

hmi ^L ngi ^{?HMR}	[Mmi ^L ngi ^{?HM} i ^H]	I ask (him)
ka ^L noh ^{MR}	[ka ^L no ^M ho ^L]	I got it

- (51) Open ballistic syllables which undergo this process are characterized by a particularly prominent breathiness in the transition from root to suffix.

/ka^L no^{MR}/ -> [ka^L no^MOo^L] ([ka^L no^Mho^L])

- (52) Reduced forms of the 1p: $R?$ which may only follow a syllable that does not possess a nasal coda.

$ni^Lla^{HR}?$	$[ni^Lla^Hha?]$	we will buy it
$ni^Lla^Hna?$	$[ni^Lla^Hhna?]$	we will buy it
$hmi^Lko^{HMR}?$	$[hmi^Lko^{HMo^?H}]$	we help
$hmi^Lko^{HMna^?H}$	$[hmi^Lko^{HMna^?H}]$	we help

- (53) The suffix is takes on all the features of the preceding supralaryngeal gesture. Intervening laryngeal gestures--either constriction, abduction, or both--are invisible.

- (54) Acoustic Explanation
laryngeals lack place features at the phonetic level; the presence of intervocalic $[h]$ has no influence on the supralaryngeal configuration.

(55) SL: vowel 1: _____
vowel 2: _____
consonant: _____

(56) SL: vowel 1: _____
vowel 2: _____
L: _____

- (57) The audible presence of these transitions may lead to their instability: Progressive assimilation

SL: vowel 1: _____
L: _____

- (59) Regressive assimilation

SL: vowel 2: _____
L: _____

- (60) Articulatory Explanation
A vowel may potentially persist through the laryngeal segment, and re-emerge on the other side.

- (61) Why is trans-laryngeal harmony here progressive, and not regressive?

Morphological Explanation: root syllables are picked from the open, or lexical class of morphemes, and in addition, are a common site for subsyllabic inflection; a greater number of contrasts is required here so that undue homophony does not result.

Non-root syllables are picked from a small, closed set of non-lexical morphemes. Fewer contrasts are necessary here.

A given affixal element is more likely to succumb to assimilatory processes such as trans-laryngeal harmony.

(62)

	<u>input:</u>	<u>output:</u>
SL:	vowel: _____	_____
L:	abduction: _____	_____

In addition, Comaltepec allows for the spread of a coda nasal segment into the empty suffix nuclear position.

SL:	nasal: _____	_____
L:	abduction: _____	_____

(63) The chameleon suffix consists of a nuclear position lacking any further lexical specification. In 1s, the suffix additionally possesses a post-nuclear glottal check. In 1px, the suffix consists of a bare vowel position.

1s: N?
1px: V

(where N = nuclear, V = vowel)

Note that similar patterns exist in, for example Mazahua (Spotts), and Rengao (Gregerson 1976).

D. Conclusions

(64) inherent acoustic Opacity

		<u>opaque gesture:</u>	
		<u>supralaryngeal</u>	<u>laryngeal</u>
	<u>supralaryngeal</u>	labiovelar stops	ejective stops
<u>transparent gesture:</u>			
	<u>laryngeal</u>	contrastively phonated nasals	vowels with both tone and

(65) contextual acoustic opacity: Comaltepec H spread

acoustic transparency

- a. phonetic sequencing (e.g. aspirated stops)
- b. temporal truncation (e.g. contrastively phonated nasals)
- c. temporal expansion (e.g. round harmony systems)

(66) coarticulation: pronominal phonology

(67) Phonological patterning may often be explained when the **phonetic properties**--articulatory, acoustic, aerodynamic-- of speech are considered, along with **functional explanations for morphological patterning**--maintaining a greater number of contrasts in the open class.