Acoustic Opacity and Acoustic Transparency in Chinantec

Daniel Silverman
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Outline

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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

<u>phonological representation (unordered)</u>:

ejective "p":

```
  [-cont, -son]
   /        \
[labial] [constricted]
```

(2) <u>unattested phonetic realization:</u>

```
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)

		opaque gesture: supralaryngeal	opaque gesture: laryngeal
transparent gesture:	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. Otomanguean, VSO.

(5)

p	t	c		k	ii	u
b	d	z		g	ee	o
	s				æ	a
			r			
m	n			ŋ		
	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

(10)

		opaque gesture:	
		supralaryngeal	laryngeal
transparent gesture:	supralaryngeal		ejective stops
	laryngeal	**contrastively phonated 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

labial:	____	alveolar:	____	velar:	____
nasal:	____	nasal:	____	nasal:	____
[spread]:	____	[spread]:	____	[spread]:	____
	= [N]		= [N]		= [N]

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.

(12)

place:	____	place:	____
nasal:	____	nasal:	____
[spread]:	__	[spread]:	__
vowel:	________	vowel:	________

(13) unattested phonetic realizations:

nasal:	________	nasal:	________
place:	________	place:	________

spread: ______ constricted: ______

= [] = [N]

(14) actual phonetic realizations:

nasal: ______ nasal: ______
place: ______ place: ______
spread: ___ constricted: ___

(15) Chinantec preaspirated nasals.

hmi:^{L}	[mmi:^{L}]	water
hniu:^{L}	[nnju:^{L}]	green beans
hɳan?^{HL}r	[ɳaɳ^{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(...)alveloar 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}la^{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?^{H}b	[pim?^{H}]	he is tiny
hiú:n^{LH} pin?^{H}	[Iyú:m^{LH} piη?^{H}]	small child

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

hiú:n^{LH} ken?^{HM}	[Iyú:η^{LH} keη?^{HM}]	big children
hiú:n^{LH} ?uín?^{H}	[Iyú:η^{LH} ?wíη?^{H}]	black child
hiú:n^{LH} han?^{HM}	[Iyú:η^{H} Aaη?^{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^{M}r	[ni^{L}Lléiη^{M}]	he will tremble
?én^{LM}r	[?éiη^{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)

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

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

phonological representation:

labiovelar stop:

```
        [-cont, -son]
         /        \
[labial]          [dorsal]
```

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

		opaque gesture:	
		supralaryngeal	laryngeal
transparent gesture:	supralaryngeal	labiovelar stops	ejective stops
	laryngeal	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:

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

tone with creaky phonation:

phonology:	H	L	[constricted]	
primary features:				
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

CGV:N?
|
[spread]

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.

*hú^{H} (word) *hwá^{H} (ash)
| |
[spread] [spread]

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

*?ién^{L} (child) *?ue^{M} (dirt)
| |
[spread] [spread]

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.

ngiú?^{L} (you vomit) *hmi^{L} ?i:?^{HM} (you take a lot of time to do it)
| |

[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 ballisticity.

[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) hí:^{LH} (edible tuber) hwí^{H} (horn of an animal)

phonology	phonetic realization	phonology	phonetic realization
hi:^{LH} | [spread]	[hi:^{LM}h]	hwi^{H} | [spread]	[hwi^{H}h]

(36) Acoustic Display for form pairs which minimally or near-minimally contrast in ballisticity (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) input: output:

vowels: vowels:

H-tone: H-tone:

L-tone: L-tone:

(43)

Rime → Tone ↓	VV		V:V	:	V?V	?
L	x	x	x	x	x	x
_		x		x		x
H	(x)	x	x	x	(x)	x
HL	x	x			x	x
LH	x	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)

L to H H to L

H tone:

L tone:

(46) supralaryngeal:

consonant:

vowel

laryngeal:

H tone:

L tone:

(47) supralaryngeal:

consonant:

vowel

laryngeal:

H tone:

L tone:

D. **Coarticulation and acoustic transparency**--Comaltepec Pronominal Phonology

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

(49) The ls reduced form: syllabic alveolar nasal whem immediately preceded by a post-nuclear nasal.

ni^{L}?i:hn^{LH}R	[ni^{L}?i:h^{LH}n^{L}]	I will sweat
ka^{L}kian?^{M}R	[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?^{HM}R	[Mmi^{L}ngi?^{HM}i^{H}]	I ask (him)
ka^{L}noh^{M}R	[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} nó^{M}R/-> [ka^{L} nó^{M}Oo^{L}] ([ka^{L} no^{M}ho^{L}])

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

ni^{L}la^{H}R?	[ni^{L}la^{H}ha?]	we will buy it
ni^{L}la^{H}na?	[ni^{L}la^{H}hna?]	we will buy it
hmi^{L}ko?^{HM}R?	[hmi^{L}ko?^{HM}o?^{H}]	we help
hmi^{L}ko?^{HM}na?^{H}	[hmi^{L}ko?^{HM}na?^{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 succomb to assimilatory processes such as trans-laryngeal harmony.

(62) input: output:

		input:	output:
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 posseses 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

		opaque gesture: supralaryngeal	laryngeal
transparent gesture:	supralaryngeal	labiovelar stops	ejective stops
	laryngeal	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.