

Towards a Conflation of Form and Function: Tone Sandhi in Comaltepec Chinantec

- Comaltepec Chinantec tone sandhi is almost always allophonic; rarely neutralizing
- Sandhi influenced by concrete physical forces and abstract functional forces
- The formal-functional dichotomy is a false one

(1) Comaltepec Chinantec lexical tone inventory (Anderson 1989, Anderson, Martinez, and Pace 1990, Pace 1990):

L, M, H, LM, LH

(2) relevant phonotactics:

Vowel length is contrastive: **V, V_i**

h is contrastive post-vocally: **Vh, V_ih**

Long open vowels cannot be **H**: ***V_i^H**

(3) tone sandhi:

Rightward spread of **H** tones from **LH** syllables

H-insertion following **M_i** syllables

(4)

<u>triggers</u>	<u>targets</u>	<u>outputs</u>	<u>exemplification</u>
LH, M_i	L(?)	HL(?)	<p style="text-align: center;"><u>Allophonic Sandhi Output</u></p> <p>L → HL / LH__</p> <p>kwa^{LH} hi^L → kwa^{LH} hi^{HL} give a book</p> <p>kwa^{LH} to^L → kwa^{LH} to^{HL} give a banana</p> <p>kwa^{LH} ŋi^{hL} → kwa^{LH} ŋi^{hHL} give a chayote</p> <p>L → HL / M_i__</p> <p>mi^M hi^L → mi^M hi^{HL} I ask for a book</p> <p>mi^M to^L → mi^M to^{HL} I ask for a banana</p> <p>mi^M ŋi^{hL} → mi^M ŋi^{hHL} I ask for a chayote</p>
LH, M_i	M_i	HM_i	<p style="text-align: center;"><u>Allophonic Sandhi Output</u></p> <p>M → HM / LH__</p> <p>kwa^{LH} ku^M → kwa^{LH} ku^{HM} give money</p> <p>kwa^{LH} ndʒu^M → kwa^{LH} ndʒu^{HM} give a jug</p> <p>kwa^{LH} ʔo^M → kwa^{LH} ʔo^{HM} give papaya</p> <p>M → HM / M_i__</p> <p>mi^M ku^M → mi^M ku^{HM} I ask for money</p> <p>mi^M ndʒu^M → mi^M ndʒu^{HM} I ask for a jug</p> <p>mi^M ʔo^M → mi^M ʔo^{HM} I ask for papaya</p>

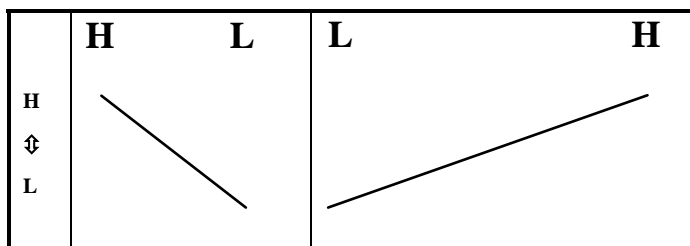
LH, M _i	Mh	Hh	<u>Neutralizing Sandhi Output</u>
			<p>Mh → Hh / LH__</p> <p>kwa^{LH} tūh^M → kwa^{LH} tūh^H give two</p> <p>kwa^{LH} ŋge:h^M → kwa^{LH} ŋge:h^H give twenty</p> <p>kwa^{LH} kjaʔs^M → kwa^{LH} kjahʔs^H give his</p> <p>Mh → Hh / M_i__</p> <p>mi:^M tūh^M → mi:^M tūh^H I ask for two</p> <p>mi:^M ŋge:h^M → mi:^M ŋge:h^H I ask for twenty</p> <p>mi:^M kjaʔs^M → mi:^M kjaʔs^H I ask for his</p>
LH, M _i	H	H	<u>Vacuous Sandhi Output</u>
			<p>(H → H / LH__</p> <p>H → H / M_i__)</p>
LH, M _i	LM(i)	LM(i)	<u>Sandhi Blocked</u>
			<p>(LM → LM / LH__</p> <p>LM → LM / M_i__)</p>
LH, M _i	LH(i)	MH(i)	<u>Allophonic Sandhi Output</u>
			<p>LH → MH / LH__</p> <p>kwa^{LH} ŋi^{LH} → kwa^{LH} ŋi^{MH} give salt</p> <p>kwa^{LH} loh^{LH} → kwa^{LH} loh^{MH} give a cactus</p> <p>kwa^{LH} kūh^{LH} → kwa^{LH} kūh^{MH} give a stone</p> <p>LH → MH / M_i__</p> <p>mi:^M ŋi^{LH} → mi:^M ŋi^{MH} I ask for salt</p> <p>mi:^M loh^{LH} → mi:^M loh^{MH} I ask for a cactus</p> <p>mi:^M kūh^{LH} → mi:^M kūh^{MH} I ask for a stone</p>

- (5) The Observations:
- LM** is not a target
 - Mh** is the only neutralizing target (to **Hh**)
 - only **LH** and **M_i** are triggers
- (6) The Question: What governs the patterning of tone sandhi?
- (7) The Proposal:
- (1) **Physical** systems--*aerodynamic, articulatory, acoustic*--in conjunction with
 - (2) The abstract **functional** principles of *contrast maintenance, conservation of effort, and pattern coherence*, and
 - (3) **historical forces** rooted in (1) and (2), all bear a direct influence on phonological patterning, and may influence tone spreading.

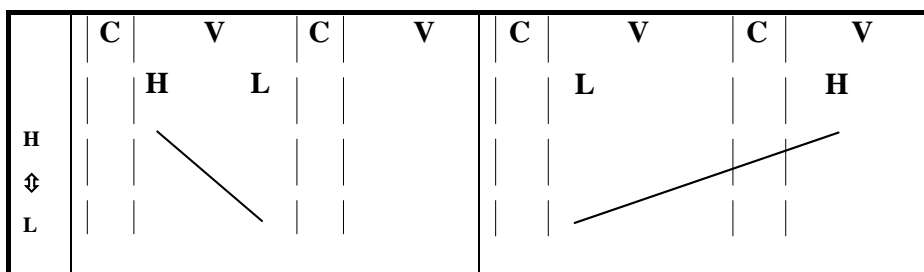
- (8) Hyman and Schuh 1974:
 (a) spreading/displacement is far more often rightward than leftward
 (b) spreading/displacement is far more likely to take place when the pitch interval between the two tones is relatively great

- (9) Physical forces affecting LH sandhi triggers:

- a. Pitch rises are accomplished much more slowly than pitch falls (Ohala and Ewan 1973, Sundberg 1973)











- b. H tones in LH contours are consequently much more likely to "spill over" on to a following vowel (Ohala 1978)



- (10) Articulatory Phonology (Browman and Goldstein 1986, 1989, 1990, 1991, 1992, 1995):
 Phonological primitives consist of temporally arranged (or "phased") gestures.
 Gestural notation employed herein:









■ = optimally recoverable
 ▨ = sub-optimally recoverable
 ▩ = unrecoverable

- (11) a. H to L:
 H-tone: ■
 ⇕
 L-tone: ■ ■
 H L
- b. L to H:
 H-tone: ■
 ⇕
 L-tone: L ■ ■
 L H











- (12) a. **H to L:**
S(upra)L(aryngeal): coronal stop: 
low vowel: 
L(aryngeal): H tone: 
L tone: 
 a^H L t
- b. **L to H:**
coronal stop: 
low vowel: 
H tone: 
L tone: 
 a^L H t

- (13) sandhi patterns:













Allophonic Sandhi Output

- a. **L → HL / LH** ____
input:
SL: coronal stop: 
low vowel: 
L: H-tone: 
L-tone: 
 a^L H t a^L
- output:
coronal stop: 
low vowel: 
H-tone: 
L-tone: 
 a^L H t a^{HL}

Allophonic Sandhi Output

- b. **M → HM / LH** ____
input:
SL: coronal stop: 
low vowel: 
L: H-tone: 
M-tone: 
L-tone: 
 a^L H t a^M
- output:
coronal stop: 
low vowel: 
H-tone: 
M-tone: 
L-tone: 
 a^L H t a^{HM}

Neutralized Sandhi Output

- c. **Mh → Hh / LH** ____
input:
SL: coronal stop: 
low vowel: 
L: H-tone: 
M-tone: 
L-tone: 
abduction: 
 a^L H t a^M h
- output:
coronal stop: 
low vowel: 
H-tone: 
M-tone: 
L-tone: 
abduction: 
 a^L H t a^H h

Vacuous Sandhi Output

d. (H → H / LH ____)

	<u>input:</u>		<u>output:</u>
SL:	coronal stop:	coronal stop:	
	low vowel:	low vowel:	
L:	H-tone:	H-tone:	
	M-tone:	M-tone:	
	L-tone:	L-tone:	
	a^L H t a^H	a^L H t a^H	

Sandhi Blocked

e. (LM → LM / LH ____)

	<u>input:</u>		<u>output:</u>
SL:	coronal stop:	coronal stop:	
	low vowel:	low vowel:	
L:	H-tone:	H-tone:	
	M-tone:	M-tone:	
	L-tone:	L-tone:	
	a^L H t a^{LM}	a^L H t a^{LM}	

Allophonic Sandhi Output

f. LH → MH / LH ____

	<u>input:</u>		<u>attested MH (allophonic):</u>
SL:	coronal stop:	coronal stop:	
	low vowel:	low vowel:	
L:	H-tone:	H-tone:	
	M-tone:	M-tone:	
	L-tone:	L-tone:	
	a^L H t a^L H	a^L H t a^M H	

(where indicates the pre-blended value)

(14) **Functional** forces affecting **LH-triggered sandhi**: The function of a phonology is to render contrasts distinct (without excessive effort)


- a. -Sandhi is **neutralizing** *only when the contrast is inherently weak*
- M** syllables which neutralize with **H** always possess contrastive post-vocalic aspiration
- post-vocalic aspiration is accompanied by a moderate pitch rise in Comaltepec (Silverman 1995)


input:
SL: coronal stop:
low vowel:
L: H-tone:
M-tone:
L-tone:
abduction:


unattested output:
coronal stop:
low vowel:
H-tone:
M-tone:
L-tone:
abduction:


-suggestion: It's not worth exerting the articulatory effort to maintain the contrast in this environment, or, the effort does not have sufficient perceptual payoff to communicate the contrast


SL: attested output:


coronal stop: 

low vowel: 

L: H-tone: 

M-tone: 


L-tone: 


abduction: 


a^L H t a^H h


b. -Sandhi into **LM** domains would neutralize a robust contrast.


input:

SL: coronal stop: 
















low vowel: 







L: H-tone: 

M-tone: 

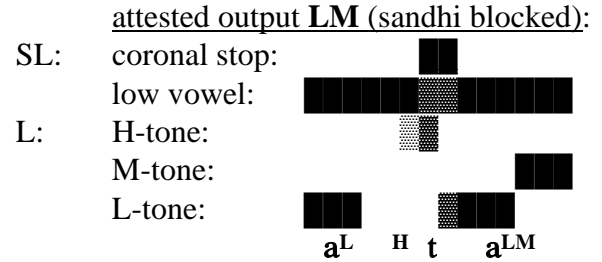
L-tone: 

a^L H t a^{LM}

output:
unattested **HLM** (neutralized):
coronal stop: 
low vowel: 
H-tone: 
M-tone: 
L-tone: 











unattested M (neutralized):
 SL: coronal stop: 
 low vowel: 
 L: H-tone: 
 M-tone: 
 L-tone: 
a^L **H** **t** **a^M**
 (where  indicates the pre-blended value)

-Blocking sandhi here salvages this contrast, although the preceding **H** tone is not optimally implemented

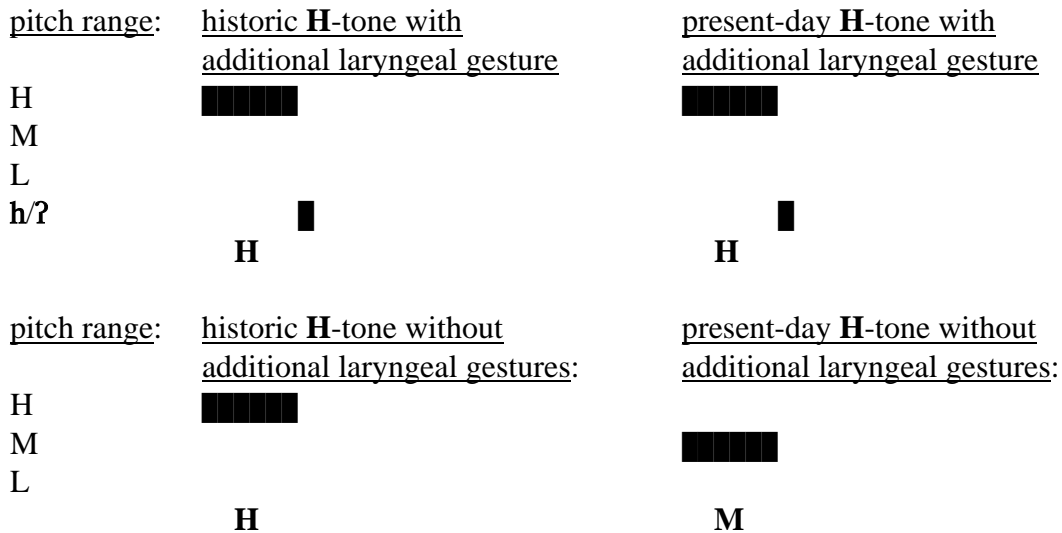


- (15) But whence **M**_i-triggered sandhi?

M_i triggers are historically derived from **H**_i (Rensch 1989):

<u>present-day Comaltepec:</u>	<u>reconstructed Proto-Chinantec:</u>	<u>gloss:</u>
ʔoɪ ^M	*ʔāɪ ^H	papaya
kuɪ ^M	*kuɪ ^H	money
ⁿ dʒœɪ ^M	*dʒuɪ ^H	earthen jar/jug
ʔwiŋ ^M	*ʔwiɪ ^H	Ojitlán (a large Chinantec village)

- (16) Post-vocalic laryngeals in Comaltepec serve to moderately raise pitch (Silverman 1995). This may phonologize as a tonal distinction.



- (17) Historic level **H**-tones lacking post-vocalic laryngeals may spread rightward *not* due to the forces of contrast maintenance, but due to natural assimilatory tendencies, i.e., *economy of effort*, in conjunction with *pattern coherence*.
- (18) Optimality Theory (Prince and Smolensky 1993, McCarthy and Prince 1993):
 -phonology may be viewed as a struggle between ease of perception and ease of production (Martinet 1952, Lindblom 1990)
 -Optimality Theory allows us to formally express this struggle as a series of ranked constraints

(19) constraint families:

recover:

(no stars)	=	cue fully (optimally) recoverable
*	=	cue sub-optimally recoverable
**	=	cue not present; unrecoverable

economize:

(no stars)	=	gesture not implemented
*	=	gesture implemented

(20) LH triggers:

Allophonic Sandhi Output:

1	input: $a^{LH}ta^L$	recover	economize
a ☞	$a^{LH}ta^{HL}$	lower pitch higher pitch lower pitch	*slack vocal folds *stiff vocal folds *slack vocal folds
b	$a^{LH}ta^L$	lower pitch *!higher pitch lower pitch	*slack vocal folds *stiff vocal folds *slack vocal folds
c	a^La^L	lower pitch *!*higher pitch lower pitch	*slack vocal folds stiff vocal folds slack vocal folds

Allophonic Sandhi Output:

2	input: $a^{LH}ta^M$	recover	economize
a ☞	$a^{LH}ta^{HM}$	lower pitch higher pitch middle pitch	*slack vocal folds *stiff vocal folds *semi-slack vocal folds
b	$a^{LH}ta^M$	lower pitch *!higher pitch middle pitch	*slack vocal folds *stiff vocal folds *slack vocal folds
c	a^Lta^M	lower pitch *!*higher pitch middle pitch	*slack vocal folds stiff vocal folds *semi-slack vocal folds

Neutralizing Sandhi Output:

3	input: $a^{LH}ta^M$	economize: neutralize M $Mh \rightarrow Hh/LH$ _____	recover	economize
a ☞	$a^{LH}ta^H$		lower pitch higher pitch **middle pitch	*slack vocal folds *stiff vocal folds semi-slack vocal folds
b	$a^{LH}ta^{HM}$	*!semi-slack vocal folds	lower pitch higher pitch *middle pitch	*slack vocal folds *stiff vocal folds
c	$a^{LH}ta^M$	*!semi-slack vocal folds	lower pitch *higher pitch middle pitch	*slack vocal folds *stiff vocal folds
d	a^Lta^M	*!semi-slack vocal folds	lower pitch **higher pitch middle pitch	*slack vocal folds *stiff vocal folds

Vacuous Sandhi Output:

4	input: $a^{LH}ta^H$	recover	economize
a ☞	$a^{LH}ta^H$	lower pitch higher pitch	*slack vocal folds *stiff vocal folds

Sandhi Blocked:

5	input: $a^{LH}ta^{LM}$	recover	economize
a ☞	$a^{LH}ta^{LM}$	lower pitch *higher pitch lower pitch middle pitch	*slack vocal folds *stiff vocal folds *slack vocal folds *semi-slack vocal folds
b	$a^{LH}ta^{HLM}$	lower pitch *higher pitch *!lower pitch *middle pitch	*slack vocal folds *stiff vocal folds *slack vocal folds *semi-slack vocal folds
c	$a^{LH}ta^M$	lower pitch *higher pitch *!*lower pitch middle pitch	*slack vocal folds *stiff vocal folds slack vocal folds *semi-slack vocal folds
d	a^Lta^{LM}	lower pitch *!*higher pitch lower pitch middle pitch	*slack vocal folds stiff vocal folds slack vocal folds *semi-slack vocal folds

Allophonic Sandhi Output:

6	input: $a^{LH}ta^{LH}$	recover	economize
a ☞	$a^{LH}ta^{MH}$	lower pitch higher pitch middle (<hi/lo) pitch *higher pitch	*slack vocal folds *stiff vocal folds *semi-slack vocal folds *stiff vocal folds
b	$a^{LH}ta^{LH}$	lower pitch *!higher pitch lower pitch *higher pitch	*slack vocal folds *stiff vocal folds *slack vocal folds *stiff vocal folds
c	$a^{LH}ta^{HLH}$	lower pitch *!higher pitch **lower pitch *higher pitch	*slack vocal folds *stiff vocal folds *slack vocal folds *stiff vocal folds
d	a^Lta^{LH}	lower pitch *!*higher pitch lower pitch *higher pitch	*slack vocal folds stiff vocal folds slack vocal folds *stiff vocal folds

- (21) **LH** triggers lend themselves to an exclusively synchronic explanation; **M_i** triggers do not. In order to *explain* sandhi here, history *must* be considered relevant to the synchronic system. Rule ordering effectively models historical change.

(1) **T** → **HT** / **H_i** ____

(2) **H_i** → **M_i**

(3) pattern coherence: minimize allophony up to recoverability.

triggers:	targets:	discussion:
☑ LH	☑L → HL ☑LH → MH ☑M _i → HM _i ☑Mh → Hh ☑H → H ☒LM → LM	sandhi motivated by contrast maintenance
☑ HØ	☑L → HL ☑LH → MH ☑M _i → HM _i ☑Mh → Hh ☑H → H ☒LM → LM	sandhi motivated by pattern coherence
HØ → MØ		sound change motivated by aerodynamic forces
☑ MØ	☑L → HL ☑LH → MH ☑M _i → HM _i ☑Mh → Hh ☑H → H ☒LM → LM	sandhi remains

(where Ø = no post-vocalic laryngeals)

(22)

Allophonic Sandhi Output:

1	input: a ^M ta ^L	recover	economize
a ☞	*a ^M ta ^L	middle pitch lower pitch	*semi-slack vocal folds *slack vocal folds
b ☝	a ^M ta ^{HL}	middle pitch lower pitch	*semi-slack vocal folds *!stiff vocal folds *slack vocal folds

Allophonic Sandhi Output:

2	input: a ^M ta ^M	recover	economize
a ☞	a ^M ta ^M	middle pitch middle pitch	*semi-slack vocal folds *semi-slack vocal folds
b ☝	a ^M ta ^{HM}	middle pitch *!higher pitch middle pitch	*semi-slack vocal folds *stiff vocal folds *semi-slack vocal folds

Neutralizing Sandhi Output:

3	input: a ^M ta ^M	economize: neutralize M Mh → Hh/Mi.____	recover	economize
a ☞	a ^M ta ^M		middle pitch middle pitch	*semi-slack vocal folds
b	a ^M ta ^{HM}		middle pitch	*semi-slack vocal folds
		*!semi-slack vocal folds	middle pitch	*!stiff vocal folds *semi-slack vocal folds
c ☝	a ^M ta ^H		middle pitch *!*middle pitch	*semi-slack vocal folds *stiff vocal folds
		*!semi-slack vocal folds		

Vacuous Sandhi Output:

4	input: a ^M ta ^H	recover	economize
a ☞ ☝	a ^M ta ^H	middle pitch higher pitch	*semi-slack vocal folds *stiff vocal folds

Sandhi Blocked:

5	input: a ^M ta ^{LM}	recover	economize
a ☞ ☝	a ^M ta ^{LM}	middle pitch lower pitch middle pitch	*semi-slack vocal folds *slack vocal folds *semi-slack vocal folds
b	a ^M ta ^{HLM}	middle pitch *!lower pitch *middle pitch	*semi-slack vocal folds *stiff vocal folds *slack vocal folds *semi-slack vocal folds
c	a ^M ta ^M	middle pitch *!*lower pitch middle pitch	*semi-slack vocal folds

Allophonic Sandhi Output:

6	input: a^Mta^{LH}	recover	economize
a ☞	a^Mta^{LH}	middle pitch lower pitch *higher pitch	*semi-slack vocal folds *slack vocal folds *stiff vocal folds
b ☝	a^Mta^{MH}	middle pitch *!*lower pitch *higher pitch	*semi-slack vocal folds *stiff vocal folds
c	a^Mta^{HLH}	middle pitch *!*lower pitch *higher pitch	*semi-slack vocal folds *stiff vocal folds *slack vocal folds *stiff vocal folds

(23) What's universal, and what's not in phonology?

universal:

- (1) Phonetic (real-world physical) constraints, and
- (2) Abstract functional constraints such as contrast maintenance

These may be formalized with constraint families such as **recover** and **economize**, and

- (3) Historical change rooted in (1) and (2)

These may be formalized with standard SPE-type rule ordering.

- (4) Pattern coherence.

All in necessary combination

not:

The constraints themselves (cf. standard OT, in which *every* constraint is present in *every* language).

(24) What can be conflated, and what can't in phonology?

can be conflated:

Formalism and functionalism

can't:

The principles which underlie sound patterning and the principles which govern the mental organization of these patterns.

This research was funded by NIH training grant T32 DC 00008.

References

- Anderson, J.L. (1989) *Comaltepec Chinantec Syntax*. Studies in Chinantec Languages v. 3. Summer Institute of Linguistics.
- Anderson, J.L., I.H. Martinez, and W. Pace (1990) "Comaltepec Chinantec Tone," in W.R. Merrifield and C.R. Rensch, eds., *Syllables, Tone, and Verb Paradigms*. Studies in Chinantec Languages v.4. Summer Institute of Linguistics, 3-20.
- Browman, C.P., and L. Goldstein (1986) "Towards an Articulatory Phonology," *Phonology Yearbook* 3:219-252.
- Browman, C.P., and L. Goldstein (1989) "Articulatory Gestures as Phonological Units," *Phonology* 6:201-251.
- Browman and Goldstein (1990a) "Gestural Specification Using Dynamically-Defined Articulatory Structures," *Journal of Phonetics* 18:299-320.
- Browman, C.P. and L. Goldstein (1990b) "Tiers in Articulatory Phonology, with some Implications for Casual Speech," in J. Kingston and M.E. Beckman, eds., *Papers in Laboratory Phonology I: Between the Grammar and the Physics of Speech*. Cambridge University Press, 341-376.
- Browman C.P., and L. Goldstein (1992) "Response to Commentaries," *Phonetica* 49:222-234.
- Lindblom, Björn. 1990. Explaining Phonetic Variation: A Sketch of The H&H Theory, in W.H. Hardcastle and A. Marchal, eds., *Speech Production and Speech Modeling*, 403-439. Dordrecht : Kluwer Academic Publishers.
- Martinet, A. (1952) "Function, Structure, and Sound Change," *Word* 8.1:1-32.
- McCarthy, J.J., and A.S. Prince (1993) "Prosodic Morphology I," Manuscript, University of Massachusetts at Amherst, and Rutgers University.
- Hyman, L.M. and R.G. Schuh (1974) "Universals of Tone Rules: Evidence from West Africa," *Linguistic Inquiry* 5.1:81-115.
- Ohala, J.J. (1978) "Production of Tone, " in V. Fromkin, ed., *Tone: A Linguistic Survey*, Academic Press.
- Ohala, J.J. and W.G. Ewan (1973) "Speed of Pitch Change," Abstract, *Journal of the Acoustical Society of America* 53:345.
- Pace, W.J. (1990) "Comaltepec Chinantec Verb Inflection," in W.R. Merrifield and C.R. Rensch, eds., *Syllables, Tone, and Verb Paradigms*. Studies in Chinantec Languages v.4. Summer Institute of Linguistics, 21-62.
- Prince, A., and P. Smolensky (1993) "Optimality Theory--Constraint Interaction in Generative Grammar," Manuscript, Rutgers University, and University of Colorado at Boulder.
- Rensch, C.R. (1989) *An Etymological Dictionary of the Chinantec Languages*. Studies in Chinantec Languages v.1. Summer Institute of Linguistics.
- Silverman, D. (1995) *Phasing and Recoverability*. UCLA Occasional Papers in Linguistics, Dissertation Series #1.
- Silverman, D. (1995) "Comaltepec Chinantec Tonology," Manuscript, University of California at Los Angeles.
- Sundberg, J. (1973) "Data on Maximum Speed of Pitch Changes," *Quarterly Progress and Status Reports, Speech Transmission Laboratory, Stockholm, Sweden* 4:39-47.

Dan Silverman
4528 Vista Del Monte 8
Sherman Oaks, CA 91403
silverma@humnet.ucla.edu