Tone in Otomanguean Languages

IntoSpan 2014

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Outline

1. Challenges to typological expectations about tone:
   a. Rising without falling tones,
   b. Very numerous tone contrasts: Chinantec, Chatino;
2. Phonology of tone:
   a. Tone sandhi in Chatino of San Juan Quiahije,
   b. Tone-laryngeal constraints in Triqui languages,
   c. Variable influence of *ʔin sound change;
3. Phonetics of tone:
   a. Numerous contrasts in Chinanteco of San Antonio Analco and San Juan Quiotepec,
   b. Classifying tones automatically;
4. Representing numerous tone contrasts phonologically.

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Classification and typology

1. Eastern:
   a. Oto-Pamean: 3 H:L:L-H,
   b. Tlapanecan: 9 (probably reducible to 3 H:M:L),
   c. Chinantecan: 12 and counting (and differing between languages);
2. Western:
   a. Popolocan: 4 H:HM:LM:L,
   b. Mixtecan:
      1. Mixtec: 3 H:M:L or H:0:L,
      2. Triqui: 8-10+ (later);
   c. Zapotecan:
      1. Zapotec: 3 H:L:LH,
      2. Chatino: 16 and counting (and differing between languages).

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      ii. Chatino: 15 and counting (and differing between languages).

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Tone sandhi in Chatino of San Juan Quiahije (Cruz, 2011)

gloss	isolation	"his/her"* noun	"that"** noun
"tobacco"	kta L	kta L ʔĩ L	kta L kãʔ L-M
"grapefruit"	stõ M-H	stõ M-H ʔĩ L	stõ M-H kãʔ L-M
"tuber"	kõ L-M	kõ L-M ʔĩ L	kõ L-M kãʔ L-M
"snake"	kna H	kna H ʔĩ M-L	kna H kãʔ L-M
"chepil"	kta M+	kta M+ ʔĩ M-L	kta M+ kãʔ L-M
"turkey"	pi M-0	pi M-0 ʔĩ M-L	pi M-0 kãʔ L-M
"nine"	ka M-L	ka M-L ʔĩ M-L	ka M-L kãʔ L-M
"dear"	tju 0-L	tju 0-L ʔĩ M-L	tju 0-L-0 kãʔ L-M
"thief"	kna M	kna M ʔĩ H	kna M kãʔ L-M
"apple"	sna H	sna H ʔĩ 0	sna H-0 kãʔ L-M
"tomato"	ʃi H-L	ʃi H-L ʔĩ 0	ʃi H-L-0 kãʔ L-M
"I run from"	sna L-0	sna L ʔĩ 0	sna L-0 kãʔ L-M

0 = super-high; * ʔĩ T = 3rd; ** kãʔ M-L = previously mentioned 3rd

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"tuber"	kõ L-M	kõ L-M ʔĩ L	kõ L-M kãʔ L-M
"snake"	kna H	kna H ʔĩ M-L	kna H kãʔ L-M
"chepil"	kta M+	kta M+ ʔĩ M-L	kta M+ kãʔ L-M
"turkey"	pi M-0	pi M-0 ʔĩ M-L	pi M-0 kãʔ L-M
"nine"	ka M-L	ka M-L ʔĩ M-L	ka M-L kãʔ L-M
"dear"	tju 0-L	tju 0-L ʔĩ M-L	tju 0-L-0 kãʔ L-M
"thief"	kna M	kna M ʔĩ H	kna M kãʔ L-M
"apple"	sna H	sna H ʔĩ 0	sna H-0 kãʔ L-M
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"tuber"	kõ L-M	kõ L-M ʔĩ L	kõ L-M kã̰ʔ L-M
"snake"	kna H	kna H ʔĩ M-L	kna H kã̰ʔ L-M
"chepil"	kta M+	kta M+ ʔĩ M-L	kta M+ kã̰ʔ L-M
"turkey"	pi M-0	pi M-0 ʔĩ M-L	pi M-0 kã̰ʔ L-M
"nine"	ka M-L	ka M-L ʔĩ M-L	ka M-L kã̰ʔ L-M
"dear"	tju 0-L	tju 0-L ʔĩ M-L	tju 0-L-0 kã̰ʔ L-M
"thief"	kna M	kna M ʔĩ H	kna M kã̰ʔ L-M
"apple"	sna H	sna H ʔĩ 0	sna H-0 kã̰ʔ L-M
"tomato"	ʃi H-L	ʃi H-L ʔĩ 0	ʃi H-L-0 kã̰ʔ L-M
"I run from"	sna L-0	sna L ʔĩ 0	sna L-0 kã̰ʔ L-M

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"tuber"	kõ L-M	kõ L-M ʔĩ L	kõ L-M kãʔ L-M
"snake"	kna H	kna H ʔĩ M-L	kna H kãʔ L-M
"chepil"	kta M+	kta M+ ʔĩ M-L	kta M+ kãʔ L-M
"turkey"	pi M-0	pi M-0 ʔĩ M-L	pi M-0 kãʔ L-M
"nine"	ka M-L	ka M-L ʔĩ M-L	ka M-L kãʔ L-M
"dear"	tju 0-L	tju 0-L ʔĩ M-L	tju 0-L-0 kãʔ L-M
"thief"	kna M	kna M ʔĩ H	kna M kãʔ L-M
"apple"	sna H	sna H ʔĩ 0	sna H-0 kãʔ L-M
"tomato"	ʃi H-L	ʃi H-L ʔĩ 0	ʃi H-L-0 kãʔ L-M
"I run from"	sna L-0	sna L ʔĩ 0	sna L-0 kãʔ L-M

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"tuber"	kõ L-M	kõ L-M ʔĩ L	kõ L-M kãʔ L-M
"snake"	kna H	kna H ʔĩ M-L	kna H kãʔ L-M
"chepil"	kta M+	kta M+ ʔĩ M-L	kta M+ kãʔ L-M
"turkey"	pi M-0	pi M-0 ʔĩ M-L	pi M-0 kãʔ L-M
"nine"	ka M-L	ka M-L ʔĩ M-L	ka M-L kãʔ L-M
"dear"	tju 0-L	tju 0-L ʔĩ M-L	tju 0-L-0 kãʔ L-M
"thief"	kna M	kna M ʔĩ H	kna M kãʔ L-M
"apple"	sna H	sna H ʔĩ 0	sna H-0 kãʔ L-M
"tomato"	ʃi H-L	ʃi H-L ʔĩ 0	ʃi H-L-0 kãʔ L-M
"I run from"	sna L-0	sna L ʔĩ 0	sna L-0 kãʔ L-M

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"snake"	kna H	kna H ʔĩ M-L	kna H kãʔ L-M
"chepil"	kta M+	kta M+ ʔĩ M-L	kta M+ kãʔ L-M
"turkey"	pi M-0	pi M-0 ʔĩ M-L	pi M-0 kãʔ L-M
"nine"	ka M-L	ka M-L ʔĩ M-L	ka M-L kãʔ L-M
"dear"	tju 0-L	tju 0-L ʔĩ M-L	tju 0-L-0 kãʔ L-M
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"apple"	sna H	sna H ʔĩ 0	sna H-0 kãʔ L-M
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Tone sandhi in Chatino of San Juan Quiahije: Interim description

Noun's tone	ʔĩ's tone
L, M-H, L-M	L
H1, M+, M-0, M-L, 0-L*	M-L
M	H
H2*, H-L*, L-0*	0

1. * 0-L, H2, H-L, L-0 are followed by 0 before kãʔ L-M.
2. Only some morphemes underdo sandhi: *ʔĩ* "3s" but not *kãʔ* L-M "previously mentioned 3s".

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Tone sandhi in Chatino of San Juan Quiahije: More data

verb gloss	isolation	"tortilla" jha	"epazote"
"I picked"	stõ L	stõ L jha L	stõ L whe L
"You picked"	stõ M-H	stõ M-H jha L	stõ M-H whe L
"he/she picked"	stõ L-M	stõ L-M jha L	stõ L-M whe L
"you ground"	jo H	jo H jha M-L	jo H whe L
"he/she swept"	kwa M+	kwa M+ jha M-L	kwa M+ whe L
"you will grind"	ko M-0	ko M-0 jha M-L	ko M-0 whe L
"he/she ground"	jo M	jo M jha H	jo M whe L
"he/she will pick"	stõ M	stõ M jha H	stõ M-L whe L
"making"	nja H	nja H jha 0	nja H-0 whe L
"I ground"	jo L-0	jo L-0 jha 0	jo L-0 whe L
"we will pick"	stõ H-L	stõ H-L jha 0	stõ ML whe L

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"you will grind"	ko M-0	ko M-0 jha M-L	ko M-0 whe L
"he/she ground"	jo M	jo M jha H	jo M whe L
"he/she will pick"	stõ M	stõ M jha H	stõ M-L whe L
"making"	nja H	nja H jha 0	nja H-0 whe L
"I ground"	jo L-0	jo L-0 jha 0	jo L-0 whe L
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"I picked"	stõ L	stõ L jha L	stõ L whe L
"You picked"	stõ M-H	stõ M-H jha L	stõ M-H whe L
"he/she picked"	stõ L-M	stõ L-M jha L	stõ L-M whe L
"you ground"	jo H	jo H jha M-L	jo H whe L
"he/she swept"	kwa M+	kwa M+ jha M-L	kwa M+ whe L
"you will grind"	ko M-0	ko M-0 jha M-L	ko M-0 whe L
"he/she ground"	jo M	jo M jha H	jo M whe L
"he/she will pick"	stõ M	stõ M jha H	stõ M-L whe L
"making"	nja H	nja H jha 0	nja H-0 whe L
"I ground"	jo L-0	jo L-0 jha 0	jo L-0 whe L
"we will pick"	stõ H-L	stõ H-L jha 0	stõ ML whe L

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"he/she swept"	kwa M+	kwa M+ jha M-L	kwa M+ whe L
"you will grind"	ko M-0	ko M-0 jha M-L	ko M-0 whe L
"he/she ground"	jo M	jo M jha H	jo M whe L
"he/she will pick"	stõ M	stõ M jha H	stõ M-L whe L
"making"	nja H	nja H jha 0	nja H-0 whe L
"I ground"	jo L-0	jo L-0 jha 0	jo L-0 whe L
"we will pick"	stõ H-L	stõ H-L jha 0	stõ ML whe L

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"you will grind"	ko M-0	ko M-0 jha M-L	ko M-0 whe L
"he/she ground"	jo M	jo M jha H	jo M whe L
"he/she will pick"	stõ M	stõ M jha H	stõ M-L whe L
"making"	nja H	nja H jha 0	nja H-0 whe L
"I ground"	jo L-0	jo L-0 jha 0	jo L-0 whe L
"we will pick"	stõ H-L	stõ H-L jha 0	stõ ML whe L

jha "tortilla" is toneless, but *whe* "epazote" is L.

Tone sandhi in Chatino of San Juan Quiahije: Even more data

1. “two tortillas” tkwa M-L jha M-L, cf. ka M-L ʔĩ M-L “his nine”
2. “twenty tortillas” kla M-L jha M-H

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   cf. ka M-L ʔĩ̃ M-L "his nine"
2. "twenty tortillas" kla M-L jha M-H

Tone sandhi in Chatino of San Juan Quiahije: Full description

Noun's tone	ʔĩ's tone
0, L, M-H, L-M	L
H1, M+, M-0, M-L1, 0-L*	M-L
M-L2	M-H
M	H
H2, H-L, L-0	0

Only toneless morphemes underdo sandhi: *ʔĩ* "3s", *jha* "tortilla' but not *kãʔ* L-M "previously mentioned 3s", *whe* L "epazote".

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M-L2	M-H
M	H
H2, H-L, L-0	0

Only toneless morphemes underdo sandhi: *ʔĩ* "3s", *jha* "tortilla' but not *kãʔ* L-M "previously mentioned 3s", *whe* L "epazote".

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M	H
H2, H-L, L-0	0

Only toneless morphemes underdo sandhi: *ʔĩ̃* "3s", *jha* "tortilla' but not *kãʔ* L-M "previously mentioned 3s", *whe* L "epazote".

Tone sandhi in Chatino of San Juan Quiahije: Sketch of an analysis

1. Floating tones:
   a. Super-Hs = +0: H2 = H+0, H-L = H-L+0, L-0 = L-0+0,
   b. +H: M = M+H,
   c. Associate to following toneless syllables,
   d. +0s associate to source if following syllable is specified for tone,
   e. +Hs disappear before specified syllables;
2. Insertions on following toneless syllables:
   a. H1, M+, M-0, M-L1, 0-L insert M-L,
   b. Alternatively, the sandhi tone is uniformly L, and in:
      i. H-M-L, M-[ ]-M-L, M-0-M-L the apparent M is transitional/coarticulatory,
      ii. M-L1-M-L, or L-M-L, the M is phonetic and derivative only,
   c. M-L2 inserts M-H ;
3. Toneless syllables default to L otherwise.

Tone sandhi in Chatino of San Juan Quiahije: Sketch of an analysis

1. Floating tones:
   a. Super-Hs = +0: H2 = H+0, H-L = H-L+0, L-0 = L-0+0,
   b. +H: M = M+H,
   c. Associate to following toneless syllables,
   d. +0s associate to source if following syllable is specified for tone,
   e. +Hs disappear before specified syllables;
2. Insertions on following toneless syllables:
   a. H1, M+, M-0, M-L1, 0-L insert M-L,
   b. Alternatively, the sandhi tone is uniformly L, and in:
      i. H-M-L, M-[-M-L, M-0-M-L the apparent M is transitional/coarticulatory,
      ii. M-L1, M-L, or L-M, the M is phonetic and demands survival,
   c. M-L2 inserts M-H ;
3. Toneless syllables default to L otherwise.

Tone sandhi in Chatino of San Juan Quiahije: Sketch of an analysis

1. Floating tones:
   a. Super-Hs = +0: H2 = H+0, H-L = H-L+0, L-0 = L-0+0,
   b. +H: M = M+H,
   c. Associate to following toneless syllables,
   d. +0s associate to source if following syllable is specified for tone,
   e. +Hs disappear before specified syllables;
2. Insertions on following toneless syllables:
   a. H1, M+, M-0, M-L1, 0-L insert M-L,
   b. Alternatively, the sandhi tone is uniformly L, and in:
      i. H-M-L, M-[ ]-M-L, M-0-M-L the apparent M is transitional/coarticulatory,
      ii. M-L1-M-L, or M-[ ]-M-L the M is underlying and remains audible,
   c. M-L2 inserts M-H ;
3. Toneless syllables default to L otherwise.

Tone sandhi in Chatino of San Juan Quiahije: Sketch of an analysis

1. Floating tones:
   a. Super-Hs = +0: H2 = H+0, H-L = H-L+0, L-0 = L-0+0,
   b. +H: M = M+H,
   c. Associate to following toneless syllables,
   d. +0s associate to source if following syllable is specified for tone,
   e. +Hs disappear before specified syllables;
2. Insertions on following toneless syllables:
   a. H1, M+, M-0, M-L1, 0-L insert M-L,
   b. Alternatively, the sandhi tone is uniformly L, and in:
      i. H-M-L2, M+-M-L2, M-0-M-L2 the apparent M is transitional/coarticulatory,
      ii. M-L1, M-L2, or M-L3, the M is underlying and remains surface,
   c. M-L2 inserts M-H ;
3. Toneless syllables default to L otherwise.

Tone sandhi in Chatino of San Juan Quiahije: Sketch of an analysis

1. Floating tones:
   a. Super-Hs = +0: H2 = H+0, H-L = H-L+0, L-0 = L-0+0,
   b. +H: M = M+H,
   c. Associate to following toneless syllables,
   d. +0s associate to source if following syllable is specified for tone,
   e. +Hs disappear before specified syllables;
2. Insertions on following toneless syllables:
   a. H1, M+, M-0, M-L1, 0-L insert M-L,
   b. Alternatively, the sandhi tone is uniformly L, and in:
      i. H-M-L2, M+, M-L, M-0, M-L, the apparent M is transitional/coarticulatory,
      ii. M-L1, M-L, or M-L, the M is underlying and remains surface,
   c. M-L2 inserts M-H ;
3. Toneless syllables default to L otherwise.

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   b. Alternatively, the sandhi tone is uniformly L, and in:
      i. H M-L, M+ M-L, M-0 M-L, the apparent M is transitional/coarticulatory,
      ii. M-L1 M-L, 0-L M-L, the M is epenthetic and demarcative,
   c. M-L2 inserts M-H ;
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Tone sandhi in Chatino of San Juan Quiahije: Sketch of an analysis

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Chatino tonal inventory: 12 tones (incomplete!)

1. Float: H+0, H-L+0, L-0+0, M+H,
2. Insert: H, M+, M-0, M-L(M-L), 0-L,
3. Insert: M-L(M-H)
4. L
5. Toneless

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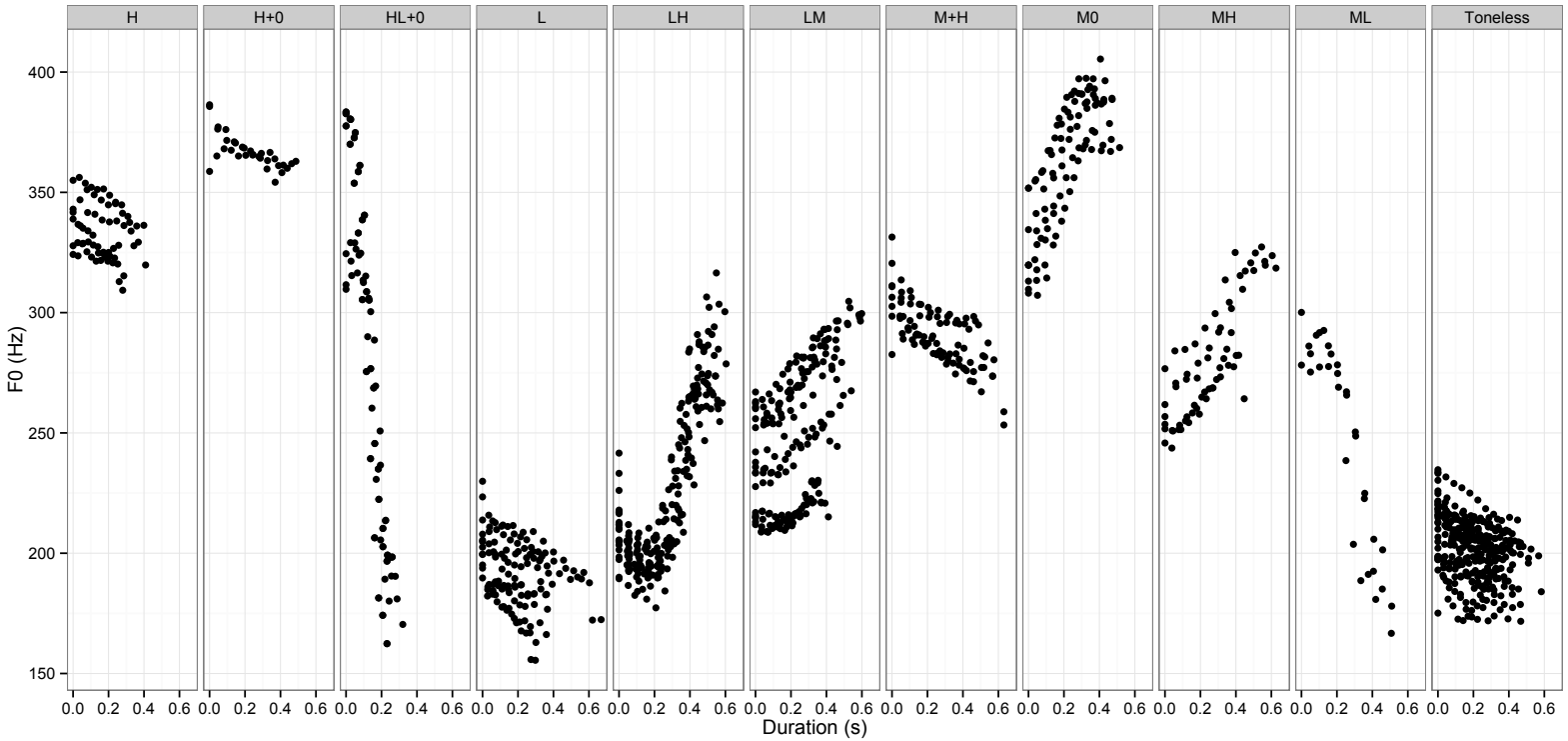

Outline

Coda laryngeal constraints on tone distributions in Triqui languages (Di Canio, 2008)

Tone	CV			CV?			CVh		
	Itun	Cop	Chic	Itun	Cop	Chic	Itun	Cop	Chic
5**	0*	+	+	0	+	−	0	+	−
4	+	+	+	+	+	+	+	−	+
3	+	+	+	+	+	+	+	+	+
2	+	+	+	+	+	+	+	+	+
1	+	+	+	+	+	+	+	+	+
35**	−	0	0	−	0	0	+	0	0
23	0	0	+	0	0	−	0	0	+
13	−	−	+	−	+	−	+	−	+
43	+	0	+	−	0	−	−	0	+
32	+	+	+	−	−	+	+	+	+
31	+	0	+	−	0	+	−	0	−
21	0	0	+	0	0	+	0	0	+

* 0 = doesn't occur in that languages; ** Itun 35 is cognate with Cop, Chic 5; Itun(yoso), Cop(ala), Chic(ahuaxtla).

Coda laryngeal–tone constraints in Triqui: Generalizations

1. Rising tones:
   a. Itunyoso (35, 13) and Chicahuaxtla (23, 13) only –h,
   b. Copala (13) only –ʔ;
2. Falling tones:
   a. Itunyoso only 32 –h, 43, 31 only when no –h, –ʔ,
   b. Chicahuaxtla 32, 31, 21 –ʔ, 42, 32, 21 –h,
   c. Copala 32 only –h;
3. Itunyoso: –h permits rising F0, –ʔ blocks any F0 change;
4. Copala: –ʔ permits rising F0, –h permits falling F0;
5. Chicahuaxtla: –h, –ʔ permit rising, falling F0 – only one rising (23) and one falling (43) tone are absent –ʔ and only one falling (31) tone –h;
6. Cf. Athabaskan tonogenesis (Krauss, 2005; Kingston, 2005).

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6. Cf. Athabaskan tonogenesis (Krauss, 2005; Kingston, 2005).

Coda laryngeal–tone constraints in Triqui: Generalizations

1. Rising tones:
   a. Itunyoso (35, 13) and Chicahuaxtla (23, 13) only –h,
   b. Copala (13) only –ʔ;
2. Falling tones:
   a. Itunyoso only 32 –h, 43, 31 only when no –h, –ʔ,
   b. Chicahuaxtla 32, 31, 21 –ʔ, 42, 32, 21 –h,
   c. Copala 32 only –h;
3. Itunyoso: –h permits rising F0, –ʔ blocks any F0 change;
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Diachronic analogue in Mixtec (Dürr, 1987; Hinton, et al., 1991; Daly & Hyman, 2007

Proto-Mixtec	*H-H	*H-H?	*L-L	*L-L?
Molinos	M-M	M-M+(M)	L-L	M-M+(M)
S Miguel el Grande	M-M	M-M+(M)	M-L	M-L+(M)
Silacayoapan	M-M	H-L	L-L	L-L
Alacatlazala	M-M	M-L	L-L	L-L
Mixtepec	M-M	M-H / ML-LH	L-L	L-H / L-LH

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*? > floating:

H tone in Chalcotongo,

L in Penoles (all other tone correspondences inverted).

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Mixtepec	M-M	M-H / ML-LH	L-L	L-H / L-LH
	*ʔ raised 2nd σ to H in CVʔV/to LH in CVCV			

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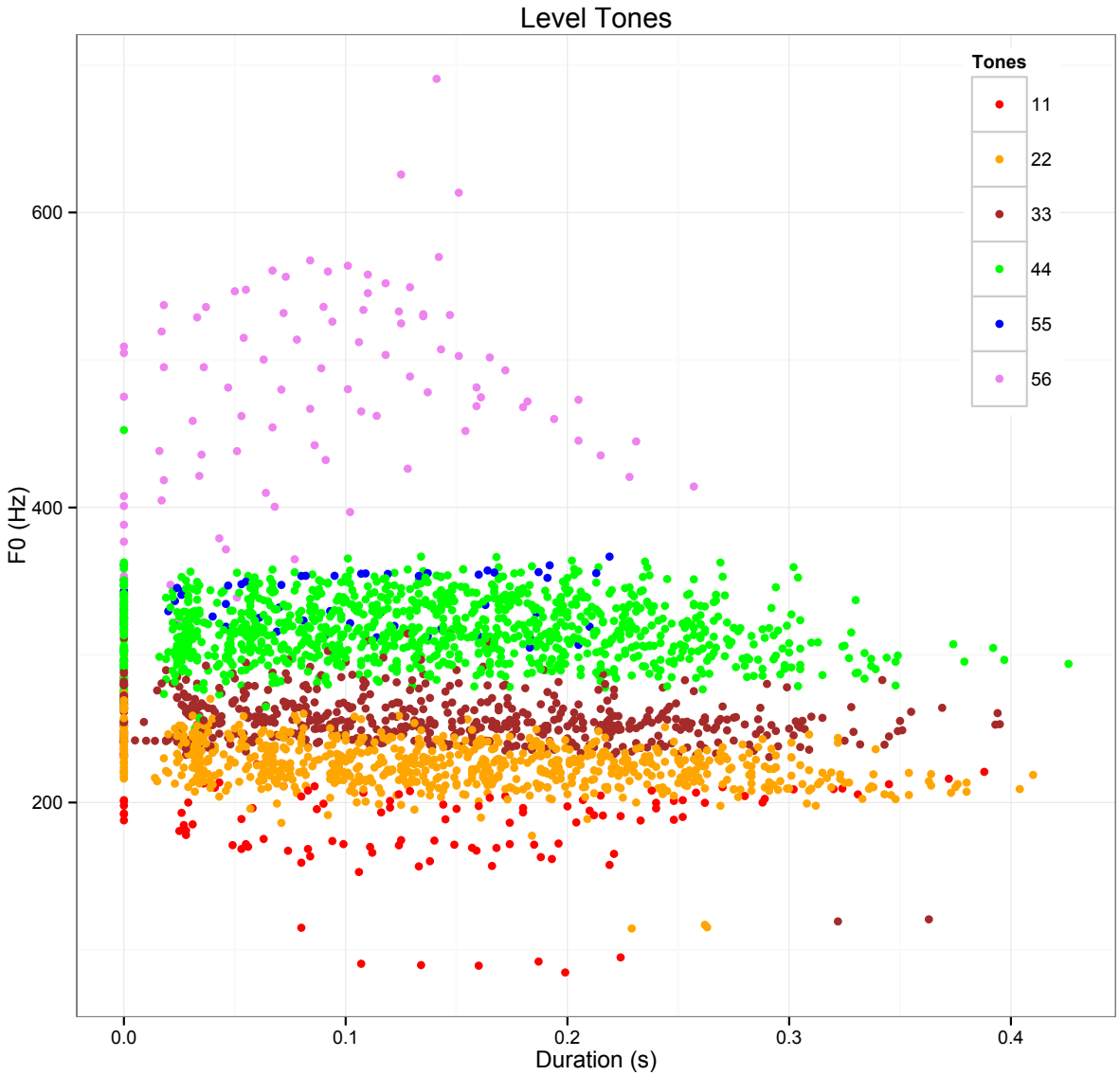
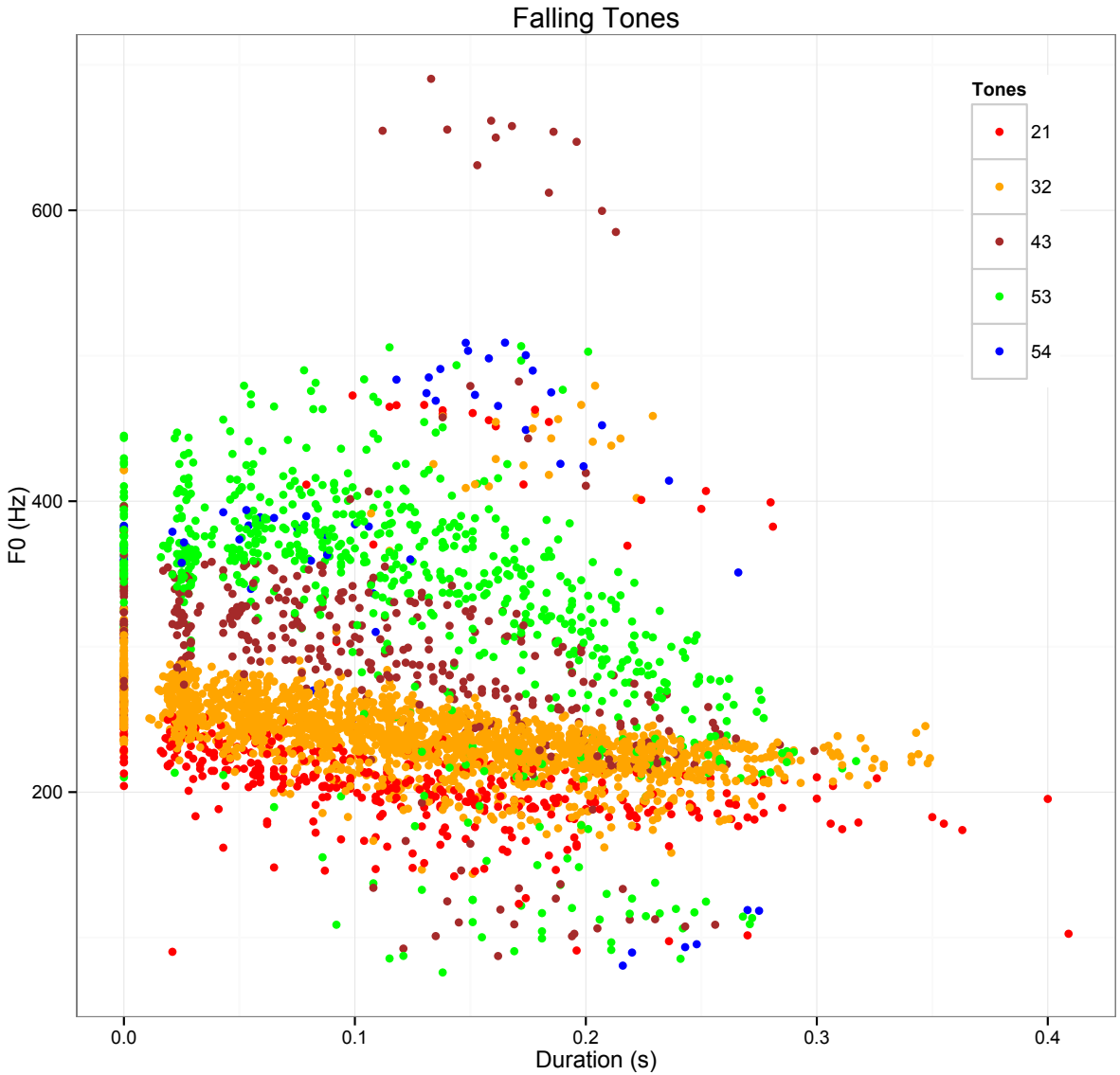
Outline

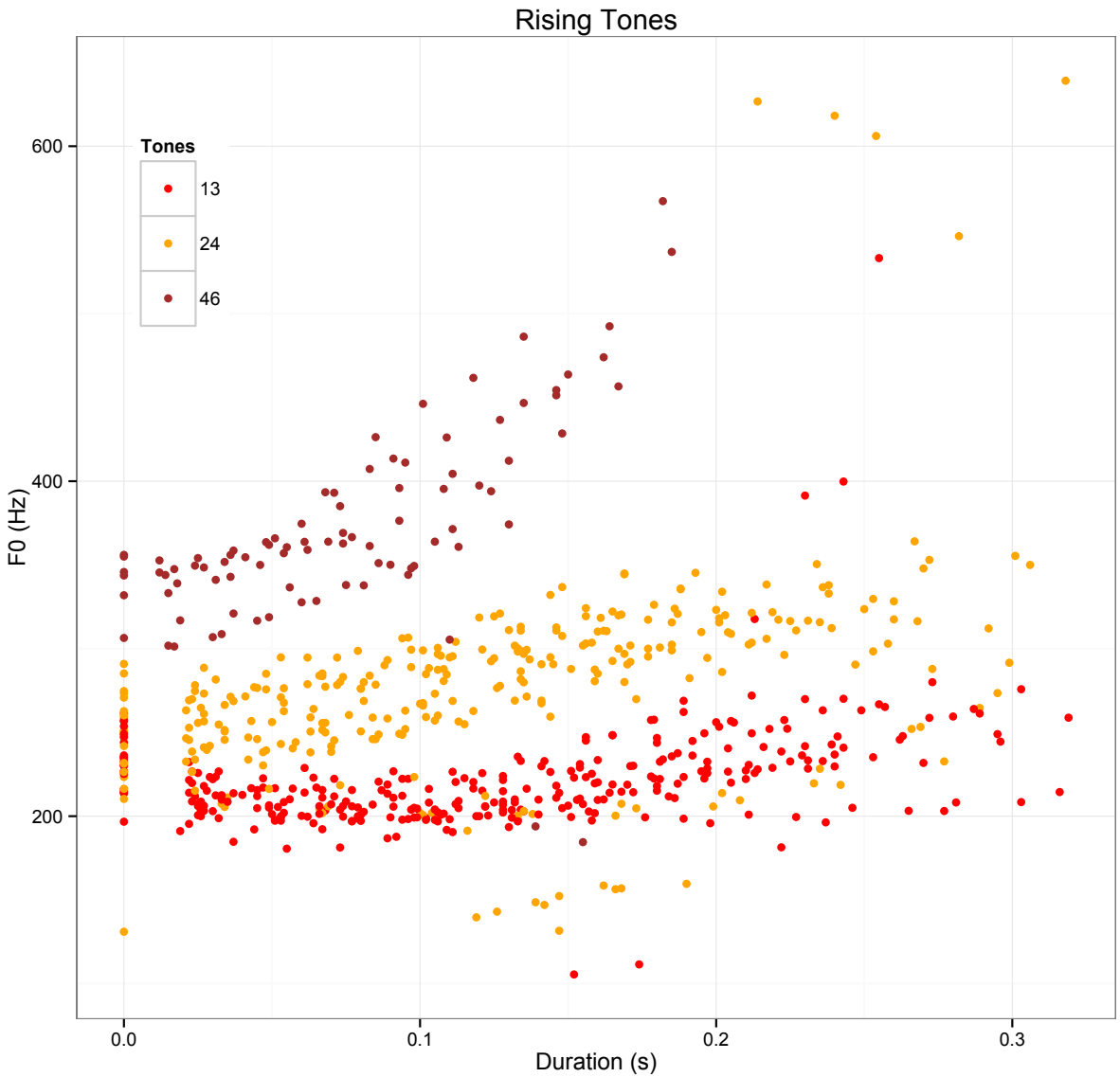
Level tones in Chinanteco of San Antonio Analco: 5 (6?)



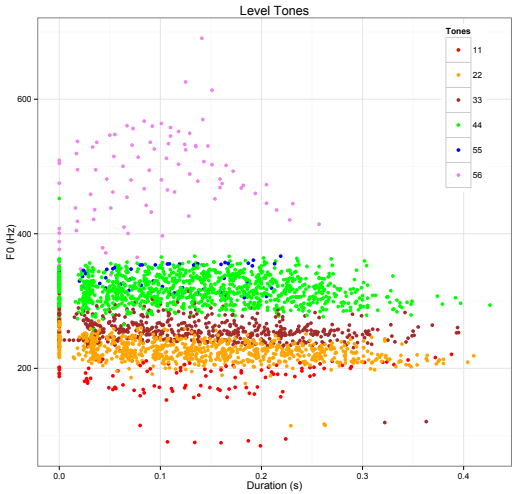
Falling tones in Chinanteco of San Antonio Analco: 4 (5?)

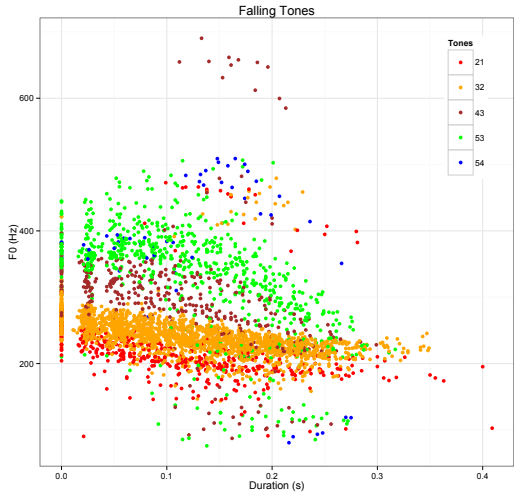


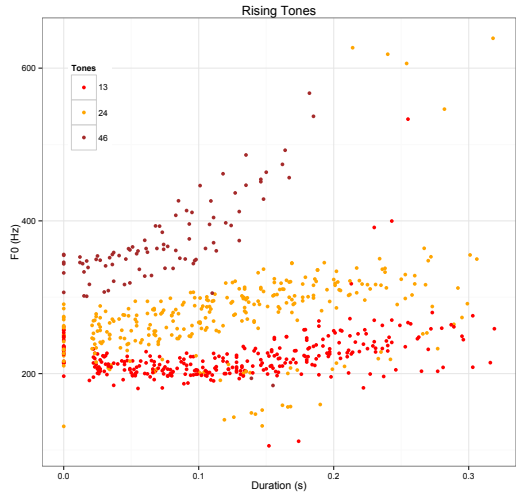
Rising tones in Chinanteco of San Antonio Analco: 3



All tones in Chinanteco of San Antonio Analco: 12 (14?)







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Estimate of number of tones in Chinanteco of San Juan Quiotepec

1. 5+1 level,
2. 3 or 4 falling,
3. 3 or 4 rising,
4. 2 concave,
5. Total: 13-15.
6. Cf. Castillo (2012), Castellanos (2014): 6 levels, 3 falling, 3 rising, plus some number of complex (concave, convex) tones.

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Automation and confirmation

Following Shosted, Wu, and Goldrich (2104)

1. Single male speaker, Chinanteco of San Juan Quiotepec,
2. 141 lexical items, $\approx$ 3 repetitions in isolation each, 444 utterances altogether,
3. F0 at all 10% points of rime,
4. 15 hypothesized tone categories (see above),
5. Principal components analysis of unnormalized F0 contours (cf. Shosted, et al., who normalized),
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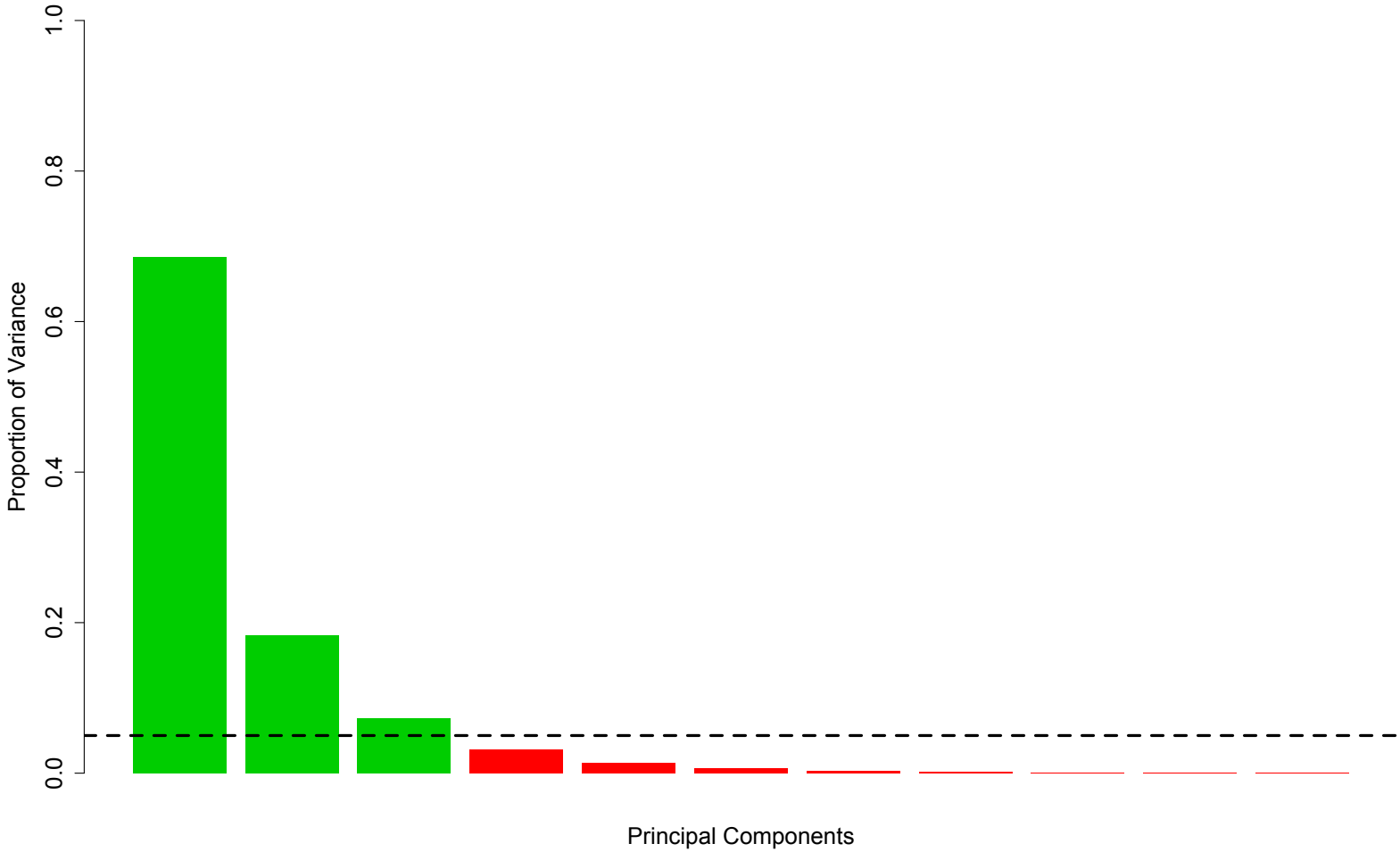
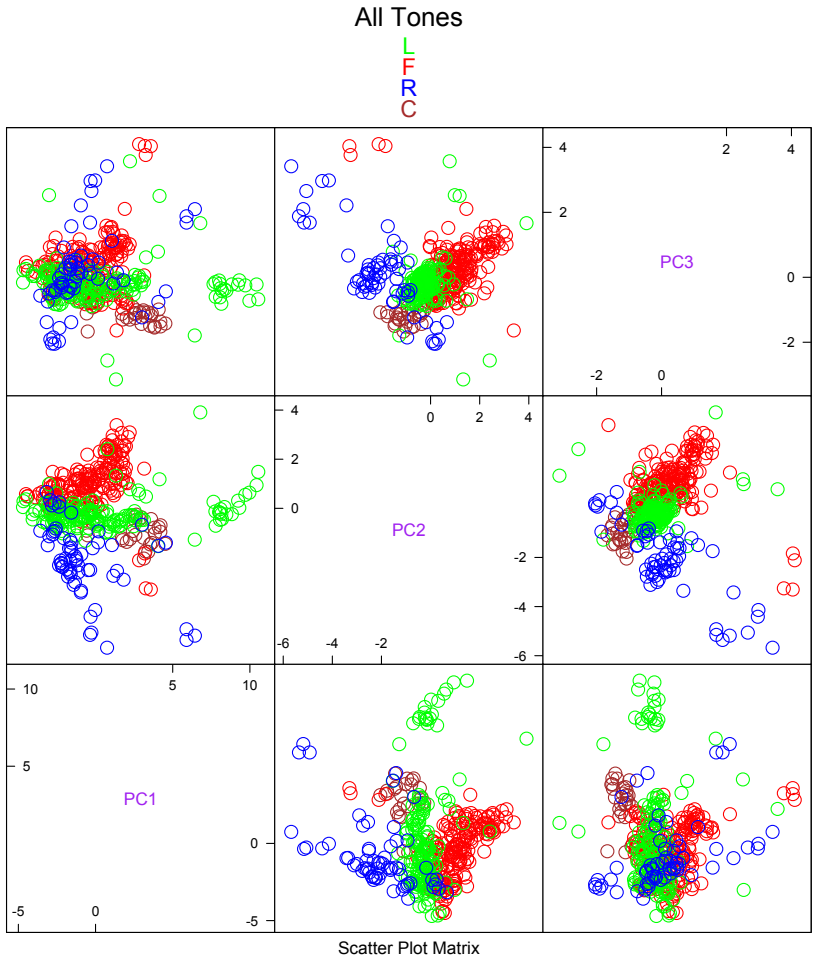
Outline

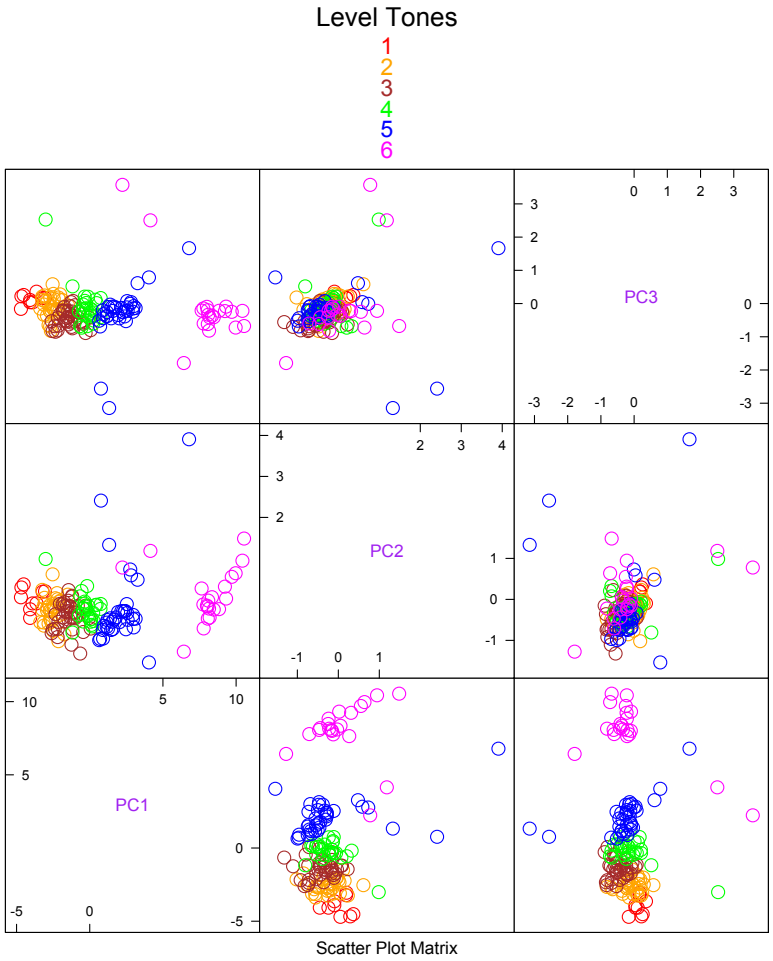
Principal components: Proportion of variance accounted for



First 3 principal components: All tones



First 3 principal components: Falling tones



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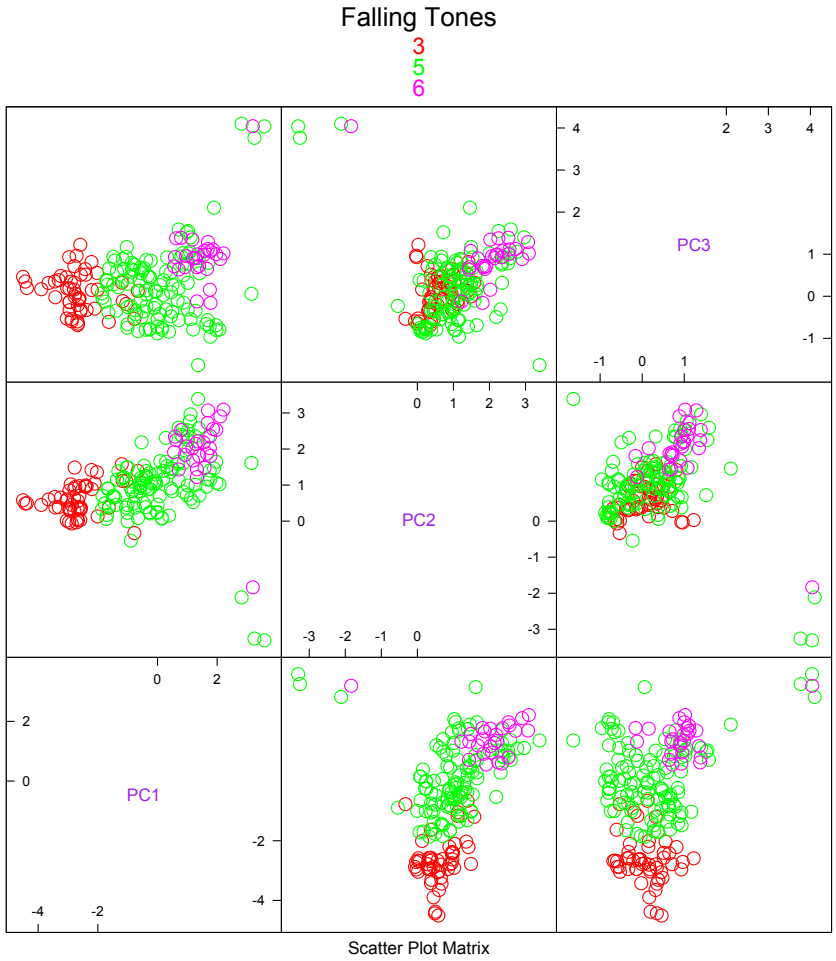
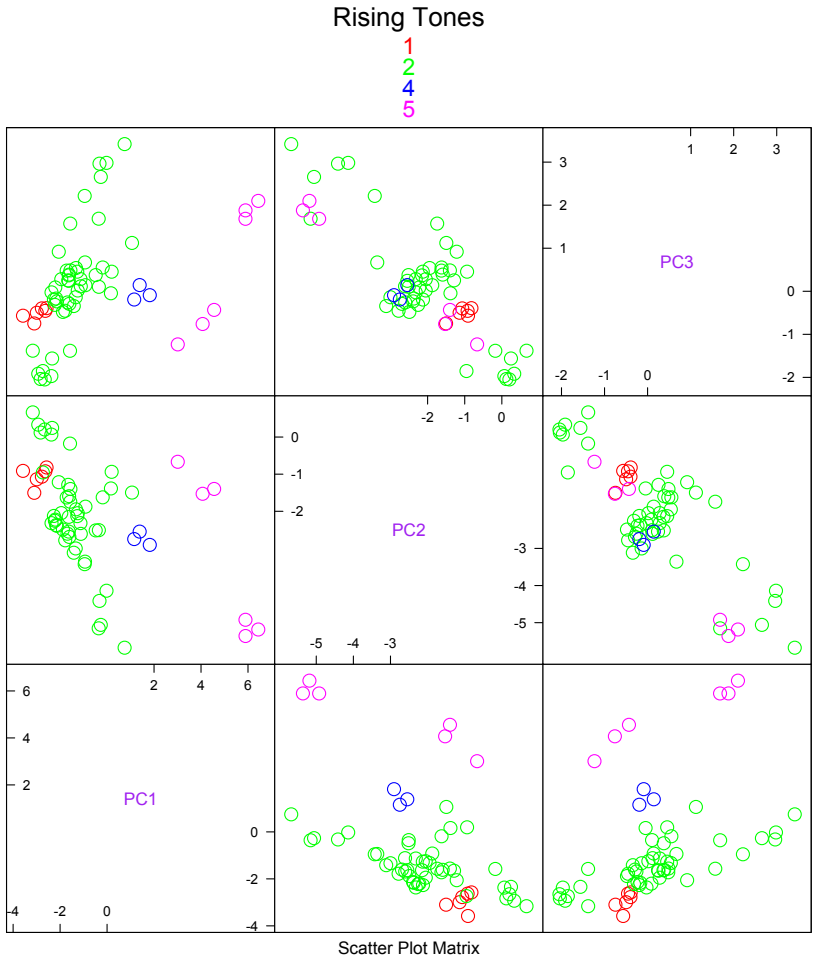
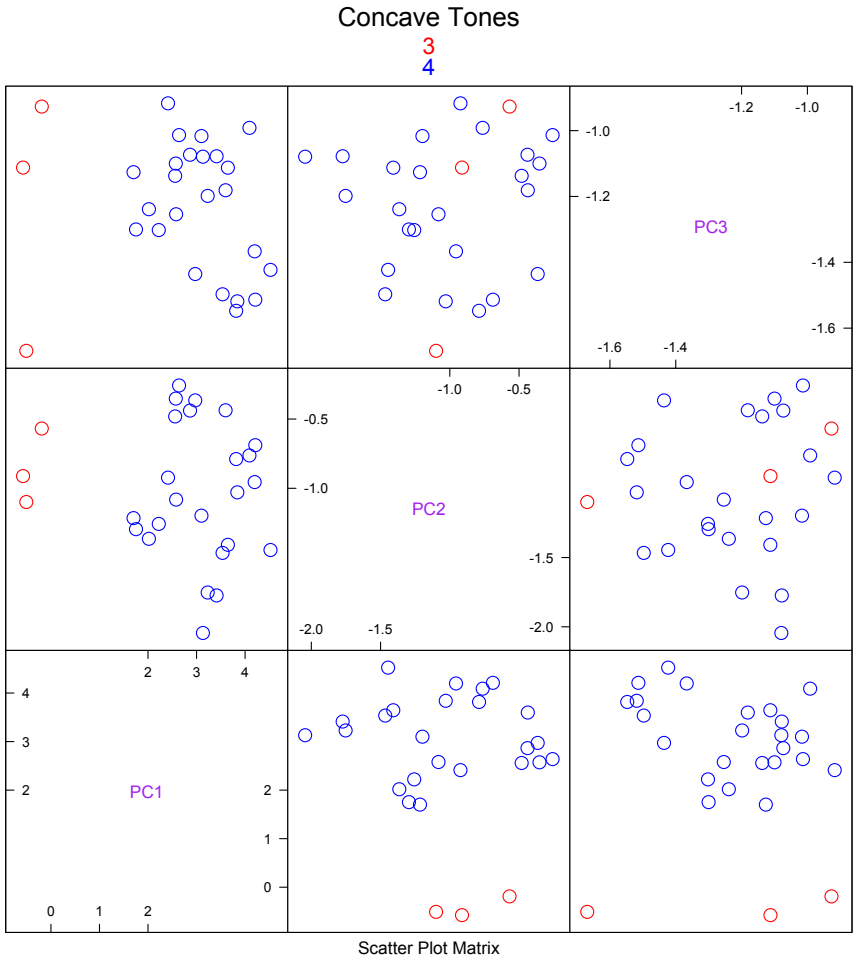


First 3 principal components: Rising tones

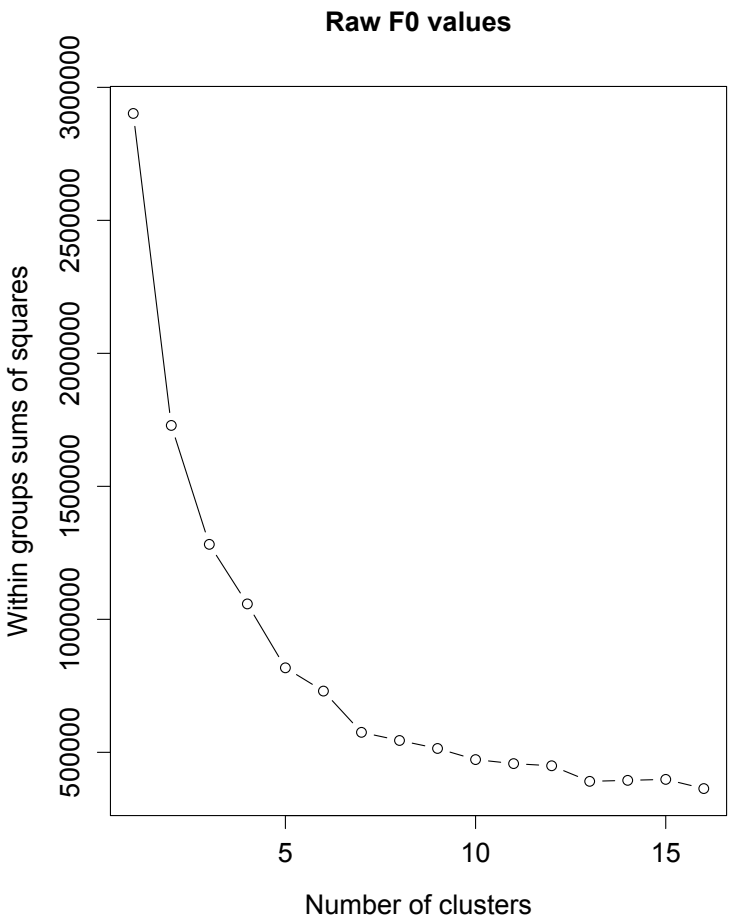


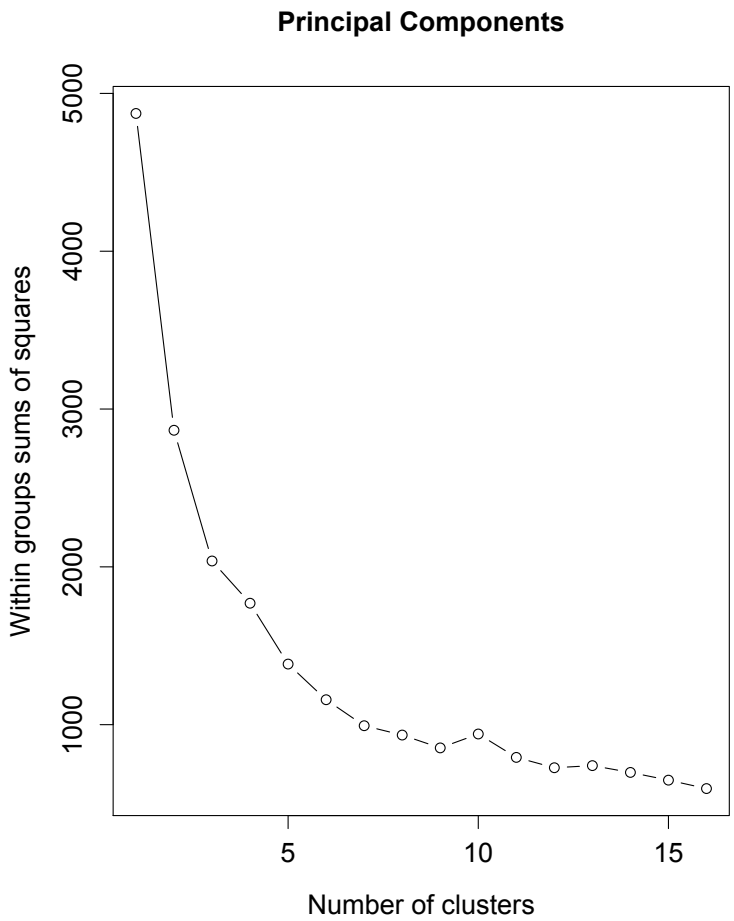
First 3 principal components: Concave tones



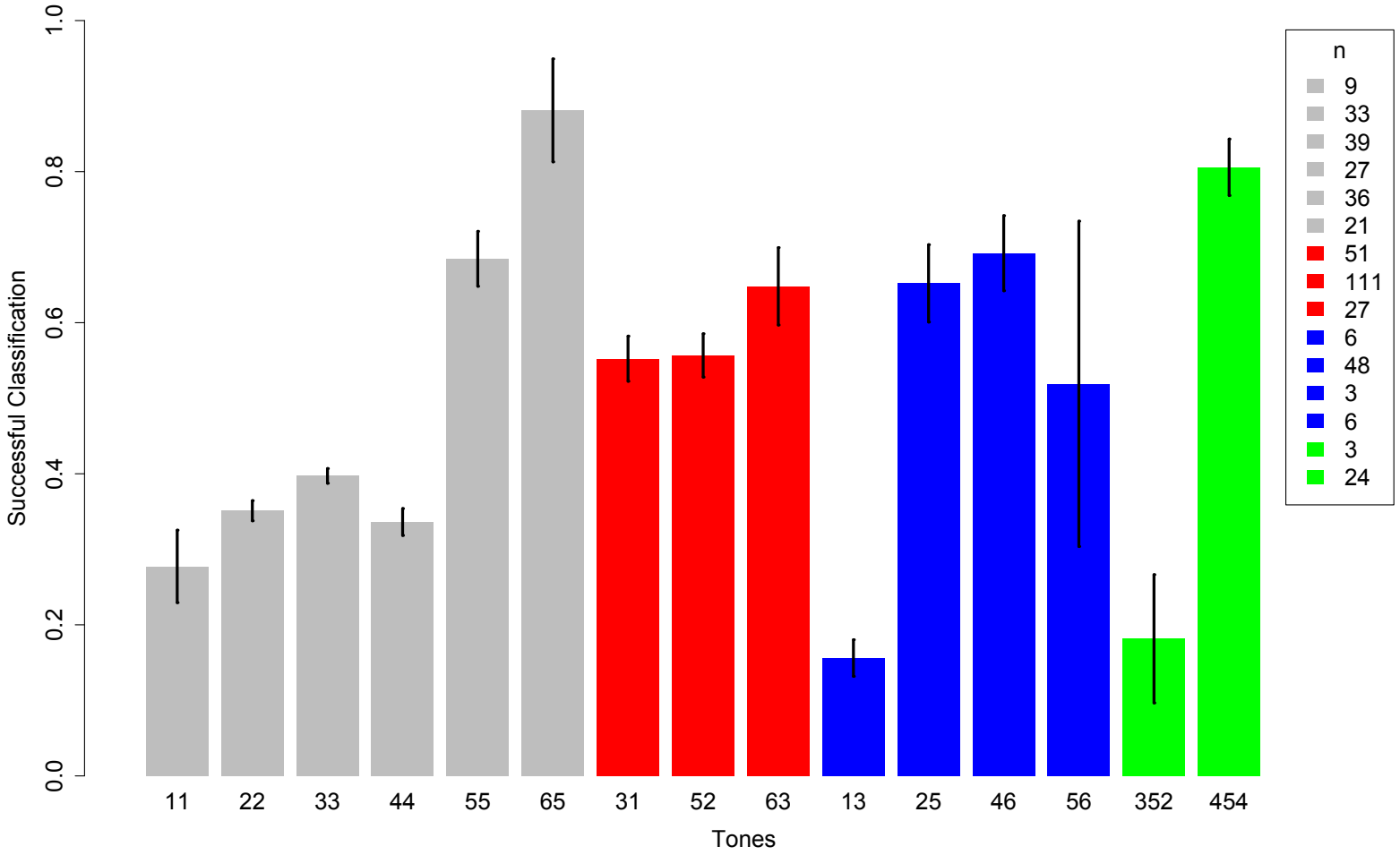
Outline

Discriminant analysis = k-means: Number of clusters





Discriminant analysis: Correctly classified from PCs by tone



Discriminant analysis: Predicting test classification from training

1. Repeatedly divided data into non-overlapping training and test halves,
2. Extracted principal components from training and test halves separately,
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4. Used results to predict classification into *a priori* tones in terms of principal components extracted from the test half,
5. Result: Roughly half the test set's tones predicted correctly,
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Hope: Proving that Hyman (2010) is wrong to argue that there are no features for tones.

Summary

1. Otomanguean languages' tone systems are quite varied;
2. Typological challenges:
   a. Rising tone favored over falling;
   b. Too many contrasting tones;
3. Tone sandhi is both concrete and arbitrary, is a partial source of multiplying contrasts, but only a partial one;
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Acknowledgments

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