ON THE REPRESENTATION OF TONE IN PEÑOLES MIXTEC[1]

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This paper presents a systematic account of the tone system of Peñoles Mixtec (PM). While /H/ and /L/ tones are unambiguously needed in underlying representations, we argue that the third tone is not /M/ but must rather be underspecified as /∅/. Perhaps the most interesting of the several arguments presented is that strings of /∅/ tone-bearing units are invisible to a process which deletes the second /L/ of a /L-∅*-L/ sequence. We propose that all /L/ tones are underlying floating and that /L/ rather than /H/ is the marked tone in this three-value system. The surface mid and low-falling pitches in outputs are shown to derive by a small number of realizational rules, which also are responsible for producing successively upstepped H tones. The PM tone system is unusually interesting both from a general tonological perspective as well as for its relation to Dürr's (1987) Proto-Mixtec tones which have the inverted values in PM.

[KEYWORDS: underspecification, markedness, obligatory contour principle, upstepping, floating tones]

1. Introduction. The complexity of Mixtec tone systems has been recognized for some time. Following Kenneth Pike's (1944; 1948) pioneering work on San Miguel El Grande dialect, there has been a steady succession of descriptive studies on other Mixtec languages and dialects. These studies have revealed a wide range of tonal variation which has great significance not only for the understanding of Mixtec but of tone systems in general. Among the striking tonal properties that have been discovered are unusual register effects, e.g., the iterative upstep of high tones in Acatlán (Pike and Wistrand 1974 and Aranovich 1994) and the nonlocal linking of floating tones, e.g., in San Miguel el Grande (Goldsmith 1990, Tranel 1995, and Hollenbach 2000) and Chalcatongo (Hinton et al. 1991 and Macaulay 1996).

[1] This paper results from a collaboration between the first author, who has worked extensively on Peñoles Mixtec since 1957, and the second, who directed a reading group on Mixtec tone at UC Berkeley in Spring 2005. The analysis builds on the essential insights of the first author's writings, especially Daly (2000), which is superseded by this paper. We are grateful to Margaret Daly, the native speakers with whom John and Margaret Daly have worked, and the participants in the Berkeley reading group for their generous contributions to our understanding of Peñoles Mixtec tone and Mixtec in general. We also thank Heriberto Avelino and Andrew Black for their input and technical help concerning the Peñoles Mixtec lexical data base and recordings and their interpretation.

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Most Mixtec languages are characterized by complex phrasal morphotonemics whereby the tones of a word undergo alternations based on the tones of the preceding word. In some variants of Mixtec, e.g., Ayutla (Pankratz and Pike 1967), the glottal properties of the first word or the syllable structure of the second may determine whether a tonal modification will occur and, if so, how it will be realized. In many cases one cannot predict which occurrences of a specific tone will trigger vs. not trigger tonal alternations. These discoveries have led to some rather unusual proposals, e.g., concerning Diuxi, which Pike and Oram (1976) analyze with multiple stresses and Daly (1978) with a cover feature [±modify]. There seems to be a growing consensus that the observed alternations require the positing of floating tones: Floating Hs have been proposed for San Miguel el Grande and Chalcatongo, floating Ls for Peñoles (Daly 2000), and both floating Hs and Ls for Magdalena Peñasco (Hollenbach 2000). That floating Ms have only marginally been needed is consistent with the view that mid tone is often unmarked, if not underspecified in three-level tone systems (Maddieson 1978 and Pulleyblank 1986), including Mixtec (Tranel 1995).

In this study we provide an analysis of the tone system of Peñoles Mixtec (Eastern Mixtec), building on Daly (1977; 1992; 1993; 2000). As will be seen, all of the issues mentioned in the previous paragraph arise in this language: Successive input H tones may be upstepped as in Acatlán, floating L tones may be linked nonlocally, and would-be M tone is underlyingly /Ø/ (underspecified). Of considerable interest is the skeleton-insensitive Obligatory Contour Principle (OCP) constraint *LL, which is responsible for the long-distance deletion of the second of two L tones in a L-Ø*-L sequence. While the underlying system consists of a contrast between /H/, /L/, and /Ø/, pitch realization rules produce high-rising, low-falling, and mid output tones. Whereas Coatzospan has the more usual opposition between H and (downstepped) $^{\downarrow}$H tones (Pike and Small 1974), Peñoles contrasts H vs. $^{\uparrow}$H and M and $^{\downarrow}$M tones on the surface.

In **2** we illustrate the lexical tone patterns which are analyzed in terms of underlying linked /H/, unlinked /L/, and /Ø/. In **3** we present phonological arguments in favor of representing the third tone as /Ø/ rather than /M/. The justification of /Ø/ is continued in **4**, which describes the surface tone realizations. In **5** we present further alternations concerning /L/ tone, while in **6** we introduce the rule of H tone spreading, which applies in specific constructions. A summary and discussion of further implications appear in **7**.

2. Lexical tone patterns. In this section we present the basic tone system of Peñoles Mixtec (henceforth, PM). Central to the analysis is the minimal phonological word, a binary constituent known as a couplet in traditional studies of Mixtec. The couplet normally consists of a root having one of the following shapes: CVCV, CVV, VCV, VV. Stress is on the first (C)V. Since there are no couplets of the shape CVVCV or CVCCV (there is no evidence that the ʔ of CVʔCV couplets occupies a skeletal slot), there is some indeterminacy about whether the couplet should be referred to as consisting of two moras or two syllables. The couplet may be preceded or followed by monosyllabic morphemes which are dependent on the root. In this study, we shall refer to those which precede the root as proclitics and those which follow the root as enclitics.

In PM, each V is an independent tone-bearing unit (TBU). However, not every TBU is underlyingly specified for tone. Rather, the analysis for which we present evidence in this study recognizes two underlying tones, /H/ and /L/ (high and low), which contrast with /Ø/ (absence of lexical tone). Although analyses of other Mixtec languages have often identified the third tone as /M/ (mid), the interpretation of /Ø/ as /M/ creates complexities in stating the phonological properties of /Ø/ as well as its phonetic realization in PM. We address these issues in **3** and **4** below. For present purposes, suffice it to say that /H/ varies between high and mid pitch, /L/ is realized on a level low pitch, and /Ø/ varies between level mid and falling low pitch.

To begin, we illustrate the majority tone patterns found on nouns in (1):

(1) Majority tone patterns on nouns

(1*a*)	/H-H^{L}/	*ñáñá*	'coyote'	*díʔú^{N}*	'money'
		šéčí	'girl'	*žúú*	'rock'
(1*b*)	/H-Ø/	*k^{w}éñu*	'squirrel'	*žóʔo*	'root'
		sánu	'daughter-in-law'	*déʔe*	'offspring'
(1*c*)	/Ø-H/	*idú*	'deer'	*iná*	'dog'
		ditó	'uncle'	*kaá*	'ax'
(1*d*)	/Ø-Ø/	*kɨtɨ*	'animal'	*nduʔu*	'tree trunk'
		kolo	'male.turkey'	*nduu*	'day'
(1*e*)	/Ø-Ø^{L}/	*nǰuši*	'chicken'	*doko*	'well'
		tɨñɨ	'mouse'	*kada*	'son-in-law'

Two facts are striking about the above tone patterns: (*i*) the two TBUs show all four combinations of /H/ and /Ø/; and (*ii*) all /H-H/ nouns and some /Ø-Ø/ nouns are followed by a floating L tone, indicated by the superscript ^{L}. (The superscript ^{N} indicates nasalization.)

The evidence for this floating L is seen when another word follows. In (2), the word *ditó* 'uncle' has underlying /Ø-H/ tone:

(2) Noun + /ditó/ 'uncle'

(2*a*)	/H-H^L/	*ñáñá*	*dìtó*	'uncle's coyote'
(2*b*)	/H-∅/	*kʷéñu*	*ditó*	'uncle's squirrel'
(2*c*)	/∅-H/	*idú*	*ditó*	'uncle's deer'
(2*d*)	/∅-∅/	*kɨtɨ*	*ditó*	'uncle's animal'
(2*e*)	/∅-∅^{L}/	*nǰuši*	*dìtó*	'uncle's chicken

However, as seen in (2*a*) and (2*e*), when *ditó* follows a /H-H^L/ or /∅-∅^{L}/ noun, it is realized as *dìtó*. While all H-H nouns have a floating L, /H-H/ is found without a floating L in other parts of speech (cf. 8 below). The contrast in (2*d*) and (2*e*) shows that the presence vs. absence of floating L is not predictable on ∅-∅ nouns, which are phonetically identical in isolation.

The examples in (3) show how each of the five tone patterns in (1) is realized after the floating L tone of /doko`/ 'well':

(3) /doko`/ 'well' + majority noun tone patterns

(3*a*)	/H-H^L/	*doko*	*ñǎñá`*	'coyote's well'
(3*b*)	/H-∅/	*doko*	*kʷěñu*	'squirrel's well'
(3*c*)	/∅-H/	*doko*	*ìdú*	'deer's well'
(3*d*)	/∅-∅/	*doko*	*kɨ̀tɨ*	'animal's well'
(3*e*)	/∅-∅^{L}/	*doko*	*nǰ̀uši*	'chicken's well'

The realizations in (3*a*) and (3*b*) show that the initial /H/ of the second noun becomes a LH rising tone (ˇ) as a result of the floating L, while those in (3*c*)–(3*e*) show that an initial /∅/ is realized as L. These changes are effected by linking the floating L to the following TBU. We shall refer to this process as L tone association (LTA). As indicated, the second noun /ñáñá`/ 'coyote' retains its final floating L in its derived form *ñǎñá`* in (3*a*), whereas the second noun /nǰuši`/ 'chicken' does not. This is due to a rule of L tone deletion discussed in **3.2** below.

Since there is a contrast between /H-∅/ and /∅-H/, the /H/ must be prelinked to its respective TBU, as in (4*a*) and (4*b*).

```
(4a) σ   σ
     |
     H

(4b) σ   σ
         |
         H
```

```
(4c) σ   σ
      \ /
       H   L

(4d) σ    σ

          L
```

One can also assume that /H-H/ consists of a single H prelinked to both TBUs, as in (4*c*). The data in (2) and (3) justify the need for a floating L which can follow /H-H/, as in (4*c*), and /$\emptyset$-$\emptyset$/, as in (4*d*). Given the absence of /H-$\emptyset^L$/ or /$\emptyset$-H^L/ in PM, one might be tempted to reanalyze /H-H^L/ and /$\emptyset$-$\emptyset^L$/ as /H-L/ and /$\emptyset$-L/ respectively, as in (5*a*) and (5*b*).

```
(5a) σ    σ
     |    |
     H    L

(5b) σ    σ
          |
          L

(5c) σ    σ
     |
     H    L

(5d) σ    σ

          L
```

As we shall see, there is a pervasive constraint against couplet- or word-final L tone in PM. Thus, representations such as (5*a*) and (5*b*) would have to be fixed by delinking the /L/, as in (5*c*) and (5*d*). While (4*d*) and (5*d*) are now identical, (4*c*) and (5*c*) are not. Not only do the representations in (5*a*) and (5*b*) require an extra step in the derivation (L-delinking), but special care would have to be taken to assure that /H-L/ is realized as H-H^L rather than H-$\emptyset^L$. We thus continue to assume that (4*c*) and (4*d*) are the correct representations. While we might propose that the L in (4*d*) remains unlinked because of the constraint against final L, this does not explain why the L does not link to the first TBU to yield L-$\emptyset$, which is otherwise well-formed. The explanation appears to be that a floating L must link to the right, in most cases onto the immediately following TBU.

The above discussion has concerned only the majority tone patterns on nouns. Among 347 bisyllabic nouns in PM, 300 have one of the underlying representations in (1). Forty-seven have one of the less frequent minority tone patterns in (6):

(6) Minority tone patterns on nouns

(6*a*)	LH-H	*čěʔnú*	‘old man’	*tǎtá*	‘father’	/^{L}H-H/
		nǎná	‘mother’	*k^{w}ǎčí*	‘twins’	
(6*b*)	LH-∅	*lǐʔi*	‘rooster’	*lǐtu*	‘pitcher’	/^{L}H-∅/
		mǐči	‘cat’	*vǐlu*	‘flute’	
(6*c*)	L-H	*čìbá*	‘goat’	*làtú*	‘plough’	/^{L}∅-H/
		k^{w}àžú	‘horse’	*šìlé*	‘chair’	
(6*d*)	L-∅	*ñɨ̀ʔɨ*	‘sweat.house’	*žèʔe*	‘door’	/^{L}∅-∅/
		tàʔa^{N}	‘relative’	*čìu^{N}*	‘work’	

The nouns in (6) differ from those in (1) by the fact that they begin with L or LH tone. Recall from (3) that the nouns in (1) also begin with L or LH after a floating L tone. The two sets of tonal patterns are identical except for the fact that the LH-H nouns in (6*a*) do not have a final floating L, whereas the derived LH-H^{L} noun in (3*a*) does. Because of this parallel, we propose to interpret the nouns in (6) with an initial floating L: /^{L}H-H/, /^{L}H-H, /^{L}∅-H/, /^{L}∅-H/. As in (3), when the floating L associates to a noun with initial /H/, a LH rising tone results. When it associates to a noun with initial /∅/, the TBU is realized as L. The same LTA rule which applies across words will thus automatically produce the LH-H, LH-∅, L-H, and L-∅ patterns in (6).

The minority tone patterns in (7) do not change when they are preceded by a floating L:

(7) /žúú`/ ‘rock’ + minority noun tone patterns

(7*a*)	/^{L}H-H/	*žúú*	*čěʔnú*	‘old man’s rock’
(7*b*)	/^{L}H-∅/	*žúú*	*mǐči*	‘cat’s rock’
(7*c*)	/^{L}∅-H/	*žúú*	*čìbá*	‘goat’s rock’
(7*d*)	/^{L}∅-∅/	*žúú*	*tàʔa^{N}*	‘relative’s rock’

Since PM never allows a L-L sequence, we can assume that the same constraint rules out ^{L}L (i.e., *$^{L\ L}$). Since all L tones are underlyingly unlinked, any citation of /L/ in the text necessarily means /^{L}/.

The preceding data illustrate the basic tone oppositions of nouns. The chart in (8) summarizes the underlying tonal shapes attested on 899 bisyllabic nouns, verbs, and adjectives among a PM lexical data base of 1,390 entries:

(8)		UNDERLYING				DERIVED
		Nouns	Verbs	Adjectives	TOTALS	All Forms
(8*a*)	H-H	0	58	4	62	H-H
	H-H^{L}	104	21	3	128	H-H^{L}
	H-Ø	42	76	7	125	H-Ø
	Ø-H	70	67	1	138	Ø-H
	Ø-Ø	54	164	20	238	Ø-Ø
	Ø-Ø^{L}	30	45	16	91	Ø-Ø^{L}
(8*b*)	^{L}H-H	6	0	2	8	LH-H
	^{L}H-Ø	9	1	3	13	LH-Ø
	^{L}Ø-H	21	21	15	57	L-H
	^{L}Ø-Ø	11	11	17	39	L-Ø
(8*c*)	^{L}H-H^{L}	0	0	0	0	LH-H^{L}
	TOTALS	347	464	88	899	

The following observations can be made based on the above tonal distributions:

(*i*) There are exactly ten underlying tone patterns: /H-H/, /H-H^{L}/, /H-Ø/, /Ø-H/, /Ø-Ø/, /Ø-Ø^{L}/, /^{L}H-H/, /^{L}H-Ø/, /^{L}Ø-H/, /^{L}Ø-Ø/. These are divided into the six majority tone patterns in (8*a*) vs. the four minority tone patterns in (8*b*).

(*ii*) Both the first and second syllable of the couplet are limited to /H/ or /Ø/.

(*iii*) Floating L occurs contrastively after /H-H/ and /Ø-Ø/ in (8*a*) and before all four combinations of /H/ and /Ø/ in (8*b*).

(*iv*) A word can have only one underlying (floating) /L/. There is thus no underlying /^{L}H-H^{L}/. As indicated in (8*c*), LH-H^{L} is, however, observed in derived forms (cf. 3*a*).

(*v*) There is no /^{L}Ø-Ø^{L}/, nor does L-Ø^{L} occur in derived forms. When ^{L} + Ø-Ø^{L} becomes L-Ø^{L}, the final floating L is effaced by a rule of L tone deletion to be discussed in **3.2** below.

(*vi*) /H-H/ is not found on nouns, while /^{L}H-H/ is not found on verbs.

(*vii*) While /H-H^{L}/ is the most frequent pattern in nouns, it is far less common in either verbs or adjectives, where /Ø-Ø/ is the most frequent pattern.

(*viii*) 13.5% of nouns (47/347) and 7.1% of verbs (33/464) occur with one of the minority tone patterns. On the other hand, 42.0% of adjectives (37/88) have one of the patterns in (8*b*).

(*ix*) As shown in table 1, /Ø/ is the most frequent tone among the 899 lexical items.

TABLE 1
FREQUENCY COUNT OF H, L, AND ∅ TONES

	#H	#L	#∅
Method #1	733	336	1,073
Method #2	531	336	644

Two methods were used to count tone. In the first method, we counted H-H as two Hs and /^{L}∅-H/ and /^{L}∅-∅/ as L-H and L-∅. This had the effect of maximizing the number of Hs and minimizing the number of ∅s. In the second method, /^{L}∅-H/ and /^{L}∅-∅/ were still evaluated as L-H and L-∅, but lexical items could contribute at most one H, L, or ∅ to the count. In this case, H-H(^{L}) and ∅-∅(^{L}) couplets were not counted as having two Hs or ∅s. Either way, the relative frequencies come out the same: ∅ > H > L. This is consistent with our view that /∅/ is the unmarked tone in PM, while /L/ is most marked.

Perhaps the most intriguing feature of the above analysis concerns the status of L tone, which can only be realized on the first (stressed) syllable of a couplet (see **3.3** for discussion of enclitics). As we have seen, the L may be by itself (L-H, L-∅) or combine with a H to form a rising tone (LH-H, LH-∅). Because of the initiality condition on L, there are no HL falling tones in the language, LH cannot appear on the second syllable of the couplet, and no form can end in L tone. In the proposed analysis, /H/ tones are underlyingly linked, while /L/ tones are underlyingly unlinked. As was seen in (4), this means that the two syllables of the couplet will be /H/ or /∅/, not /L/. This of course presupposes the correctness of analyzing the non-H tone as /∅/ rather than, say, /M/ tone, an issue which is taken up in the next section.

3. Justification of /∅/ tone. Most Mixtec languages and dialects have been described in terms of three level tones: H, M, and L. In some cases an analysis is presented in terms of underlying /H/ and /L/, even though the surface categories appear to involve a M level as well, e.g., Diuxi (Pike and Oram 1976). To some extent this is because of distributional asymmetries. In PM there is a four-way opposition on the first syllable (H, L, LH, ∅) but only a binary opposition on the second (H, ∅). It is fair to say that past researchers have had quite different intuitions concerning Mixtec tone. The first author has generally taken the view that PM has /H/ and two kinds of L tones, which we analyze here as /∅/ vs. /L/. As we shall further explore in **4**, /L/ is realized on a low level pitch, while /∅/ is realized either as a low falling contour or on a mid pitch. There are at least four arguments in favor of underspecifying the third tone as /∅/ rather than /M/. The first three are taken up in **3.1–3.3**, the fourth in **4**.

3.1. Contour tones. The first argument is that /∅/ never forms a contour with /H/ or /L/ on a single TBU. We saw in **2** that when a floating L links to a following /∅/ syllable, the result is L tone. If this syllable were instead analyzed with /M/ tone, we would need to add a statement to account for why floating L does not join a following /M/ to form a LM rising tone. Similarly, there is no MH rising tone in PM. The absence of HM and ML contours could be attributed to the fact that PM does not allow falling tones at all (*HL). The contour argument may be the weakest of the four to be presented, since a simple constraint against LM can be introduced to rule it out. We note, however, that the absence of LM is automatically accounted for if the third tone is represented as /∅/.

3.2. OCP(L). The second argument is more interesting—and more compelling. PM has an active prohibition against successive L tones, which we account for by invoking the Obligatory Contour Principle in (9):

(9) OCP(L): * L L

The OCP constraint in (9) indicates that two L tone features cannot be adjacent on the tonal tier. It intentionally makes no reference to how the two L tones associate to specific TBUs. We know from **2** that there are no L-L couplets. The OCP is not needed to rule this out, since there is a constraint against final L in general. However, the formulation in (9) is needed to account for the alternations seen in (10):

(10) Loss of initial L after a L-∅ sequence (*ndèku* 'CON.be.located')

<table>
<tr><td>(10a)</td><td>ndeku</td><td>čeʔnu</td><td>→</td><td>ndèku</td><td>čéʔnú</td><td>'there are old men'</td></tr>
<tr><td></td><td>|</td><td>/\ /</td><td></td><td>|</td><td>\ /</td><td>(čěʔnú)</td></tr>
<tr><td></td><td>L</td><td>L H</td><td></td><td>L</td><td>H</td><td></td></tr>
<tr><td>(10b)</td><td>ndeku</td><td>miči</td><td>→</td><td>ndèku</td><td>míči</td><td>'there are cats'</td></tr>
<tr><td></td><td>|</td><td>/\</td><td></td><td>|</td><td>|</td><td>(mǐči)</td></tr>
<tr><td></td><td>L</td><td>L H</td><td></td><td>L</td><td>H</td><td></td></tr>
<tr><td>(10c)</td><td>ndeku</td><td>čiba</td><td>→</td><td>ndèku</td><td>čibá</td><td>'there are goats'</td></tr>
<tr><td></td><td>|</td><td>| |</td><td></td><td>|</td><td>|</td><td>(čìbá)</td></tr>
<tr><td></td><td>L</td><td>L H</td><td></td><td>L</td><td>H</td><td></td></tr>
<tr><td>(10d)</td><td>ndeku</td><td>taʔa^N</td><td>→</td><td>ndèku</td><td>taʔa^N</td><td>'there are relatives'</td></tr>
<tr><td></td><td>|</td><td>|</td><td></td><td>|</td><td></td><td>(tàʔa^N)</td></tr>
<tr><td></td><td>L</td><td>L</td><td></td><td>L</td><td></td><td></td></tr>
</table>

In (10) we show the inputs with the floating Ls linked to the first syllable of each couplet. As seen, the second L is not realized in the output. The words in (10*a*) and (10*b*), which begin with LH tone in isolation, are realized with H on their first syllable, while the words in (9*c*) and (9*d*), which begin with L tone in isolation, are realized as ∅. Recall from (3) that a floating L converts a following H to LH and a following ∅ to L. The data in (10) represent the opposite process whereby initial LH and L revert to H and ∅, respectively. We thus have the bidirectional correspondences in (11):

(11) Bidirectional correspondences

After L-∅		After Floating L
H-H	⇔	LH-H
H-∅	⇔	LH-∅
∅-H	⇔	L-H
∅-∅	⇔	L-∅

The rule responsible for the alternations in (10) is formulated as shown in (12):

(12) L tone deletion (LTD): L → ∅ / L ____

As seen, LTD is stated in terms of a single tonal tier, since the second, deleted L tone is linked to a nonadjacent TBU. The examples in (13) show that any number of /∅/ TBUs can intervene between the two L tones (Daly 1977:7):

(13) LTD applies across any number of /∅/ TBUs

(13*a*) *ndùku žɨɨ-ši k^{w}àžú → ndùku žɨɨ-ši k^{w}a̲žú*
CON.look.for husband -she horse (CON = continuative aspect)
'her husband is looking for a horse'

(13*b*) *ɨɨ^{N} dìi-ni-k^{w}e-ši kada-k^{w}e-ši ɨɨ^{N} ɨɨ^{N} čìu^{N} → ɨɨ^{N} dìi-ni-k^{w}e-ši kada-k^{w}e-ši ɨɨ^{N} ɨɨ^{N} či̲u^{N}*
one alone-only-pl-she POT.do-pl-she one one work (POT = potential aspect)
'only one of them will do each of the jobs'

In (13*a*) the L of *ndùku* (/^{L}nduku/) 'CON.look.for' conditions the loss of the L of *k^{w}àžú* (/^{L}k^{w}ažú/) 'horse' across four /∅/ TBUs. In (13*b*) the L of *dìi* (/^{L}dii/) 'alone' conditions the loss of the L of *čìu^{N}* (/^{L}čiu^{N}/) 'work' across 12 /∅/ TBUs! The examples in (14) show that more than one L can be deleted within the same clause:

(14) LTD applies to any number of Ls within a clause

(14*a*) *kène-ši žèʔe kàʔnu žàkáᴺ → kène-ši že̲ʔe ka̲ʔnu ža̲káᴺ*
CON.come.out-she doorway large over.there

'she is coming out of the large doorway over there'

(14*b*) *ndùku-ši naña kʷìi ndèku ndɨʔɨ nǎná-ši → ndùku-ši naña kʷi̲i nde̲ku ndɨʔɨ na̲ná-ši*
CON-look.for chayote green CON.be.located mother -she

'she is looking for the green chayote her mother has'

In both (14*a*) and (14*b*) three L tones fail to be realized as a result of LTD.

It is clear that a L tone will be deleted following a L-∅* sequence, where ∅* indicates that there can be any number of /∅/ TBUs occurring between the two Ls. As a result of LTD, /L-∅*-L/ sequences will be realized as L-∅*-∅. We have suggested that OCP(L) motivates LTD: regardless of the distance between them, two L tone features may not appear in succession on the tonal tier. On the other hand, if a H tone intervenes between the Ls, LTD will not apply.

(15) LTD will not apply if a H tone intervenes between two L tones

```
(15a) šidi    čeʔnu   →   šìdí   čěʔnú   'old men are sleeping'
      | |     /\ /
      L H     L H

(15b) šidi    miči    →   šìdí   mǐči    'cats are sleeping'
      | |      /\
      L H     L H

(15c) šidi    čiba    →   šìdí   čìbá    'goats are sleeping'
      | |      | |
      L H      L H

(15c) šidi    taʔaᴺ   →   šìdí   tàʔaᴺ   'relatives are sleeping'
      | |      |
      L H      L
```

As expected, the initial L tones of the nouns in (15) are realized on the surface rather than being deleted, as they were in the corresponding sentences in (10). This is because the L tones are not adjacent on their tonal tier. Finally, sentences like *kaka tàʔaᴺ* 'relatives will walk' show that there is nothing wrong with a ∅ to L or a L to ∅ transition. It is specifically L-∅*-L which is ruled out.

The above account crucially relies on /∅/ TBUs being underspecified. The question is how we would account for LTD if these TBUs were fully specified for tone, say /M/. In this case we would have to say that a L-M*-L sequence is prohibited. How this constraint might be expressed depends on how the tones, including this /M/, are represented in terms of features. One possibility involving full specification is presented in (16*a*).

(16) Feature specifications for the three tones of PM

(16*a*) Full specification

	H	L	M
[upper]	+	−	+
[raised]	+	−	−

(16*b*) Minimal specification

	H	L	∅
[upper]	+	−	
[raised]			

(16*c*) Partial specification

	H	L	∅
[upper]	+	−	
[raised]			−

For reasons of clarity, we adopt the binary features Upper and Raised (Yip 1980 and Pulleyblank 1986). However, the same points can be made using the tone and register features {H, L, h, l} (see Snider 1999 and Bao 1999 for surveys and exemplifications of various proposals). The problem with the full specification in (16*a*), or any other, is that we would have to explain why /M/ is transparent to LTD, while /H/ is not. LTD is no longer driven by the OCP. Rather, a constraint against L-M*-L sequences would be needed, with violations repaired by a rule that assimilates a /L/ to M when preceded by a L-M* sequence. This rule seems particularly unrevealing when expressed with fully specified features:

(17) L → M expressed with fully specified M tone

$$[-u] \rightarrow [+u] \ / \ [-u, -r]\ [+u, -r]^{*} \ \_\_\_\_$$

The rule in (17) looks like an assimilatory process whereby a L assimilates to a preceding M. Two questions must, however, be addressed: First, why must the M-L sequence be preceded by another L? Second, why doesn't L assimilate to a preceding H, which is also [+u]? (See **7.2** where we discuss alternative interpretations concerning the motivation of LTD in PM.)

What is needed is for /∅/ to be underspecified for [upper], as in (16*b*). In (18) the LTD rule of (12) is reformulated in terms of features:

(18) LTD as OCP[−u]: [−u] → ∅ / [−u] ____

As seen, LTD is stated as a dissimilatory process driven by the OCP. We believe in the correctness of treating /∅/ as conceptually different from the two underlying tones /H/ and /L/. There is no phonological evidence that /∅/ is a "mid" tone in the sense of being a third value on a tone height scale. Phonetically, /∅/ or a sequence of /∅/s is realized on a continuously low falling pitch before /L/ or pause, but on a mid pitch when followed by /H/. As will be seen in **4**, these realizations can be accounted for whether /∅/ is featureless, as in (16*b*), or is prespecified as [−raised], as in (16*c*). We therefore propose that the basic tonal opposition in PM is between /H/ vs. /L/, which we characterized as [±upper] in (16). Importantly, /∅/ is underspecified for [upper]. As a result, the OCP can be stated as a prohibition against two successive [−upper] features, and LTD can remain as formulated in (18).

3.3. Enclitic /∅/ tone. A third argument for underspecifying /∅/ is that enclitic /∅/ tones are transparent to the linking of floating L tones (LTA). In (19*a*) the floating L of /nduku^{L}/ 'POT.look.for' skips the pronominal enclitic /-ši/ to link on the following word /núní`/ 'corn':

(19) Transparency of /∅/ tone enclitics

(19*a*) *nduku` -ši núní → nduku -ši nu̲ní`*
POT.look.for -she corn
'she will look for corn'

(19*b*) *nduku` -ši -dɨ ñuú → nduku -ši - dɨ ñu̲ú*
POT-look.for -she -animal town
'she will look for it in town'

(19*c*) *nduku` -ni -ši -dé → nduku -ni -ši -dĕ̲*
POT-look.for -only -she -him
'she will look just for him'

In (19*b*) the floating L skips the two enclitics /-ši/ and /-dɨ/ and links on the following word /ñuú/ 'town'. While (19*a*) and (19*b*) might suggest that the floating L is attracted to the following word, which consists of a canonical couplet, the sentence in (19*c*) shows that the floating L will skip /∅/ enclitics to link to a H tone enclitic, here /-dé/. What is important is that when a word such as /nduku`/ is followed only by /∅/ tone enclitics, the floating L will not link. Rather, it floats around the /∅/ enclitics, as in (20*a*).

(20) Words with only /∅/ enclitics

(20*b*) *nduku` -ni -ši → nduku -ni -ši`*
POT-look.for -only -she
'she will just look for'

(20*b*) *nduku` -kʷe -ši -dɨ → nduku -kʷè̲ -ši -dɨ*
POT-look.for -plural -she -animal
'they will look for the animal'

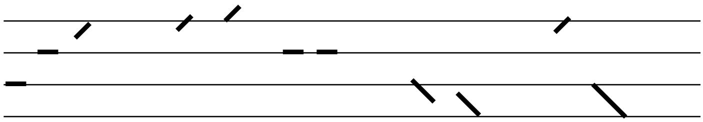
The only postverbal /∅/ morpheme that has been found to accept the floating L is /-kʷe/ 'plural', as seen in (20*b*). This morpheme can be treated as exceptional.

We conclude that there is a prohibition against a floating L linking to /∅/ enclitics, but not to /H/ enclitics such as /-dé/. This is somewhat surprising, since in other cases a /∅/ syllable does accept the floating L, after which /ᴸ∅-H/ and /ᴸ∅-∅/ are realized as L-H and L-∅, respectively. We might attempt an explanation in terms of prominence: /∅/ enclitics do not have enough prominence to accept the floating L, whereas both /∅-∅/ couplets and /H/ enclitics do. Fortunately, we do not have to resort to such ad hoc stipulations: The relevant generalization is that a linked /L/ may not be domain-final in PM. Since /∅/ enclitics are both monosyllabic and toneless, if the floating L were to link to them, this would violate the constraint. An analysis with /∅/ provides a more transparent account of the facts than a fully specified /M/.

4. Surface tone realizations. We saw in the preceding section that a fully specified /M/ tone would complicate, if not obscure, PM phonology. By representing this tone as /∅/, we account for the absence of tonal contours such as LM (**3.1**), the long-distance triggering of LTD (**3.2**), and the long-distance linking of floating Ls (**3.3**). In this section we demonstrate that a fully specified /M/ would also misrepresent the phonetic nature of /∅/ tone.

The phonetic properties of PM tones have been studied in great detail by the first author. Extensive pitch tracings are provided by Daly (1992), who presents an analysis of PM tones in terms of the tone features {H, L} and the register features {h, l}. As a practical means of showing the pitch relations, Daly (1977) situates the surface realizations along a scale consisting of four lines and three spaces. His (5*a*) is reproduced as (21), which shows how four different noun tone patterns are realized after *šìní -dé* 'he sees' (from /`šiní-dé/):

(21) *šìní -dé* + /čáká/ /ditó/ /kɨtɨ/ /sánu/



'he sees . . .' 'fish' 'uncle' 'animal' 'daughter-in-law'

Corresponding pitch traces of the four utterances are shown in figure 1. From these studies we arrive at the following generalizations concerning the realization of /H/, /L/, and /∅/:

(*i*) A /H/ tone or tone sequence is realized level or rising. The tendency to rise is much greater when preceded by /L/, after which the first H is realized mid, with subsequent Hs rising quite high, as indicated in (21). After /∅/ or pause, a H or sequence of Hs is realized on a mid level and is less likely to rise.

(*ii*) A /∅/ tone or tone sequence is realized at a mid level before a /H/ vs. low-falling before either /L/ or pause. Since /H/ is realized mid after /∅/, a /∅/ + /H/ input is typically realized mid-mid (cf. below).

(*iii*) A /L/ tone is realized at a low level whether the preceding or following tone is /H/ or /∅/ or whether following pause. /L/ tone sequences do not exist, and /L/ does not appear before pause in PM.

The above realizations are interesting for a number of reasons, not the least of which is what they tell us about the representation of /∅/. In the following statement, Daly (1977:10) refers to /∅/ as "low" and /L/ as "modified low": "A low tone or string of low tones begins at a pitch between mid and low and ends at low when preceding a modified tone . . . , or begins at a pitch between mid and low and ends at extra-low when preceding pause. . . ." Thus, the two /∅/ tones of *ɨɨ*^{N} 'one' in (22*a*) are realized as low-falling (l):

(22) Realization of /∅/ as low-falling (l)

(22*a*) *ɨɨ*^{N} *k*^{w}*àžú* [l-l L-m] 'one horse'
(22*b*) *ɨɨ*^{N} *kɨtɨ* [l-l l-l] 'one animal'

In (22*b*), where all of the TBUs are /∅/, the utterance is realized over a continuous low fall. In the above and subsequent examples, the system in table 2 is used to refer to the output pitches. The symbols [H] and [L] are used to indicate high and low outputs, respectively. As seen, these "simple" tones have the respective representations [+upper] and [−upper] proposed in **3.2** above. The last column of table 2 shows that the two tones receive a default value for [raised] which agrees with its value for [upper].

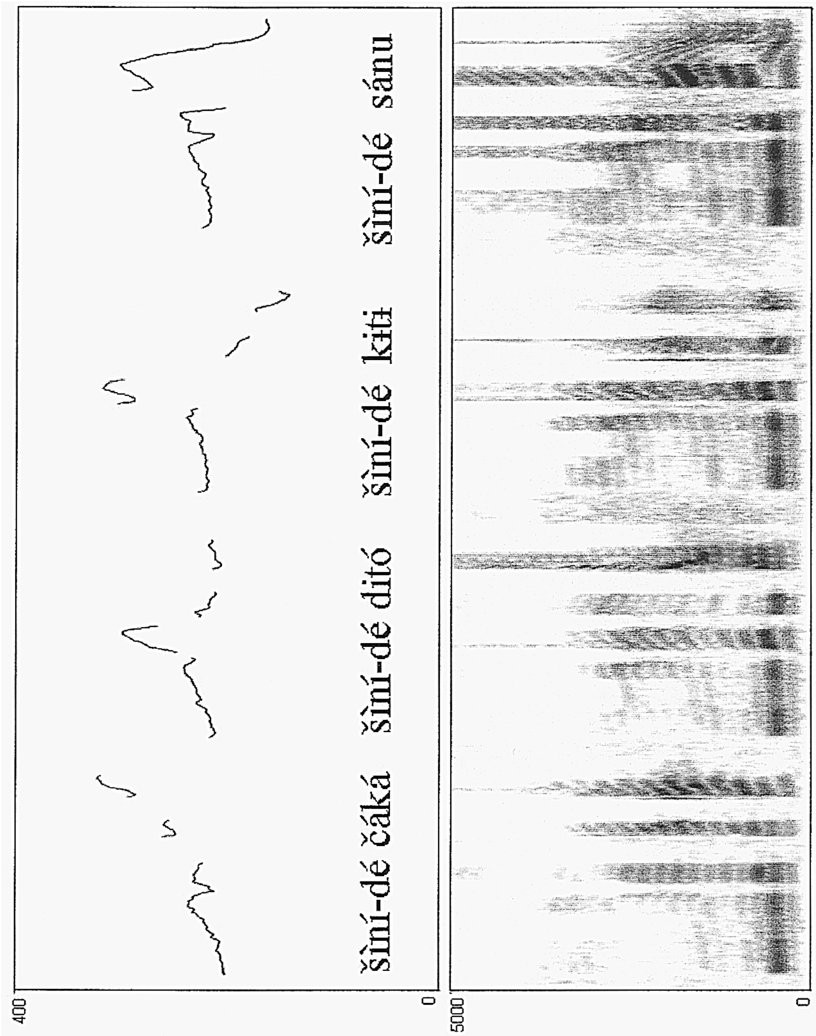


FIG. 1.—Pitch tracings and spectrograms of the sentences in (21): 'he sees fish/uncle/animal/daughter-in-law'.

TABLE 2
FEATURAL REPRESENTATION OF PM TONES

Surface Tones	Symbols	Description	Underlying	With Default [r]
simple	H	high level/rising	[+u]	[+u, +r]
	L	low level	[−u]	[−u, −r]
+register	m	mid level		[+u, −r]
	l	low falling		[−r]

In addition to output [H] and [L], a mid [m] tone is also attested. In (22*a*) we saw that a /H/ TBU is realized [m] after /L/. Compare also the sentences in (23):

(23) Realization of /H/ and /∅/ as [m]

(23*a*)	/šìdí kɨtɨ/	[L-m l-l]	'the animal is sleeping'
(23*b*)	/kiní kɨtɨ/	[m-m l-l]	'the animal will see'
(23*c*)	/šìní-dé kɨtɨ/	[L-m-H l-l]	'he sees the animal'

In (23*a*) the /H/ of /šìdí/ 'CON.sleep' is pronounced [m]. This [m] is in turn followed by two /∅/ tones which are realized [l-l]. In this case there will be a drop from the [m] to the [l], and the final [l] will drop to the lowest level before pause. Thus, although /kɨtɨ/ 'animal' has /∅-∅/ tone, its realization in isolation (and before pause in general) sounds very much like what would be expected of a L-L sequence. As Daly (1977) points out, tone sequences such as (23*a*) encourage the analyst to identify the initial level [L] and final falling [l-l] as allophones of the same toneme, presumably /L/. That this is not the case is seen in the contrast in (23*b*) and (23*c*). (23*b*) shows that the /∅/ of /kiní/ 'POT.see' is realized [m] (as is the following /H/). In (23*c*), however, the /L/ of the corresponding verb /šìní/ 'CON.see' remains L. It turns out that /kɨtɨ/ is realized [m-m] when there is a following /H/:

(24) Realization of /∅/ before /H/

(24*a*)	/kɨtɨ šéčí`/	[m-m m-m]	'girl's animal'
(24*b*)	/kɨtɨ sánu/	[m-m m-l]	'daughter-in-law's animal'
(24*c*)	/kɨtɨ ditó/	[m-m m-m]	'uncle's animal'

Any number of /∅/ tones become [m] in a pre-H context. Thus, all three sentences in (25) are realized as [m-m m-m m-m m-m]:

(25) Unbounded realization of /∅/ as [m] before /H/ (Daly 1977:10–11)

(25*a*)	/kaˀni ditó úní ñáñá/	'uncle will kill three coyotes'
(25*b*)	/kaˀni kɨtɨ úní ñáñá/	'the animal will kill three coyotes'
(25*c*)	/kaˀni kɨtɨ ɨɨ^{N} ñáñá/	'the animal will kill one coyote'

TABLE 3
PITCH ASSIGNMENTS TO TWO-TONE SEQUENCES

	H	L	∅	∅(H)
(L-H)H	H-$^{\uparrow}$H	H-L	H-l	H-m
(L)H	m-H	m-L	m-l	m-$^{\downarrow}$m
H	**m-m**	**m-l**	**m-l**	m-$^{\downarrow}$m
L	**L-m**	*	**L-l**	L-m
∅	**m-m**	**l-L**	**l-l**	m-m

A summary of tonal realizations is provided in table 3. In table 3, H = high, m = mid, L = low level, and l = low falling, as before. In addition, $^{\downarrow}$ = downstep and $^{\uparrow}$ = upstep. The unmarked pitch realizations /H/ → [m], /L/ → [L], and /∅/ → [l] are in boldface in the table. These realizations are obtained when the tones are not affected by one of two contextual factors:

(*i*) A post-L sequence of Hs is subject to upstep. The top row of table 3 shows how a /H/ + another tone is realized when they are preceded by a L-H sequence, while the second row shows the realization of these sequences after L. In a LH* sequence, the first H is obligatorily pronounced [m] (= the lowest realization of /H/), while the last H is pronounced [H] or high-rising. H tones which intervene vary in their realization. In (26*a.i*), the realization we have discussed thus far, each H following L is realized on a successively higher level or rising pitch (upstep).

(26) Two interpretations of the alternate realizations of /^{L}∅-H-H-H-H/

	(*i*) With upstep and [m]	(*ii*) With upstep and no [m]
(26*a*)	L-m-H-$^{\uparrow}$H-$^{\uparrow}$H	L-H-$^{\uparrow}$H-$^{\uparrow}$H-$^{\uparrow}$H
(26*b*)	L-m-m-H-$^{\uparrow}$H	L-H-H-$^{\uparrow}$H-$^{\uparrow}$H
(26*c*)	L-m-m-m-H	L-H-H-H-$^{\uparrow}$H
(26*d*)	*L-m-m-m-m	*L-H-H-H-H

(26*b.i*) and (26*c.i*) show that one or more of the upsteps may be "flattened" so as to produce a [m] tone plateau before a step up. The tone may also be a rising contour interpolated between the endpoint of the preceding pitch and the beginning point of the following. What is not permitted is (26*d.i*), where the whole sequence of Hs has been flattened to [m].

(*ii*) As was seen in (23) and (24), a /∅/ or sequence of /∅/s is realized [m] before /H/, shown in the rightmost column of table 3. Since /H/ is also realized [m] when not in a post-L sequence, underlying /∅-H/ is realized [m-m]. (See below for discussion of [$^{\downarrow}$m] tone.)

The question which naturally arises is how many of the above realizations should be expressed in terms of phonological rules and features rather than in terms of phonetic implementation: All? Some? None? It seems that all three possibilities are reasonable.

First, consider the upstepping phenomenon schematized in (26*i*). We note first that no phonological rule requires that the [H] vs. [m] realizations have distinct representations. In fact, as can be seen from table 3, [m] can be the realization of either /H/ or /∅/. The variable and iterative nature of the upstepping process suggests alternative strategies for realizing the L to H transition. What is unusual is not only the upstepping of Hs but also the fact that the process is triggered by a preceding L. From a phonetic point of view, we expect a H to be raised before a L, not after. It is certainly possible to propose, as we did in table 2, that [H] is [+u, +r], while [m] is [+u, −r], adding that each successive [+u, +r] TBU of a LH* sequence can be realized one step higher than the preceding TBU. Since raising/upstepping is exclusively triggered by a L tone, we might slightly modify an earlier analysis of Daly (1992) and propose that an underlying /L/ is not only [−u] but also has a floating [+r] which can and must be assigned only if the L is followed by at least two H TBUs. But why should there be such a requirement?

A potential answer is seen in the second interpretation of the upstep facts in (26*ii*). Here we have chosen not to represent the [m] output as such. Rather, any H which is not upstepped is pronounced [m]. As we have seen, this includes any /H/ which is preceded by /∅/ or pause. It also includes the first /H/ which follows a L. The reason for this is perhaps more clearly seen in the interpretation in (26*ii*): A /H/ can be upstepped only after another /H/. Thus, in this interpretation, it is not that the /L/ lowers the following /H/ to [m] but rather that non-upstepped H = [m]. To capture the variability, we can say that [+r] can skip one or more /H/ TBUs, but once linked, its effect continues to the end of the H sequence. Alternatively, we could say that the [+r] links to the last H TBU and is optionally anticipated onto preceding TBUs. As seen in (26*d*), an upstep is obligatory on the final H if at least two Hs follow the L. However, a L-H sequence is pronounced [L-m] when followed by /L/, /∅/, or pause. This is because [+r] can only upstep a H after another H. Whether we think of a single [+r] which is multiply linked, or a sequence of [+r] specifications, we must still add that each [+u, +r] is realized higher than the preceding one.

We have no evidence to choose between the different interpretations mentioned in the preceding paragraphs. Since we are interested in motivating /∅/, and since /∅/ does not condition upstep, we need not decide the issue here. Rather, we must be able to show that there is a reasonable way to obtain the appropriate [m] realizations without having to prespecify /∅/.

As seen in the rightmost column of table 3, a /∅/ tone is realized as [m] before /H/. In addition, /H/ is realized as [m] after /∅/ (and after pause). As a result, a /∅/-H/ sequence surfaces as [m-m]. Again, we have indeterminacy as to how much of this should be expressed phonologically vs. phonetically. If phonological, two operations are required: insertion of [−r] onto the /H/ and anticipation of the [+u] specification of the /H/ onto preceding /∅/ TBUs. Let us refer to this rule as H tone anticipation (HTA). The processes can be simultaneous or [−r] assignment can precede HTA.

Although all three are pronounced [m-m] in some environments, it is important that HTA not merge /∅/-∅/ and /∅-H/ with /H-H/. As Daly (1977:12) shows, a combination of /∅-∅/ + /H-H/ is often realized on a single [m] pitch, as HTA predicts. If /∅-∅/ has no tonal representation, and /H-H/ is specified only for [+u], the [m*] realization of utterances such as those in (25) can be left as a matter of phonetic interpretation. Less straightforward is whether and, if so, how to represent the iterative downstepping observed in cases where /∅/ and /H/ tones are interspersed, as in (27).

(27) Tone terracing

(27*a*) /kiní kolo-dé ɨɨ^{N} kóo`/ [m-m ↓m-m-m ↓m-m m-m]
POT.see male.turkey-his one snake
'his turkey will see one snake'

(27*b*) /kiní ditó didí šɨtɨ́ itú/ [m-m ↓m-m ↓m-m ↓m-m ↓m-m]
POT.see uncle aunt stomach cornfield
'the uncle will see the aunt in the cornfield'

(27*c*) /kiní diʔa^{N} úní kolo ditó/ [m-m ↓m-m ↑m-m ↓m-m m-m]
POT.see hawk three male.turkey uncle
'the hawk will see three of uncle's turkeys'

In (27*a*) we see that when the /∅/ tones of *kolo* 'male.turkey' assimilate to the H of /-dé/ 'his', the [m-m-m] sequence drops from the level of the preceding H [m] of /kiní/ 'POT.see'. The same happens on the numeral *ɨɨ^{N}* 'one'. As indicated by the symbol ↓, we identify these drops with the non-automatic or phonemic downstep phenomenon reported in African languages (see Clements 1979, Hyman 1979, and references cited therein). The same downstep realization is observed when /∅-H/ words follow each other in sequence, as in (27*b*), for which a pitch tracing is reproduced in figure 2. Finally, as indicated in (27*c*), speakers sometimes raise the pitch in transitioning from /∅-∅/ to /H-H/, particularly if a downstep follows.

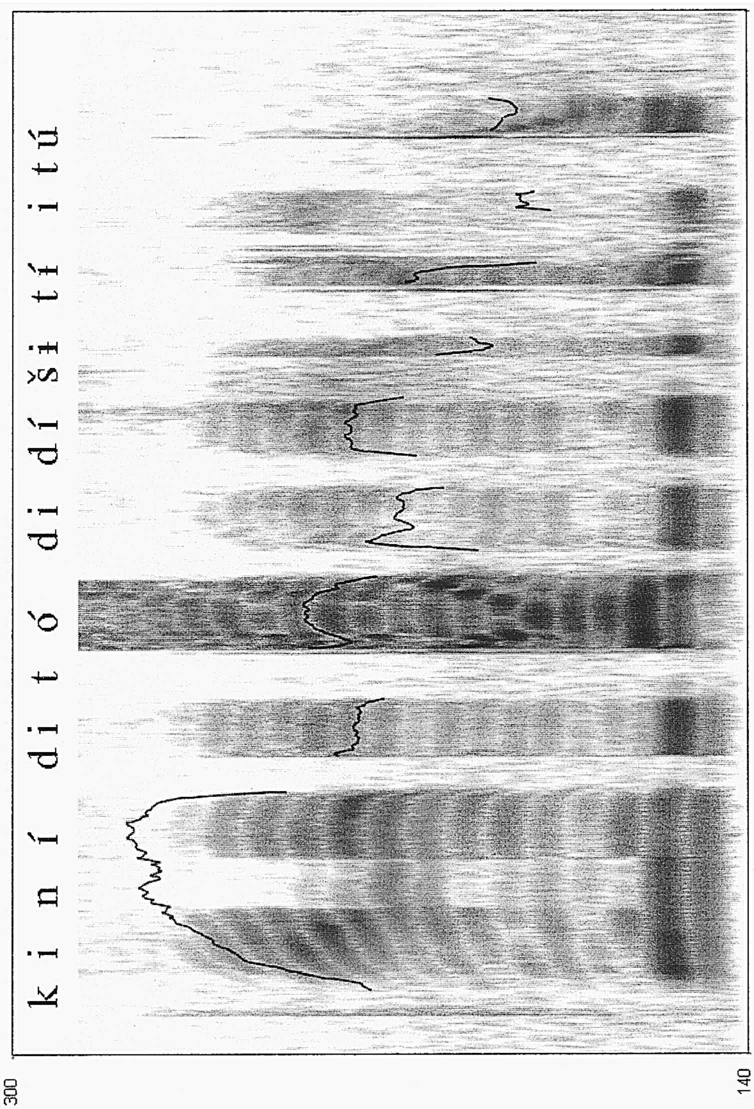


FIG. 2.—Pitch tracings and spectrograms of the sentences in (27*b*): 'the uncle will see the aunt in the cornfield'.

The problem is keeping H + ∅-H distinct from H + H-H. If we assume a phonological rule of HTA involving the leftward spreading of [+u], the two could incorrectly merge, as in (28):

(28) Derivation of downstep from a /H-∅*-H/ sequence

(28*a*) H + ∅ − H [m-$^{\downarrow}$m-m]

```
σ   σ  σ
|    \ |
[+u] [+u]
```

(28*b*) H + H − H [m-m-m]

```
σ   σ  σ
|    \ /
[+u] [+u]
```

There are two solutions to this problem. First, we could say that all of the pitches are directly read off the input Hs and Ls (Carlos Gussenhoven, personal communication). There would be no rule of HTA and no introduction of additional tone features. The pitches are assigned by phonetic implementation: Each H of a ∅-H + ∅-H sequence receives a lower pitch value than the preceding H. The [m] and [$^{\downarrow}$m] pitches result from each ∅ being pronounced at the same level as the following H tone. As a second option, we could keep the rule of HTA but assign a [−r] feature according to the pre-HTA representations: A [−r] would be assigned as a downstep operator on each new sequence of underlying H tones. In (28*a*) two [−r]s would be inserted, one operating on each of the noncontiguous [+u] features. Since the [+u] features are contiguous in (28*b*), only one [−r] would be assigned to the sequence.

Whichever approach is followed, there clearly is no need for /∅/ to be prespecified for tone. The fact that /diʔa^{N}/ 'hawk' can be realized lower than /úní/ 'three' in (27*c*) would seem to favor the phonetic implementation approach: The level realization of /∅-∅/ before /H-H/ may anticipate the [m] level of the latter, or it may be slightly lower.

5. More on the phonology of L tone. In the previous sections we showed that L tone has several special properties: First, L cannot occur on the second syllable of a couplet or finally on any other morpheme. Second, /L/ tones cannot occur in sequence. Third, all instances of L can be analyzed as underlyingly floating, i.e., /^{L}/. These properties are related: The fact that /L/ cannot occur morpheme-finally means that a L-L sequence could only arise if there were morphemes of three syllables, in which case, in the absence of the OCP, L-L-H and L-L-∅ might be well-formed. Since all trisyllabic words are analyzable as morphologically complex, such sequences will not occur, nor will a single L ever occur in the middle syllable. Instead, L is restricted to a position which is both morpheme-initial and non-morpheme-final. Since the position of /L/ is so restricted, it is possible to analyze all L tones as floating: /H-H^L, Ø-Ø^L, ^{L}H-H, ^{L}H-Ø, ^{L}Ø-H, ^{L}Ø-Ø/. With these representations it is possible to get two floating L tones in succession, e.g., /H-H^L + ^{L}H-H/, but the two Ls will always be simplified to one.

The tonal alternations we have seen center on the effects of /L/ tones, either their deletion by LTD (18) or their association by LTA. In this section we expand our coverage to present further effects of the two general processes concerning /L/ tone. In **6** we consider alternations produced by the spreading of /H/ tone.

5.1. Floating L tone deletion. In table 4, the verbs at the left of the rows are followed by the nouns at the top of the columns. At the intersection of the rows and columns are the tones of each of the nouns following each of the verbs. Those noun tones which undergo modification are underlined. Other noun tones are unaffected. All eight tone patterns on verbs are illustrated (cf. 8). The six verbs in [*a*]–[*f*] are in the potential aspect (POT), whereas the two verbs in [*g*] and [*h*] occur in the continuative aspect (CON). The six nouns in [1]–[5] represent the majority tone patterns, while the four nouns in [6]–[9] represent the minority tone patterns.

Since there are no complications, let us first consider the effects of LTD on these forms. As expected, the minority tone patterns lose their initial ^{L} in [6*h*]–[9*h*]. The outputs therefore are exactly as shown in (10). In addition, the ^{L} of /Ø-Ø^L/ is deleted after /Ø-Ø^L/ and /L-Ø/ in [5*f*] and [5*h*].

The effects of L tone association are more complex. We see that the floating L of /níˀí`/ 'POT.find' and /koko`/ 'POT.swallow' associates to the first syllable of the /H-H^L/, /H-Ø/, and /Ø-H/ nouns in [1*b*]–[3*b*] and [1*f*]–[3*f*]. The floating L of /koko`/ also links to the /Ø-Ø/ and /Ø-Ø$^L$/ nouns in [4*f*]–[5*f*] and the $^L$ of /Ø-Ø$^L$/ undergoes LTD in [5*f*], as expected. On the other hand, the outputs in [4*b*]–[5*b*] are unexpected. The $^L$ of /níˀí`/ fails to link to /Ø-Ø/ and /Ø-Ø^L/ nouns. As seen in (29), the same is true of noun + noun possessive constructions:

(29) /žúú`/ 'rock' + majority noun tone patterns

(29*a*)	/H-H^L/	*žúú*	*ñǎñá`*	'coyote's rock'
(29*b*)	/H-Ø/	*žúú*	*k^{w}ěñu*	'squirrel's rock'
(29*c*)	/Ø-H/	*žúú*	*ìdú*	'deer's rock'
(29*d*)	/Ø-Ø/	*žúú*	*kɨtɨ*	'animal's rock'
(29*e*)	/Ø-Ø^L/	*žúú*	*nǰuši`*	'chicken's rock'

TABLE 4
GENERAL TONAL ALTERNATIONS

		[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
		H-H^{L}	H-∅	∅-H	∅-∅	∅-∅^{L}	LH-H	LH-∅	L-H	L-∅
		ñáñá`	*kʷéñu*	*idú*	*kɨtɨ*	*nǰuši`*	*čěʔnú*	*lǐʔi*	*čìbá*	*ñɨ̀ʔɨ*
		‘coyote’	‘squirrel’	‘deer’	‘animal’	‘chicken’	‘old.man’	‘rooster’	‘goat’	‘sweat.house’
[*a*]	*ndáʔí* ‘POT.cry’	H-H^{L}	H-∅	∅-H	∅-∅	∅-∅^{L}	LH-H	LH-∅	L-H	L-∅
[*b*]	*níʔí`* ‘POT.find’	LH-H^{L}	LH-∅	L-H	∅-∅	∅-∅^{L}	LH-H	LH-∅	L-H	L-∅
[*c*]	*ndúʔa* ‘POT.become well’	H-H^{L}	H-∅	∅-H	∅-∅	∅-∅^{L}	LH-H	LH-∅	L-H	L-∅
[*d*]	*kiní* ‘POT.see’	H-H^{L}	H-∅	∅-H	∅-∅	∅-∅^{L}	LH-H	LH-∅	L-H	L-∅
[*e*]	*kaka* ‘POT.walk’	H-H^{L}	H-∅	∅-H	∅-∅	∅-∅^{L}	LH-H	LH-∅	L-H	L-∅
[*f*]	*koko`* ‘POT.swallow’	LH-H^{L}	LH-∅	L-H	L-∅	L-∅	LH-H	LH-∅	L-H	L-∅
[*g*]	*šìdí* ‘CON.sleep’	H-H^{L}	H-∅	∅-H	∅-∅	∅-∅^{L}	LH-H	LH-∅	L-H	L-∅
[*h*]	*ndèku* ‘CON.be.located’	H-H^{L}	H-∅	∅-H	∅-∅	∅-∅	H-H	H-∅	∅-H	∅-∅

The floating L of /žúú`/ ‘rock’ links to the nouns in (29*a*)–(29*c*) but not to those in (29*d*) and (29*e*). Since the final floating L is preserved in [5*b*] and (29*e*), escaping LTD, we assume that a rule of floating L tone deletion (FLD) is needed, as in (30):

(30) Floating L tone deletion (FLD)

```
σ σ     σ σ
\ /
[+u]  [−u]
        ↓
        ∅
```

The floating L of a /H-H^{L}/ couplet is deleted when followed by a toneless couplet (encircled), whether the latter is in turn followed by a floating tone or not. In case there is any concern about having to refer to TBUs which lack a tone, the above rule could also be as a rule of allomorphy: The allomorph /H-H^{L}/ can be restricted to occurring before a word which contains a /H/, in the absence of which /H-H/ appears instead.

There is another seemingly related context where FLD is observed. PM is primarily a VSO language. However, an NP may be fronted to express various syntactic functions, e.g., subject, object, or locative. Preposing of the subject is shown in (31).

(31) /dútú`/ ‘priest’ + majority verb tone patterns

(31*a*)	/H-H^{L}/	*dútú*	*nǐʔí`*	‘the priest will find’
(31*b*)	/H-∅/	*dútú*	*ndǔʔa*	‘the priest will become well’
(31*c*)	/∅-H/	*dútú*	*kiní*	‘the priest will see’
(31*d*)	/∅-∅/	*dútú*	*kaka*	‘the priest will walk’
(31*e*)	/∅-∅^{L}/	*dútú*	*nduku`*	‘the priest will look for’

When a /H-H^{L}/ noun is fronted, /H-H^{L}/ and /H-∅/ verbs become LH-H^{L} and LH-∅, as in (31*a*) and (31*b*). However, not only /∅-∅/ and /∅-∅^{L}/ in (31*d*) and (31*e*) but also /∅-H/ verbs in (31*c*) remain unchanged. It therefore appears necessary to extend (30) to allow a /∅-H/ verb to condition FLD.

Both the FLD rule in (30) and the extended effects on /∅-H/ verbs apply only to a floating L that follows an underlying /H/. In **6** we discuss specific contexts where H tone spreading produces a derived H^{L} output on certain morphemes. For example, the enclitic /-ndo`/ ‘you pl.’ becomes H^{L} after /H/. As seen in (32) and (33), FLD does not apply to a floating L that follows a derived H tone:

(32) /níʔí -ndó`/ 'you pl. will find' + majority noun tone patterns

(32*a*)	/H-H^{L}/	*níʔí -ndó*	*ñăñá`*	'you pl. will find a coyote'
(32*b*)	/H-∅/	*níʔí -ndó*	*k^{w}ĕñu*	'you pl. will find a squirrel'
(32*c*)	/∅-H/	*níʔí -ndó*	*ìdú*	'you pl. will find a deer'
(32*d*)	/∅-∅/	*níʔí -ndó*	*kɨ̀tɨ*	'you pl. will find an animal'
(32*e*)	/∅-∅^{L}/	*níʔí -ndó*	*nǰùši*	'you pl. will find a chicken'

(33) /dútú -ndó`/ 'your pl. priest' + majority verb tone patterns

(33*a*)	/H-H^{L}/	*dútú -ndó*	*nǐʔí`*	'your pl. priest will find'
(33*b*)	/H-∅/	*dútú -ndó*	*ndǔʔa*	'your pl. priest will become well'
(33*c*)	/∅-H/	*dútú -ndó*	*kìní*	'your pl. priest will see'
(33*d*)	/∅-∅/	*dútú -ndó*	*kàka*	'your pl. priest will walk'
(33*e*)	/∅-∅^{L}/	*dútú -ndó*	*ndùku*	'your pl. priest will look for'

What this means is that FLD must apply on the basis of the input tones.

Whether underlying or derived, a floating L never associates to a conjunction that has /∅/ tone. These conjunctions include *či* 'because', *te* 'and', and *diko* 'but'. Also immune to L tone association are the verb proclitics *ta-* 'in.process', *sa-* 'already', *ni`* 'completive negative', and *na`* 'hortatory'. Except for *diko* 'but', we can attribute this to the fact that these morphemes are monosyllabic with /∅/ tone. Recall from **3.2** that a floating L also does not associate to monosyllabic /∅/ enclitics. While this seems related, note that enclitics can pass the floating L on to the next word, while the /∅/ conjunctions cannot.

5.2. H tone delinking. Two constructions have been found where LTA applies, but in an irregular fashion. The first concerns verb proclitics with a floating L tone, after which a /H-H/ or /H-H^{L}/ verb has its first H replaced by a floating L to give the pattern L-H. The sentence in (34*a*) shows that this change takes place after the floating L of the continuative (CON) aspect, while (34*b*) shows the same change after the negative potential (NEG.POT) proclitic /bá`-/:

(34) /H-H/ and /H-H^{L}/ verbs → L-H after aspectual floating L

(34*a*) *dútú`* + ` + *níʔí`* *-dé -dɨ* → *dútú ni̠ʔí -dé -dɨ*
priest CON find -he -animal

'the priest finds the animal'

(34*b*) *bá`* + *níʔí`* *-dé -dɨ* → *bá-ni̠ʔí -dé -dɨ*
NEG.POT find -he -animal

'he will not find the animal'

(34*c*) *dútú*` + *níʔí*` *-dé -dɨ* → *dútú nǐʔí -dě -dɨ*
priest POT.find -he -animal

'the priest will find the animal'

As also seen in (34*a*) and (34*b*), /H-H^{L}/ verbs such as /níʔí`/ 'POT.find' lose their final floating L as part of this process. The following enclitic *-dé* 'he' thus remains H. Compare this to (34*c*), where the floating L of the subject noun /dútú`/ 'priest' conditions the change of /níʔí`/ to *nǐʔí*` by the general L tone association process, and its floating L survives to convert the enclitic *-dé* to *-dě*, also by general L tone association. Other proclitics with floating L that condition the change of /H-H(^{L})/ to L-H include *ñá*`- 'negative', *na*`- 'hortatory', and *ndá*`-, derived from *nda-* 'go up' by H tone spreading (**6**).

A second construction showing the same irregular alternations concerns quantifiers with /H-H/ or /H-H^{L}/ tone. Words or proclitics which have been found to trigger the change to L-H are *ndɨ*`- 'together', *sá*`- 'that/thing', and *núú*` 'face/upon':

(35) /H-H/ and /H-H^{L}/ quantifiers → L-H after specific morphemes with floating L

(35*a*) *ndɨ*`- *úší -k*^{w}*e -ši* → *ndɨ- u̱ší -k*^{w}*e -ši*
together ten -plural -she

'ten of them together'

(35*b*) `*káčí -dé sá*` *úní -k*^{w}*e -dé* → *kàčí -dé sá u̱ní -k*^{w}*e -de kɨ́ʔɨ*^{N} *-k*^{w}*e -dé*
CON.say -he that three plural he POT.go -plural -he

'he says that three of them will go'

(35*c*) *núú*` *íñú nduu* → *núú ḭñú nduu*
on six day

'on the sixth day'

In both (34) and (35) we assume that the indicated morphemes condition the delinking of the initial /H/ such that /H-H/ and /H-H^{L}/ first become ∅-H, with /H-H^{L}/ also losing its final floating L. The derived ∅ then becomes L by L tone association.

6. H tone spreading. The last process to be considered is H tone spreading (HTS). As in the case of FLD and H tone delinking discussed in **5**, HTS occurs in specific constructions and precedes the more general processes of LTA and LTD.

6.1. Noun + adjective. The forms in table 5 establish that HTS applies across noun + adjective sequences. Adjectives which undergo modification due to LTA and LTD are underlined. Those which are subject to HTS are double-underlined. As seen, only /∅-∅/, /∅-∅^{L}/, and /^{L}∅-∅/ adjectives are affected: These all become H-H^{L} in rows [*a*], [*c*], and [*f*] of table 5, i.e., after a noun whose tone pattern is /H-H^{L}/, /∅-H/, or /^{L}∅-H/. The generalization is that a noun that ends H will spread that H onto an adjective that lacks a H. The floating L tone of a /H-H^{L}/ or /^{L}∅-∅/ target has no blocking effect, suggesting that HTS applies before LTA (and confirming our decision to treat all L tones as underlyingly unlinked). On the other hand, the H-H sequence derived by HTS is always followed by a floating L. Sample derivations are given in (36).

(36) HTS in noun + adjective sequences

(36*a*) *kaá* + *kaši*^{N} → *kaá káší*^{N}\`

[+u] [+u] [−u]

'hard ax'

(36*b*) *žúú*\` + \`*k*^{w}*ɨñɨ* → *žúú k*^{w}*ɨ́ñɨ́*\`

[+u] [−u] [−u] [+u] [−u]

'narrow rock'

In (36*a*), [+u] spreads, and an unlinked [−u] is inserted after it. Since /∅-∅/ couplets such as *kaši*^{N} 'hard' are unspecified for tone, we assume that the floating [−u] must be inserted. We considered assigning /∅/ a zero or possibly [−r] "tonal node," which would delink as the result of HTS and then receive a [−u] specification. In the end we thought this unnecessary, given that FLD and H tone delinking had already had to manipulate floating [−u] in ways that did not seem to be phonologically motivated. In (36*b*) we see that HTS is not hindered by the final ^{L} of /žúú\`/ 'rock' and the initial $^{L}$ of /\`kʷɨñɨ/ 'narrow', after which there is a single unlinked L.

6.2. Enclitics. In **3.2** we saw that a floating L tone cannot link to a /∅/ enclitic. Enclitics potentially undergo HTS independent of the part of speech of the preceding H-final word. They fall into three classes:

(*i*) Some /∅/ enclitics undergo HTS whenever preceded by either an underlying or derived H tone. In (37*a*) note that *-ndo*\` 'you.plural' undergoes HTS after the /^{L}∅-H/ adjective *k*^{w}*ɨ̀tɨ́* 'short':

(37) *-ndo*\` → *-ndó*\` after underlying and derived H tone.

(37*a*) *kaá* + \`*k*$^{w}$*ɨtɨ́* -\`*ndo*\` → *kaá k*$^{w}$*ɨ̀tɨ́ -ndó*\` 'your pl. short ax'
(37*b*) *kaá* + *kaši*^{N} -\`*ndo*\` → *kaá káší*^{N} -\`*ndó*\` 'your pl. hard ax'

TABLE 5
NOUN + ADJECTIVE TONAL ALTERNATIONS

		[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
		H-H	H-H^{L}	H-∅	∅-H	∅-∅	∅-∅^{L}	LH-H	LH-∅	L-H	L-∅
		úá	*íí`*	*báˀa*	*čaˀnǰí*	*kaši*^{N}	*k*^{w}*eči`*	*vǐdí*	*lǐˀli*	*k*^{w}*ɨ̀tɨ́*	*k*^{w}*ɨ̀nɨ́*
		‘sour’	‘sacred’	‘good’	‘shining’	‘hard’	‘small.pl’	‘citrus’	‘small’	‘short’	‘narrow’
[*a*]	*žúu`* ‘rock’	$\underline{\text{LH-H}}$	$\underline{\text{LH-H}}^{L}$	$\underline{\text{LH-∅}}$	$\underline{\text{L-H}}$	$\underline{\underline{\text{H-H}}}^{L}$	$\underline{\underline{\text{H-H}}}^{L}$	LH-H	LH-∅	L-H	$\underline{\underline{\text{H-H}}}^{L}$
[*b*]	*žóˀo* ‘root’	H-H	H-H^{L}	H-∅	∅-H	∅-∅	∅-∅^{L}	LH-H	LH-∅	L-H	L-∅
[*c*]	*kaá* ‘ax’	H-H	H-H^{L}	H-∅	∅-H	$\underline{\underline{\text{H-H}}}^{L}$	$\underline{\underline{\text{H-H}}}^{L}$	LH-H	LH-∅	L-H	$\underline{\underline{\text{H-H}}}^{L}$
[*d*]	*nduˀu* ‘tree.trunk’	H-H	H-H^{L}	H-∅	∅-H	∅-∅	∅-∅^{L}	LH-H	LH-∅	L-H	L-∅
[*e*]	*doko`* ‘well’	$\underline{\text{LH-H}}$	$\underline{\text{LH-H}}^{L}$	$\underline{\text{LH-∅}}$	$\underline{\text{L-H}}$	$\underline{\text{L-∅}}$	$\underline{\text{L-∅}}$	LH-H	LH-∅	L-H	L-∅
[*f*]	*làtú* ‘plough’	H-H	H-H^{L}	H-∅	∅-H	$\underline{\underline{\text{H-H}}}^{L}$	$\underline{\underline{\text{H-H}}}^{L}$	LH-H	LH-∅	L-H	$\underline{\underline{\text{H-H}}}^{L}$
[*g*]	*žužèˀe* ‘door’	H-H	H-H^{L}	H-∅	∅-H	∅-∅	$\underline{\text{∅-∅}}$	$\underline{\text{H-H}}$	$\underline{\text{H-∅}}$	$\underline{\text{∅-H}}$	$\underline{\text{∅-∅}}$

In (37*b*) *-ndo`* becomes *-ndó`* along with the adjective *kaši*^{N} 'short' (→ *kóši*^{N}).

(*ii*) Some /∅/ enclitics undergo HTS only after derived H tones. In (38*a*) *-ši* 'she' fails to undergo HTS after the underlying /H/ of *k*^{w}*ɨ̀tɨ́* 'short':

(38) *-ši* → *-ší`* after derived H tone only

(38*a*) *kaá* + *`k*^{w}*ɨtɨ́ -ši* → *kaá k*^{w}*ɨ̀tɨ́ -ši* 'her short ax'
(38*b*) *kaá* + *kaši*^{N} *-ši* → *kaá káší*^{N} *-sí`* 'her hard ax'

However, (38*b*) shows that *-ši* undergoes HTS if the preceding H itself derives from HTS. In this case HTS has applied iteratively to the adjective and the enclitic.

(*iii*) A few /∅/ enclitics do not undergo HTS at all, e.g., *-k*^{w}*e* 'plural' in (39).

(39) *-k*^{w}*e* does not undergo HTS

(39*a*) *kaá* + *`k*$^{w}$*ɨtɨ́ -k*$^{w}$*e -ndo`* → *kaá k*^{w}*ɨtɨ́ -k*^{w}*e -ndo`* 'your pl. short ax'
(39*b*) *kaá* + *kaši*^{N} *-k*^{w}*e -ši* → *kaá káší*^{N} *-k*^{w}*è -si* 'their hard ax'

Additional enclitics which do not undergo HTS include *-na* 'now' and *-tu* 'again' (from *tuku* 'again'). These few enclitics will simply have to be listed as exceptions to HTS.

Concerning the distinction seen in (37) vs. (38), an examination of the two classes of enclitics reveals that those which undergo HTS after both underlying and derived H have a final floating L (e.g., *-ndo`* 'you.plural'), while those which undergo HTS only after a derived H do not (e.g., *-ši* 'she'). -∅^{L} enclitics thus show the same tonal behavior as adjectives, undergoing HTS when following a H-final word, while -∅ enclitics such as *-dɨ* 'animal' can only undergo a second iteration of HTS:

(40) Iterative vs. noniterative HTS on enclitics

(40*a*) *kiní -ndo` -dɨ* → *kiní -ndó -dɨ́`*
POT.see -you.pl -animal
'you pl. will see the animal'

(40*b*) *kiní -dɨ -ndo`* → *kiní -dɨ -ndo`*
POT.see -animal -you.pl
'the animal will see you pl.'

It is not clear why HTS should apply differently to -∅^{L} vs. -∅ enclitics, a distinction which comes up again in **6.3**.

6.3. HTS within the verb complex. HTS may also apply within the verb complex (proclitics + root + enclitics). The same conditions on initial vs. iterated applications of HTS on enclitics hold: A H tone spreads to an immediately following form which has a floating L tone and applies iteratively to each successive form with /∅/ tone(s). For example:

(41) HTS onto /∅ᴸ/ proclitic + iteration

(41*a*) *ní- da`- kunu -ši -dɨ → ní- dá- kúnú -ší -dɨ́`*
CMP- causative- run -she -animal

'she chased the animal away'

(41*b*) *ní- da`- kunu -ndo` -dɨ → ní-dá- kúnú -ndo -dɨ́`*
CMP- causative- run -you.pl -animal

'you pl. chased the animal away'

In (41), the H of the completive marker *ní-* first spreads onto the causative proclitic *da`-*. Since the latter has a floating L, the verb *kunu* 'run' and the following two enclitics undergo iterations of HTS.

There are, however, complications. One problem is illustrated in the sentences in (42).

(42) HTS onto /∅/ + iteration

(42*a*) *bá`- kunu -dɨ → bá- kúnú -dɨ́`*
NEG.POT- run -animal

'the animal will not run'

(42*b*) *bá`- ta- kunu -ši → bá- tá- kúnú -ší`*
NEG.POT- IN.PROCESS- run -she

'she has not run yet'

The first application of HTS targets *kunu* 'run' and *ta-* 'in.process', even though these morphemes do not have a final floating L. In **6.2** we saw that /∅/ morphemes may only undergo iterations of HTS. It turns out that *bá`-* is an exceptional trigger—it behaves as if it had itself undergone the first application of HTS, with the following /∅/ tone sequences undergoing the iterations. We may either mark *bá`-* as an exceptional trigger or give it the exceptional underlying representation /´ba`-/. The floating H may now trigger the initial application of HTS on /ba`-/, and subsequent /∅/ morphemes undergo the iterations.

Further complications are illustrated in the utterances in (43).

(43) Limited iteration of HTS

(43*a*) *bá`- da`- kunu -ši -dɨ → bá- dá- kùnu -ši -dɨ*
NEG.POT- causative- run -she -animal

'she will not chase the animal away'

(43*b*) *bá`- ta- da`- kunu -ši -dɨ → bá- tá- dá- kùnu -ši -dɨ*
NEG.POT- IN.PROCESS- causative- run -she -animal

'she has not chased the animal away as yet'

(43*c*) *ñá`- ni`- šinu -dɨ → ñá- ní- šìnu -dɨ*
NEG- CMP.NEG- run -animal

'the animal did not run'

(43*d*) *ñá- ni`- da`- kunu -ši -dɨ → ñá- ní- dà- kunu -ši -dɨ*
NEG- CMP.NEG- causative- run -she -animal

'she did not make the animal run''

Although *da`*- 'causative' can pass HTS onto *kunu* 'run' in (41*a*) and (41*b*), it cannot do so in (43*a*) and (43*b*). In (43*c*) and (43*d*) HTS applies to *ni`*- 'CMP.NEG' but goes no further. What these four examples have in common is the combination of /H^L/ + /$\emptyset^L$/ proclitics. The two occur in sequence in (43*a*), (43*c*), and (43*d*), and are separated by a /∅/ proclitic in (43*b*). The generalization is that HTS ends with the spread of a H to a proclitic which has the second of two floating L tones.

The above examples all involve cases where the initial trigger of HTS is a proclitic. The sentence in (44*a*) shows that HTS may also apply across a word boundary to a form which is preceded by the floating L of the continuative aspect:

(44) HTS applies across a word boundary in the presence of the L of continuative aspect

(44*a*) *didí`- da`- kunu -ši -dɨ → didí- dá- kùnu -ší -dɨ*
aunt CON- causative- run -she -animal

'the aunt is making the animal run'

(44*b*) *njòˀó ndùku -ndo -dɨ → njòˀó ndúkú -ndó -dɨ́`*
you.pl CON.look.for -you.pl -animal

'you pl. are looking for the animal'

(44*c*) *didí da`- kunu -ši -dɨ → didí- da- kùnu -ši -dɨ*
aunt POT.causative- run -she -animal

'the aunt will make the animal run'

As expected, HTS applies only to the proclitic *da`*- and not beyond, since it cannot proceed beyond a proclitic which has the second of two floating L tones. In (44*b*), on the other hand, HTS spreading applies both to the verb and the two enclitics which lack a floating L tone. (44*c*) shows that HTS does not apply in the absence of the continuative floating L tone.

The proclitics *ta-* 'in.process' and *na*`- 'hortatory' are like *da*`- 'causative' when it is preceded by the floating L of the continuative aspect in that HTS applies to them across a word boundary but does not spread beyond them. However, as seen in (45), the conditions for HTS to *da*`- do not hold for *ta-* and *na*`-:

(45) HTS onto *ta-* and *na*`-

(45*a*) *didí ta-` -šinu -ši → didí- tá- šìnu -ši*
aunt in.process CON run -she

'the aunt is now running'

(45*b*) *didí na`- kunu -ši → didí- ná- kùnu -ši*
aunt hortatory- run -she

'that the aunt run'

While the form *da*`- in (44*a*) is preceded by the continuative L tone and is followed by a floating L, *ta-* precedes the continuative L and does not have a floating L of its own. The form *na*`- has a floating L but is not preceded by the floating L of the continuative aspect. It may therefore be necessary to add these as special cases where HTS applies across a word onto a verb complex.

The above characterizes the major environments where HTS takes place in PM. There are a few other forms not included in the categories already mentioned. As shown in (46), HTS applies to postverbal *ñaʔa*` 'animate object' and *mee*` 'same':

(46) Isolated cases of cross-word HTS

(46*a*) *žòʔó kiní ñaʔa` -ɨ$^{N}$` šii -o` → žòʔó kiní ñáʔá -ɨ^{N} šìi -o*
you.sg POT.see anim.obj -you.sg to -us.incl

'you will see us'

(46*b*) *sá`- `-kačí mee` -ɨ$^{N}$` → sá- kàčí méé -ɨ^{N}*
thing- CON- say same -you.sg

'whatever you yourself say'

With few exceptions, there is a prohibition against HTS applying to two consecutive words. Two words following a verb and syntactically closely related to it may both undergo HTS in some idiolects or as a free variant. The sequence *ñaʔa`* plus *mee`* in (47) is one such case:

(47) One vs. two applications of HTS to *ñaʔa`* + *mee*

(47*a*) *kiní ñaʔa` mee` -dé šii -ndɨ́* → *kiní ñáʔá mèe -dé šii -ndɨ́*
POT.see anim.obj same -he to us.excl

‘he himself will see us’

(47*b*) *kiní ñaʔa` mee` -dé šii -ndɨ́* → *kiní ñáʔá méé -dě šii -ndɨ́*
POT.see anim.obj same -he to us.excl

‘he himself will see us’

In (47*a*) HTS applies only to *ñaʔa`* ‘animate.object’, while in (47*b*) it applies both to *ñaʔa`* and *mee`* ‘same’.

As a summary of the tonal processes at work in PM, and a demonstration of the order in which the tone rules apply, we give the derivation of (47*a*) in (48).

(48) Derivation of *kiní ñaʔá mèe -dé šii -ndɨ́* ‘he himself will see us’ (47*a*)

```
(48a) /kini  ñaʔa   mee   -de   šii   -ndɨ́/   →   (HTS)
        |                   |            |
        H     L      L      H            H

(48b) /kini  ñaʔa   mee   -de   šii   -ndɨ/   →   (LTA)
        |                   |            |
        H     L      L      H            H

(48c) /kini  ñaʔa   mee   -de   šii   -ndɨ/   →   (LTD)
        |            |     /\            |
        H            L     L H           H

(48d) /kini  ñaʔa   mee   -de   šii   -ndɨ/   →   ([−r] or ↓ assignment)
        |            |      |            |
        H            L      H            H

(48e) /kini  ñaʔa   mee   -de   šii   -ndɨ/   →   (HTA—if adopted)
        |            |      |            |
       ↓H            L     ↓H           ↓H

(48f) /kini  ñaʔa   mee   -de   šii   -ndɨ/   →   (pitch assignment)
       \|                                 
       ↓H            L     ↓H           ↓H

(48g) /kini  ñaʔa   mee   -de   šii   -ndɨ/
       \|                         \
       m             L      m    ↓m
```

The underlying representation is given in (48*a*), where /H/ and /L/ stand for [+u] and [−u], respectively. The first rule is HTS, which applies to *ñaʔa*` in (48*b*). In (48*c*) the two floating Ls are linked by LTA. This is followed by LTD in (48*d*), which deletes the L that had been assigned to *-dě*. A [−r] or downstep ($^{\downarrow}$) is assigned before each successive H in (48*e*). (48*f*) shows that, if adopted, HTA applies twice: The H of *-dé* spreads onto the second TBU of *mèe*, and the H of *-ndɨ́* spreads onto the two TBUs of *šii*. The output pitches are shown in (48*g*). As discussed in **4** above, the output pitches could also be derived directly by phonetic implementation, i.e., without HTA.

7. Summary and further implications. In the preceding sections we have presented and justified an analysis of Peñoles Mixtec starting with underlying /H/, /L/, and /∅/, represented featurally as [+u], [−u], and ∅, respectively. We have seen that the postlexical rules of HTS, LTA, LTD, and (if adopted) HTA may modify the input tones in significant ways. In the output, three identifiable tone levels are obtained by fully specifying the feature [raised]: [H] tones are [+u, +r], [m] tones are [+u, −r], and [L] tones are [−u, −r]. The drop in a [m-$^{\downarrow}$m] sequence is signaled by successive [−r] features. Finally, the [l] tone from /∅/ may possibly be viewed as [−r] but is not specified for [upper]. All H tones are [+u]. A sequence of Hs marked by [+r] may rise in pitch, while a sequence of Hs marked by a single [−r] is realized on a level [m] pitch. Hs which have separate [−r] designations are subject to downstep, i.e., [m-$^{\downarrow}$m]. A [l] or sequence of [l] tones appears only before L or pause and falls in pitch.

The PM tone system is of general interest for several reasons, discussed below.

7.1. Evidence for tonal underspecification and markedness. Pulleyblank (2004) has recently argued that the classic case of underspecified M in Yoruba (Pulleyblank 1986 and Akinlabi 1985) should be rejected in favor of total specification. We present several arguments in favor of analyzing "M" as /∅/, where /∅/ is underspecified for the tone feature [upper]. While /∅/ is both the most frequent and unmarked tone in PM, /L/ is the least frequent and most marked. It also has culminative and quasi-demarcative properties: (*i*) L may occur only once per root, specifically on the initial, stressed syllable; (*ii*) a floating L cannot link to one or more /∅/ enclitics which will be skipped over to link to a following /H/ enclitic or (in the latter's absence) to the initial syllable of the next word. Both of these properties follow from de Lacy's (2002) observation that the most marked tone can be restricted to prominent ("head") positions. The marked /L/ of PM, however, contradicts de Lacy's universal markedness scale (H > M > L). As in Athabaskan (Leer 1999) and Bantu (Hyman 2001), which have two levels, the marked /L/ of

PM vs. the marked H of other Mixtec dialects, e.g., San Miguel el Grande (Tranel 1995) and Chalcatongo (Hinton 1991 and Macaulay 1996), shows that a three-level tone system can also be either H-marked or L-marked—but apparently not M-marked.

7.2. Phonological action at a distance. The rule of LTD provides an interesting example of phonological "action at a distance" (Poser 1982). We have identified LTD as a repair of an OCP violation *LL defined on the tonal tier. Thus, all /L-Ø*-L/ sequences become L-Ø*-Ø. As was shown in **4** above, it is possible to invoke the OCP only if the third tone /Ø/ is underspecified for [upper]. If we assume that the OCP is the correct account, this supports the /Ø/ representation and the general analysis. There are, however, at least two other interpretations of the process which do not invoke the OCP. First, if /Ø/ were represented as /M/, one could view /L-M*-L/ → [L-M*-M] as an assimilatory rule. Since both L-M* and (nonfinal) M*-L exist, the question is why the putative assimilation of M*-L to M*-M requires a preceding L. Recall also that a /Ø/ or sequence of /Ø/s is realized as [m] only when followed by /H/, otherwise it is realized on a low-falling [l] pitch.

Another interpretation worth considering is that the process has to do with establishing register spans and a constraint such as in (49*a*), where H and L refer to [+u] and [−u], respectively:

(49) Constraints on register spans?

(49*a*) Peñoles: Once a L tone is pronounced, there cannot be another L tone unless a H tone intervenes

(49*b*) Engenni: Once a H tone is pronounced, there cannot be another H tone unless a L tone intervenes (see below)

The generalization in (49*a*) is certainly true and is stated without reference to the OCP (or to /Ø/ tone): Whenever two L tones surface in a PM utterance, there is necessarily an intervening H tone somewhere. Recall that PM does not allow a sequence of L tones. According to the OCP account given in **3.2**, PM does not allow a succession of two TBUs realized on the same L pitch, i.e., *[L-L]. Let us instead suppose that /L/ is a dynamic feature (Clark 1978) which provides a categorical instruction for a TBU to DROP to the lowest tone level (⇓σ). A /L-L/ would thus consist of two successive instructions (⇓σ ⇓σ) to drop. But if the first TBU is already at the lowest categorical tone level, it clearly cannot drop any farther. Since /Ø/ provides no phonological instruction, and since the drop is defined on the basis of the last phonological tone, L-Ø*-L is also ruled out because it has two successive instructions to drop to the lowest level. When a /H/ intervenes, L-H-L is well-formed because the second L drops from the preceding H, whose instruction is to rise to the highest level. Like Acatlán (Pike and Wistrand 1974), PM allows successive upstepping of /H/ but not successive downstepping of /L/.

The PM generalization in (49*a*) appears to be the inverse of the corresponding generalization stated in (49*b*) for Engenni, an Edoid language spoken in Nigeria (Thomas 1974; 1978; see also Hyman 1993 and Snider 1998/1999). Thomas refers to the three tone levels of Engenni as "high," "low," and "top," where the last is derived from a "high" which is raised before a "low." If we instead refer to these tones as H, M, and L, the parallel in (49*b*) is evident: Although elision of a /L/ vowel and assignment of a /H/ tonal morpheme in certain constructions could in principle produce H-H sequences, Engenni does not permit two H tones in a row, nor can two H tones be separated from each other only by a M. If M is /∅/, then the OCP could be invoked to ban H-∅*-H sequences just as it bans L-∅*-L in PM. On the other hand, a dynamic feature analysis is also possible whereby /H/ provides an instruction to STEP UP to the highest level ($\Uparrow\sigma$). In inverse fashion to PM, which does not allow iterative drops to /L/, H-H and H-∅*-H would both be ruled out because Engenni does not allow iterative upstepping of /H/.

Whatever the interpretation of the constraint in PM and its inverted analogue in Engenni, we are impressed by the fact that these rare action-at-a-distance restrictions are found in two languages where a phonological /∅/ tone appears otherwise motivated. We saw this motivation in PM. In Engenni, only the H and L features are activated: L triggers insertion of H, and H may be a grammatical morpheme. The so-called M is the default tone.

7.3. Upstep. As in the case of Acatlán Mixtec (Pike and Wistrand 1974), PM exhibits "upstepping" of H tones, specifically those which are not lowered to [m]. Recall that a /H/ or sequence of /H/s is realized [m] after pause and after /∅/ (which also undergoes HTA). After /L/, the first /H/ TBU is realized [m], while subsequent H TBUs are often realized on a progressively higher pitch. While upstep is considerably rarer than downstep, the fact that a /L/ is implicated is quite puzzling from a synchronic point of view. In **7.2** we showed that Engenni M is raised to H before a L, a phonologization of the tendency for a H + L tone sequence to undergo F0 polarization. A L + H sequence, on the other hand, tends to undergo F0 compression (Hyman 2004). The PM facts seem to suggest the opposite, since it is L + H* which undergoes polarization. We assume that the L + upstep combination is a reflex of earlier glottal articulations which have been lost (cf. **7.4**).

7.4. Comparative Mixtec. While the PM facts bear on issues of general phonology, they are also of considerable interest from a comparative Mixtec point of view. In our analysis, we have argued that the basic tone contrast is between /H/ and /∅/, which occur in all combinations on couplets, and that

TABLE 6
PROTO-MIXTEC/PEÑOLES TONAL CORRESPONDENCES

Proto-Mixtec	Peñoles	Examples			
*H-H	/∅-∅/	*kóʔó	>	koʔo	'drink'
		*ɨ́ɨ́^{N}	>	ɨɨ^{N}	'one'
	/∅-∅^{L}/	*ndútíʔ	>	nduči`	'bean'
		*yɨ́kíʔ	>	žɨkɨ`	'bone'
	/∅-H/	*ínà	>	iná	'dog'
*H-L		*téyù	>	težú	'stool'
*L-H	/H-∅/	*ndòʔó	>	ndóʔo	'adobe'
		*yùté	>	žúte	'river'
*L-L	/H-H/	*kàʔà^{N}	>	káʔá^{N}	'speak'
		*ɨ̀ɨ̀^{N}	>	ɨ́ɨ́^{N}	'nine'
	/H-H^{L}/	*kàtìʔ	>	káčí`	'cotton'
		*kòòʔ	>	kóó`	'snake'

all input /L/ tones are floating. If one compares this to Chalcatongo, one sees just the opposite situation (Hinton et al. 1991): The basic tonal opposition appears to be /L/ vs. /∅/, with many or most of the /H/ tones being underlyingly floating. Hinton's (1991) intuition that the basic opposition is an accentual one is based in part on the possible analysis of linked /L/ vs. /∅/ as the presence vs. absence of a feature in Chalcatongo (cf. linked /H/ vs. /∅/ in PM).

There is good reason to believe that PM has inverted the tones of Proto-Mixtec. A comparison with Dürr's (1987) reconstructions reveals the regular correspondences in table 6. As seen in the examples (many more of which could have been cited), Dürr's *L and *H correspond, respectively, to PM /H/ and /∅/ in the majority tone patterns. (Correspondences with the minority tone patterns are too few to inspire confidence.) Concerning final ^{L}, it is significant that PM has floating Ls where Chalcatongo and San Miguel el Grande have floating Hs. As hypothesized by Longacre (1957) and further substantiated by Dürr (1987), these floating tones come from earlier final glottal stops which have dropped out in most dialects other than Ayutla (Pankratz and Pike 1967). While this is no doubt an oversimplification, the relevant effects of the proto-glottal stop are indicated in (50).

(50) Deriving the third tone from glottal stop

	Peñoles	Chalcatongo/San Miguel
*H	/H/	/∅/
*L	/∅/	/L/
*ʔ	/L/	/H/

As seen, the lost glottal stop produces the lowest tone in PM but the highest tone in Chalcatongo and San Miguel el Grande. The resulting "middle" /∅/ tone thus derives from *L in PM but from *H in the other dialects. While we are speculating, perhaps *ʔ has a raising effect in dialects where it was realized as a glottal stop vs. a lowering effect in dialects where it was realized as creakiness (cf. Hombert et al. 1979, Thurgood 2002, and Kingston 2003; 2005). The same inverse relationship seems to affect initials as well: The prefixal continuative aspect is marked by floating L in PM but by floating H in Chalcatongo (Hinton 1991). Glottalization is clearly an important feature within the Mixtec family (Macaulay and Salmons 1995 and Gerfen and Baker 2005). With the increasing attention being placed on thorough synchronic phonetic and phonological analyses of the Mixtec dialects, future research should produce additional discoveries and further understanding of the historical processes that have produced the enormous tonal variation for which these languages are renowned.

8. Postscript. PM /∅/ shares with Yoruba the fact that the third tone is unmarked with respect to /H/ and /L/. One of the arguments Pulleyblank (2004) gives for specifying mid tone in Yoruba concerns an optional process which Bamgboṣe (1966) calls "pronoun coalescence," illustrated in the following examples:

(*i*) [mo jɛ ɛ́] ~ [mo jɛ́] 'I ate it'

(*ii*) [mo gbé e] ~ [mo gbe] 'I lifted it'

In (*i*), the H of the object pronoun replaces the M of the verb /jɛ/ 'eat', as expected. In (*ii*), however, the M of the object pronoun replaces the H of the verb /gbé/ 'lift'. (The input tone of the object pronoun is predictable from the tone of the verb root.) The question is how this is possible if this M is analyzed as /∅/. Pulleyblank argues that /M/ must be specified.

In his note, Pulleyblank's (2004) general point is that the relative unmarkedness of Yoruba /M/ results from the ranking MAX(H) >> MAX(L) >> MAX(M), whereby MAX(TONE) roughly means that an input tone must be realized in the output (perhaps identically, perhaps not). As a result, whenever /M/ is in competition with either /H/ or /L/, it will lose out. Thus, when the constraint NOCONTOUR, which prohibits contour tones, is ranked between MAX(L) and MAX(M), the result is that potential *HM or *MH and *LM or *ML contours will surface as H and L, respectively.

Pulleyblank does not show how the /M/ of the pronoun wins out over the /H/ of /gbé/ in (*ii*), where MAX(H) is violated and MAX(M) is not. In another context he alludes to root tone winning over affix tone as a case of Beckman's positional faithfulness (1998:418), but the data in (*i*) and (*ii*) suggest that input–output identity of the pronominal tone is ranked higher than input–output identity of the verb root tone. If we replace MAX with IDENT constraints which require that the input and output tones be exactly identical, a reasonable strategy might be to establish the following ranking: IDENTTONE(pronoun) >> IDENTTONE(verb root). Under such an approach, IDENTTONE(pronoun) would be violated if an underlying /H/ or /M/ were modified or deleted in the output. However, once this step is taken, the argument against treating [M] as underlying /∅/ can be called into question. If we assume /∅/, then if (*ii*) were realized as *[mo gbé], the input tone would not be identical to the output, since a [H] output feature would correspond to the absence of an input feature on the pronoun.

Whatever the ultimate analysis of Yoruba, it is clear that Pulleyblank's ranked constraints do not help us express the transparency of PM /∅/, which is required to account for cases of long-distance LTD, as in (13). If the third tone of PM were analyzed as /M/, considerable complications would thus arise. While the arguments presented support an analysis with /∅/ in PM, we end with one complication that deserves mention.

Corresponding to Yoruba pronoun contraction is a process in PM by which the segments of the past tense marker /ní/ are optionally deleted in fast casual speech:

(*iii*)	/H-H/	*ní ndáˀí*	~	*ndáˀí*	[m-m]	'cried'
	/H-∅/	*ní ndúˀa*	~	*ndúˀa*	[m-l]	'recuperated'
(*iv*)	/L-H/	*ní tàká*	~	*tâká*	[mL-m]	'gathered'
	/L-∅/	*ní kwìta*	~	*kwîta*	[mL-l]	'was weak'
(*v*)	/∅-∅/	*ní kaku*	~	*káˉku*	[ml-l]	'was born'
	/∅-H/	*ní šiní*	~	*šíˉní*	[m↓m-m]	'was weak'

In (*iii*), where the verbs begin with /H/ tone, /ní/ deletes without having any effect. In contrast, when /ní/ deletes in (*iv*), where the verbs begin with /L/ tone, its /H/ joins with this /L/ to form an exceptional HL falling contour. Since both /H/ and /L/ are tonally specified, the resulting HL contour is easily accounted for. It should be noted, however, that some speakers do not accept *ni*-deletion in (*iv*). We attribute this to two facts. First, the HL falling tone which would result otherwise does not occur in language. Second, if it did occur, it would also violate the generalization that /L/ can only be realized domain-initially.

The more serious issue concerns (*v*), where the verbs begin with /∅/ tone. Here we expect that the H of /ní/ will join with the initial /∅/ to produce **káku* (H-∅) and **šíní* (H-H). As shown, however, we obtain what looks like a "H∅" contour on the first syllable, which we mark as [´ˉ]. The transcription in brackets shows that the second part of this contour is realized exactly as we would expect /∅/ to be realized: falling [l] before another /∅/ vs. [$^{\downarrow}$m] when wedged between Hs.

Although the HL falling contour in (*iv*) already indicates that something exceptional is going on here, the key question is how the /∅/ tone in (*v*) manages to form a contour. There appear to be three options. The first is to fully specify /∅/ as /M/, i.e., [+upper, −raised], as in (16*a*). Since this would create the problems we discussed in the body of the paper, we reject this option. Alternatively, we might adopt the partially specified representation [−raised] in (16*b*), which would be available to contour with the /H/ of /ní/. This would of course conflict with the general approach we developed in **4**, where the register features are all introduced by phonetic implementation. This leaves the original proposal that the tone is phonologically /∅/. We propose to maintain the /∅/ representation and postulate that the deletion process be conflated with phonetic implementation: Phonetic target values for /H/, /L/, and /∅/ will have to be introduced simultaneously with *ni*-deletion. In this sense, /∅/ does not stay featureless to the very end.

REFERENCES

AKINLABI, AKINBIYI. 1985. Tonal underspecification and Yorùbá. Ph.D. dissertation, University of Ibadan.

ARANOVICH, RAUL. 1994. The tone system of Acatlán Mixtec and some exceptions to the OCP. Linguistic Notes from La Jolla 17:3–26.

BAMGBOṢE, AYO. 1996. A Grammar of Yoruba. Cambridge: Cambridge University Press.

BAO, ZHIMING. 1999. The Structure of Tone. New York and Oxford: Oxford University Press.

BECKMAN, JILL. 1998. Positional faithfulness. Ph.D. dissertation, University of Massachusetts, Amherst.

CLARK, MARY. 1978. A dynamic treatment of tone. Ph.D. dissertation, University of Massachusetts, Amherst.

CLEMENTS, G. N. 1979. The description of terraced-level tone languages. Language 55:536–58.

DALY, JOHN P. 1977. A problem in tone analysis. Studies in Otomanguean Phonology, ed. William R. Merrifield, pp. 3–20. Dallas: Summer Institute of Linguistics.

______. 1978. Notes on Diuxi Mixtec tone. Work Papers of the Summer Institute of Linguistics 22:98–113.

______. 1992. Phonetic interpretation of tone features in Peñoles Mixtec. Proceedings of the IRCS Workshop on Prosody in Natural Speech, August 5–12, 1992, pp. 53–62. Philadelphia: Institute for Research in Cognitive Science, University of Pennsylvania.

______. 1993. The role of tone sandhi in tone analysis. Notes on Linguistics 61:5–24. Dallas: Summer Institute of Linguistics.

______. 2000. Tone sandhi in Peñoles Mixtec. Ms., Summer Institute of Linguistics.

DE LACY, PAUL. 2002. The interaction of tone and stress in optimality theory. Phonology 9:1–32.

DÜRR, MICHAEL. 1987. A preliminary reconstruction of the Proto-Mixtec tonal system. Indiana 11:19–62. Berlin.

GERFEN, CHIP, AND KIRK BAKER. 2005. The production and perception of laryngealized vowels in Coatzospan Mixtec. Journal of Phonetics 33:311–34.

GOLDSMITH, JOHN A. 1990. Autosegmental and Metrical Phonology. Oxford: Basil Blackwell.

HINTON, LEANNE. 1991. An accentual analysis of tone in Chalcatongo Mixtec. Papers from the American Indian Languages Conference, University of California, Santa Cruz, July and August 1991, ed. James E. Redden, pp. 173–82. Carbondale: Southern Illinois University.

HINTON, LEANNE; EUGENE BUCKLEY; MARVIN KRAMER; AND MICHAEL MEACHAM. 1991. Preliminary analysis of Chalcatongo Mixtec tone. Papers from the American Indian Languages Conference, University of California, Santa Cruz, July and August 1991, ed. James E. Redden, pp. 147–55. Carbondale: Southern Illinois University.

HOLLENBACH, BARBARA E. 2000. The historical source of an irregular tone-sandhi pattern. Ms., Summer Institute of Linguistics, Mexico.

HOMBERT, JEAN-MARIE; JOHN J. OHALA; AND WILLIAM G. EWAN. 1979. Phonetic explanations for the development of tones. Language 55:37–58.

HYMAN, LARRY M. 1979. A reanalysis of tonal downstep. Journal of African Languages and Linguistics 1:9–29.

______. 1993. Register tones and tonal geometry. The Phonology of Tone: The Representation of Tonal Register, ed. Keith Snider and Harry van der Hulst, pp. 75–100. The Hague: Mouton de Gruyter.

______. 2001. Privative tone in Bantu. Cross-linguistic Studies of Tonal Phenomena: Tonogenesis, Japanese Accentology, and Other Topics, ed. Shigeki Kaji, pp. 237–57. Tokyo: Institute for the Study of Languages and Cultures.

______. 2004. Universals of tone rules: Thirty years later. Paper presented at the International Conference on Tone and Intonation, Santorini, September 9–11, 2004. [To appear in Tones and Tunes: Studies in Word and Sentence Prosody, ed. Carlos Gussenhoven and Tomas Riad. Berlin: Mouton de Gruyter.]

KINGSTON, JOHN. 2003. Mechanisms of tone reversal. Cross-linguistic Studies of Tonal Phenomena: Historical Development, Phonetics of Tone, and Descriptive Studies, ed. Shigeki Kaji, pp. 57–120. Tokyo: Institute for the Study of Languages and Cultures.

______. 2005. The phonetics of Athabaskan tonogenesis. Athabaskan Prosody, ed. Sharon Hargus and Keren Rice, pp. 137–84. Amsterdam: John Benjamins.

LEER, JEFF. 1999. Tonogenesis in Athapaskan. Cross-linguistic Studies of Tonal Phenomena: Tonogenesis, Typology, and Related Topics, ed. Shigeki Kaji, pp. 37–66. Tokyo: Institute for the Study of Languages and Cultures.

LONGACRE, ROBERT E. 1957. Proto-Mixtecan. Indiana University Research Center in Anthropology, Folklore and Linguistics, Memoir 5. Bloomington: Indiana University.

MACAULAY, MONICA. 1996. A Grammar of Chalcatongo Mixtec. University of California Publications in Linguistics 127. Berkeley and Los Angeles: University of California Press.

MACAULAY, MONICA, AND JOE SALMONS. 1995. The phonology of glottalization in Mixtec. IJAL 61:38–61.

MADDIESON, IAN. 1978. Universals of tone. Universals of Human Language, vol. 2, Phonology, ed. Joseph H. Greenberg, pp. 335–65. Stanford, Calif.: Stanford University Press.

PANKRATZ, LEO, AND EUNICE V. PIKE. 1967. Phonology and morphotonemics of Ayutla Mixtec. IJAL 33:287–99.

PIKE, EUNICE V., AND JOY ORAM. 1976. Stress and tone in the phonology of Diuxi Mixtec. Phonetica: 33:321–33.

PIKE, EUNICE V., AND PRISCILLA SMALL. 1974. Downstepping terrace tone in Coatzospan Mixtec. Advances in Tagmemics, ed. Ruth Brend, pp. 105–34. Amsterdam: North-Holland.

PIKE, EUNICE V., AND KENT WISTRAND. 1974. Step-up terrace tone in Acatlán Mixtec. Advances in Tagmemics, ed. Ruth Brend, pp. 83–104. Amsterdam: North-Holland.

PIKE, KENNETH L. 1944. Analysis of a Mixteco text. IJAL 10:113–38.

______. 1948. Tone Languages. Ann Arbor: University of Michigan Press.

POSER, WILLIAM J. 1982. Phonological representations and action-at-a-distance. The Structure of Phonological Representations, pt. 2, ed. Harry van der Hulst and Norval Smith, pp. 121–58. Dordrecht: Foris.

PULLEYBLANK, DOUGLAS. 1986. Tone in Lexical Phonology. Dordrecht: Reidel.

______. 2004. A note on tonal markedness in Yoruba. Phonology 21:409–25.

SNIDER, KEITH. 1998/1999. Tonal "upstep" in Engenni. Journal of West African Languages 27:3–15.

______. 1999. The Geometry and Features of Tone. Dallas: Summer Institute of Linguistics.

THOMAS, ELAINE. 1974. Engenni. Ten Nigerian Tone Systems: Studies in Nigerian Languages 4, ed. John Bendor-Samuel, pp. 13–26. Dallas: Summer Institute of Linguistics and University of Texas at Arlington.

______. 1978. A Grammatical Description of the Engenni Language. Dallas: Summer Institute of Linguistics and University of Texas at Arlington.

TRANEL, BERNARD. 1995. Rules vs. constraints: A case study. Paper presented at the Conference on Current Trends in Phonology: Models and Methods, Royaumont, France, June 19–21, 1995.

THURGOOD, GRAHAM. 2002. Vietnamese and tonogenesis: Revising the model and the analysis. Diachronica 19:333–63.

YIP, MOIRA. 1980. The tonal phonology of Chinese. Ph.D. dissertation, Massachusetts Institute of Technology.