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Tone Sandhi and Rule Ordering

in Peñoles Mixtec

John P. Daly

The tone sandhi of Peñoles Mixtec¹ is accounted for by a small number of simple, interrelated rules, involving the two tones high and low and the modification or lack of modification of these tones in specified environments.² The tones high and low are formally represented by the feature [high] in its two values plus and minus, and the modification or lack of modification of them by the feature [modify] in its two values.³ The two tonal features have their values changed by the tone rules, in environments specified phonologically and to a limited extent, syntactically.⁴

In this paper we will consider the four rules which account for tone sandhi in sequences consisting solely of bisyllabic morphemes, inasmuch as the most important aspects of tone sandhi are manifested in these sequences.⁵ We will also consider the order in which the rules must apply, the need for the tone cycle, and the way in which the tone cycle reduces the number of ordering restrictions.

1. The Rules of Tone Sandhi

1.1 Modifier Adjustment

One kind of change occurring in tone sandhi is illustrated in Table 1, showing the effect of combining bisyllabic morphemes having only low tones with following bisyllabic morphemes having the four possible combinations of unmodified high and low tones.⁶

	šěčí	kìtì	sánu	ditó
	'girl'	'animal'	'daughter-in-law'	'uncle'
njuši	šěčí	kìtì	sánu	ditó
'chicken'				
kolo	šěčí	kìtì	sánu	ditó
'turkey'				

Table 1

In Table 1 each of the two morphemes at the left of the horizontal rows is followed by each of the four morphemes at the top of the vertical columns. At the intersection of each row and column appears the second morpheme of each combination with its resultant tones. The second morpheme possesses the first, e.g., njuši šěčí 'the girl's chicken' and kolo šěčí 'the girl's turkey'. Following njuši 'chicken', the morpheme šěčí 'girl' becomes šěčí, the unmodified high tone on the first syllable of šěčí becoming modified. And so for all the morphemes following njuši: the unmodified tone on the first syllable of each becomes modified. However, following kolo 'turkey', the morpheme šěčí retains its basic tones. And so for all of the morphemes following kolo: their tones remain unchanged.

Formally, the difference between morphemes following njuši and morphemes following kolo is that the former have the feature specification [-modify] on the first syllable of each changed to [+modify] whereas the latter retain the feature specification [-modify].

The difference between *njuši* and *kolo* in their effect on immediately following morphemes is not phonologically motivated; there is no overt phonological difference, tonal or segmental, in *njuši* and *kolo* that can account for the different effects on following morphemes. These two morphemes represent two large classes of morphemes, both of which consist of members having only unmodified low tones but which condition following morphemes differently. The two classes of morphemes will be differentiated by making use of the feature [modify] in the following way. Morphemes like *njuši*, which cause a following tone to become modified, will be marked in the lexicon with the feature specification [+modify] on their second syllable, where it is not actualized but forms the condition for the modification of the next following tone. Morphemes like *kolo* will have the feature specification [-modify] on their second syllable, leaving the next following tone unchanged.

The rule which effects the changes represented in Table 1 is:

Rule 1: Modifier Adjustment

$$[\text{modify}] \longrightarrow [+ \text{modify}]$$

$$/ [+ \text{modify}] + \underline{\quad}$$

Rule 1 states that the feature [modify] is specified as [+modify] when it is morpheme initial and is preceded by [+modify].⁷

In the discussion which follows the feature specification [+modify] on the first syllable of a morpheme will be referred to as a modifier and the same feature specification

on the second syllable of a morpheme will be referred to as a conditioner. A feature specification which is present in the lexicon is called basic, and one which arises from the application of a rule is called derived. Thus in Table 1, njuši, hereafter written njuši,⁸ has a basic conditioner which conditions the introduction of a derived modifier on each of the following morphemes.⁹

The tone patterns which result from the application of Rule 1 and which are exemplified in Table 1 are identical to the patterns which appear on some other morphemes in their basic form. The latter morphemes, which have four modified tone patterns, are exemplified in Table 2.

	nǎná	tà'ǎ	mǐči	kwàžú
	'mother'	'relative'	'cat'	'horse'
njuši	nǎná	tà'ǎ	mǐči	kwàžú
'chicken'				
kolo	nǎná	tà'ǎ	mǐči	kwàžú
'turkey'				

Table 2

The morphemes following njuši 'chicken' and kolo 'turkey' have their basic tones (including basic modifier). The correct forms appear following njuši whether or not Rule 1 applies to them; but given the present form of Rule 1, it will apply since the feature [modify] which undergoes the change in Rule 1 is specified as neither plus nor minus. Whatever its original feature specification, it will be

specified as [+modify]. Rule 1 formulated in this way makes explicit the identity between derived patterns and basic patterns.

1.2 Conditioner Reduction

Consider now Table 3:

	šěčí	kítì	sánu	ditó
	'girl'	'animal'	'daughter-in-law'	'uncle'
kúmǐ	šěčí	kítì	sánu	ditó
'four'				
úú	šěčí	kítì	sánu	ditó
'two'				

Table 3

kítì 'animal' is unchanged following kúmǐ 'four' whereas šěčí 'girl', sánu 'daughter-in-law', and ditó 'uncle' receive a derived modifier on their first syllable. No change takes place in any of the forms following úú 'two'.¹⁰ These data taken with the data given in Table 1 show that high tone morphemes, i.e., morphemes of all high tones, have the same effect on following morphemes that low tone ones do, with one exception: high tone morphemes with a basic conditioner do not affect following low tone morphemes, whereas low tone morphemes with a basic conditioner do. In other words, a high tone morpheme with the feature specification [+modify] on its second syllable conditions the modification of the tone patterns high high, high low, and low high of following morphemes, but leaves unaffected the tone pattern low low

of a following morpheme; on the other hand, a low tone morpheme with the feature specification [+modify] on its second syllable conditions the modification of all four tone patterns. High tone morphemes without a conditioner, like low tone ones, leave following morphemes in their basic form.

In order to prevent *kiti* 'animal' following *kúmi* 'four' from becoming *kati* by Rule 1, it will be necessary to change [+modify] on the second syllable of *kúmi* to [-modify] when this morpheme precedes low tone morphemes. The rule to reduce [+modify] is:

Rule 2: Conditioner Reduction

$$[\text{modify}] \longrightarrow [-\text{modify}]$$

$$/ \quad [+high] \left[\begin{array}{c} +high \\ \hline \end{array} \right] + [-high] \quad [-high]$$

Rule 2 states that the feature [modify] is specified as [-modify] when associated with [+high] preceded by [+high] and followed by a morpheme specified as [-high] [-high]. Or, stated informally, a conditioner is deleted in a high tone morpheme when preceding a low tone morpheme. Rules 1 and 2 must apply in such a way that the conditioner before a low tone morpheme will be reduced by Rule 2 before it can serve as the environment for the modification of the next following tone by Rule 1. In this way a sequence such as *kúmi kití* 'four animals' will not enter Rule 1 and *kití* will remain unmodified.¹¹

The preceding two rules account for the process whereby unmodified tones become modified. The next rule accounts

for the reverse of this process, i.e., the way in which modified tones become unmodified.

1.3 Modifier Reduction

Consider now the sandhi which occurs when a morpheme with a modified low tone pattern combines with a morpheme of each of the four modified tone patterns.

	nǎná	tà'ǎ	mǐči	kwàžú
	mother'	'relative'	'cat'	'horse'
čǐy	náná	tǎ'ǎ	mǐči	kwàžú
'work'				
žǐkǐ	nǎná	tà'ǎ	mǐči	kwàžú
'bone'				

Table 4

Following čǐy 'work' in Table 4, each of the modified tones becomes unmodified, but following žǐkǐ 'bone' no change takes place. The rule which makes the change following čǐy is:

Rule 3: Modifier Reduction

$$[\text{modify}] \longrightarrow [-\text{modify}]$$

$$/ \left[\begin{array}{l} +\text{modify} \\ -\text{high} \end{array} \right] \quad [-\text{high}] + \underline{\quad}$$

Rule 3 states that the feature [modify] is specified as [-modify] when it is preceded by a morpheme with [+modify] on its first syllable and [-high] on both of its syllables. Or stated informally, a modifier is deleted when it is preceded by a low tone morpheme which contains a modifier. In the present form of Rule 3, [+modify] will be reduced to [-modify]

nđùku 'look-for(cont.)' becomes nduku and tătá 'father' becomes tátá. In (4 a) the high tone of ditó 'uncle' prevents čìy 'work' from becoming čìy in (4 b).

Consideration of these and other data leads us to the following generalizations:

A modified tone, either high or low, becomes unmodified following a modified low tone; between these two tones any number of low tones may intervene, providing they are not interrupted by a high tone. Every modified low tone up to the first high tone becomes unmodified, and should the high tone be modified it also becomes unmodified.

Rule 3 revised to allow for all the environments¹² in which tone reduction takes place is:

Rule 3: Modifier Reduction (revised)

$$[\text{modify}] \longrightarrow [-\text{modify}]$$

$$/ \left[\begin{array}{c} -\text{high} \\ +\text{modify} \end{array} \right] [-\text{high}] + ([-\text{high}]) \text{ ______}$$

In the revised form of Rule 3 the parentheses are to be interpreted as permitting the feature [-high] to occur zero or more times, there being no lower or upper limit on the number of times the feature may occur. The absence of morpheme and word boundaries within the parentheses means that there is no restriction on the occurrence of these boundaries. Thus the environments in which Rule 3 applies are neither restricted by the number of low tones which follow a morpheme with a modified low tone nor by the distribution of these tones in morphemes and words.

In the preceding examples each of the modifiers which meets the environmental condition for the operation of Rule 3

is basic. However, a derived modifier (one which results from the previous application of Rule 1) may also meet the environmental condition of Rule 3. Consideration of this possibility is left to §2.1 below.

1.4 Tone Assimilation

The preceding rules have only phonological conditions but the next rule to consider has syntactic as well as phonological conditions. The application of the rule is limited not only by the tonal environment but also by the syntactic class of ^{the} morpheme undergoing the change. For example, an adjective undergoes change, but not a noun; a verb in the continuative aspect undergoes change, but not a verb in the potential aspect.¹³ Table 5 illustrates the kinds of change which the rule must account for.

	tɥɥ	kwii
	'black'	'green'
tutú	túŷ	kwíŷ
'paper'		
ñunu	tɥɥ	kwii
'net'		

Table 5

Following the high tone morpheme tutú 'paper', the low tone morphemes become high toned. The resulting high tone which comes first in each of the morphemes is unmodified and the second high tone includes a conditioner. In Table 5 the morpheme which conditions the change is without a modifier

and without a conditioner, but the same change takes place following any tone pattern which ends in a high tone. For example šilé 'chair', kwáčí 'twins', čakă 'fish', and ká?á 'to speak', all produce the same change. No change takes place after ñunu 'net' or any other morpheme ending in a low tone.

The rule which effects the tone changes following a high tone is:

Rule 4: Tone Assimilation

$$[-\text{high}] [-\text{high}] \rightarrow \begin{bmatrix} -\text{modify} \\ +\text{high} \end{bmatrix} \quad \begin{bmatrix} +\text{modify} \\ +\text{high} \end{bmatrix} \\ / [+high] + \underline{\hspace{2cm}}$$

where the morpheme undergoing the change is a verb in the continuative aspect or an adjective.

2. Rule Ordering and the Tone Cycle

Some of the tone rules must apply to the output of other tone rules if all possible tone sequences are to be generated. Furthermore, the rules must apply in a particular order if only actually occurring tone sequences are to be generated. The order in which the rules apply will be determined partially by the cyclic application of the rules and partially by ordering restrictions on the rules as they apply within each cycle. In Section 2.1 we will consider the order in which the rules must apply, without regard to the tone cycle, and in Section 2.2 consider the extent to which the cyclic application of the rules meets the ordering requirements.

2.1 Ordering Considerations

We have already observed that Rule 2 (Conditioner Reduction) must apply before Rule 1 (Modifier Adjustment). Rule 2 deletes a conditioner on a high tone morpheme when this morpheme precedes a low tone morpheme. After the conditioner has been deleted, Rule 1 can no longer apply to produce a derived modifier in the sequences in which Rule 2 has operated, but Rule 1 can apply to all other sequences containing a conditioner (where Rule 2 has not applied) to produce a derived modifier. If Rule 1 were to apply first, Rule 2 would serve no purpose at all and a derived modifier would be wrongly introduced in those environments where Rule 2 should have applied.

Rule 4 (Tone Assimilation) must also apply before Rule 1. Rule 4 introduces a derived conditioner which subsequently conditions the formation of a derived modifier on the next syllable by Rule 1 (just as a basic modifier conditions the formation of a derived modifier by the same rule). Therefore, Rule 4 must apply before Rule 1, as seen in derivation (5).

- (5) (a) žaká saa ditó
 (b) žaká sáǎ ditó (Rule 4)
 (c) žaká sáá ditó (Rule 1)
 corn crib new uncle
 the uncle's new corn crib

If Rule 1 were not to apply to the output of Rule 4, Rule 4 would have to duplicate the effect of Rule 1 by introducing a derived modifier on the next following syllable instead

of introducing a conditioner that subsequently conditions the introduction of a derived modifier. But to revise Rule 4 in this way would mean that derived tone patterns and basic tone patterns would condition following morphemes in two different rules instead of in one, thereby obscuring the similarity between basic and derived tone patterns.

Although basic and derived conditioners have similar effects on following tones, they are not identical. A high tone morpheme with a basic conditioner causes a modifier to be formed on all but low tone morphemes (the exception provided for by Rule 2), but a high tone morpheme with a derived conditioner causes a modifier to be formed on morphemes of all tone patterns. Thus high tone morphemes with a derived conditioner have no exceptions in their effect on following morphemes, just as low tone morphemes with a basic conditioner have no exceptions.

Rule 2, therefore, must eliminate a basic conditioner on high tone morphemes, but must leave a derived conditioner unaffected. Compare derivations (6) and (7).

- (6) (a) $\text{d}^{\text{h}}\text{k}^{\text{h}}$ kolo
 (b) $\text{d}^{\text{h}}\text{k}^{\text{h}}$ kolo (Rule 2)
 head turkey
 the turkey's head
- (7) (a) tak^{h} saa $\text{k}^{\text{h}}\text{t}^{\text{h}}$
 (b) tak^{h} $\text{s}^{\text{h}}\text{a}$ $\text{k}^{\text{h}}\text{t}^{\text{h}}$ (Rule 4)
 (c) tak^{h} $\text{s}^{\text{h}}\text{a}$ $\text{k}^{\text{h}}\text{t}^{\text{h}}$ (Rule 1)
 nest new animal
 the animal's new nest

In order to generate both (6) and (7), Rule 2 must apply before, not after, Rule 4 introduces the derived conditioner; otherwise derivation (8) would be wrongly generated in place of (7).

(8) (a)	taká	saa	kítá	
(b)	taká	sáǎ	kítá	(Rule 4)
* (c)	taká	sáá	kítá	(Rule 2)
	nest	new	animal	
	the animal's new nest			

Rule 2 could follow Rule 4, if Rule 4 were to introduce a derived modifier instead of a derived conditioner, since there would no longer be a derived conditioner for Rule 2 to delete. But this alternative, already rejected in reference to the ordering relation between Rules 1 and 4, would lose the generalization that, but with one exception (Rule 2), both basic and derived tone patterns condition the next following tone in the same way.

Now consider the order in which Rules 1 and 3 must apply. Rule 3 (Modifier Reduction) deletes a basic modifier following a basic modifier on a low tone morpheme as we have already seen in (1), repeated here as (9).

(9) (a)	ndùku	njoo	čìy
(b)	ndùku	njoo	čìy
	look-for(cont.)	we	work
	we are looking for work		

Just as Rule 3 deletes a basic modifier following a basic modifier, so it does following a derived modifier.

It is Rule 1 which introduces the derived modifier which serves as the environment for the application of Rule 3; therefore Rule 1 must apply before Rule 3, as derivation (10) shows.

- (10) (a) tušì žutu kwii
 (b) tuši žùtu kwii (Rule 1)
 (c) tuši žùtu kwii (Rule 3)
 hew tree green
 hew the green tree

If Rule 3 were to apply independently of Rule 1, it would have to operate not only in the context of a modifier, but also in the context of a conditioner. The consequent loss of generality is similar to that mentioned in respect to Rule 4.

Rule 1 not only introduces a derived modifier which serves as the environment for Rule 3, but it also introduces a derived modifier which can be deleted by Rule 3. Consider derivation (11).

- (11) (a) sàà kadà ndučì
 (b) sàà kada ndùči (Rule 1)
 (c) sàà kada ndučì (Rule 3)
 buy(cont.) son-in-law beans
 the son-in-law is buying beans

ndučì 'beans' first becomes ndùči under the influence of kadà 'son-in-law' by Rule 1 and then ndučì once again by Rule 3 under the influence of sàà 'buy(cont.)'. Since Rule 3 applies to the output of Rule 1 the generalization being made is that, given the proper environment, a morpheme with a basic or derived modifier loses its modifier.

A problem arises in the ordering of Rule 4 and Rule 1. We have seen that Rule 4 must apply before Rule 1 so as to introduce a derived conditioner that forms the environment for Rule 1, as illustrated in (5) and repeated here as (12).

- | | | | | |
|----------|---------------------------|-----|-------|----------|
| (12) (a) | žaká | saa | ditó | |
| (b) | žaká | sáá | ditó | (Rule 4) |
| (c) | žaká | sáá | ditó | (Rule 1) |
| | corn crib | new | uncle | |
| | the uncle's new corn crib | | | |

But Rule 4 must also apply after Rule 1 as derivation (13) shows.

- | | | | |
|----------|--------------|-------|----------|
| (13) (a) | šítŭ | tŭŭ | |
| (b) | šítŭ | tŭŭ | (Rule 1) |
| (c) | šítŭ | tŭŭ | (Rule 4) |
| | oven | black | |
| | a black oven | | |

In (13) a derived modifier is introduced in tŭŭ 'black' to give tŭŭ by Rule 1; the derived modifier is subsequently deleted (along with certain other changes) to give tŭŭ by Rule 4.

The same kind of consideration that led to applying Rule 4 before Rule 1 leads to applying them in reverse order. Just as Rule 4 must apply before Rule 1 so that the conditioner introduced by Rule 4 is available to Rule 1, so Rule 1 must apply before Rule 4 so that the modifier introduced by Rule 1 is available to Rule 4.

- (14) (a) bitũ saa taši
 (b) bitú sàa taši (Rule 1)
 (c) bitú sǎǎ taši (Rule 4)
 (d) bitú sǎá tàši (Rule 1,
 board new give(pot.)
 give (me) the new board

In derivation (14), saa 'new' becomes sàa by Rule 1 and subsequently becomes sǎǎ by Rule 4. Finally, taši 'give' becomes tàši by Rule 1.

This derivation demonstrates the need for the tone cycle, in which Rule 1 gives sàa on one cycle and gives tàši on another cycle.

2.2 The Tone Cycle

The rules are applied cyclically from left to right within the limits of a phonological phrase. On the first cycle, the first morpheme in the phonological phrase undergoes a change, if that morpheme is changed by a rule, not simply that it conditions a change. After all the rules which can apply to the first morpheme have applied, they apply to the second morpheme, etc., throughout the phonological phrase. For example, Rule 2 applies on the first cycle in derivation (15) since it is the first morpheme in the phonological phrase and it is subject to change under the influence of the following morpheme.

- (15) (a) dítĩ kítĩ.
 (b) dítĩ kítĩ (Rule 2)
 nose animal

In derivation (14) above, saa 'new' became sàa by Rule 1 and in the same cycle became sǎǎ by Rule 4. On the next cycle Rule 1 applied again to change taši 'give' into tǎši. Since Rule 4 could apply before Rule 1 in the same cycle thereby giving the wrong derivation (16), Rule 1 must be ordered before Rule 4.

(16)	(a)	bítǔ	saa	taši	
	(b)	bítǔ	sǎǎ	taši	(Rule 4)
	* (c)	bíú	sǎǎ	taši	(Rule 1)
	* (d)	bítú	sǎǎ	tǎši	(Rule 1)
		board	new	give(pot.)	
		give (me) the new board			

In the same way, Rule 4 could apply before Rule 2 in the same cycle giving the wrong derivation (17). Therefore Rule 2 must also be ordered before Rule 4.

(17)	(a)	žučí	saa	taši	
	(b)	žučí	sǎǎ	taši	(Rule 4)
	* (c)	žučí	sǎǎ	taši	(Rule 2)
		knife	new	give(pot.)	
		give (me) a new knife			

No ordering restriction needs to be placed on Rule 1 with respect to Rule 3, given the requirement that if a rule can apply on a particular cycle it must apply. In derivation (18) only Rule 1 can apply to nǎñǎ 'ear of corn' to give nǎñǎ in (18 b). Now Rule 3 can apply to nǎñǎ to give nǎñǎ

in (18 c). Rules 1 and 3, therefore, are intrinsically ordered, whereas Rules 1 and 4, as well as Rules 2 and 4, are extrinsically ordered.

- (18) (a) šèši tĩñĩ nĩñĩ
 (b) šèši tĩñĩ nĩñĩ (Rule 1)
 (c) šèši tĩñĩ nĩñĩ (Rule 3)
- eat(cont.) mouse ear-of-corn
 the mouse is eating an ear of corn

Rule 1 is unordered with respect to Rule 2, since in reference to a particular conditioner the two rules operate on different cycles. Rule 2 applies on one cycle to provide the exception to Rule 1, and on the next cycle Rule 1 can no longer apply as it would have, had Rule 2 not already applied.

Rule 3 is unordered with respect to Rule 4, since these two rules apply in different environments, Rule 3 applying after low tones and Rule 4 after high tones. Rule 2 and Rule 3 are also unordered with respect to each other since they apply to different morphemes, Rule 2 applying to high tone morphemes and Rule 3 to low tone ones.

All of the possible combinations of the four rules have now been considered showing that ordering restrictions need to be placed only on Rules 1 and 2 with respect to Rule 4.

A further restriction will be placed on Rule 4. As it stands Rule 4 could apply to a bisyllabic morpheme on one cycle to produce a high tone

pattern and again to a second bisyllabic morpheme on the next cycle to produce a second high tone pattern. If Rule 4 were to apply twice in this way derivation (19) would wrongly result.

- (19) (a) žučí saa tàši ditó
 (b) žučí sáá tàši ditó (Rule 4)
 (c) žučí sáá tàši ditó (Rule 1)
 * (d) žučí sáá táši ditó (Rule 4)
 * (e) žučí sáá táši ditó (Rule 1)

knife new give(cont.) uncle
 the uncle gives (me) a new knife

The restriction on Rule 4 revised to prevent derivation (19) and other similar ones is:

where the morpheme undergoing the change is an adjective or verb in the continuative aspect which is preceded by a morpheme which has not undergone this rule.

FOOTNOTES

1. Peñoles Mixtec is spoken in the town of Santa María Peñoles, which is located some 30 miles due west of the city of Oaxaca, the capital of Oaxaca, Mexico. There are approximately 2,000 speakers of this dialect and another 8000 speakers of mutually intelligible dialects spoken in neighboring villages.

2. Although the tone rules are simple, the tone data gives the impression of being extremely complex. The main difficulty for the analyst is to arrive at a phonemicization of

tone that makes possible a relatively simple statement of both morphophonemic and phonetic processes. Central to the analysis is recognizing that in some environments an unmodified low tone plus an unmodified high tone are on the same pitch level, whether the two tones are in two different morphemes or are within the same morpheme (rising sequences within a morpheme being due to tone modification). Recognizing this relationship between unmodified high and low tones also results in a simple explanation of tone neutralization and terracing. The neutralization of high tone and low tone is due to the fact that any number of unmodified low tones followed by any number of unmodified high tones within the same phonological phrase are actualized on the same pitch. Tone terracing results from the fact that alternating sequences of unmodified low and high tones are actualized on successively lower pitch levels.

The analyst can easily be misled into positing three level tone phonemes. Following a frame ending in a high tone, one readily arrives at the following tone patterns (ignoring uncertainties due to the absence of some combinations of two tones on two syllables): high high, high mid, high low, mid high, low mid, low low and two patterns with two tones on a single syllable low mid-low and mid-high low. However, it can be shown that this analysis leads to an unnecessarily complex statement of the tone morphophonemics. It is much more advantageous to treat

these patterns as involving the two tones high and low and the modification or lack of modification of them. High high, high low, and low low of a three tone system are the same tone patterns without modification in a two tone system. Mid high, mid-high low, mid high and low mid-low are equated with high high, high low, low high and low low, respectively, with modification accompanying the first tone of each. The pattern high mid arises from the tone sequence high low high.

Although Peñoles Mixtec is susceptible to an analysis involving the tones high and low and the modification or lack of modification of them, it does not necessarily mean that the other Mixtec languages are susceptible to the same kind of analysis. Most Mixtec languages have been analyzed as having three tones (c.f. K. Pike, 1948; Mak, 1958; Pankratz and E. Pike, 1967); Atatláhuca Mixtec has been analyzed as having four tones (Mak, 1953).

3. The tonal feature [modify] is proposed by Nancy Woo (1969). The feature is realized as a modification of the pitch of the tone with which it is associated, and not in a difference of intensity.

A modified high tone is manifested phonetically as a short upward glide in the mid register and a modified low tone as a level low tone, which is at a level lower than all unmodified low tones except those which occur phrase finally (where an unmodified low tone glides to an extra low pitch). Both modified high tones and modified low tones effect a

noticeable rise in pitch in following high tones, even if separated by a long series of low tones.

A description of the phonetic processes is given in Daly, "Phonetic Realization of Peñoles Mixtec Tones" (in preparation).

4. See Daly (1973) for a description of Peñoles Mixtec syntax.

5. The same rules generalized somewhat along with two additional rules not discussed in this paper account for sandhi in sequences which include the other two morpheme types, monosyllabic and trisyllabic morphemes.

6. In the orthography employed here, the acute accent mark represents high tone and the absence of this mark represents low tone. The grave accent on the first syllable of a morpheme represents tone modification and the absence of the mark represents the absence of tone modification.

The segmental phonemes are: voiceless stops p, t, č, k, kw, ʔ; voiced stops mb, nd, nǰ, ng, ngw; voiceless fricatives f, s, š, h; voiced fricatives b, d, ž; nasals m, n, ñ; liquids l, ř; and vowels i, e, ĩ, a, u, o. There is also phonemic nasalization of vowels.

7. By convention, the feature specification [+modify] conditioning the change in Rule 1 becomes [-modify] upon application of the rule, and becomes [-modify] phrase finally, where Rule 1 does not apply.

8. Morphemes such as *n̄jusi*, which condition a change in a following morpheme, could just as well be marked with a final glottal stop (represented formally by a feature of glottal closure) since the glottal stop never occurs morpheme finally but only morpheme medially in Peñoles Mixtec. Historically, tone modification in Peñoles Mixtec (PM) may have been conditioned by a morpheme-final glottal stop, which still appears in Ayutla Mixtec (AM) (with a glottal stop: AM $k\bar{u}^3m\acute{i}^1$, PM *kúmĭ* 'four'; AM $k\bar{a}s\acute{a}^2$, PM *kaðà* 'son-in-law'; without a glottal stop: AM $t\acute{u}^3tu^3$, PM *tutú* 'paper'; AM $v\acute{a}^3a^3$, PM *bá?a* 'good'.) The glottal stop in Ayutla Mixtec is actualized when occurring phrase finally, but is deleted phrase medially after conditioning a change in the tones of an immediately following morpheme. See Pankratz and E. Pike (1967) for their description of this process.

9. A conditioner, but never a modifier, occurs on the second syllable of bisyllabic morphemes in the lexicon and in sandhi. A conditioner occurs in only three tone patterns; it occurs commonly in the patterns high high and low low and in one case in the pattern high low $\check{s}\acute{a}^?à$ 'say'. No tone pattern occurs with both a basic modifier and a basic conditioner.

Sometimes through the loss of a vowel (by a rule which applies after the tone rules discussed in this paper) a modified tone is actualized on an immediately preceding syllable, resulting occasionally in two modified tones

being actualized on the adjacent vowels, e.g., kúmí kǒ'ǒ-í 'my four bowls' becomes kúmí kǒ'ó-ǐ by Rule 1 and subsequently kúmí kǒ'ǐ. A closely related process has been called regressive perturbation. A high tone occurs in the morpheme -'žú 'people' where it is never actualized. The tone transfers to the immediately preceding syllable as in kití-žú 'the people's animal' which derives from kití-'žú. If the high tone has become modified by Rule 1, the tone with its modification is transferred to the preceding syllable, e.g., ní'ǐ-'žú 'the people will find' becomes ní'í-žú by Rule 1 and finally ní'ǐ-žú.

10. The numerals kúmǐ 'four' and úú 'two', which quantify the following nouns, appear in Table 3, rather than nouns as in the previous two tables; there are no high tone nouns like úú, but all are like kúmǐ with a basic conditioner.

11. The ordering relationship between Rules 1 and 2 will be discussed further in §2 below where it will be seen that these two rules, as well as the next two rules to be introduced, may retain the original order in which they are introduced because of the manner in which the tone cycle operates.

12. One exception to this rule has been encountered; immediately following tǎ'ǐ 'nothing' the rule does not apply.

13. Verbs occur in three aspects. They are potential (pot.), the basic form of the verb; continuative (cont.)

the basic form of the verb modified tonally and in some cases modified segmentally; and completive (comp.) the morpheme ní- 'completive' plus the basic form of the verb modified segmentally but not modified tonally (other than by general rules of tone sandhi).

14. The restrictions placed on Rule 4 are expanded in §2.2.

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