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OTOMANGUEAN
PHONOLOGY

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STUDIES IN

**OTOMANGUEAN
PHONOLOGY**

William R. Merrifield, editor

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INTRODUCTION

This volume of phonology papers, treating languages of the Otomanguan group, includes materials from three of its major families: Mixtecan, Popotecan, and Zapotecan.

The Mixtecan family is represented by two quite diverse approaches to Mixtec languages and a contrastive analysis of two Trique dialects. Daly provides an innovative and detailed discussion of a Mixtec tone problem for Peñoles Mixtec which challenges the kind of traditional interpretation that has dominated much of Mixtec phonological analysis. North and Shields, in contrast, present a traditional description, combining an analysis of segmental and tone phonemes with a few morphophonemic observations. Hollenbach takes a different tack altogether in her topological comparison of two Trique dialects by first inquiring into the details of the two phonological systems and then speculating upon the kinds of adjustments the speaker of one must make to understand a speaker of the other.

The Popotecan family is here represented by descriptions of both a Popolocan and a Mazatecan language. Stark and Machin highlight the roles of stress and tone in their description of the phonological word and phrase in a northern Popolocan language, while Jamieson provides a description--divided into two papers because of its thoroughness and careful attention to phonetic detail--of Chiquihuitlan Mazatec segments and tone.

Finally, the Zapotecan family is represented by two papers. Larry and Rosemary Lyman bring the fruits of several years of research to bear upon a hierarchical study of Coapan Zapotec phonology, dealing with phoneme through sentence levels, including a discussion of an extensive system of tone sandhi; and Jones collaborates with consultant Knudson to give us a first look at Guelavfa Zapotec with a traditional analysis of segmental phonemes and tone, highlighting contrastive features and distribution.

Although two or three papers in this collection do address interesting theoretical questions or innovative approaches, the volume finds its major strength and usefulness in the presentation of a wide range of phonological facts which will stand us in good stead for many years to come as we seek a greater understanding of an important group of Meso-American languages.

William R. Merrifield

A PROBLEM IN TONE ANALYSIS

John P. Daly

1. Peñoles Mixtec presents a problem in tone analysis that demonstrates the need to balance morphophonemic and phonetic considerations in determining tone phonemes. An overreliance on phonetic similarity of tone levels leads to an unnecessarily complicated account of morphophonemic processes, while a simple account of morphophonemic processes is consistent with a relatively simple account of the phonetic manifestation of tones, including a natural explanation of tone terracing and tone neutralization.

Placing words in tone frames to aid in determining the phonetic levels of tone leads naturally to positing three phonemic tones. Close attention to morphophonemic processes, however, leads to positing four phonemic tones. In the four-tone analysis there is some unexpected phonetic overlap in the tones, but the analysis makes possible a simple statement of morphophonemic processes which would otherwise be very complex, and leads to a simple and natural explanation of tone terracing and tone neutralization.¹

Disyllabic nouns carry nearly all the combinations of tone, both basic and derived, which occur in Peñoles Mixtec and can readily be placed in a variety of tone frames. In a frame ending in a high tone, such as the word for *he sees*, the basic tones of the nouns occur. Three tones, high (H), mid (M), and low (L), are all that are needed to account for the basic tone patterns with one tone to a syllable, except in one pattern where two tones are needed to account for a glide from mid to low on a single syllable (1).²

(1a)	ʂiL _n i ^M -de ^H	ʒa ^H ka ^H	<i>he sees fish</i>
(1b)	ʂiL _n i ^M -de ^H	ʒa ^H kwa ^M	<i>he sees the wood chips</i> ³
(1c)	ʂiL _n i ^M -de ^H	sa ^H nu ^L	<i>he sees the daughter-in-law</i>
(1d)	ʂiL _n i ^M -de ^H	ta ^M ta ^H	<i>he sees father</i>
(1e)	ʂiL _n i ^M -de ^H	di ^M to ^M	<i>he sees the uncle</i>
(1f)	ʂiL _n i ^M -de ^H	mi ^M ʒi ^L	<i>he sees the cat</i>
(1g)	ʂiL _n i ^M -de ^H	kwa ^L ʒu ^M	<i>he sees the horse</i>
(1h)	ʂiL _n i ^M -de ^H	ki ^L ti ^L	<i>he sees the animal</i>
(1i)	ʂiL _n i ^M -ce ^H	ʒi ^L ly ^M L	<i>he sees (knows) the work</i>

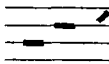




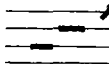




Comparing the nine nouns, one finds obvious contrast for the three tones. The three tones contrast following high and following mid, and they contrast before mid and before low. Only one of the nine theoretically possible tone patterns of one tone to a syllable is missing: low high.

The analysis to this point is not too different from what the linguistic investigator might be expected to arrive at in his beginning work, but as more of the language is brought into focus it becomes more difficult to maintain this phonemicization of tone or a modification of it. A completely new approach is needed.

2. The most direct approach to determining the tones of Peñoles Mixtec is to look for a phonemicization that will make possible a simple statement of the morphophonemic relations between tone patterns, while at the same time making possible a simple statement of the phonetic manifestation of the tones.

2.1 To show the morphophonemic relations between tone patterns, I have placed disyllabic nouns in one frame which gives their basic tone patterns and in a second frame which gives the same nouns with one kind of their derived tone patterns. Comparing the basic and derived patterns aids in determining the tone phonemes, which facilitate the description of the change of each of the basic tone patterns to each of the corresponding derived ones.

In (2), I have placed eight of the nine nouns in the two kinds of frames, leaving the noun for *wood chips* until later, since it brings in a complication not found in the other eight nouns. In (2a) and (2b), each of the eight nouns occurs in a frame (the word for *he sees*) which gives the eight basic tone patterns. In (2c) and (2d), the eight nouns occur in a frame (the phrase for *over there she is looking for*) that gives four derived patterns (2c) and four basic patterns (2d).

	frame	substitution items			
(2a)	šini-de	čaka	dito	k+ti	sanu
					
(2b)	šini-de	tata	kwažu	člų	miči
					

	frame	substitution items			
(2c)	žakā nduku-ši	čaka	dito	kīti	sanu
(2d)	žakā nduku-ši	tata	kwažu	čīu	miči

The basic tone patterns of (2a) are replaced by the derived tone patterns of (2c). Note that the derived patterns of (2c) are identical to the basic patterns of (2b) and that the basic patterns of (2b) occur unchanged in (2d). In other words, no new pattern is produced in tone sandhi, but the eight basic patterns fall together into four. Comparing the tone patterns of (2a) with those of (2b)-(2d) leads to a new phonemicization of tone and to a simple description of the change from the basic patterns to the derived ones.

Two tones, high (ˆ) and low (unmarked), are sufficient to differentiate the patterns in (2a). Assigning these two tones in the most obvious way gives čáká, kīti, and sánu, with the remaining pattern, low high, assigned to ditó, even though it is not immediately obvious that this is correct. The feature specifications [+High] and [-High] can now be assigned to the tones high and low, respectively, and to the corresponding forms in (2b)-(2d).

To account for the difference between (2a) and (2b)-(2d), an additional binary feature [Modify]⁴ is posited for each noun. The first syllables of the nouns in (2a) are specified as [-Modify], and the first syllables of the nouns in (2b)-(2d) are specified as [+Modify]⁵. There are now four tones: high [+High, -Modify], modified high [+High, +Modify], low [-High, -Modify], and modified low [-High, +Modify].

With the additional two tones, modified high (˘) and modified low (ˆ), the basic tone patterns of the nouns in (2) are as in (3).

	frame	substitution items			
(3a)	šīnī-dé	čáká	dító	kīti	sánu
(3b)	šīnī-dé	tátá	kwažú	čīu	mīči
(3c)	žākā ndúkú-ši	čáká	dító	kīti	sánu

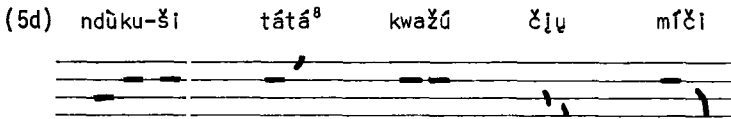
(3d) žàkà ndúkú-šǐ tǎtá kwàžú čǐy mǐčǐ⁶

The kinds of morphemes which form the condition for the tone changes from those of (3a)-(3b) to those of (3c)-(3d) are arbitrary subclasses of morphemes with basic high high tones (e.g., ní?í to *find* conditions the changes, but kúdú to *sleep* does not), arbitrary subclasses of morphemes with basic low low tones (e.g., nǐjušǐ *chicken* conditions the changes, but kǐtǐ *animal* does not), and all morphemes with derived high high tones (see (12) below). In order to differentiate the morphemes which condition the tone changes from those which do not, [+Modify] can be introduced in the underlying or, in the case of the derived high tones, in the derived structure on the last syllable of the morphemes which condition the changes. Informally, the rule which accounts for tone modification is:

- (4) TONE MODIFICATION RULE: Tone modification on the last syllable of a morpheme is shifted to the next following syllable.⁷

2.2 Rule (4) accounts for one kind of tone derivation. A second kind, in which each of the modified tones becomes unmodified (i.e., the opposite change), takes place following the frame ndúku-šǐ *she looks for*. The basic patterns of (5a) remain unchanged in (5c), while the tone patterns of (5b) are replaced by the tone patterns of (5d). The changes of the tones in (5b) to those in (5d) are conditioned by a preceding modified low tone.

	frame	substitution items			
(5a)	šǐnǐ-dé	čáká	ditó	kǐtǐ	sánu
(5b)	šǐnǐ-dé	tǎtá	kwàžú	čǐy	mǐčǐ
(5c)	ndúku-šǐ	čáká	ditó	kǐtǐ	sánu



Any number of low tones may intervene between the modified low tone which conditions a change and the tone which loses its modification (6).

- (6) ndũku ži+ši kwàžú > ndũku ži+ši kwažú *her husband is looking for a horse*

The modified low tone causes the loss of modification on every modified low tone up to the first high tone (7) or modified high tone (8). The modification of the modified high tone is also lost.

- (7) ndũku-ši žjy kwèndá náná-ši > ndũku-ši čjy kwendá náná-ši *she is looking for work for her mother*
- (8) ndũku-ši naña kwii ndèku ndi?i náná-ši > ndũku-ši naña kwii ndèku ndi?i náná-ši *she is looking for the green chayote her mother has*

The rule which accounts for these changes is:

- (9) LOSS OF TONE MODIFICATION RULE: Following a modified low tone plus any number of low tones, tone modification is lost.

2.3 There is another important kind of tone sandhi. Within a word, contiguous low or modified low tones (i.e., those with the feature [-High]) sometimes become high. The changes shown in (10) are conditioned by an immediately preceding high tone and are restricted to certain syntactic classes. For example, adjectives but not nouns, and verbs in the continuative aspect but not verbs in the potential aspect, undergo this kind of change.

- (10a) tutú t̩y > tutú t̩ú *black paper*
- (10b) tutú kw̩i > tutú kw̩í *green paper*
- (10c) žàkə ndũku-ši-d̩ > žàkə ndúkú-ší-d̩ *she is looking for it (animal) over there*

The rule which accounts for the changes following high tone is:

- (11) TONE ASSIMILATION RULE: Following a high tone, subject to syntactic constraints, contiguous tones specified as [-High] within a word become high.

An addition must be made to rule (11) since tone modification is introduced following the last high derived by it. The rule must specify that the last derived tone is marked as modified so that this tone may form the condition for the modification of the next following tone by the TONE MODIFICATION RULE (4), as in (12).

- (12) tutú tɥu-dé (underlying form)
 tutú tǔǔ-dé (by the TONE ASSIMILATION RULE)
 tutú tǔǔ-dě (by the TONE MODIFICATION RULE)
 his black paper

3. The foregoing four-tone analysis makes possible a simple statement of tone sandhi, but what of the phonetic consequences?

3.1 The statement of the phonetic manifestation of the two modified tones is simplest: a modified high tone is a short, upward glide, ending at mid pitch (13); a modified low tone is a low level tone, always followed by a tone beginning at a higher pitch (14).⁹

- (13a) mǎči *cat* (13b) nǎná *mother*
- 

- (14a) kwǎžú *horse* (14b) čǐu *work*
- 

A modified low tone, and to a lesser degree a modified high tone, is often more readily recognized by its effect on following unmodified tones than it is by its own phonetic pitch, as can be seen in the following discussion of the conditioned variants of unmodified tones.

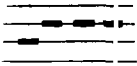
3.2 A high tone immediately following a modified low tone is lowered to mid pitch (15). The same lowering of high to mid takes place following a modified low tone plus any number of intervening low tones (16). Only the first high tone in a sequence of high

tones is lowered to mid (17).

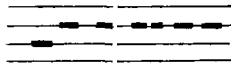
(15) kwàžú horse



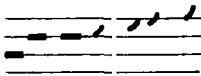
(16a) čl̥y dító uncle's work



(16b) ndũku-š ɪɪ žučí she is looking for a knife

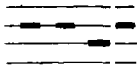


(17) čl̥y tátá méé-ší the work of that very girl's father

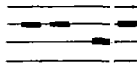


There is a second kind of lowering from high to mid. Following pause (18) or following one or more low tones not immediately preceded by a modified low tone (19), each high tone of one or more contiguous high tones is lowered to mid.

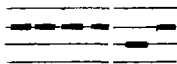
(18) žfʔf žàkâ the wolf over there



(19a) žučí žàkâ the knife over there

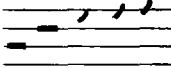


(19b) ɪɪ kútú žàkâ one musical instrument over there



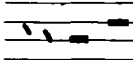
An unlowered high tone or string of unlowered high tones begins at a pitch between high and mid and ends at high.

(20) s̀nĩ-dé čáká he sees the fish

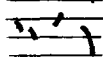


A low tone or a string of low tones begins at a pitch between mid and low and ends at low when preceding a modified tone (21), or begins at a pitch between mid and low and ends at extra-low when preceding pause (22). Each low tone of one or more contiguous low tones is mid when preceding high tone (23).

(21a) ʃĩ kwàžú one horse




(21b) ʃĩ mýčĩ one cat



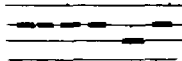
(22a) kiti animal



(22b) sánu daughter-in-law

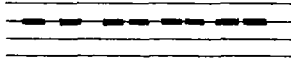


(23) ʃĩ čáká žàkâ one fish over there

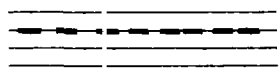


3.3 Inasmuch as one or more low tones followed by one or more high tones are all at mid pitch, there is neutralization of high and low tones. It is impossible from the phonetic data alone to say at which point the low tones end and the high tones begin.¹⁰ In (24) all tones are on the same phonetic level: there is no contrast between the high tone of ditó and the low tones of kiti, and there is no contrast between the high tones of únĩ and the low tones of ʃĩ. Of course, in a different environment there is contrast between high and low in these morphemes (25).

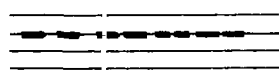
(24) kaʔni ditó únĩ ñáñá uncle will kill three coyotes



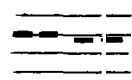
(24b) ka?ni kiti úni ñáñá the animal will kill three coyotes



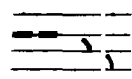
(24c) ka?ni kiti ií ñáñá the animal will kill one coyote



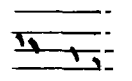
(25a) úni ditó three uncles



(25b) úni kiti three animals

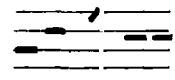


(25c) ií kiti one animal

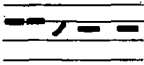


3.4 The high and low tones which were said to be at mid pitch are actualized on a slightly lower pitch when they follow an unlowered high tone (26) or a modified high tone (27). They are actualized on successively lower pitches when they form a series of alternating high and low tones. Each low tone or string of low tones is lower than the immediately preceding high tone(s), and each high tone or string of high tones is on the same pitch as the immediately preceding low tone(s) (28). However, a nonfinal word ending in a high tone is slightly higher than a low tone of the preceding word, but does not return to the level of an earlier high tone (29).

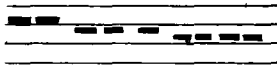
(26) šĩní-dé ditó he sees the uncle



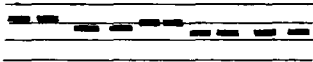
(27) úú mǎč'i-dé two of his cats



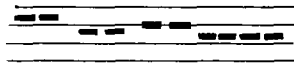
(28) kiní kolo-dé ÷÷ kóó his turkey will see one snake



(29a) kiní dɪʔə úní kolo ditó the hawk will see three of the
uncle's turkeys



(29b) kiní kolo ditó ÷÷ kóó the uncle's turkey will see one snake



The lowering of high to the same pitch as a preceding low occurs at morpheme boundaries and within morphemes. Thus the low plus high of ditó are on the same pitch,¹¹ and in a sequence of morphemes like ditó, each successive morpheme is on a lower pitch than the immediately preceding morpheme (30).¹²

(30) kiní ditó didí šitf itú the uncle will see the aunt in the
cornfield



This phenomenon, known as tone terracing, has a different explanation in Peñoles Mixtec than that for any other language I know about. Tone terracing has been accounted for elsewhere by positing a low tone which causes a lowering of high to mid with the subsequent deletion of the low tone (McCawley 1970), but in Peñoles Mixtec the low tone actually occurs as part of the tone pattern of the lowered morpheme. Tone terracing has also been accounted for by positing a tone phoneme of 'drop', which is defined as a tone lower than the immediately preceding tone (Weimers 1959), but in Peñoles Mixtec the tone which brings about the lowering has other

phonetic manifestations as well. A third way tone terracing has been accounted for is by positing 'non-automatic downstep' where its only phonetic manifestation is found in the lowering of a following high tone (Stewart 1964), but 'non-automatic downstep' is unnecessary for Peñoles Mixtec since the tone phonemes needed in any case are sufficient to account for terracing.¹³

4. The analysis developed to this point receives further confirmation from the tone sandhi which occurs before *žu* (3pl, human). This sandhi is accounted for by positing a high tone before the low tone of *žu* in underlying structure: $\acute{z}u$. If the conditions for the TONE MODIFICATION RULE are met, the high tone becomes modified. The high tone or modified high tone is never actualized on $\acute{z}u$ but always shifts to the immediately preceding syllable. If the high tone becomes modified, it replaces the immediately preceding tone; and if it remains unmodified, it follows the immediately preceding tone to make two tones to one syllable (31).

- (31a) $\acute{s}i\acute{n}i-d\acute{e} \acute{c}á\acute{k}á-\acute{z}u > \acute{s}i\acute{n}i-d\acute{e} \acute{c}á\acute{k}\acute{a}-\acute{z}u$ *he sees their fish*
 (31b) $\acute{s}i\acute{n}i-d\acute{e}i \acute{d}i\acute{t}ó-\acute{z}u > \acute{s}i\acute{n}i-d\acute{e} \acute{d}i\acute{t}ó-\acute{z}u$ *he sees their uncle*
 (31c) $\acute{s}i\acute{n}i-d\acute{e}i \acute{k}i\acute{t}i-\acute{z}u > \acute{s}i\acute{n}i-d\acute{e} \acute{k}i\acute{t}i-\acute{z}u$ *he sees their animal*
 (31d) $\acute{s}i\acute{n}i-d\acute{e}i \acute{s}ánu-\acute{z}u > \acute{s}i\acute{n}i-d\acute{e} \acute{s}ánu-\acute{z}u$ *he sees their daughter-in-law*
 (31e) $\acute{s}i\acute{n}i-d\acute{e}i \acute{t}á\acute{t}á-\acute{z}u > \acute{s}i\acute{n}i-d\acute{e} \acute{t}á\acute{t}\acute{a}-\acute{z}u$ *he sees their father*
 (31f) $\acute{s}i\acute{n}i-d\acute{e}i \acute{k}wá\acute{z}ú-\acute{z}u > \acute{s}i\acute{n}i-d\acute{e} \acute{k}wá\acute{z}ú-\acute{z}u$ *he sees their horse*
 (31g) $\acute{s}i\acute{n}i-d\acute{e}i \acute{c}\acute{i}\acute{y}-\acute{z}u > \acute{s}i\acute{n}i-d\acute{e} \acute{c}\acute{i}\acute{y}-\acute{z}u$ *he sees their work*
 (31h) $\acute{s}i\acute{n}i-d\acute{e}i \acute{m}\acute{y}\acute{c}i-\acute{z}u > \acute{s}i\acute{n}i-d\acute{e} \acute{m}\acute{y}\acute{c}i-\acute{z}u$ *he sees their cat*
 (31i) $\acute{s}i\acute{n}i-d\acute{e}i \acute{n}\acute{y}u\acute{s}i-\acute{z}u > \acute{s}i\acute{n}i-d\acute{e} \acute{n}\acute{y}u\acute{s}\acute{i}-\acute{z}u$ *he sees their chicken*

In $\acute{c}á\acute{k}\acute{a}-\acute{z}u$, $\acute{t}á\acute{t}\acute{a}-\acute{z}u$, and $\acute{n}\acute{y}u\acute{s}\acute{i}-\acute{z}u$ the high tone of $\acute{z}u$ becomes modified and then replaces the immediately preceding tone. In $\acute{s}ánu-\acute{z}u$ and $\acute{m}\acute{y}\acute{c}i-\acute{z}u$ the high tone immediately follows the preceding low tone to produce a level mid tone, in accordance with the foregoing description of the conditioned variants of low and high. In $\acute{k}wá\acute{z}ú-\acute{z}u$ the high tone immediately follows the high of $\acute{k}wá\acute{z}ú$ to produce a mid-high glide, the first of the two high tones being lowered to mid following the modified low (3.2).

The basic tone pattern seen in the noun for *wood chips* can now be accounted for, since its pitch contour is identical to that of $\acute{s}ánu$ in $\acute{s}ánu-\acute{z}u$. The noun for *wood chips* is phonemically $\acute{c}á\acute{k}wá$, having a high tone in the first syllable and a low tone followed by a high tone in the second syllable.¹⁴

By analogy with $\acute{k}wá\acute{z}ú-\acute{z}u$, $\acute{s}ánu-\acute{z}u$, and $\acute{m}\acute{y}\acute{c}i-\acute{z}u$, we may assume that the high tone of $\acute{z}u$ immediately follows the preceding tone of

the remaining examples, but whether the high tone immediately follows or replaces the preceding tone, the phonetic results are the same.

The rule which accounts for the changes before $\acute{z}u$ is:

- (32) TONE SHIFT RULE: The first tone of $\acute{z}u$ is shifted to the immediately preceding syllable. If the tone of $\acute{z}u$ is modified it replaces the tone of the preceding syllable, and if it is unmodified it follows the tone of the preceding syllable.

Two additional patterns of two tones to a syllable are found in enclitics.

An enclitic which becomes modified high by the Tone Modification Rule subsequently becomes modified high plus high under the influence of following $\acute{z}u$, as in (33).

- (33) $\acute{z}ak\acute{a} \ n\acute{?}\acute{f}\acute{-}d\acute{o}\acute{-}\acute{z}u$ (underlying form)
 $\acute{z}ak\acute{a} \ n\acute{?}\acute{f}\acute{-}d\acute{o}\acute{-}\acute{z}u$ (by the TONE MODIFICATION RULE)
 $\acute{z}ak\acute{a} \ n\acute{?}\acute{f}\acute{-}d\acute{o}\acute{-}\acute{z}u$ (by the TONE SHIFT RULE)
over there he will find them (human)

Following high, the low tone of the enclitic *ndo* (2pl) becomes high by the TONE ASSIMILATION RULE, and subsequently a following high tone becomes modified by the TONE MODIFICATION RULE. If the modified high comes from the high of $\acute{z}u$, it is shifted to *ndó* to give high plus modified high,¹⁵ as in (34).

- (34) $\acute{z}ak\acute{a} \ n\acute{?}\acute{f}\acute{-}nd\acute{o}\acute{-}\acute{z}u$ (underlying form)
 $\acute{z}ak\acute{a} \ n\acute{?}\acute{f}\acute{-}nd\acute{o}\acute{-}\acute{z}u$ (by the TONE ASSIMILATION RULE)
 $\acute{z}ak\acute{a} \ n\acute{?}\acute{f}\acute{-}nd\acute{o}\acute{-}\acute{z}u$ (by the TONE MODIFICATION RULE)
 $\acute{z}ak\acute{a} \ n\acute{?}\acute{f}\acute{-}nd\acute{o}\acute{-}\acute{z}u$ (by the TONE SHIFT RULE)
over there you (pl) will find them (human)

5. That the description of tone sandhi would be more complex in a three-tone analysis should be obvious. In the three-tone analysis morphophonemic rules amount to little more than a listing of each tone pattern and its corresponding derived pattern. For example, some of the changes before $\acute{z}u$ would be: high high becomes high low-mid, low low becomes mid mid, low mid becomes low mid-high, low mid-low becomes low mid, and high low becomes high mid. Instead of the TONE MODIFICATION RULE, there would be a rule which lists the changes of high high to mid high, mid mid to low

mid, high low to mid low, and low low to low mid-low, or some similar listing. Instead of the LOSS OF TONE MODIFICATION RULE, there would be a rule which would have the same degree of complexity as the previous one. In the three-tone analysis there would be a slight loss of generality in describing tone assimilation. Instead of being able to refer to the two tones, low and modified low, by [-High], it would be necessary to refer to two patterns, low low and low mid-low, as undergoing change.

The advantage of paying careful attention to tone sandhi in determining the number and kinds of tones in Peñoles Mixtec is thus clear. Giving morphophonemic and phonetic considerations equal weight results in an analysis that is cohesive and simple. A few simple morphophonemic rules, along with a few well-motivated definitions of the phonetic variants of the tones, account for the surface complexity of tone.

Morphophonemic and phonetic considerations combine in Peñoles Mixtec to make stringent demands on the analysis. Tone phonemes which make possible a simple description of morphophonemic processes should not lead to undue phonetic complexity, and tone phonemes which have simple phonetic correlates should not lead to undue morphophonemic complexity. The fact that a satisfactory explanation of phenomena as different as tone sandhi on the one hand and tone terracing and tone neutralization on the other results from the phonemic analysis developed here gives us good reason to believe that the analysis is basically correct.

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NOTES

1

Peñoles Mixtec is spoken in the municipality of Santa María Peñoles, Etla, Oaxaca, by about two thousand speakers and, with dialect variation, in another ten communities by an additional eight thousand speakers. It is mutually unintelligible with other Mixtec languages (often called dialects) spoken throughout the state of Oaxaca and in parts of the states of Puebla and Guerrero. The data for this paper are based on field work begun in 1957 and carried on intermittently since then.

In the techniques for determining tone phonemes given by Pike (1948), morphophonemic considerations enter into analysis only to the extent of determining whether a tone frame remains unchanged or not and whether any new tone classes result from placing substitution lists in a variety of frames. My experience in the analysis of Peñoles Mixtec convinces me that in some cases much more attention must be given to morphophonemic processes if a wrong analysis is to be avoided. In principle, Pike is not in disagreement with the position I have taken here. He states (1947:viii b): '...many phonemic conclusions are based, not upon absolute data as such, but upon the correlation and interrelationships of data or upon the observation of the effect of a total structure exerting a pressure upon the interpretation of some one point of that system.'

Compare Schachter (1961) who takes into account tone morphophonemics in determining the tones which account for tone terracing in Twi.

2

The phonemes of Peñoles Mixtec, not including tone, are: voiceless stops /p t č k kw ?/, prenasalized stops /mb nd n] ngw/, voiceless fricatives /f s š h/, voiced fricatives /b d ž/, nasals /m n ñ/, liquids /l r/, vowels /i e ɨ a u o/, and nasalization. Stress occurs on the first syllable of disyllabic nouns. In the orthography employed here, enclitics are set off by hyphens.

3

I have found only the two nouns ča^Hkwa^M and mi^Mxi^L with these basic tone patterns, but the patterns are common in tone sandhi.

4

I have adopted the feature [Modify] from Woo (1972). This feature has the advantage of keeping the feature analysis of the tones in focus, since the tones can be referred to as high versus modified high and low versus modified low. The phonetic correlates of [Modify] in Peñoles Mixtec are given on page 13 in terms of the phonetic height of tones with the feature. It remains to be seen whether the feature [Modify] as I have used it in Peñoles Mixtec

has some one of the phonetic correlates described by Woo. She states (1972:125): 'A modified sound is one produced with the vocal cord and larynx configuration of either a high-toned sound or a low-toned sound and is one in which either the configuration of the pharynx has been changed, or the manner in which the vocal folds vibrate has been changed, or some other mechanism has been employed to change the "normal" waveform of the pitch produced.'

5

It might at first appear that [+Modify] could just as well be assigned to the morpheme as a whole, but it will be seen in 5 that it can occur on both syllables of a disyllabic morpheme.

6

Some tones which are allotones of one phoneme in the three-tone analysis are allotones of different phonemes in the four-tone analysis. Instead of the first tone of *kwàžú* being an allotone of the same phoneme as the two tones of *kítí*, they are allotones of different phonemes; and instead of the first tone of *tátá* and the first tone of *ditó* being allotones of the same phoneme, they are allotones of different phonemes. Conversely, some tones which were analyzed as allotones of different phonemes are allotones of the same phonemes: the glide on the second syllable of *člú*, both tones of *kítí*, and the first tone of *ditó* are allotones of the same phoneme; and the second tone of *ditó* and the two tones of *čáká* are allotones of the same phoneme.

7

There are some exceptions to the rule: nouns with basic high high tones do not condition the introduction of modification on disyllabic morphemes with basic low low tones, whereas morphemes with basic low low tones and derived high high tones do condition this change; nouns with modified high high tones condition the introduction of modification only on enclitics of high tone; and modification passes over low-tone enclitics to the first high-tone enclitic, or if there is no high-tone enclitic, to the first tone of the next word.

[+Modify] on the last syllable of a morpheme is never actualized there unless it shifts to the next syllable by the Tone Modification Rule and then shifts back again (see 6). To minimize confusion, I will indicate [+Modify] in the tone of the last syllable of morphemes in the examples only when this feature reappears there in sandhi and thus is actualized there.

8

The phonetic difference between *tátá* in (5b) and *tátá* in (5d) is difficult to detect, and except for pattern pressure exerted by morphophonemic processes more clearly seen elsewhere, the difference

between the two tones could easily be missed or wrongly attributed to subphonemic conditioning by adjacent tones. For the condition under which a high tone is lowered as it is in (5d), see page 13 .

9

These claims about the phonetic manifestations of the tones are supported by evidence from sound spectrograms.

10

It should be noted that in deliberate speech a down glide may appear on one or more low tones before word boundary but never within a word ending in high tone.

11

It is not uncommon in tone languages for high to be lowered following low, sometimes even to the level of low. For example, in Degema of Nigeria, Pike (1970:99) reports that high is lowered to the same pitch as low, but not within words or morphemes as in Peñoles Mixtec: "Between words (but not within them, under penalty of collapsing some of the system) a word-final low depresses a following word-initial high to its own low phonetic pitch, but a following word-initial low to lower than the first low."

12

The difference in pitch between the first and last morphemes is commonly two whole steps of the musical scale. By contrast, the difference between a high tone lowered to mid and a modified low tone is commonly three whole steps. The change in register brought about by alternating low and high tones does not have a noticeable effect on the pitch of a following modified tone. The modified tone tends to retain a constant pitch relationship to the first lowered high tone regardless of how many intervening high and low tones there are, and it tends to reestablish the beginning register.

13

The three alternatives rejected for Peñoles Mixtec are all found in Stewart (1964), except that he speaks of a zero tone bearing unit instead of a deleted low tone. The tone of 'drop' is also known as downstep, step-down, mid, middle-tone, and high-change in descriptions of this phenomenon in various tone languages. 'Non-automatic downstep' as described by Stewart is called a 'process phoneme' by Pike (1970:102).

14

An alternate pronunciation for čákwa^ˀ is ˀčakwá, where the low tone appears on the first syllable instead of the second, and in combination with the first high tone produces a down glide.

15

The modified high tone follows the high of ndó rather than replacing it as it would in a disyllabic form. An alternate treatment is to posit two underlying low tones on ndo, both of which become high with the subsequent replacement of the second high by a modified high.