



## Evidence for Underlying Mid Tones in South-eastern Nochixtlán Mixtec

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### Abstract

This paper provides evidence for the presence of underlying Mid tones in South-eastern Nochixtlán Mixtec (NM), an Otomanguean language of southern Mexico. I show that in the underlying tonal inventory there are High, Mid, and Low tones, as well as moras which are unspecified for tone. Thus, there are more options phonologically for the tone of a mora than the phonetic opposition shows. Evidence for this claim comes from the surface tonal patterns of nouns as well as verbal morphology. In addition to the underlying tones, there is also a Default tone which is inserted when no other tone is available to provide a surface tone for an otherwise toneless TBU. However, this tone does not participate in phonological processes nor does it form part of tonal contours. Acoustic analysis shows that Default and Mid are indistinguishable. However, in the sequence High Low Mid, the Low tone is raised to Mid, whereas Low raising does not occur in the sequence High Low Default.

**Index terms:** tone, tonal inventory, Mixtec, Otomanguean

### 1. Introduction

For many tone languages, it is claimed that underlyingly there is one less level than what appears on the surface<sup>1</sup>. Hyman further develops this idea, giving examples from many different tonal languages<sup>2</sup>. Hyman shows that the most common option for languages which have two tones, High and Low, is that one be unmarked, usually Low. Likewise, for some systems that have three levels —High, Mid and Low—the Mid tone may be unmarked. In a paper on Peñoles Mixtec tone, a variety geographically adjacent but mutually unintelligible with NM, Daly and Hyman argue that the surface Mid tone is better analysed as Unspecified<sup>3</sup>. As evidence for this claim, they show that Mid tones are transparent for phonological processes and also never form part of a contour. In this paper I show that for NM in the underlying forms there is a contrast between Mid and Unspecified, and in the surface forms there is a contrast between Mid and Default. The result of this analysis is that rather than reducing the number of phonemic tones, I argue that in NM in the underlying representation there are four options: High, Mid, Low and Unspecified.

I first describe the tonal inventory of mono-morphemic nouns. Secondly, I show that there is contrast between underlying Mid tone and moras that are unspecified for tone in the underlying form. Thirdly, I show that the surface default tone differs from the underlying Mid tone in that it does not participate in phonological processes. Fourthly I present

acoustic evidence to substantiate the claim that default tones do not participate in phonological processes.

### 2. Tones of mono-morphemic nouns

In this section, I describe behaviour of the tones of mono-morphemic nouns. I show that in NM the initial mora of many nouns is unspecified for tone. I also present three strategies used to provide a tone for this toneless TBU.

In Table 1, I show the underlying tone patterns of mono-morphemic nouns. In (a) and (b) the underlying tones align at the left edge. In these cases, the underlying tones are written as diacritics on each mora. However, in the remainder of the examples, the tones are aligned at the right edge, thus leaving the initial mora toneless. In these examples, the tones are written as superscript letters.

Table 1 *Tone patterns of mono-morphemic nouns*

		Example	Gloss
a	H M	k <sup>w</sup> ĩlĩ	jay
b	H L	sóli	buzzard
c	H	litu <sup>H</sup>	kid
d	H L	k <sup>w</sup> aju <sup>HL</sup>	horse
e	M	βe <sup>°</sup> e <sup>M</sup>	house
f	M H	<sup>a</sup> dʒo <sup>°</sup> o <sup>MH</sup>	humming bird
g	M L	iðo <sup>ML</sup>	rabbit
h	L	ðutu <sup>L</sup>	priest
i	L H	taðu <sup>LH</sup>	hawk
j	L M	kiði <sup>LM</sup>	cooking pot

When words in group (d) or (g) occur pre-pause, the falling contour is audible. However, rising contours are prohibited on single mora. Therefore, the high tones sponsored by words in groups (f) and (i) can only be detected in the surface forms where the floating High associates with the following morpheme. The Low Mid sequence of words in group (j) occurs as Lowered Mid, that is as a tone which is phonetically between Low and Mid, when these words occur pre-pause. In other contexts, the Low tone associates with its sponsoring word and the Mid tone associates with the initial syllable of the following morpheme as seen in Table 2. In the underlying forms, the tones sponsored by both *kiði*<sup>LM</sup> ‘pot’ and *ðutu*<sup>L</sup> ‘priest’ are aligned at the right edge of their sponsoring word. The Mid tone sponsored by *kiði*<sup>LM</sup> associates with the initial mora of *ðutu*<sup>L</sup>. A Default tone is inserted to provide a tone for

the initial mora of the utterance. In these data and subsequent data, diacritics are used in the surface forms.

Table 2 *Association of Floating Mid tone*

kiðì <sup>LM</sup>	+ ðutu <sup>L</sup>	→	kīðì	ðūtù
pot	priest		'priest's pot'	

The data in Table 2 provide an example of the association of a floating tone to provide a tone for the toneless initial mora. Another strategy is to link the final tone of the first word in a phrase to the initial mora of the following word as shown in Table 3. This is seen in the linking of the final High of *litu<sup>H</sup>* 'kid' with the initial mora of *ðutu<sup>L</sup>* 'priest'. In both Table 2 and Table 3, I argue that the initial Mid tone of the utterance is an inserted Default tone which provides a tone for the toneless utterance initial mora.

Table 3 *Spread of the final tone*

litu <sup>H</sup>	+ ðutu <sup>L</sup>	→	lītù	ðūtù
kid	priest		'priest's kid'	

I argue that in noun phrases there are three strategies to provide a tone for a toneless TBU: 1) associate a floating tone 2) spread the final tone, or 3) insert a default tone. These three strategies are further exemplified in Table 4 which gives examples of genitival phrases. The object possessed is initial, the possessor second. The tones of the words *βe'e<sup>M</sup>* 'house' and *na'a<sup>MH</sup>* 'hand' sound identical in isolation, as do *kuka<sup>L</sup>* 'comb' and *ðita<sup>LH</sup>* 'tortilla'. However, in (b) and (d), the high tones sponsored by the words *na'a<sup>MH</sup>* and *ðita<sup>LH</sup>* associate with the initial syllable of *ðutu<sup>L</sup>* 'priest'. Thus, in these two examples, the surface tones of *ðutu<sup>L</sup>* are High Low whereas in (a) and (c) it is Mid Low.

Table 4 *Association and spread of tones*

a	βe'e <sup>M</sup> + ðutu <sup>L</sup>	βe'e ðūtù	the priest's house
b	na'a <sup>MH</sup> + ðutu <sup>L</sup>	nā'a ðūtù	the priest's hand
c	kuka <sup>L</sup> + ðutu <sup>L</sup>	kūkà ðūtù	the priest's comb
d	ðita <sup>LH</sup> + ðutu <sup>L</sup>	ðītā ðūtù	the priest's tortilla

The data in Table 4(a) shows the spread of the final Mid *βe'e<sup>M</sup>* 'house' to the initial mora of *ðutu<sup>L</sup>*. However, in (c) we see that the final tone of *kuka<sup>L</sup>* 'comb' does not spread to the initial mora of *ðutu<sup>L</sup>* 'priest'. I argue that the Low tone of *kuka<sup>L</sup>* is prevented from associating with *ðutu<sup>L</sup>* as there is already a Low tone associated with this word. These and other data show that in NM two adjacent Low tones are not permitted. Thus in Table 4 there are two contexts in which a Default tone is inserted: the initial mora of the utterance, and also to prevent two adjacent Low tones.

I further argue that although the surface tones of *ðutu<sup>L</sup>* 'priest' are Mid Low following both *kiðì<sup>LM</sup>* 'pot' in Table 2 and *kuka<sup>L</sup>* 'comb', in Table 4, the surface Mid tone on the initial mora of *ðutu<sup>L</sup>* following *kiðì<sup>LM</sup>* is an underlying tone, whereas the one following *kuka<sup>L</sup>* is a Default tone which is inserted to prevent two adjacent Low tones. Evidence for this claim is seen when the surface sequence Low Mid occurs as the final elements in the sequence High Low Mid. If the surface Mid tone is an underlying tone, then the sequence is

realised as High Mid Mid. However, if the surface Mid tone is the inserted Default tone, then the process of raising does not occur, and the surface tones are High Low Mid. The behaviour of the Default tone is further described in Sections 4 and 5.

### 3. Evidence for Underlying Mid Tone

So far, the data presented assume that there are underlying Mid tones. In this section I provide data to substantiate the presence of Mid tones in the underlying form. I take as given that High and Low tones are fully specified given that both tones participate in phonological processes, form barriers to the spread of tones, and also form contours.

In this section, I use the association patterns found on verbs to illustrate that in NM there are underlying Mid tones, as well as mora which in the underlying representation are unspecified for tone.

#### 3.1. Unspecified versus Mid tone

In this section I show that underlyingly there are some moras which are unspecified for tone, in addition to the initial moras which are unspecified as a result of rightward tone shift. Differentiating between Mid and Unspecified provides a way to account for the surface tones of sentences such as those in Table 5. In these data the nouns are pre-posed for contrastive focus. In (a) the verb is in the irrealis form. In this form, verbs occur with the tones sponsored by their root: the verb *tasi<sup>M</sup>* 'give' has an underlying Mid tone. The final Low tone of *βilù* 'cat' spreads to the initial mora of the verb and the tone of the verb root is associated at the right edge. In (b) the verb 'give' is in the imperfective. The imperfective prefix is a floating High tone. The Low tone of *βilù* 'cat' spreads to both moras of the verb. The floating High tone is left unassociated.

Table 5 *Contrast between Mid and Unspecified*

a	βilù + tasi <sup>M</sup>	βilù tàsī	CAT will give.
b	βilù + (H)- + tasi	βilù tàsì	CAT is giving.

Based on the data in Table 5, I argue that the realis stem of *tasi* 'give', given in (b) is unspecified for tone. Corroboration for this claim is found in the tonal phenomena of verbal forms. In NM there are verbs which have identical underlying tone melodies, —Mid or Mid Floating High— in the irrealis form but have differing surface tonal patterns in the subjunctive and imperfective. Each of the verbal prefixes given in Table 6 has a floating High tone. In the case of the imperfective the CV segments have been lost, only the High tone being retained.

In Table 6, I give verb forms from both groups. The word *lana<sup>MH</sup>* 'child' is the subject. The surface tones are the same for both groups in the first three forms (a-c). However, in both (d) and (e), the floating High tone sponsored by the prefix skips the verb entirely and associates only with the noun.

Table 6 *Forms of verbs with a Mid tone in the irrealis*

		Group 1 to fall	Group 2 to wake
a	irrealis	ᵀkāβā lānā	nōtō lānā
b	progressive	ta(H)- tã-ᵀkāβā láná	tã-nōtō láná
c	counterfactual	niᵀ(H)- nĩ-ᵀkāβā láná	nĩ-nōtō láná
d	subjunctive	naᵀ(H)- nā-ᵀkāβā láná	nā-nōtō láná
e	imperfective	Ø(H)- ᵀkāβā láná	nōtō láná

To account for the differences, I propose that for verbs in Group 2, the Mid tone of the root is absent in the subjunctive and imperfective forms. Thus, neither mora of the stem is specified for tone in the underlying form.

For some verbs, the moras of the verb stem are unspecified, but there is also a floating High tone. In Table 7, the surface tones of both moras of the verb are Low, whether the stem has no floating High tone as in (a) or has a floating High tone as in (b).

Table 7 *Unspecified verb stems*

- |   |  |  |                   |
|---|--|--|-------------------|
| a | $\beta\dot{\text{il}}\text{ù} + (\text{H}) + \text{noto}$                      | $\beta\dot{\text{il}}\text{ù} \text{ nòtò}$            | CAT is waking up  |
| b | $\beta\dot{\text{il}}\text{ù} + (\text{H}) + \text{ta}\beta\text{a}(\text{H})$ | $\beta\dot{\text{il}}\text{ù} \text{ tà}\beta\text{à}$ | CAT is taking out |

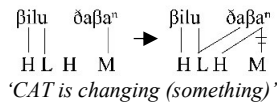
The data in Table 7 show the imperfective forms of Group 2 verbs; that is, verbs whose stems are unspecified for tone in the imperfective. In Table 8, I give examples of Group 1 verbs which have either a Mid or Mid High melody in the irrealis. In these cases, the final tone of  $\beta\dot{\text{il}}\text{ù}$  ‘cat’ spreads to the initial mora of the verb, and the floating High tone of the imperfective prefix deletes the Mid tone and associates with the second mora of the verb stem.

Table 8 *Stems with a Mid tone*

- |   |  |   |                 |
|---|--|---|-----------------|
| a | $\beta\dot{\text{il}}\text{ù} + (\text{H}) + \delta\text{a}\beta\text{a}^{\text{M}}$ | $\beta\dot{\text{il}}\text{ù} \delta\text{à}\beta\text{á}^{\text{a}}$ | CAT is changing |
| b | $\beta\dot{\text{il}}\text{ù} + (\text{H}) + \delta\text{ute}^{\text{M}}(\text{H})$  | $\beta\dot{\text{il}}\text{ù} \delta\text{ùtè}$                       | CAT is swimming |

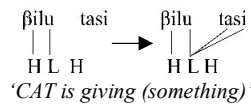
The differences in underlying forms of Groups 1 and 2 verbs are illustrated in Table 9 and Table 10. In Table 9, the floating High tone of the imperfective prefix deletes the Mid tone associated with the second mora of the stem, and the Low tone of  $\beta\dot{\text{il}}\text{ù}$  ‘cat’ spreads to the initial mora of  $\delta\text{a}\beta\text{a}^{\text{a}}$  ‘change’.

Table 9 *Tonal association for Group 1 verbs*



In Table 10, the floating High tone of the imperfective prefix does not associate with the unspecified moras of the root, and the Low tone of  $\beta\dot{\text{il}}\text{ù}$  ‘cat’ spreads to both moras of  $\text{tasi}$  ‘give’.

Table 10 *Tonal association for Group 2 verbs*



The floating High tone of the imperfective prefix will associate with morphemes or words to the right, dependent on certain tonal conventions.

#### 4. Default tone

In this section, I first describe further the environments in which a Default tone is inserted. Secondly, I show that underlying Mid tones participate in phonological processes which the Default tone does not.

In the data in Table 11(a), a Default tone is added as the Low tone sponsored by  $\text{kuka}^{\text{L}}$  ‘comb’ does not spread to  $\text{ta}\delta\text{u}^{\text{LH}}$  ‘hawk’ since there is already a Low tone associated at the right edge, and adjacent Low tones are prohibited. However, in Table 11(b), the second tone of the underlying tone melody of the first word of the phrase associates with the initial mora of the second word. In (b), the Mid tone of  $\text{tuu}^{\text{LM}}$  ‘feather’ associates with the initial mora of  $\text{ta}\delta\text{u}^{\text{LH}}$  ‘hawk’.

Table 11 *Default vs Mid tone*

- |   |         |                          |  |
|---|---------|--------------------------|--|
|   |         |                          | hawk $\text{ta}\delta\text{u}^{\text{LH}}$             |
| a | comb    | $\text{kuka}^{\text{L}}$ | $\text{kū}\text{kà} \text{tā}\delta\text{ù}$           |
| b | feather | $\text{tuu}^{\text{LM}}$ | $\text{tū}\text{ù}^{\text{a}} \text{tā}\delta\text{ù}$ |

The insertion of a Default tone to prevent a sequence of two Low tones provides the context for the study of default tones. As will be shown below, the inserted default tone does not participate in process whereby a Low tone is raised to Mid in the sequence High Low Mid.

In NM there is a general prohibition against the surface sequence of High Low Mid. However, this prohibition does not exclude the sequence High Low Default. When the quantifier  $\text{kuu}^{\text{LH}}$  ‘four’ is added to the data in Table 11, the sequences High Low Mid and High Low Default are produced. In Table 12, I give the resultant surface forms.

Table 12 *Avoidance of the sequence HLM*

- |   |         |                          |   |
|---|---------|--------------------------|---|
|   |         |                          | hawk $\text{ta}\delta\text{u}^{\text{LH}}$  |
| a | comb    | $\text{kuka}^{\text{L}}$ | $\text{kū}\text{ù}^{\text{a}} \text{kú}\text{kà} \text{tā}\delta\text{ù}$           |
| b | feather | $\text{tuu}^{\text{LM}}$ | $\text{kū}\text{ù}^{\text{a}} \text{tū}\text{ù}^{\text{a}} \text{tā}\delta\text{ù}$ |

In both cases the floating High tone of  $\text{tuu}^{\text{LH}}$  ‘four’ associates with the initial mora of the second word of the phrase. In (a) the surface tones of  $\text{kuka}^{\text{L}}$  ‘comb’ are High Low; in (b), the surface tones of  $\text{tuu}^{\text{LM}}$  ‘feather’ are High Mid. I argue that the difference in surface form is due to the fact that in the case of (a) the Mid tone on the initial mora of  $\text{ta}\delta\text{u}^{\text{LH}}$  ‘hawk’ is a Default tone inserted to prevent two adjacent Low tones, whereas in (b) the Mid tone on the initial mora of  $\text{ta}\delta\text{u}^{\text{LH}}$  is sponsored by  $\text{tuu}^{\text{LM}}$  ‘feather’. I argue that the data in (b) show that the Low tone of  $\text{tuu}^{\text{LM}}$  ‘feather’ is raised to Mid when it forms part of the sequence High Low Mid. However, as shown in (a) this process does not occur when the sequence is High Low Default.

#### 5. Acoustic evidence

In this final section, I present evidence to show that there is no acoustic difference between an underlying Mid tone, a Default tone and a raised Low tone. As Low tones are not raised in the sequence High Low Default, these data also provide evidence for the presence of a fully specified underlying Mid tone, as well as a surface Default tone.

In order to be able to verify this hypothesis, eleven nouns with a variety of underlying tonal patterns were used in sentences with each of the two verbs  $\text{see}^{\text{aM}}$  ‘buy’ and  $\delta\text{iko}^{\text{MH}}$  ‘sell’. In addition, two nouns  $\delta\text{ita}^{\text{LH}}$  ‘tortilla’ and  $\text{tíft}^{\text{MH}}$  ‘avocado’ were used with the verb  $\text{kasi}^{\text{MH}}$  ‘eat’. Three enclitics were used:  $\delta\text{a}^{\text{HL}}$  1HON,  $\text{no}(\text{H})$  1INCL and  $\text{si}(\text{H})$  3G. The combinations of verbs, enclitics and nouns provide a wide

range of tonal contexts. Crucially, the sequences in which Low tones are raised occur. Sample utterances are given in Table 13. When Low tones which form part of the sequence High Low Mid are raised, this is indicated by ↑ as in Table 13(a).

Table 13 *Sample elicitation sentence*

a	nĩ <sup>n</sup> -	sèē <sup>n</sup>	nō	kíðĩ↑	kājĩnĩ <sup>n</sup>
	ni <sup>n</sup> (L)-	see <sup>nM</sup>	no <sup>(H)</sup>	kiðĩ <sup>LM</sup>	kājĩnĩ <sup>n</sup>
	PFV	buy	1INCL	pot	day before yesterday
	<i>We bought pots the day before yesterday.</i>				
b	nĩ <sup>n</sup> -	sèē <sup>n</sup>	ǎá	kĩðĩ	kājĩnĩ <sup>n</sup>
	ni <sup>n</sup> (L)-	see <sup>nM</sup>	ǎa <sup>HL</sup>	kiðĩ <sup>LM</sup>	kājĩnĩ <sup>n</sup>
	PFV	buy	1HON	pot	day before yesterday
	<i>I bought pots the day before yesterday.</i>				

The data for this experiment were recorded by 5 speakers. The sentences were read in random order. A preliminary repeated measures ANOVA was conducted with the following factors: Speaker, Tone and Vowel. The results show an interaction between the factors Tone and Vowel. Therefore, the in-depth analysis was carried out using only occurrences of the vowel /i/, the most frequent in this data set. In Table 14, I give the number of occurrences of the vowel /i/ per speaker.

Table 14 *Database size*

Speaker	Count
MR	169
LF	156
GO	143
GA	111
PG	166
Total	745

In Table 15, I give the number of occurrences of each tone, noting that the sequence High Low Mid (hLm) and High Low Default (hLd) were classified separately as was the Default tone (D). In sequences, the frequency of the tone indicated by uppercase letter is the one being measured.

Table 15 *Number of occurrences of each tone level or sequence*

Tone	Count
L	118
hLd	37
hLm	199
M	123
D	35
H	233

A repeated measures ANOVA was run using the factors Speaker and Tone. The mean F0 of the mid 50% of the vowel being measured was used. Considering that NM is a tone language it is not surprising that the mean F0 of the different tone levels is significantly different, [F(5, 20) = 161.02, p < 0.01]. However, what is of interest is the comparison of the mean F0 of the Low tones in the sequences hLd and hLm

with Low and Mid. The results of the post hoc pairwise comparisons are given in Table 16. The results which show no significant difference are shaded in grey. There is no significant difference between the F0 of a Low tone and the Low tone in the sequence High Low Default, p = 0.2. On the other hand, a comparison of the F0 of Low tones and the Low in a High Low Mid sequence is significantly different, p = < 0.01. The data also show that there is no significant difference between the F0 of Mid and Default, p = 1.0.

Table 16 *Pairwise comparison*

Tone 1	Tone 2	Mean Difference (1-2)	Std. error	Value of p
L	hLd	-3.432	1.391	0.2
	hLm	22.079	.838	<0.01
	M	-21.486	.924	<0.01
	D	-23.79	1.348	<0.01
	H	-40.185	.816	<0.01
hLd	hLm	-18.646	1.309	<0.01
	M	-18.054	1.366	<0.01
	D	-20.358	1.682	<0.01
	H	-36.752	1.295	<0.01
hLm	M	0.592	.794	1.000
	D	-1.712	1.262	1.000
	H	-18.106	.666	<0.01
M	D	-2.304	1.321	1.000
	H	-18.699	.772	<0.01
D	H	-16.394	1.248	<0.01

These data provide evidence that Low tones in the sequence High Low Mid are raised so that phonetically they are indistinguishable from Mid tones. The data also show that F0 of Low tones in the sequence High Low Default is indistinguishable from Low tones in unambiguous contexts. As the raising of F0 does not occur in the sequence High Low Default, these data also provide evidence that underlying Mid tones in NM are distinct from the inserted Default tones as underlying Mid tones participate in phonological processes which Default tones do not.

## 6. Conclusion

I have presented data to show that there is indeed an underlying Mid tone in NM, in addition to High and Low. I have also shown that some verb stems are unspecified for tone, although they may have a floating High tone. I have also given examples of the insertion of the Default tone to prevent two adjacent Low tones. However, the Default tone in the sequence High Low Default does not trigger Low Raising, whereas in the sequence High Low Mid, the Low tone is raised.

## 7. Acknowledgements

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## 8. References

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