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Preliminaries to Tonemic and Tonomechanical Analysis
for the Chalcatongo Dialect of Mixtec

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This study is a phonetic description of the phenomenon of tone in the Chalcatongo dialect of Mixteco as well as a preliminary analysis of tone sandhi phenomena.

The transcription system used in this study is that of the international phonetic association, as revised in 1979. Chao's system of tone representation is used throughout, only three levels of tone (7 hi, 4 mid, 1 lo) being necessary in most cases. However, when data from the San Esteban dialect is cited, 4 is used to represent level 3 (between mid and lo). Acoustic data is always given in Hertz and always refers to the level of the fundamental frequency of the audio signal.

The data upon which this work is based was collected during the course of some sixty sessions with language consultant Nicolás Cortes, without whose most patient and gracious cooperation, such a project would be an impossibility. Any inaccuracies or oversights herein are due solely to the writer's lack of care or experience in collecting or analyzing the data.

Preliminaries to Tone Analysis

In the dialect of Chalcatongo, as in other dialects of Mixtec, the basic morphemic canon is CVCV or CVV. CVV morphemes are disyllabic,

even if both vowels are of the same quality. Each vowel is associated with a tone. Because all non-cliticized morphemes in the Chalcatongo dialect are disyllabic, two tones are associated with each of them. It is convenient, then, to consider as a single unit each of these pairs of tones commonly referred to as tone couplets.

In his classic study of tone, Kenneth Pike (1948) makes considerable reference to the variability of tone at the phonetic level (Pike, 1948). The realization of tonemes, the tonal equivalent of phonemes, depends on two major types of factors. On one hand, tone may be affected by the pragmatic or segmental context in which it is found. In some languages, particular phonetic environments, such as following a voiced stop or utterance-final position, cause change in tone. In all languages such factors as the physical and emotional state of the speaker are known to influence tone (Pike, 1948:27). On the other hand, tones may be altered by the position they occupy in the general tonal pattern of the utterance or syntactic unit of which they are a part. In this type of perturbation of tone, called sandhi, the tone of certain syllables is determined by the tone of adjacent or nearby syllables. The capacity of a given toneme (or, in our case, of a given tone couplet) to cause a perturbation or to be perturbed by another toneme determines the tonomechanical relationship of that toneme to the other tonemes of the language in question.

In order to determine the nature of tonemes and their tonomechanical interaction, it is necessary to know precisely in which environments and to what degree the physical and phonetic contexts of the utterance are influencing the realization of tone.

In order to do just this in our study of the dialect of chalcatongo, several elicitations were made under controlled conditions at the phonology laboratory of the University of California at Berkeley. Data thus obtained was then analyzed for fundamental frequency level (the primary acoustic cue for tone, abbreviated F_0) using a pitch extractor and an oscillograph printer.

(tables are at end of paper)

Table #1 indicates that tone level, as predicted by prior analysis by means of minimal pairs and test by ear, clusters around three frequency levels. The samples in Table #1 were recorded on two separate occasions. The fact that tone range varies from session to session is graphically illustrated here in the dramatic difference in overall range of tone between the samples. Nevertheless, the validity of the analysis of the tonemic system of the chalcatongo dialect as consisting of three tones; one high, one low and one at roughly mid-level, is confirmed by the almost identically proportional relationship of the level of one tone with respect to another between the samples. The level of tone so determined for each elicited morpheme was checked against the tone level determined by ear and cross-checked against the tone level recorded for the neighboring dialect of San Miguel El Grande by Anne Dyk and Betty Stoudt (1965). Results were remarkably consistent, except for morphemes classed in our sample as having lo-lo tone (a category which does not exist in San Miguel) which in almost every instance had been reported as lo-mid by Dyk and Stoudt.

Since the position of the syllable in which a given toneme finds itself in the utterance may also affect its realization, an analysis of

the data was made in terms of which syllable of the couplet a given toneme at a given level occurred. The results are shown in Table #2.

Mid tone and especially low tone are significantly lower in the second syllable of a morpheme than in the first, but it has proved unnecessary to consider tonemic neutralization or to posit new tonemes to account for this phenomenon.

Next, an analysis was made of each tonal level in terms of couplet structure and of vocalic and consonantal composition. The results are represented in Tables #3, #4, and #5. Tonemes seem to be influenced slightly, by the level of the other toneme of the couplet in which they are found. In fact, the overall pitch patterns for many morphemes with tonemes at different levels looked more like gliding contours from one level to the other than like couplets of two level tones. Of course, such glide formation is predictable and in no way bars us from analyzing the tonemes of the Chalcatongo dialect as being level.

Tone measurements were made in conformity with the guidelines set forth by Pike (1948:6) at the endpoints of glides and at points where the direction of F_0 variation changes. Partly because of the fact that measurements were taken at these points rather than elsewhere, the pitch level for low tone is dramatically different for the low-low couplet in relation to low tones that represent the beginning of a rising contour, or especially the end of a falling contour. This difference, however, is not significant, since the lowest mid tones in the same environment are not only a full twenty Hertz higher than the highest low tones, but are phonetically if not tonemically endpoints also of downward glides.

Tone level does not appear to be significantly affected by the canonical structure (CVCV or CVV) of the morpheme concerned. Variation

in terms of vocalic and consonantal makeup of the syllable associated with a given toneme, while noticeable in some cases, is never significant.

In order to determine the pitch differences inherent in Chalcatongo vowels an experiment was devised where in the language consultant read sixty random sentences, including morphemes identical in structure and tone, varying only in the quality of their vowels (twenty contained [ə], twenty contained [u], and twenty contained [i], which were embedded in identical frames. The results were analyzed much like the other data thus far presented and are shown in Table #6. It appears that variation due to vowel quality, while comparable to that found in other languages, is not great enough to cause confusion in toneme perception.

Mariscela Amador (personal communication) reports that, in the chalcatongo dialect, syllable duration, closely related to syllable structure, is not correlated to tone or amplitude. While the majority of morphemes in our sample had higher amplitude on the first syllable, first syllables were almost invariably shorter than second syllables. Stressed second syllables were not notably longer than unstressed second syllables in relation to first syllables and unstressed initial syllables bore roughly the same relation to final syllables in duration as did stressed initial syllables.

Amplitude seems to be correlated, though not perfectly, with the beginning of a falling contour or with the end of a rising contour, that is, with the highest tone in the morpheme. Morphemes with two tonemes at the same level are very commonly realized with near equal amplitude on both syllables, especially when the structure is CVCV.

This positive correlation between amplitude and toneme level renders toneme identification relatively easy in most cases, but in a

significant minority of cases, where the correlation does not hold, a great deal of concentration was required to determine the couplet type of the morpheme concerned. Since such 'aberrant' morphemes have similar F_0 levels as others of their class and, as we shall see shortly, behave as others of the same couplet type, we may conclude that the primary cue for toneme level is F_0 level, but that amplitude may be a secondary cue of some importance (at least to the ear of an English-speaking linguist trying to identify tonemes!)

Amplitudes were extracted from the sample with the same machinery used for fundamental frequency extraction. The importance of experimental verification of audial impressions cannot be stressed enough here. Native speakers of English rely on change in pitch primarily, and on duration, absolute pitch, and amplitude secondarily to determine stress patterns. In the Chalcatongo dialect a similar correlation exists between absolute pitch and amplitude, and, to a limited extent, pitch change. However, duration of syllables is completely disassociated from these other variables, and furthermore, it is not at all clear that the phenomenon of stress has anywhere near the importance in the Mixtec of Chalcatongo as it does in English, vowel quality being much more stable in the former than in the latter.* In any case, further investigation in the areas of amplitude and stress is sorely needed.

Mixtec couplets may at one time have been two or more separate morphemes. A possible trace of this type of development is the

* In many cases, pitch and amplitude are not correlated, and these are precisely the cases where speakers of English will have most difficulty in distinguishing tonemes in the chalcatongo dialect. (in the silacayopayan dialect (North and Shields, 1977) stress falls regularly on the first syllable of all couplets).

existence of two vowels of different quality in the same morpheme, especially the CVV type. If the percentage of morphemes containing vowels not differing in timbre is checked against couplet types, some types emerge as more likely than others to have arisen from this type of process than other couplet types. Table #7 shows that couplets with rising contours are not only rarer than other types of couplets, but are also more likely to contain vowels that are not identical in quality.

In this connection, we may also consider the percentage of each couplet type in the data sample used in this study. A total of 177 couplets were used. Each type was represented in the following proportion:

77	5%
74	18%
7J	5%
47	9%
44	20%
4J	28%
J7	5%
J4	9%
JJ	6%

The data sample, however, reflects only indirectly the actual proportion of a given couplet type in the dialect, since rare couplet types were more actively elicited than more commonly occurring couplet types in order to ensure an adequate data base for each type. Therefore,

couplet types rare in the sample are most probably even rarer in proportion to the entire Chalcatongo lexicon.

Preliminary Analysis of Some Sandhi Phenomena in Certain
Chalcatongo Constructions

Because of time limitations, a complete study of tonemic perturbation patterns in the Chalcatongo dialect has thus far not been possible. Analysis of sandhi phenomena is extremely time-consuming, since data must be checked and rechecked to control for variation due to style, utterance rhythm and speed, special behavior of particular morphemes or classes of morphemes, and variations in degree or type of sandhi due to syntactic context.

In our sample, all possible couplet types were found, another indication that our analysis of the tonemic system as consisting of three level tones is correct. In the San Miguel dialect, however, the sequence lo-lo is not found (Pike, 1948:79) and in the dialect of San Esteban Atatláhuca, as described by Mak (1953:86) which contains four level tones, lo-lo sequences are also not found. Whether the sequences lo-lo and lo-mid may be collapsable in the Chalcatongo dialect is an as yet unsolved problem (see below).

In the Chalcatongo dialect, as in other Mixtecan dialects, a genitival relationship may exist between two nouns in sequence. For example:

┘ 4 7 4	┘ ┘ 4┘
[sq [?] n tʃaa]	[hi to tʃaa]
leg man	bed man
'the man's leg'	'the man's bed'

the tonemes associated with the morpheme [tʃaa] in isolation are 11. We may conclude, then, that in this type of noun-noun construction, the couplet 11 is perturbed to 14 after 14 and to 41 after 11, at least in the morpheme [tʃaa].

In Table #8 the general patterns of tone perturbation in noun-noun constructions are schematically represented. Across the top row of the table are found the perturbing couplets (i.e. the couplet types of the first noun) and the horizontal rows represent the perturbed couplets (i.e. the second term of the noun-noun construction.)*

On the basis of the data in Table #8, a preliminary classification of couplet types into tonomechanical groups can be made.

Class I - 11, 41, 11, and 41.

a) 11 and 41 never perturb any couplet type, except 44 which goes to 11. We shall call this type of perturbation, where two successive tones are each raised by one tonemic level double one tone raising.

b) 11 - never perturbs any couplet types except another 11 which is perturbed to 41. In this way, a sequence of four tones at the same level is avoided 11 + 11 → 11 41. This seems to be a common process in the Mixtec of Chalcatongo and is everywhere accomplished by raising

* Abbreviations used in Table 8: N.C. - no change, Var. - variation, N+N - noun-noun construction, B/P - body part locative construction, ADJ - noun-adjective construction, CVV, CVCV, etc. - canonical structure.

the first tone of the perturbed couplet by one tonemic level, a process which we will call one tone raising.*

c) ɿɿ - never causes perturbation, except if the following couplet ends in ɿ, in which case one tone raising applies to the first toneme while the final ɿ goes to ɿ.**

Class I, in general, is a non-perturbing class. In the limited number of instances where class I couplet types do cause perturbations, these always involve one tone raising (simple or double).

Class II - ɿɿ, ɿɿ

a) When the sequences ɿɿɿɿ and ɿɿɿɿ occur underlyingly the second couplet is perturbed by means of one tone raising. Notice that once again one tone raising is used to avoid a sequence of four tonemes at the same level in the case of ɿɿɿɿ → ɿɿɿɿ.

b) When class II couplets precede ɿɿ or ɿɿ, all low tones of the perturbed couplet are changed to high tones, as if a mirror image on an axis perpendicular to the frequency axis were being made of the contour. We shall call this phenomenon two step raising. An example of lo-hi raising is:

ɿ	ɿ	ɿ	ɿ	+	ɿ	ɿ	ɿ	ɿ
{ndu	tʃa}	+	{na	ni}	→	{ndu	tʃa	na ni}
water			brother			'the brother's		water'

* In the San Miguel dialect, what we call "one tone raising" above is the most common, indeed nearly the only type of morphotonemic perturbation reported for noun-noun constructions.

** Similar lowering phenomena are attested to in other dialects of Mixtec, as well as in other Otomanguean and non-Otomanguean languages (Daly, 1977:19) where they are allophonic in nature. We judge these to be allophonic here also. Further study is necessary.

c) 74 and 44 regularly perturb JJ couplets to 74. In fact, except for the above-cited perturbation of JJ by JJ, a perturbed JJ couplet always goes to 74, in noun-noun constructions.

Class II couplets always perturb tone level upward, by the processes of one tone raising, two step raising, and special lo-lo raising (JJ → 74).

Class III - 77, J7, J4

a) Just as class II couplets, class III couplets perturb 44 → 74 and 47 → 77 by one tone raising.

b) As after class II couplets, JJ → 74 after class III couplets.

c) The tone patterns for J4 and 4J following class III couplets are reversed. Example:

7 7 4 J 7 7 J 4
 [tʃa ka] + [na ni] → [tʃa ka na ni]

We shall call this type of perturbation pattern reversal.

d) J4 - differs in its perturbing effect, with a particular four-tone series occurring in almost all couplet pairs with J4 as the first component, yielding the tonal pattern J44J (that is, J4 plus its mirror image on the axis parallel to the frequency axis.) Therefore J4 does not perturb 4J following it as do other class III couplets. 44 following J4, is perturbed to 4J instead of 74. Pattern reversal may not account for the perturbatory effect of 4J on the couplets to which it typically applies (4J and J4) since 4J remains 4J, and while the pattern of J4 is reversed to 4J, this seems to be due more to conformity to the overall J44J sequence pattern than any other factor.

In any case, class III couplets distinguish themselves from those of other classes in that syllables of morphemes following class III couplets and perturbed by them can have a toneme at a lower level associated with them in their derived form than the level of the toneme associated with them in their citation form. Whether we want to interpret this phenomenon as actual tone lowering or, as I prefer, as a type of pattern reversal or pattern mirroring is an important question.

The pattern reversal analysis is favored for several reasons. In the first place, phenomena involving 'lowering' are never as simple as one tone raising, but always are included in patterns of perturbation involving more than one toneme. Secondly, in the neighboring dialect of San Miguel El Grande (Pike, 1948:80) perturbation always involves the process of one tone raising except in very isolated cases (Mak, 1950: 82-86). The extent of 'lowering' in Chalcatongo is extremely limited in comparison to other dialects in which lowering has been reported (Mak, 1953:82). Notice that only three out of the nine couplet types cause 'lowering,' and only one does so exclusively.*

A classification of couplet types on the basis of their perturbability is not as easy to devise as one based on their perturbatory effect. 77, 74, and 7J are never perturbed. As mentioned above JJ has a peculiar but regular pattern of perturbability. 47 can only be perturbed to 77. Accounts of the perturbability patterns of the other couplets would amount to case-by-case descriptions of the data in Table #8.

* It should also be noted that the perturbed second couplet of a couplet pair has a falling pattern much more often than a rising one.

Certain generalizations are possible concerning the correlation of couplet makeup with tonomechanical behavior. It appears that couplets ending in a hi toneme will be most likely to cause perturbation, while those ending in a lo toneme are least likely to do so. However, lo tonemes in couplet initial position seem to increase the susceptibility of the couplet to perturbation, while hi tonemes in initial position block perturbability.

The tonomechanical constraints cited thus far conform to the following applicational hierarchy:

- 1) Hi tone perturbability blocking.
- 2) Four toneme sequence at the same tonemic level avoided.
- 3) JJ is only perturbed to 74.

Hi tone perturbability blocking must be ordered before four same level toneme avoidance because the sequence 7777 remained unperturbed. Four same level toneme avoidance must be ordered before JJ → 74 because JJJJ → JJ4J, following the perturbation pattern typical of the avoidance constraint.

The above account of the tonomechanics of the noun-noun construction is by no means exhaustive. In other Mixtec dialects, couplets with the same basic toneme patterns behave differently in the same environment, grouping themselves into subclasses (Mak, 1953:89). In the San Esteban dialect certain syntactic units involve one type of perturbation while other constructions involve another (Mak, 1953:88).

Such may very well be the case in Chalcatonogo, since body part-noun locative constructions and potential verb-noun imperative constructions, while in some cases having similar or identical (hii-with, e.g.) tonomechanics to noun-noun genitive constructions, in other cases show

tonomechanical patterns particular to themselves. Noun-adjective constructions, on the whole, seem to pattern themselves after noun-noun constructions.

Verb-noun (or pronoun) direct object constructions involve almost no perturbation. Only 77 verbs appear to perturb in this instance, and then only two couplet types are affected (7774 + 7774 and 7774 + 774J).

In Chalcatongo, as in other Mixtec dialects, disyllabic morphemes may be cliticized to other morphemes, a process which involves the reduction of the cliticized morpheme to one syllable. Although in other dialects the toneme associated with the cliticized morpheme is that which was associated with the initial syllable of its non-cliticized counterpart, such a relationship does not seem to hold in Chalcatongo.

As illustrated in Table #9,^{*} tonomechanical patterns for pronouns before or after verbs or after nouns (in the possessive construction) are distinct from those considered above in that pronouns may be perturbed by a following morpheme. This anticipatory perturbation pattern occurs in the San Esteban dialect as well (Mak, 1953:88).

Pronoun enclitics may be classified loosely into four groups:

a) Group 1 - mainly hi

A) [na], [ni] - mainly stay 7 after 7

B) [ro], [ri] - go to 4 or J after 7

* Abbreviations used in Table #9: 1s - first person singular, etc., P - plural, I - informal, R - respected or formal, F - feminine, M - masculine, REP - repetitive particle, FUT - future, VEN - ventive.

b) Group 2 - mainly mid

A) [na] - ɨ goes to ɨ after ɨ
3s

B) [de] - ɨ remains ɨ after ɨ
3s

c) Group 3 - [ʒo]

d) Group 4 - [to] - always lo, but with ɨ variant.

The preverbal particles tested followed two main patterns:

A) [ka] }
[kiʔi] } Perturb following morpheme downward.
[ni] }

B) [na] }
[ha] } Perturbed by following morpheme variously.

The great variety of perturbation by following morphemes on [na] and especially [ha] may indicate that these monosyllables are in reality neutral in tone. Such encliticized elements with neutral tone are called 'unstable neutral syllables' by Pike (1948:25). [ha] appears, however, to be basically lo when used preverbally to form relative clauses, acting as an unstable neutral syllable mainly in pre-nominal or pre-adjectival position. Relativizers before verbs in general, such as [nda sa] 'how', [noʔo] 'that', and [ndeʊ] 'which' also neither perturb nor are perturbed.

Conclusion

It is obvious that we have only begun to account for sandhi phenomena in the Chalcatongo dialect. It is our hope that this study will serve as the point of departure for deeper probes into the tonomechanics of Chalcatongo morphophonology.

Acknowledgements

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Overall Mean Levels of Tones in Hertz (F_0)

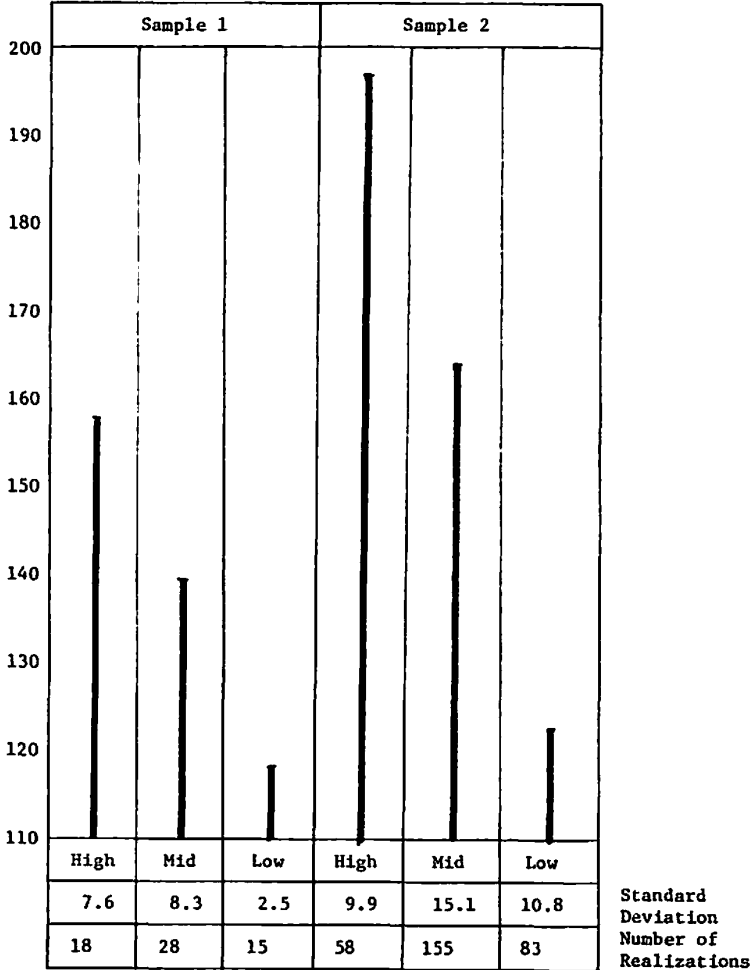


Table 1

Overall Mean Levels of Tones in Hertz by Syllable (F_0)

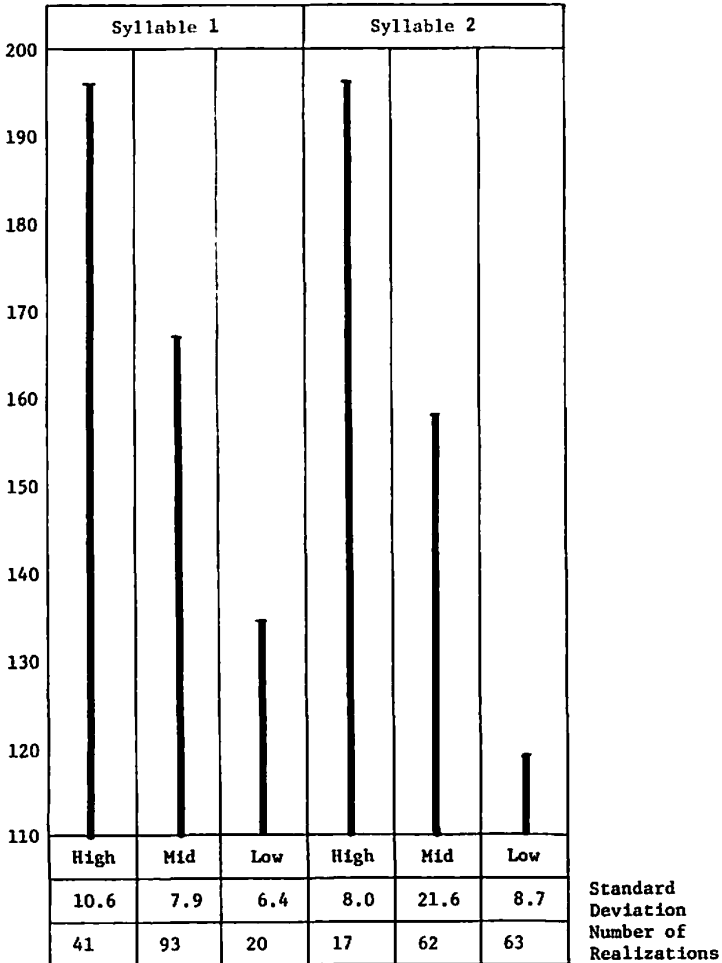
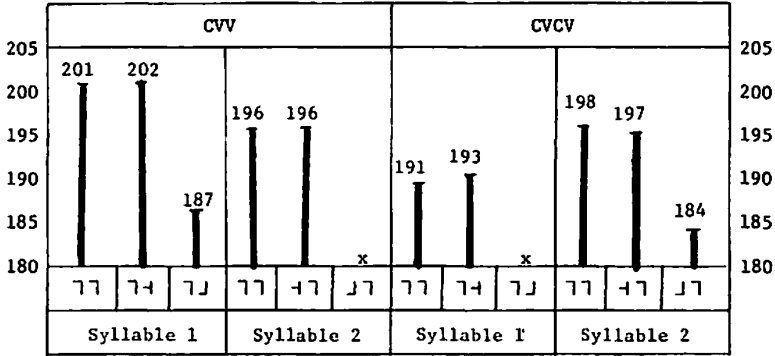
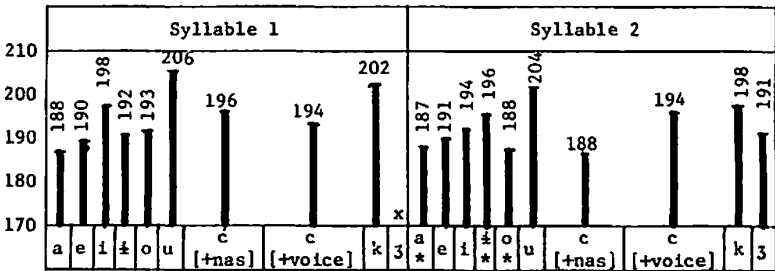


Table 2

High Tone



Mean Level in Hertz by Couplet Type (F_0)



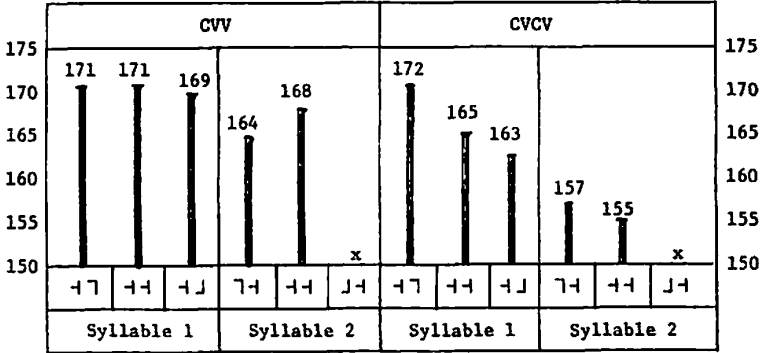
* = < 3 realizations
in sample

x = no data

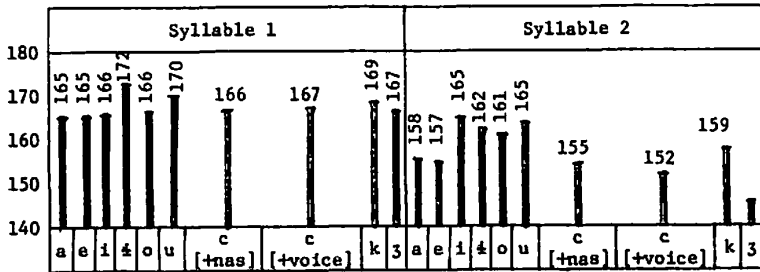
Mean Level in Hertz by Vowel of Syllable Nucleus or by
Syllable Initial Consonant (F_0)

Table 3

Mid Tone



Mean Level in Hertz by Couplet Type (F_0)



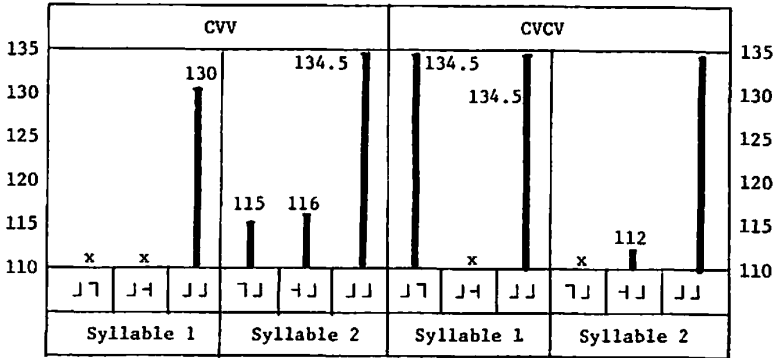
* = < 3 realizations in sample

x = no data

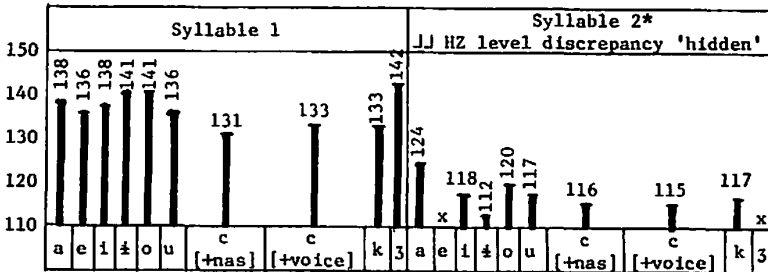
Mean Level in Hertz by Vowel of Syllable Nucleus or Syllable Initial Consonant (F_0)

Table 4

Low Tone



Mean Level in Hertz by Couplet Type (F_0)



* = < 3 realizations
in sample

x = no data

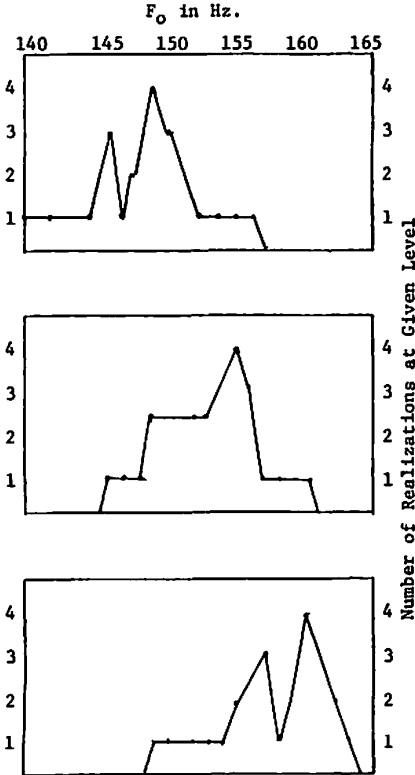
Mean Level in Hertz by Vowel of Syllable Nucleus or by
Syllable Initial Consonant (F_0)

Table 5

Fundamental Frequency Level for

[a] [u] and [i]

Number of Realizations at a Given f Level (in Hz.)



[a]

<u>Vowels</u>	[a]	[u]	[i]
Mean F_0 in Hz.	148.4	153.8	157.1
Standard deviation	3.70	3.65	3.99
Variance	13.73	13.33	15.80

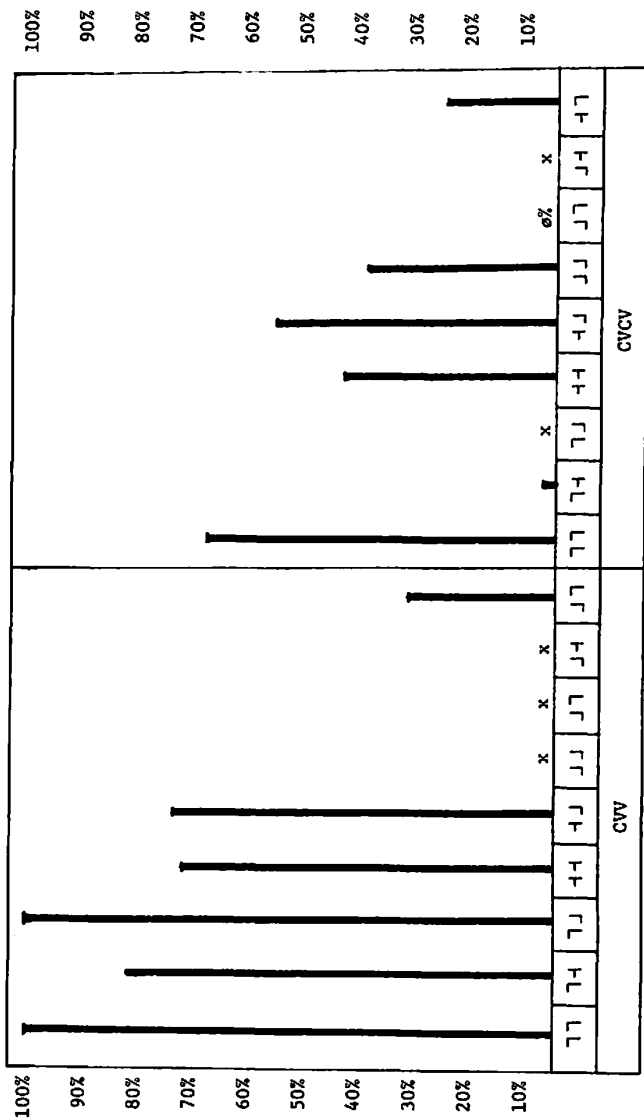
[u]

<u>Variables</u>	t-value	% freedom	level/signif.
[a] vs. [u]	4.52	38	<.0005
[a] vs. [i]	6.97	38	<.0005
[u] vs. [i]	2.66	38	<.01

[i]

Table 6

Percentage of Couplets where $V_1 = V_2$ by Couplet Type



x = < 3 realizations in sample

Table 7

Verbs	Encliticized Pronouns													Pronouns and Particles Preceding Verbs									
	1PI	1PR	2PP	2PR	3SF	3SM	3SN	1PP	1SP	2PI	2PF	1PP	PL	(REP.)	PAST	FUT	VEN						
	ri	na	ro	ni	na	de	to	ʒo	ru'u	na'a	ro'o	ni'i	ʒo'o	ka	na	ni	kifi	bei					
natf ʒi	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ					
pot. ʒi																							
tʒinde ʒʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ					
pot. ʒʒ																							
ndiso ʒi	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ					
pot. ku.ʒʒ																							
(pot. ʒ real) kep ʒi	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	x					
hini ʒʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ					
kuni ʒi																							
Nouns																							
ʒʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ					
ʒi																							
ʒʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ					
ʒi																							
ʒʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ					
ʒi																							
ʒʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ	ʒ					
ʒi																							
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ʒi																							

* Also var. (ʒ)

Tonal Patterns of Pronouns and Particles

(if verb or noun is perturbed by the pronoun or particle, tones are indicated)

Table 9



**STUDIES IN
MESOAMERICAN
LINGUISTICS**

Report #4

Survey of California and Other Indian Languages

**Reports from the Survey
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