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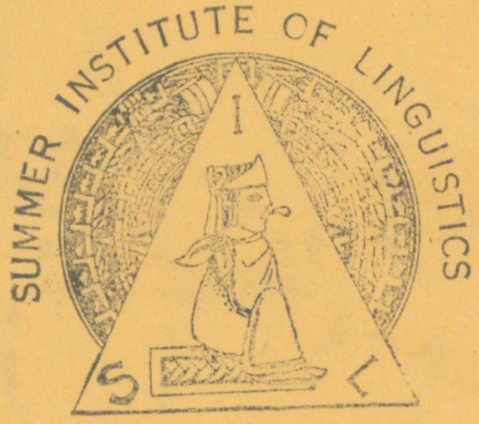

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1. The purpose of this paper[1] is to present the problems of, and solution for, the tone analysis of Villa Alta Zapotec, of Oaxaca, Mexico.[2]

Villa Alta Zapotec has three tone registers: high /¹/, mid /²/, low /³/. These are demonstrated by CONTRASTIVE SETS. (A CONTRASTIVE SET may be defined as a group of tone-sequence patterns, in some particular position, which differ only by one tone in the same relative place in the sequence; the segmental phonemes of a contrastive set do not have to be uniform.)

Note the following contrastive sets, the first of which differ by slight segmental changes which are not pertinent to the tone contrast:[3] de³za¹n ya¹ *a lot of bamboo*: de³za¹n ya² *many steam baths*: de³za¹n ya³ *a lot of weapons*; ye³ṛ go²lï² *old flower*: bg^{w}e²ṛ go²lï² *old hoe*: ye¹ṛ go²lï² *old stone*; za³ ni²? *that bean*: ža² ni²? *that day*: za¹ ni²? *that lard*; ye³l na²ǰo² *night we say*: ye²l na²ǰo² *cornfield we say*: ye¹⁻²l na²ǰo² *sandal we say*; bče³čbo²? *he* (fam.) *pounded*: go²pbo²? *he* (fam.) *cared for*: ǰa¹tbo²? *he* (fam.) *dies*.

2. The most severe problem in this tone analysis is the lack of a system which is completely symmetrical. The contrastive sets which demonstrate the three tone registers are rare and are therefore easily overlooked. The reason that they are rare is because certain tone-sequence patterns do not occur preceding zero, but only as a result of certain tone perturbations. That is, their occurrence is due to the mechanical effect that one tone may have upon another.

2.1. In a tone language of three registers, there are nine potential tone-sequence patterns of dissyllabic words: those with /¹/ on the first syllable (¹ ¹, ¹ ², ¹ ³), those with /²/ on the first syllable (² ¹, ² ², ² ³), those with /³/ on the first syllable (³ ¹, ³ ², ³ ³).

These nine tone-sequence patterns theoretically could combine into three groups of three, and recombine into three more groups. With each of the nine tone-sequence patterns used twice, there are potentially six different groups of three which may occur in any of four positions, namely, preceding /¹/, /²/, /³/, and zero. These six different groups in the four different positions form 24 contrastive sets.

Three of the groups mentioned are the nine tone-sequence patterns as grouped above. The other three groups are those same nine potential tone-sequence patterns rearranged: those with /¹/ on the second syllable (¹ ¹, ² ¹, ³ ¹), those with /²/ on the second

[1] Data for this paper were gathered in connection with a field trip to Yatzachi el Bajo, Oaxaca, Mexico, during April and May, 1947, under the auspices of the Summer Institute of Linguistics. An outline of the data contained herein was presented as a paper at a meeting of the Linguistic Society of America, August 2, 1947.

[2] The analysis of the segmental phonemes I have taken from my colleagues Otis and Mary Leal. Only the tone analysis is mine. The segmental phonemes are described by them as: fortis p, t, č, k, k^{w}, s, š, ṣ, M, N, L, y; lenis b, d, ǰ, g, g^{w}, ṛ, ṛ^{w}, z, ž, ẓ, n, l; glottal stop ?. The following additional consonants occur in Spanish loans: f, x^{w}, x, r, r·. The vowel phonemes are: i, e, a, ï, o.

[3] Throughout this paper, two tones on one syllable are actualized as a glide from one tone to the other, whether on a single vowel, a vowel cluster, or a sequence of V?V.

syllable ($^{1\,2}$, $^{2\,2}$, $^{3\,2}$), those with /^{3}/ on the second syllable ($^{1\,3}$, $^{2\,3}$, $^{3\,3}$).

Preceding zero, dissyllabic words appear in only six of the nine potential tone-sequence patterns; and of the six contrastive sets, which potentially precede zero, two occur. Of these two, samples in which the segments are identical are very rare, or lacking, even though unconditioned tone contrast does occur. Of the sets which occur, one set has /^{2}/ on the second syllable: $^{1\,2}$: $^{2\,2}$: $^{3\,2}$; ẓši^1-tbo^2? *his* (fam.) *bone* : go^{2}tbo^2? *he* (fam.) *died* : Li^{3}šbo^2? *his* (fam.) *paper*. The other set has /^{3}/ on the second syllable: $^{1\,3}$: $^{2\,3}$: $^{3\,3}$; ẓši^{1}tï^{3}b *his* (animal's) *bone* : ẓi?i^{2}nï^{3}b *his* (animal's) *nose* : Li^{3}šï^{3}b *his* (animal's) *paper*.

Preceding a syllable of tone /^{3}/, dissyllabic words appear in only six of the nine potential tone-sequence patterns, and of the six contrastive sets which potentially precede a syllable of tone /^{3}/, one occurs; i.e. the set with /^{3}/ on the second syllable: $^{1\,3}$: $^{2\,3}$: $^{3\,3}$; bi^1-ši^3? nga^3 *this grasshopper* : ni^{2}ži^3? nga^3 *this milk*: ye^{3}ži^3? nga^3 *this skin disease*. (This same group may also occur preceding a syllable of tone /^{2}/ or a syllable of tone /^{1}/.)

Preceding a syllable of tone /^{2}/, dissyllabic words appear in only seven of the nine potential tone-sequence patterns, and of the six contrastive sets which potentially precede a syllable of tone /^{2}/, two sets occur. They are: the set with tone /^{2}/ on the first syllable: $^{2\,1}$: $^{2\,2}$: $^{2\,3}$; g^{w}a^{2}gï^1 ẓe^{2}n *big firewood* : ẓi^{2}gï^2? ẓe^{2}n *big gourd* : g^{w}a^{2}ži^3? ẓe^{2}n *big fat corncake*; the set with tone /^{3}/ on the second syllable: $^{1\,3}$: $^{2\,3}$: $^{3\,3}$; bi^{1}ši^3? ẓe^{2}n *big grasshopper* : g^{w}a^2-ži^3? ẓe^{2}n *big fat corncake* : La^{3}gï^3? ẓe^{2}n *big leaf*.

Preceding a syllable of tone /^{1}/, dissyllabic words appear in only seven of the nine potential tone-sequence patterns, and of the six contrastive sets which potentially precede a syllable of tone /^{1}/, two sets occur. Those sets are: those with tone /^{1}/ on the first syllable: $^{1\,1}$: $^{1\,2}$: $^{1\,3}$; g^{w}a^{1}gï^1 ko^{1}bï^2 *new firewood* : ẓta^{1}sǰo^2 ko^{1}bï^2 *our* (inc.) *new cup* : la^{1}pi^{3}s ko^{1}bï^2 *new pencil*; the set with tone /^{3}/ in the second syllable: $^{1\,3}$: $^{2\,3}$: $^{3\,3}$; la^{1}pi^{3}s ko^{1}bï^2 *new pencil* : g^{w}a^{2}ži^3? ko^{1}bï^2 *new fat corncake* : La^3-gï^3? ko^{1}bï^2 *new leaf*.

Therefore of the 24 potential contrastive sets of dissyllabic words occurring before /^{1}/, /^{2}/, /^{3}/, and zero, only seven of the sets actually occur. Few if any of these sets have items with identical segments, even though the tone appears in clear unconditioned contrast.

The remaining thirteen sets are lost for predictable reasons. Nine are lost because of certain tono-mechanical changes. Four are lost because of a tono-mechanical restriction, i.e. a non-permitted perturbation. Four are eliminated by certain non-permitted innate[4] tone-sequence patterns.

2.2. There are 27 potential tone-sequence patterns of words of three syllables: those with /^{1}/ on the third syllable and /^{1}/ on the second syllable ($^{1\,1\,1}$, $^{2\,1\,1}$, $^{3\,1\,1}$) or /^{2}/ on the second syllable ($^{1\,2\,1}$, $^{2\,2\,1}$, $^{3\,2\,1}$) or /^{3}/ on the second syllable ($^{1\,3\,1}$, $^{2\,3\,1}$, $^{3\,3\,1}$); those with /^{2}/ on the third syllable and /^{1}/ on the second syllable ($^{1\,1\,2}$, $^{2\,1\,2}$, $^{3\,1\,2}$) or /^{2}/ on the second syllable ($^{1\,2\,2}$, $^{2\,2\,2}$, $^{3\,2\,2}$) or /^{3}/ on the second syllable ($^{1\,3\,2}$, $^{2\,3\,2}$, $^{3\,3\,2}$); those with /^{3}/ on the third syllable and /^{1}/ on the second syllable ($^{1\,1\,3}$, $^{2\,1\,3}$, $^{3\,1\,3}$) or /^{2}/ on the second syllable ($^{1\,2\,3}$, $^{2\,2\,3}$, $^{3\,2\,3}$) or /^{3}/ on the second syllable ($^{1\,3\,3}$, $^{2\,3\,3}$, $^{3\,3\,3}$).

These 27 tone-sequence patterns theoretically could combine into nine groups of three, and recombine into nine more groups of three, and again into nine more groups. With each of the 27 tone-sequence patterns used three times, there are potentially 27 different contrastive sets of three which may occur in any of the four positions, namely, preceding /^{1}/, /^{2}/, /^{3}/, and zero. These 27 different contrastive sets in the four different positions form a total of 108 potential contrastive sets.

[4] By an "innate" tone we mean the tone appearing on the basic alternant of the morpheme in question. This tone appears when the morpheme is in isolation, and any perturbations are described in terms of changes from the innate tone.

Actually only 16, not 27, of these tone-sequence patterns occur in any one position; and therefore the number of contrastive sets is greatly reduced. Notice that it is not the same 16 tone-sequence patterns which occur in any one position.

Of the 27 potentially contrastive sets, five occur when preceding zero. The set with tone /²/ in the third and first syllables occurs: ²¹² : ²²² : ²³²; ẓko²ne¹gʷbo²? *his* (fam.) *rabbit* : ǰẓi²tï?ï²bo²? *he* (fam.) *jumps* : ẓsa²ga?a³ke²? *their lard.* The set with tone /²/ in the third syllable and with tone /³/ in the first syllable occurs: ³¹² : ³²² : ³³²; bši³-bï¹ǰbo²? *he* (fam.) *picked more fruit* : ẓa³gï?ï²-bo²? *her* (fam.) *blouse* : ǰa³ke³ne²? *he thinks.* The set with tone /²/ in third and second syllables occurs: ¹²² : ²²² : ³²²; ye¹ya²zbo²? *he* (fam.) *will transplant* : ǰẓi²tï?ï²bo²? *he* (fam.) *jumps* : bža³gna?a²bo²? *he* (fam.) *married.* The set with tone /²/ in the third syllable and tone /³/ in the second syllable occurs: ¹³² : ²³² : ³³²; ga¹tï?ï³bo²? *he* (fam.) *lies down* : ẓsa²ga?a³kbo²? *their* (fam.) *lard* : ǰa³ke³ne²? *he thinks.* The set with tone /³/ in the third and second syllables occurs: ¹³³ : ²³³ : ³³³; ṣa¹ẓta?o³to³? *our* (exc.) *ancestors* : ẓsa²ga?a³kï³b *their* (animal's) *lard* : gʷLa³žï?ï³to³? *we* (exc.) *pulled up.* Groups similar to the one in this last set also occur preceding /¹/, /²/, and /³/, and these same words may be used in them.

Preceding a syllable of tone /³/, there are only three of the 27 potential contrastive sets. The set with tone /¹/ in the third syllable and tone /²/ in the second syllable occurs: ¹²¹ : ²²¹ : ³²¹; ye¹ya²z bo¹? . . .³ (in which . . . indicates any semantically permissible word of the innate tone indicated) *he* (fam.) *will transplant* . . . : be²ži²ne¹? . . .³ *he came* . . . : ẓa³gï?ï²bo¹? . . .³ *her* (fam.) *blouse.* . . . The set with tone /³/ in the third and second syllables occurs: ¹³³ : ²³³ : ³³³; see the preceding paragraph for examples of this set. The set with tone /¹/ in the third syllable and tone /³/ in the second syllable occurs: ¹³¹ : ²³¹ : ³³¹; ga¹tï?ï³bo¹? . . .³ *he* (fam.) *lies down* : ẓsa²ga?a³kbo¹? . . .³ *their* (fam.) *lard* . . . : ǰa³ke³ne¹? . . .³ *he thinks* . . . . The group of tone-sequence patterns, similar to the one in this last set, also occurs preceding /¹/ and /²/ and these same words may be used in them.

Preceding a syllable of tone /²/, there are three of the 27 potential contrastive sets. The groups of tone-sequence patterns are similar to those which may occur before a syllable of tone /³/.

Preceding a syllable of tone /¹/, there are four of the 27 potential contrastive sets. The set which has tone /¹/ in the second syllable and tone /³/ in the first syllable occurs: ³¹¹ : ³¹² : ³¹³; bža³gna?a¹bo¹? . . .¹ *he* (fam.) *married* . . . : bši³bï¹bo²? . . .¹ *he* (fam.) *picked fruit* : ǰa³tï¹ǰo³? . . .¹ *you* (sing.) *lie down again.* . . . The set which has tone /¹/ in both the third and the first syllables occurs: ¹¹¹ : ¹²¹ : ¹³¹; to¹čo¹pï¹ . . .¹ *a few* . . . : ye¹ya²-zbo¹? . . .¹ *he* (fam.) *will transplant* . . . : ga¹tï?ï³bo¹? . . .¹ *he* (fam.) *lies down.* . . .The set which has tone /¹/ in the third syllable and tone /³/ in the second syllable occurs: ¹³¹ : ²³¹ : ³³¹. The words of this group, are the same as those of the similar group preceding tone /³/. The set with tone /³/ in the third and second syllables occurs: ¹³³ : ²³³ : ³³³. The words of this last group are the same in all four positions, that is, preceding tones /¹/, /²/, /³/, and zero.

In summary then, of the 108 potential contrastive sets in the four positions, only 15 occur. The remainder are lost for predictable reasons. 43 of the sets have been eliminated by tono-mechanical rules. (28 of these are lost because in the position in which those sets would appear, the third syllable, tone /²/, would have been perturbed to tone /¹/. Four are lost because in the position in which these sets would appear, namely preceding tone /¹/, the sequence of syllables on tone /²/ would have been perturbed to tone /¹/. 11 of the sets are lost because of a tono-mechanical restriction, i.e. tone /²/ when in a sequence in which it immediately follows tone /¹/ cannot be perturbed.) 38 of the sets have been eliminated by certain non-

permitted innate tone-sequence patterns. (26 of these are lost because in a word of three syllables, there is no innate tone-sequence pattern in which the first two syllables are tone /¹/. 12 are lost because in a word of three syllables there is no innate tone-sequence pattern in which the third syllable is tone /¹/.) There still remain 12 which cannot be eliminated by any rules so far discovered, but which we have failed to find after considerable search. Each of those sets contains one tone-sequence of which the second syllable is tone /²/ and the third syllable is tone /³/. We conclude this uniformity of type to be significant and therefore expect never to find those 12 sets.

Notice that of the 15 sets which occur, only seven use different words; the remaining eight sets occur only as perturbations of the first seven. The words which have a third and second syllable of tone /³/ (¹ ³ ³, ² ³ ³, ³ ³ ³) may occur in all four positions mentioned, i.e. preceding /¹/, /²/, /³/, and zero. Words which have a third syllable of tone /²/ and a second syllable of tone /³/ (¹ ³ ², ² ³ ², ³ ³ ²) may occur when preceding zero. Those same words, with the third syllable changed from tone /²/ to tone /¹/, may occur when preceding tones /¹/, /²/, or /³/ (¹ ³ ², ² ³ ², ³ ³ ² > ¹ ³ ¹, ² ³ ¹, ³ ³ ¹). The words which have a third and a second syllable of tone /²/ (¹ ² ², ² ² ², ³ ² ²) may occur when preceding zero. Those same words with the third syllable changed from tone /²/ to tone /¹/, may occur when preceding tones /²/ and /³/ (¹ ² ², ² ² ², ³ ² ² > ¹ ² ¹, ² ² ¹, ³ ² ¹). The other four sets of words occur in only one position.

The lack of so many patterns makes it difficult to find the contrasts, and even if the investigator does find them, many of them do not have identical segments.

3. Turning from the actual absence of certain potential contrastive sets, we now focus our attention on the tono-mechanical changes, or perturbations, which are responsible for so many of these losses. These tono-mechanical interferences cause difficulty, not only through the loss of the contrastive sets, but also because they change the tones of particular morphemes, so that the investigator finds it very distressing to locate points of reference which are unchanging in phonemic pitch, and to which other pitches can be compared for analysis of contrasts. If he analyzes a contrast of pitch in one context, and if he assumes that this tone pattern remains the same in another context, he may fall into serious error, if and when one tone is substituted for another without his being aware of it. Thus, the difficulty of analyzing the number of Zapotec tones is seriously increased.

3.1. Tone /³/ morphemes are divided into three classes: Class A, morphemes whose tone cannot be perturbed; Class B, morphemes whose tone may or may not be perturbed depending upon the particular context; Class C, those tone /³/ monosyllabic suffixes which become perturbed when the stem to which they are suffixed is perturbed.

3.1.1. Class A, those tone /³/ morphemes which cannot be perturbed regardless of the context in which they occur. That is, they remain tone /³/: Li³š ~ yi³š (class A) *paper*; preceding a syllable of tone /³/: Li³što³? *our* (exc.) *paper*; preceding a syllable of tone /²/: Li³šbo²? *his* (fam.) *paper;* preceding a syllable of tone /¹/: yi³š ko¹bï² *new paper*.

3.1.2. Tone /³/ syllables in Class B[5] are those morphemes which are tone /³/, but

[5] Some tone /³/ class B, stems have suppletive stems for the possessed forms. These suppletive stems have either tone /¹/ or a glide from tones /¹/ to /²/. ya³g *tree* : ẓya¹⁻²g *tree* (possessed); ži³t *bone* : ẓši¹t *bone* (possessed). The suppletive stem for the first person singular may be of a different tone than the suppletive stems for the other persons. Notice, therefore, the different tones which must be used for the one morpheme. The innate tone, tone /³/, class B, ya³g *tree*; preceding a syllable of tone /²/, ya²g ni²? *that tree;* possessed by the first person singular, ẓya¹ga³? *my tree;* possessed by another person, ẓya¹⁻²gbo²? *his* (familiar) *tree*.

which may or may not be perturbed according to their context. These morphemes are never perturbed when they precede a syllable of tone /³/, but they are perturbed to tone /²/ when they precede either a syllable of tone /²/ or a syllable of tone /¹/. This perturbation occurs both if the following syllable of tone /²/ or tone /¹/ is within the word, and if it occurs in the following word; ye³z ya?a³ (class B) *fresh corn on the cob*, ye³n (class B) *neck*; preceding a syllable of tone /³/: ye³nto³? *our* (exc.) *necks*, ye³z ya?a³ nga³ *this fresh corn on the cob*; preceding a syllable of tone /²/ within the word: ye²nǰo² *our* (inc.) *necks*; preceding a syllable of tone /²/ which is in the following word: ye²n na²ǰo² *neck we say*, ye²z ya?a² ẓe²n *big fresh corn on the cob*; preceding a syllable of tone /¹/: ye²z ya?a² ko¹bï² *new fresh corn on the cob.*

A syllable which is innately tone /³/, class B, may be perturbed, the first time from /³/ to /²/, to³ *one* + go¹ *potato* > to² go¹ *one potato*; the second time from /²/ to /¹/: to³ *one* + čo²pï² *two* > to²čo²pï² *a few*, then to²čo²pï² *a few* + go¹ *potato* > to¹čo¹pï¹ go¹ *a few potatoes.*

Certain tone /³/ word pairs which are homophonous when preceding zero have a tonal contrast when preceding a syllable of tone /²/ or tone /¹/. This is because of the tono-mechanical differences in sandhi. Preceding zero: bia³ (class A) *cactus*, bia³ (class B) *animal.* Preceding tone /²/: bia³ go²lï² *old cactus*, bia² go²lï² *old animal.* Another word pair, preceding zero: ya?a³ (class A) *market place*, ya?a³ (class B) *mountain*; preceding tone /²/: ya?a³ na²ǰo² *market place we say*, ya?a² na²ǰo² *mountain we say.*

3.1.3. Class C suffixes are innately tone /³/, but may be perturbed, or may remain unperturbed, along with, and depending upon the stem to which they are suffixed. Notice that -o³? *you* (sing.) is tone /³/ and remains tone /³/ when suffixed to a tone /³/, class A, stem, even when followed by a syllable of tone /²/: ǰa³kdo³? (class A and C) *you* (sing.) *think*, ǰa³kdo³? ni²? *you* (sing.) *think there.* This same morpheme -o³? *you* (sing.) when suffixed to a syllable of tone /³/, class B, stem, is perturbed to tone /²/ when followed by a syllable of tone /²/ or tone /¹/. Preceding zero: ǰa³zo³? (class B and C) *you* (sing.) *plant;* preceding a syllable of tone /²/: ǰa²zo²? ni²? *you* (sing.) *plant there.*

The descriptive order of the suffixation of this class C morpheme is as follows: First, the suffix is added to the stem, with the appropriate perturbation or lack of it. Then certain tone changes may be made in the stem to show aspect. Notice that even when the innately tone /³/, class B, stem has, with the addition of aspect, become tone /¹/, the class C morpheme is still perturbed when preceding a syllable of tone /²/. Preceding zero: go³to³? (class B and C) *you* (sing.) *died*, ga¹to³? (class B and C) *you* (sing.) *will die.* Preceding a tone /²/: go²to²? le² *you* (sing., with subject pronoun) *died*, ga¹to²? le²? *you* (sing., with subject pronoun) *will die.* Notice that this same class C morpheme is not perturbed when preceding a syllable of tone /²/ if the suffix is added to a tone /³/, class A, stem. Preceding zero: ǰyi³lo³? (class A and C) *you water* (*something*), či¹lo³? (class A and C) *you will water* (*something*). Preceding a tone /²/: ǰyi³lo³? le²? *you* (sing., with subject pronoun) *water* (*something*), či¹lo³? le²? *you* (sing., with subject pronoun) *will water* (*something*).

3.2. With the exception of those tone /²/ syllables which are always preceded by an innately tone /¹/ syllable, any tone /²/ syllable may be perturbed to tone /¹/.[6] Whether or not the tone /²/ syllable is perturbed in a particular instance depends upon whether or not it is (a) preceding zero, (b) immediately

[6] With some speakers, a monosyllabic word of tone /²/, when preceding a syllable of tone /²/ or tone /¹/, is perturbed to a glide from tone /²/ to tone /¹/: ẓi²n? *nose*, ẓi²⁻¹n? nga³ *this nose.* With these same speakers, a monosyllabic word of tone /²/ which ends in anything but a vowel, n, or glottal stop is perturbed to a glide from tone /²/ to tone /¹/: wi² *orange*, wi¹ ko¹bï² *new orange;* ẓi²s *stick*, ẓi²⁻¹s ko¹bï² *new stick.*

preceded by a tone /¹/, (c) at the end of the word.

A tone /²/ syllable is perturbed only by that which follows it; that is, it is not perturbed preceding zero. For example, ² + ² > ¹ ²: ẓi²s *stick* + ẓe²n *big* > ẓi¹s ẓe²n *big stick*. Perturbation of tone /²/ is conditioned only by the syllable of the following word, never by the syllable of the same word. Contrast ² + ² + ² > ² ¹ ² with ² + ² ² > ¹ ² ²: ẓi²s *stick* + ẓe²n *big* + ni²ʔ *that* > ẓi²s ẓe¹n ni²ʔ *that big stick*, but ẓi²s *stick* + go²lï² *old* > ẓi¹s go²lï² *old stick*. A tone /²/ syllable is not perturbed if there is a tone /¹/ syllable immediately preceding it, even though that tone /¹/ syllable is part of the preceding word. For example, ¹ + ² + ² > ¹ ² ²: ye¹Ṛ *stone* + ẓe²n *big* + ni²ʔ *that* > ye¹Ṛ ẓe²n ni²ʔ *that big stone*.

A tone /²/ syllable does not condition the perturbation of a sequence of tone /²/ syllables, but only the tone /²/ syllable immediately preceding it. Thus, ² ² + ² > ² ¹ ²: g^{w}a²gï² *firewood* + ni²ʔ *that* > g^{w}a²gï¹ ni²ʔ *that firewood*.

A tone /³/ syllable conditions the same types of perturbations of a preceding tone /²/ syllable as those conditioned by the tone /²/ just described. That is, ² + ³ > ¹ ³: ẓi²s *stick* + nga³ *this* > ẓi¹s nga³ *this stick*; ² ² + ³ > ² ¹ ³: g^{w}a²gï² *firewood* + nga³ *this* > g^{w}a²gï¹ nga³ *this firewood*.

The tone /¹/ syllable conditions a more extensive perturbation of the tone /²/ syllables. A tone /¹/ syllable conditions a sequence of preceding innate tone /²/ syllables to become tone /¹/. ² ² + ¹ > ¹ ¹ ¹: čo²pï² *two* + go¹ *potatoes* > čo¹pï¹ go¹ *two potatoes;* ² + ² ² + 1 > ¹ ¹ ¹ ¹: na²ǰ *and* + čo²pï² *two* + go¹ *potatoes* > na¹ǰ co¹pï¹ go¹ *and two potatoes.*

3.3. The innately tone /¹/ syllable is perturbed only rarely,[7] i.e. only in certain compounds. The second member of a compound is perturbed from tone /¹/ to tone /²/ if the first member of the compound is also tone /¹/. ¹ + ¹ > ¹ ² (in compound) : ẓa¹ *skin* + go¹ *potato* > ẓa¹go² *potato skin*. If the first member of the compound is innately tone /³/, class A, the second member, tone /¹/, is perturbed to tone /²/. ³(A) + ¹ > ³ ² (in compound): de³- (nominalizer, class A) + zi¹ẓ *sweet* > de³zi²ẓ *a sweet*. If the first member of the compound is tone /³/ (class B) it is perturbed to tone /²/, and the second syllable, tone /¹/, is also perturbed to tone /²/. ³(B) + ¹ > ² ² (in compound): ni³s (class B) *water* + yi¹ʔ *fire* > ni²syi²ʔ *kerosene*.

An innately tone /¹/ morpheme which has become tone /²/ in compound is perturbed to tone /¹/ again, according to the same rules that govern the perturbation of an innate tone /²/. ³(B) + ¹ > ² ² (in compound); in turn this ² ² + ³ > ² ¹ ³ : ni³s (class B) *water* + yi¹ʔ *fire* > ni²syi²ʔ *kerosene* + nga³ *this* > ni²syi¹ʔ nga³ *this kerosene*.

3.4. All these perturbations are regressive. A tone /³/ when perturbed to tone /²/ then conditions perturbations the same way an innate tone /²/ would have done. But a tone /²/, once perturbed to /¹/, loses its power to condition a preceding tone /²/ to be perturbed; it will however still condition a preceding tone /³/ of class B to be perturbed. For example, ² + ² + ² ² > ² ¹ ² ²: ẓi²d *cat* + ẓe²n *big* + go²lï² *old* > ẓi²d ẓe¹n go²lï² *big old cat*; ² + ² ² + ² > ¹ ² ¹ ²: ẓi²d *cat* + go²lï² *old* +ẓe²n *big* > ẓi¹d go²lï¹ ẓe²n *old big cat.*

These are the perturbations which eliminate nine of the 24 potential contrastive sets of words of two syllables (see **2.1**), and 32 of the 108 potential contrastive sets of words of three syllables (see **2.2**), and which in the initial investigation tend to obscure the innate tone of the individual morphemes.

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[7] Adjectives of one syllable with an innate tone glide of tone /¹⁻²/ at times are changed to tone /²/. This may prove to be an alternation of the prosodic phonemes, but should be checked for further perturbation rules.

With some speakers, a word of tone /¹/ ending in a vowel or glottal stop, preceding a word of tone /²/ or tone /³/, is perturbed from tone /¹/ and becomes a glide from tone /¹/ to tone /²/: ẓa¹ *clothes*, ẓa¹⁻² nga³ *these clothes*.

4. The problem of non-phonemic vowel length[8] has a vital effect upon tone analysis. There is a tendency for a vowel with a tone /¹/ to have a slightly shorter allophone than does a vowel with tones /²/ or /³/. This is especially true in monosyllables preceding zero, and preceded by a syllable of tone /³/: ge³yï³? ya³ *five weapons*, ge³yï³? ya² *five steambaths*, ge³yï³? ya¹ *five bamboo*. In this position, the length differential between a vowel with tone /¹/ and a vowel with tone /²/ tends to be more prominent than the pitch differential.[9] That is to say, the phonemic contrast between tone /¹/ and tone /²/ of monosyllables is retained when in this position, but tends to be accompanied by a more striking difference between short and long, sharp attack and easy attack. When, however, the same words occur in other positions, the basic tone contrasts reappear.

Elsewhere there is no persistent difference of length. Any apparent difference is non-phonemic and can for practical purposes be ignored. Long and short varieties of vowels tend to interchange freely, or the long ones are limited to positions where a short-long contrast does not exist, but the pitch differential is clearly and persistently present.

Considerable non-phonemic variation of the length of vowels occurs in other positions. These tendencies are not rigidly fixed, but are useful in explaining puzzling differences which at first may appear phonemic even though semantic contrasts cannot be found.

Some of the conditions where length most frequently, but optionally, occurs are: Vowels are frequently long when preceding fortis or lenis nasals and laterals, or when preceding other lenis consonants: ǰo¹ẓkle²n *thank* : bze¹⁻²be² *last*. Vowels toward the front of a long word are frequently shorter than vowels in the last two syllables of a word or phrase: ṛe¹ne²žṛʷa?a²ne²? *I went to give him* : ye³ṛʷbe³? *rainfall*. The stem vowel of a monosyllabic stem at times may be longer than other vowels of the word: ẓya¹ga³? *my tree*. Also, vowels may be lengthened under emphasis, or in slow pronunciation. The vowel /ï/ is probably the shortest of all vowels, and the vowel /a/ seems to be the longest: bo²za² *mulberry*, ẓwa²gï² *jar*.

5. A further problem is that of non-phonemic tone variation. There is a tendency

[8] Morris Swadesh, in an unpublished manuscript, describes vowel length in several of the dialects of Zapoteco as being non-phonemic: "Cuando un fonetista, entrenando para distinguir vocales largas y cortas, como las que caracterizan el alemán o el mexicano, escucha el habla de los zapotecos, observa muchas vocales largas, pero se puede demostrar que la duración vocálica no tiene significación especial en estos idiomas. La vocal tiene a ser corta ante el saltillo (que se escribe ?) y ante las consonantes fuertes (p t ȼ č k s š ṣ), mientras que ante las demás consonantes y, en menor grado, al final de las palabras generalmente es larga. Ante grupos consonánticos, también puede abreviarse la vocal. Por otra parte, la sílaba acentuada alarga su vocal, sobre todo si se trata del tono bajo o ascendiente en una palabra monosilábica. Las sílabas no acentuadas generalmente son muy breves."

[9] Note an analogous situation in English, where voiceless and voiced contrast between consonants is phonemic and length of vowel is not phonemic. But in some syntactic positions, such as phrase final, this voiceless-voiced contrast of English stops may be very weak; nevertheless the phonemic contrast is retained in secondary characteristics, induced by the consonant in the length of preceding vowels. When the voiced and voiceless contrast of the English stops lessens, the differences of the preceding vowel supply the clues for the differences of phonemic contrast. Compare [kæt] *cat* and [kæ·d̥] *cad*. In a phonemic orthography, however, one still writes /kæt/ and /kæd/, and ignores the clues obtained from the vowels. So in Zapotec, in the instances mentioned, one writes ya¹ *bamboo* and ya² *sweatbath*, even though the clue of length for monosyllables is easier to hear in that one particular syntactic position, phrase finally following a tone /³/, than is the minute pitch difference in that position.

In English, a change of position will bring out the more normal contrast of voiceless to voiced. Compare /bæt boy/ and /bæd boy/. So for Zapotec the pitch difference between the tone /²/ and the tone /¹/ becomes very clear phrase finally, if it is preceded by a tone /¹/: de³za¹n ya¹ *much bamboo;* de³za¹n ya² *many sweatbaths;* de³za¹n ya³ *many weapons*.

for the pitch to rise before fortis consonants and before a glottal stop. This tendency is most prominent before glottal stop at the end of a word of the tone-sequence pattern (3 3), as in ba^{3}dï^{3}? *tumpline*, in which the pitch of the second syllable is higher than the pitch of the first. This interval between the normal tone /3/ and the raised tone /3/ is slight. However, the interval between the phonemic tone /1/ and the phonemic tone /2/ is also slight. This tends to confuse the initial investigation.

In fact, in the beginning I wrote three registers, but after further study heard the two low pitches and so began writing with four registers. Still further study proved that the higher of the two low pitches was conditioned and therefore non-phonemic. My next hypothesis was: if the two lower pitches have proved to be phonemically one, then the two upper pitches might also prove to be phonemically one. Therefore, I began writing with only two tone registers. However, no conditioning factors could be discovered for uniting the two upper pitches and the decision as to whether the lower of the two should be written as low tone or as high tone was frequently arbitrary. Therefore I resumed writing with three registers and subsequently, with the contrastive sets which ultimately began to appear, was able to prove them phonemic. Had these sets been more frequent, probably this time of confusion would have been lessened.

6. Another problem is caused by the free alternation between the phonemic pitches of certain morphemes. The investigator may hear the sequence (1 2), only to hear it the next time as (2 2). In these instances the informant is conscious of his change of pronunciation, and may use first one alternant and then the other. A few of these alternate pronunciations are as follows: zo^{3}zi^{3}l ~ zo^{1}zi^{3}l *the east*, si$^{1-2}$l ~ śi^{3}l *the morning*, ga$^{2-1}$n ~ ga$^{1-2}$n *where*, ẓg^{w}i^{2}bo^{2}? ~ ẓg^{w}i^{1}bo^{2}? *his*(fam.) *orange*, ṣa^{2}le^{2} ~ ṣa^{1}le^{2} *your* (pl.) *father*, ži^{3}nla$^{1-2}$zbo^{2}? ~ ži$^{1-2}$nla^{1}zbo^{2}? *his* (fam.) *breakable things*.

7. There is a problem of pitch glides. These quick, short glides are hard to hear but are phonemic and must be analyzed. Glides from tone /1/ to tone /2/ are frequent and may occur either on monosyllables composed of one morpheme, or monosyllables composed of two morphemes: be$^{1-2}$L *fish*, yi$^{1-2}$ẓ *corn fodder*, ẓe$^{1-2}$? *his clothing*. This glide contrasts with a glide from tone /1/ to tone /3/, which occurs only on syllables which are composed of two morphemes. Contrast with the preceding examples such forms as: ẓa$^{1-3}$b *his* (animal's) *clothing*, ǰo?a$^{1-3}$n *his* (devil's) *mouth*. The glide from tone /2/ to tone /3/ also occurs between two morphemes, but not on a single morpheme: ga^{2}kï$^{2-3}$b *he* (animal) *will be able*.

Another glide which occurs on single morphemes is that from tone /2/ to tone /1/: ba$^{2-1}$t *when*, ǰta$^{2-1}$se^{2}? *he sleeps*. This contrasts with the glide from tone /3/ to tone /2/, which occurs only on syllables which are composed of two morphemes: ẓse$^{3-2}$? *his beans*, Le?e$^{3-2}$ *his stomach*.

8. Certain practical suggestions arising from the preceding analysis are now presented. These have been of specific usefulness to colleagues studying Zapotec for the purposes of communication. This application, especially that of frames in **8.3**, may also serve to suggest a general technique for the application of structural tone analyses to the practical necessities of learning and teaching tone languages.

If the person learning Zapotec keeps in mind the distribution of the tone-sequence patterns, and the positions in which one tone causes another tone to be perturbed, he hears and writes those tones more easily. This is due to (1) restricted patterns to listen for, (2) recognition of innate forms, (3) useful frames for classification.

8.1. In checking new words, if one remembers that only /¹/, /²/, /³/, /¹⁻²/, and /²⁻¹/ occur on morphemes of one syllable, he will work that much more rapidly since he will not need to try to differentiate between them and other types.

Similarly, he will remember that there are no innate tone-sequence patterns of ¹ ¹,² ¹, or ³ ¹. He will not need to look for them in phrase final position. The three patterns do occur, however, as perturbed forms in some other circumstances.

8.2. One may recognize the tone of the innate forms by noticing the tone of that form as it appears in phrase final position, i.e. when preceding zero. The innate tone of any morpheme is the tone of that morpheme when it precedes zero.

He may also recognize the innate tone of noun or verb stems by comparing the tone of the stem with the tone of the personal enclitics which are attached to those stems. Because he knows that tone /²/ may not be perturbed by a syllable within the word, he knows that neither a tone /²/ stem (nor a tone /¹/ stem) have been perturbed by these personal enclitics. Therefore, a tone /³/, class A, stem will not be perturbed by the personal enclitic, but a tone /³/, class B, stem may be perturbed. Except for those morphemes of tone /³/, class B, whatever is the tone of the stem when preceding the personal enclitic, that is the innate tone of the stem.

8.3. Certain words are especially useful as frames[10] for classification of other words. They help in recognizing, not only the innate tone, but also the tone to which the form has been perturbed.

Numerals and certain words of measure make good frames in Zapotec, in that they precede the word being tested and therefore do not cause it to be perturbed. Examples of these frames are now shown.

ge³yï³? . . .ˣ (in which . . .ˣ indicates a word with an unknown tone /ˣ/) *five* . . . This frame is tone /³/, class A, and cannot be perturbed. Anything on a level with it is therefore tone /³/ also; anything higher than this frame is tone /²/ or tone /¹/.

za¹n . . .ˣ *much* . . . or *many* . . . This word, although innately tone /²/, is perturbed to tone /¹/ before another word, and therefore serves as a frame of tone /¹/. Any syllable following it, which is on a level with it, is therefore tone /¹/.

to³ . . .³ or to² . . .²/¹ *one* . . . This word, innately tone /³/, class B, is perturbed to tone /²/ when preceding a tone /²/ or tone /¹/. This frame must be used with caution. If the syllable following to³ *one* (or its alternant to²) is on a level with it, that syllable may be either tone /³/ or /²/. If it is /³/, the to³ *one* simply retains its innate tone /³/. If it is /²/, the to³ *one* is perturbed to tone /²/. If, however, the syllable following to³ *one* is higher than to³ *one*, that second syllable must be tone /¹/, not tone /²/, because if it were tone /²/ the to³ *one* would be perturbed to tone /²/ as in the case just given. Therefore, to³ *one* is useful in distinguishing a tone /²/ from a tone /¹/, but not in distinguishing a tone /²/ from a tone /³/. (Occa-

[10] A "frame" is the part in a syntactic or morphological construction which remains unchanged while the remaining part of that construction is removed, and one by one other items are substituted for it. For further discussion of this procedure, see Kenneth L. Pike, Tone Languages (Glendale: Summer Institute of Linguistics, 1945), 36–58. This procedure has proved extremely valuable in the determining of phonemic registers, as well as in the proof of those registers. Note, for example, the tonal description achieved in part by these techniques in K. L. Pike and E. V. Pike, Immediate Constituents of Mazateco Syllables, IJAL 13.78–91 (1947).

K. L. Pike, however, had not dealt with a language in which the tone perturbations drastically limited the symmetrical system, even though hints to it may be found on pages 68–71 of his Tone Languages. The present paper carries his technique further, to apply toward problems which he had not faced on a large scale.

sionally to^{3} *one* will be perturbed all the way to tone /^{1}/. This probably happens when it compounds to the following form, as in to^{1}čo^{1}pï^{1} go^{1} *a few potatoes.*)

čo^{2}pï^{1} . . .$^{2/3}$ *two* . . .; or čo^{1}pï^{1} . . .^{1} *two* . . . This is a dissyllabic frame with the innate tone $^{2\ 2}$ (as found preceding zero), and is therefore very useful in distinguishing a tone /^{2}/ from a tone /^{1}/. When checking, one listens to the pitch of the frame. If the tones of the two frame syllables are identical (i.e., čo^{1}pï^{1}) then the following syllable (that one being tested) is tone /^{1}/. If the second syllable of the frame is higher than the first (i.e., čo^{2}pï^{1}) then the following syllable (that one being tested) is tone /^{2}/ or tone /^{3}/.

Adjectives or demonstratives make good frames to follow the word being tested. In this case, the frame itself will not be perturbed (if it precedes zero), but the frame may cause the perturbation of the word being tested. Nevertheless, if the rules for these perturbations are known, they help rather than hinder the classification of tone. Examples of adjective and demonstrative frames are now shown.

. . .^{x} nga^{3} . . . *this.* Any syllable preceding this frame, and level with it, is tone /^{3}/: . . .^{3} nga^{3}. A word with innate tone-sequence $^{2\ 2}$ when checked with this frame is perturbed to $^{2\ 1}$: . .^{2} . .^{1} nga^{3}. A word with innate tone-sequence $^{1\ 2}$ when checked with this frame is not perturbed. The sequence remains $^{1\ 2\ 3}$: . .^{1} . .^{2} nga^{3}.

. . .^{x} go^{2}lï^{2} . . . *old.* Any syllable preceding this frame, and level with it, is a perturbed tone /^{3}/, class B. (A tone /^{2}/ syllable would have been perturbed up to tone /^{1}/ by this frame. The only exception is that a tone /^{2}/ in the tone-sequence $^{1\ 2}$ would not have been perturbed.) Any syllable lower than this frame is a non-perturbable tone /^{3}/, class A. A syllable higher than this frame may prove to be either an innate tone /^{1}/, or a tone /^{1}/ resultant from a perturbed tone /^{2}/. Possible combinations: . . .^{2} (perturbed tone /^{3}/, class B) go^{2}lï^{2}, . . .^{3} (innate tone /^{3}/, class A) go^{2}lï^{2}, . . .^{1} (perturbed tone /^{2}/) go^{2}lï^{2}, . . .^{1} (innate tone /^{1}/) go^{2}lï^{2}.

. . .^{x} ko^{1}bï^{2} . . . *new.* This frame causes the perturbation of a preceding tone /^{2}/ syllable to tone /^{1}/, and of a tone /^{3}/, class B, to tone /^{2}/. It also causes the perturbation of a preceding $^{2\ 2}$ tone pattern to a $^{1\ 1}$ pattern.