ARBITRARY AND NATURAL FEATURES OF NON-TONE LANGUAGE WHISTLE SPEECH AS EVIDENCE OF DIFFUSION[1]

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Whistle speech based on a non-tone language (in contrast to that based on tone language) is usually produced by articulating the segments of speech, silently or otherwise, while whistling. The whistle of La Gomera, Canary Islands, described by Andre Classe (1957a;b) and the whistled Tepehua of Hidalgo, Mexico, described by George Cowan (1952; 1973) are examples of this type. Occasionally, a non-tone language whistle is reported which imitates the intonational contours of the language, as tone language whistles normally do: for example, Kickapoo courtship whistling (Ritzenthaler and Peterson, 1954; Hurley, 1968) or the American wolf whistle. But these are not true whistle languages, conveying any message that can be spoken. In fact it seems obvious that an intonational whistle based on a non-tone language could never develop beyond a small set of stereotyped signals.

The whistle of the shepherds of Aas, French Pyrenees, reported by Busnel, Moles, and Vallancien (1962) represents still another type. It is not intonational, but does consist of a small number of stereotyped signals, similar to the articulations of Spanish while whistling, but learned as wholes and not analyzable into whistled representations of segments. This is in fact believed to be a vestige of a former whistle speech of the articulation of segments type. A surprising proportion of the non-tone language whistle speeches reported to date belong to peoples who speak Spanish as a first or second language. Of the eleven cases I have encountered in the literature, nine are in Spanish language areas.[2] While this might be an accident of the distribution of research, it raises a question of the possibility of historical diffusion either simply of the idea of articulating while whistling, or actually of specific whistled forms, throughout the former Spanish empire.

One way in which diffusion can be identified, or at least suspected, is by the discovery of specific, arbitrary forms in two separate locations. A form would be considered arbitrary, as opposed to natural, if it is extremely rare in distribution, or if its genesis is understood and the factors that might be expected

to promote it are not present. The idea of articulating while whistling is quite rare throughout the world (given present data) but we do not know what factors promote it. If the presence of tone languages and associated intonational whistles tend naturally to promote articulation while whistling in nearby non-tone languages, then Africa and Mexico might be plausibly argued to be two separate sources of diffusion, either one of which could have loaned the custom to Spain. Thus, without more knowledge of the circumstances in which it is natural, we cannot judge the likelihood of diffusion of the idea of non-tone language whistle speech. However, it might be possible to decide whether specific whistled representations of segments show evidence of having diffused, by studying the acquisition of whistle speech to learn which representations are most natural, and then studying their distribution in the world. A highly natural whistled representation of, say, a consonant, in different localities, would provide no evidence for diffusion, since it might be expected to arise independently. But a highly arbitrary form in different localities would be difficult to explain except by diffusion.

This paper will compare two cases of whistled Spanish: the whistle of La Gomera; and the whistle of San Juan Zacualpan, Tlaxcala, Mexico, recently discovered by Gene Wilken, a professor of Economics and geographer at Colorado State University (Wilken, n.d.). Since information is not available on the acquisition of whistle speech by speakers of the two Spanish dialects, I will instead judge the naturalness of the whistled forms which are shared by both, by studying novice attempts to whistle English segments, made by several American children and teen-agers. The Tlaxcalan data is contained in a thirty-minute cassette recording of conversation and whistling lent to me by Prof. Wilken, from which I made spectograms of 71 whistles. The La Gomeran data is drawn from Classe's articulatory and acoustic descriptions.

1.COMPARISON OF THE WHISTLED VOWELS. The clearest distinctions heard in whistle speech are between the whistled vowels, which are represented by differences in pitch. In both Tlaxcalan and La Gomeran the relative pitch levels are as follows: i highest; e next; then a; and lowest o. On La Gomera, u is whistled above a. The data from Tlaxcala are inconclusive, since u, the least common vowel in Spanish, occurs only three times, but it seems to be about the same height as a. The intervals between the pitch levels in Tlaxcalan whistling are not the same, so that each vowel contrast is recognizable no matter what pitch it is

whistled on. However, the whistler does not always make these contrasts exactly; the low vowels, especially, may all be whistled on about the same pitch, or even, rarely, reversed. This is true of the low vowels in the La Gomeran whistle also.

It is particularly difficult to identify the relative height of u in the Tlaxcalan whistle because two of its three occurrences are as the initial segment of a whistled utterance. Initial vowels are usually somewhat lower than normal, relative to the pitches of the other vowels in the utterance, in both Tlaxcalan and La Gomeran whistles. Vowels toward the end of an utterance also tend to be relatively low in both whistles. In addition to these shared intonational features, two more intonation patterns are characteristic only of the La Gomeran whistle: a slow rise in the last vowel of a whistled question; and a slight rise in pitch on the stressed vowel of a sentence. To the extent that a whistle expresses intonation, of course, it loses vowel contrasts. Therefore these two principles upon which a whistle can be based are in conflict.

The naturalness of the shared ordering of vowel pitches became clear when four American junior high school students were asked to articulate English while teeth-whistling (as is done on La Gomera and in Tlaxcala.) From their first tries, the students produced whistled vowels with approximately the same relative pitch levels as in the Spanish whistles: highest i; then e; then usually u, a, and lowest o, but with a tendency for the three low vowels to be confused. One student showed a strong tendency to whistle in imitation of my intonation as I pronounced the English words to her, which of course destroyed the vowel contrasts. Although one other student seemed to do this a few times also, the other three whistled over 80% of the phrases with the expected relative vowel pitches.

This suggests that articulation while whistling naturally produces just this ordering of the vowel pitches, unless a tendency to whistle intonation interferes. Therefore, we might expect to find the same system for vowels, with more or less interference from intonation, in all non-tone language whistle speeches. It follows that the similarity between La Gomeran and Tlaxcalan whistled vowels is not evidence of diffusion of these forms.

1.1 PHONETIC BASIS FOR THE NATURALNESS OF THE WHISTLED VOWELS. Of course we can be more sure that a similarity is natural and does not indicate diffusion if we understand the reason for it. We can guess at the phonetic explanation for the similarity of these three whistled vowel systems by studying Classe's and Wilken's descriptions, and the actual articulatory behavior of the young Americans. Both La Gomeran and Tlaxcalan whistlers normally use the technique of whistling through the teeth, often with fingers inserted into the mouth, rather than whistling with the lips, and so I asked the Americans to whistle this way also. Teeth whistling produces a louder whistle than lip whistling, according to the testimony of La Gomerans, Tlaxcalans, and young Americans. This is also shown on the spectograms, where teeth whistling, unlike lip whistling, shows numerous harmonics. It is doubtless preferred for communication purposes for that reason.

There are an immense variety of ways to whistle through the teeth, but they apparently have in common that the tongue is well forward and either bunched together and somewhat grooved, or else turned sharply up or down. In any case, its function seems to be to act as an obstruction, forcing the air stream past a narrow opening bounded by the teeth, or occasionally the lips held stretched and rigid. Fingers inserted into the mouth further narrow the opening, and possibly amplify the sound. While there is no way to be sure what is going on acoustically without extensive experiment, the facts seem to accord well with the assumption that the whistle is an edgetone produced against the edge of the teeth, attached to a resonating cavity which imposes one of its harmonic frequencies on the whistle pitch, as is characteristic of edgetone systems. Possibly the teeth and fingers provide harder reverberating surfaces than pursed lips, absorbing less energy from the whistle.

Classe reports that the whistled vowels were articulated more or less as in speech, with tongue movements but not with lip rounding. The American students were asked to articulate as much like speech as possible while maintaining the teeth whistle. Presumably the tongue movements, as they alter the size of the oral cavity, alter its resonance frequency which is imposed on the whistle. The relative heights of the whistled vowels seem to correspond to tongue position in the same way as the height of the second formant in spoken speech would if the lips were unrounded.

It is curious, however, that the actual mean pitches for Tlaxcalan whistled vowels are consistently several hundred cps higher than the second formant values of the whistler's spoken unrounded vowels: a is consistently about 300 cps higher in the whistle than in speech, and e about 500 cps higher. Two explanations, not mutually exclusive, may be suggested. First, the whistle may have a fairly high fundamental which tends to pull its pitch above that of the resonating cavity, although one wonders if this would account for a difference of 500 cps or more. Second, the resonating cavity in teeth whistling may actually be only the very front of the oral cavity, between the tongue and the teeth. The vocal folds, after all, generate sound from deep in the throat when they cause resonance throughout the oral, nasal, and subglottal tracts. The whistle oscillation, by contrast, occurs at the edge of the teeth, almost outside the mouth, and may cause resonance only in the immediately adjacent cavity. This hypothesis would explain the much higher pitch of the whistle than the speech formant, while the correspondence between changes in tongue height and changes in relative pitch would be roughly the same as when the entire oral tract resonated.

Under either hypothesis, the similar ordering of the pitches of the vowels seems to be a natural result of articulating as in speech, while holding the lips rigid as in teeth whistling. A type of whistle that allows the lips to round and unround, as apparently the Tepehua whistle does to some extent (Cowan, 1973), might produce a natural ordering of the vowel pitches corresponding more closely to the order of the second formant pitches in speech.

It is well to point out that the whistles can be transposed higher or lower, although normally the pitches of each vowel cluster about a mean. This suggests that the whistlers have some idea of how a sequence should sound, and are actually aiming at auditory goals, much of the time, not deafly articulating. Nevertheless, the whistle forms seem to be based on the natural results of whistling while articulating speech.

2. COMPARISON OF THE WHISTLED CONSONANTS. Consonants are expressed in whistle speech by slight bends in the whistle, similar to the bends of speech formants before and after spoken consonants, and occasionally by brief gaps in the whistle. Like consonants in speech, therefore, they are less easy to distinguish than the vowels. It is in their whistled representation of consonants that La Gomeran and Tlaxcalan whistle speeches chiefly differ.

Phonetic Segments	Whistle Pitch Rises	Whistle Pitch Falls	Break in Whistle	Gentle Attack	Shorter Rise, Less Steep
t	+	-	+	-	-
s	+	-	+	-	+
d	+	-	+	+	
ɗ	+	-	-		
n	+	-	-		
ŋ	+	-	-		
ř	+	-	-		
r̂	+	-	-		
l	+	-	-		
y	+	-	-		
p	-	-	+	-	
k	-	?	+	-	
b	-	-	+	+	
g	-	?	+	+	
x	-	+	+		
f	-	+	+		
ƀ	-	+	-		
ɡ	-	?	-		
m	-	+	-		
w	-	+	-		

Sets of phonetic segments that are indistinguishable in the whistle: (1) ɗ, n, ŋ, ř, r̂, l, y (2) ƀ, probably ɡ, m, w (3) p,k (4) b,g (5) x,f (6) t (7) s (8) d

CHART I. La Gomeran Whistle Features which Distinguish Consonants

Both whistle speeches break the whistle to indicate stops and some other consonants, but differ in the additional consonants, as Charts I and II show. Tlaxcalans break the whistle for all consonants except liquids; even among those, l is actually broken about half the time, and the audible trill of the trilled r̂ eventually interrupts the whistle also. La Gomerans break only for stops and for three fricatives: x, f, and s.

In both whistle speeches, the whistle line usually rises going into coronal consonants and falls afterward; in other words, coronals raise the pitch of the whistle. There are specific exceptions, however. In La Gomeran, the segment written as ŋ,

Phonetic Segments	Whistle Pitch Rises	Audible Trill	Break in Whistle	Long Break (inter-vocal-ically)	Short Break (inter-vocal-ically)
t	+		+	+	
y	+		+	-	+
s	+		+	-	+
d	+		+	-	+
ḍ	+		+	-	±
č	+		+	-	-
n	+		+	-	-
l	+		±		
p	-	-	+	+	
k	-	-	+	+	
b	-	-	+	-	+
ƀ	-	-	+	-	+
g	-	-	+	-	+
ɡ	-	-	+	-	+
m	-	-	+	-	-
f	-	-	+	-	±
ř	-	-	-		
r̆	-	+			

Sets of phonetic segments that are indistinguishable in the whistle: (1) y, s, d, ḍ or (2) č, n, d, ḍ (3) b, ƀ, g, ɡ, f or (4) m,f (5) p,k (6) t (7) l (8) ř (9) r̆

CHART II. Tlaxcalan Whistle Features which Distinguish Consonants

presumably a velar, also causes the whistle pitch to rise, although velar stops and fricatives do not. In Tlaxcalan, the whistle pitch falls rather than rising for the flap and trill r's, although they are both coronal. There is even more variation among labials and velars. Both of these types of consonant lower the pitch consistently in Tlaxcalan. Classe's data from La Gomeran are not clear; he reports that La Gomeran p and k are whistled with no change of pitch; but his sketches of spectograms show k, p, and x lowering the pitch, and only p causing no change. Thus it is not certain whether, and how much the two whistles differ representations of velars and labials.

Other differences are shown on the two charts. La Gomerans distinguish some consonants that break the whistle by the gentleness or gradualness of the onset of the break, caused by not

making a glottal stop, a distinction which I cannot hear in the Tlaxcalan material. The rise before the break is also shorter and less steep for ə than for t in La Gomeran. In Tlaxcalan, consistent differences in the length of the break distinguish consonants. In certain environments, additional distinctions are made in Tlaxcalan: utterance-initial p and b can be recognized by their especially long and gradual falls from the silence of the initial stop, in contrast to utterance-initial m, which is always fairly abrupt, and utterance-initial y which is a high steep fall; utterance-initial k and g, however, vary a good deal, overlapping with the labial stops and with m. In utterance-final position, a very slight upglide can be n or ř; a steep upglide can be s, ř or l. It will be noted that the sets of consonants which are indistinguishable in the whistle also vary between the two whistle speeches, even though the language is Spanish in both cases. Yet both whistle speeches can be understood well.

In short, the consonants of the Spanish whistles are quite different, but they have two general tendencies in common: (1) the tendency for coronals to raise the pitch, and for labials and velars to lower it; (2) the tendency for stops and at least some other consonants to cause a break in the whistle.

The American teen-agers and an additional child, attempting to whistle English, duplicated these two tendencies, and did not seem to distinguish consonants in any other consistent way. Their whistles broke for stops but not for other consonants, rose during coronals and fell during labials and velars fairly consistently, except for final consonants which often seemed to be dropped from the whistle. From the comparative evidence alone, therefore, we might conclude that the consonant features which the two Spanish whistles share are highly natural ones that might be expected in any non-tone language whistle speech, and which therefore do not provide any evidence of diffusion.

2.1 PHONETIC EXPLANATIONS FOR THE NATURALNESS OF SHARED CONSONANT FEATURES. We can state that these features are natural with more confidence if we can explain how they are based on universal (or at least pan-Spanish-English) features of the articulation of stops, coronals, labials, and velars. The question of the naturalness of features that differ between the two whistles is not important for this argument, since differences between them simply fail to give positive evidence for diffusion.

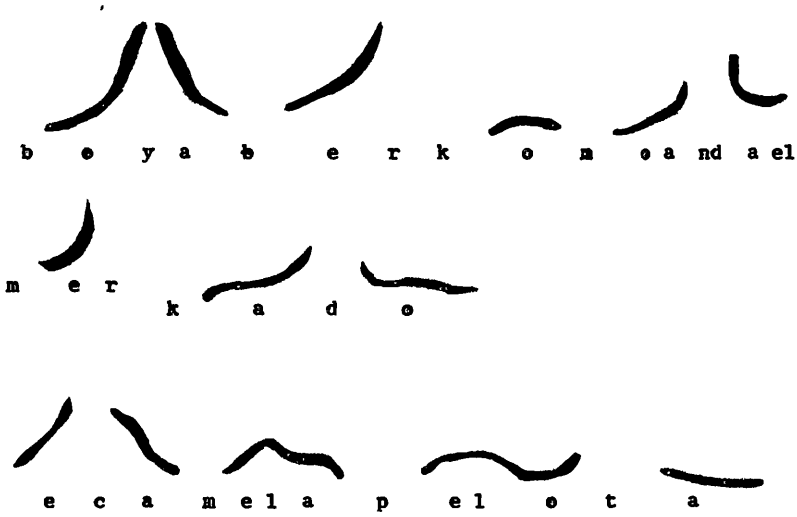

FIGURE I. Sketch of Two Spectograms, Showing Whistle Fundamental for Two Utterances: 'Voy a ver como anda el mercado' and 'Heche me la pelota'.

The break in the whistle during stops can be accounted for obviously: when the air stream is cut off, the whistle ceases. The rise in pitch during coronals would occur for the same reason as the rise in pitch during high vowels, because the tongue rises. It is strange, however, that coronals do not lower the whistle pitch relative to the high front vowel, as spoken alveolars do the second formant. Possibly coronal articulations are all made farther forward in teeth whistling than in speech, decreasing the cavity size, while front vowels are made much the same way in whistling and speech. It is even stranger, however, that the whistle pitch lowers during velars, when the second formant is at its highest for consonant articulations, and that it lowers during labials, which cannot even be articulated while teeth whistling. The explanation for the fall in pitch during labials may be that some velar articulation occurs along with labial closure in the speech of La Gomerans, Tlaxcalans, and Americans.

Unable to close their lips while teeth whistling, they nevertheless make some velar articulation, which lowers the pitch. Two explanations can be suggested for the lowering of pitch during velars. The jaw probably must rise, or the tongue be pulled back, or possibly both, to make a velar articulation when the tongue is held bunched and fairly rigid toward the front of the mouth for whistling. Raising the jaw would of course narrow the front opening, lowering the pitch. Pulling back the tongue would enlarge the front cavity and thus also lower the pitch, assuming the earlier hypothesis that only the cavity in front of the tongue resonates in whistling. Thus the phonetic explanations for the naturalness of these patterns of pitch rise and fall are speculative. But it nevertheless seems likely that the patterns are natural, since five naive American whistlers, four of them interviewed separately, showed this pattern on first trying to whistle.

3.CONCLUSIONS. The whistled forms which are shared by La Gomeran and Tlaxcalan whistle speeches are the following: (1) the basic vowel-consonant distinction, a smooth whistle vs. a quick rise or fall of pitch; (2) the relative levels of the vowel pitches; (3) the break in the whistle for stops, extended to some other consonants; (4) the tendency for coronals to raise the pitch, and for labials and velars to lower it, with a few exceptions among segments. These are precisely the distinctions between segments that were produced by the American children in their first attempts at whistling English, except that they did not break the whistle for non-stops. Furthermore, phonetic explanations can be given for these similarities, based on the acoustics of whistling, and the similarities between the vowels, coronals, labials, and velars in English and Spanish, although the explanations are not proven. Thus it seems likely that they are highly natural features of whistled Spanish. Since the similarities between La Gomeran and Tlaxcalan whistle speeches seem to be highly natural, there is no evidence suggesting diffusion of whistle speech forms between the two cultures.

NOTES

[1] I am indebted to John Jensen, Alan Bell, and Frances Ingemann for helpful comments and criticism.

[2] Spanish language areas: La Gomera; French Pyrenees (Busnel, Moles, Gilbert, 1962); Tepehua, Mexico (Cowan, 1952; 1973); Totonac, Mexico (Hasler, 1960); 'Nahuas', Tlaxcala, Mexico (Hasler, 1960); 'Nahuas', northern Hidalgo region, Mexico (Hasler, 1960); 'Nahuas', north of Tepehua and Totonac (Hasler, 1960); Spanish speakers in northern Hidalgo, Mexico (Hasler, 1960); Spanish speakers, Tlaxcala, Mexico (Wilken, nd.)

Non-Spanish areas: Kuskköy, Turkey (Moles, 1970; Leroy, 1970; Lenneberg, 1970; Busnel, 1970); Chepang, Nepal (Caughley, n.d., ref. in Umiker, 1974)

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