

## The Study of tone and related phenomena in an Amazonian tone language: Gavião of Rondônia

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This paper describes the methods used to study the tone and some related phenomena of the language of the Gavião of Rondônia, Brazil, which is part of the Mondé branch of the Tupi family. Whistling of words by indigenous informants was discovered to be a very effective method for obtaining phonetic accuracy in tone and length. Methods were devised to map out the system of tone and length. They were subsequently used in the study of other Amazonian languages, including Karitiana, Munduruku, Zoró, and Surui of Rondônia, with success. Some notes on tone considerations in orthography are offered, as well as notes on procedures that proved useful in the diachronic study of tone in the Mondé languages. Methods for the study of natural whistled speech used for distance communication are also described, with special attention to the whistled speech of the Gavião, including its use, its efficiency, and the whistling techniques used. The relation between some aspects of Gavião instrumental music and the suprasegmental aspects of the language are also discussed and the methods used to study this are described. Audio and video clips illustrate the phenomena being discussed.

**1. INTRODUCTION**<sup>1</sup>. This paper explains methods used in studying tonal phenomena in the language of the Gavião tribe of the state of Rondônia in western Brazil. Five inter-related subjects are discussed:

- achieving phonetic accuracy in the field
- orthographic representation and its consequences

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- reconstructing tone/length in a protolanguage
- the use of tone/length in natural whistled speech
- instrumental music and its relation to language tone/length

The first three subjects have been developed by the first author since the middle of the 1970s. The last two have been developed in field studies by the second author since 2009. Some observations about linguistic work and the history of tone study in the region are included to give a concrete picture of what occurs in practice. Some results are presented, though these are too extensive to include in detail. Aside from the study of Gavião the application of the methodology for tone investigation to several other Tupian languages is discussed briefly.

**2. LANGUAGES.** A forthcoming study using phylogenetic methods (Galucio et. al. submitted) basically confirms and extends the internal classification of the Tupi language family that has been generally accepted (Rodrigues 1984/5). Of the ten branches of the family, five are spoken primarily in Rondônia: Arikém, Tupari, Puruborá, Ramarama, and Mondé. Others are scattered to the north, east, and south: Munduruku, Juruna, Mawé, Aweti, and Tupi-Guarani. The last three of these obviously form a subfamily, which contains no known tonal language. The two languages of the Muduruku branch are tonal (Picanço 2005). Of the two languages of the Juruna branch, Xipaya (ISO: xiy) has been reported (Rodrigues 1995) as without contrastive tone, while Juruna (ISO: jur) is claimed to be tonal by Fargetti (2007). Of the branches in Rondônia, Karitiana (ISO:ktn) the remaining language of the Arikém branch, is said to have non-contrastive pitch accent (Storto 1999, Storto & Demolin 2005). The one remaining language of the Ramarama branch, Karo (ISO:arr), is analyzed as having pitch accent (Gabas 1999). The Tupari branch and the Puruborá branch have not been reported as tonal.

We will be mainly concerned with the languages and dialects of the Mondé family, all of which have contrastive tone and length. Of the Aruá (ISO: arx), who have been in contact since the 1930s, only five speak their language. There are two semi-speakers of Salamãý (also called Mondé, ISO: mnd), who have also been in contact since the 1930s. The other dialects and languages, Gavião (ISO:gvo), Zoró (no ISO), Cinta Larga (ISO: cin), and Suruí (Paiter, ISO: mdz) are vigorous. The language of the Suruí is not mutually intelligible with the others. The speech of four tribes of Group B, Aruá, Gavião, Zoró, and Cinta Larga, is mutually intelligible, but that of the Salamãý is significantly different from these, though closer to Group B than to Suruí. The internal classification of the branch (Moore 2005) is given below (Figure 1).

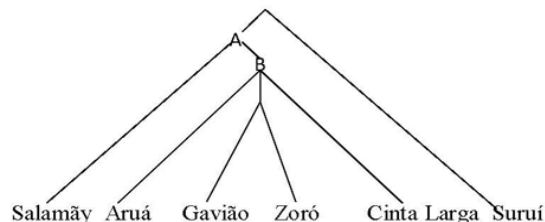


FIGURE 1. Internal classification of the Mondé branch of the Tupi family

A different internal classification has recently been offered by Anonby (2012) but it suffers from severe problems<sup>2</sup> in the data used.

At the time of the first author's original research, 1975-8, the Amazonian languages were relatively unknown. The five branches of the Tupi family in the state of Rondônia in western Brazil had little study. The region was a frontier zone and the Zoró and Cinta Larga tribes were largely still out of contact with national society. The Surui (Paíteer) had come into contact only in 1969 and were in a state of hostility with the Zoró. Of the numerous Tupi languages it was thought at that time that only Munduruku was tonal.

### 3. DETERMINING PHONETIC ACCURACY—INITIAL DIAGNOSIS AND WHISTLING.

One of the first stops in the first author's field research was a visit to the SIL missionaries who were working with the language of the Surui. One of them remarked that, oddly, a two-syllable word could be stressed on both syllables. Asked if that was not high tone instead, the missionary replied that, no, some people had had that idea, but an investigation by SIL consultants had concluded that it was not.

As field research began among the Gavião one of them remarked one evening that it was hard to read in their language: there were many words that were the same but somewhat different. Fears that the language was tonal were confirmed after three days of elicitation. Four different two-syllable words were found which had the same consonants and vowels. And the linguist, who is devoid of musical talent, could not hear what the differences between the words were. If the contrast were in stress, then one would expect only two contrasts: one word stressed on the first syllable and one stressed on the second syllable. But there were four words, which would be consistent with tone contrasts. After one or two weeks of futile struggle to hear the tone, the linguist was enlightened by his consultant, who dandled his cap and, with a meaningful glance, whistled six syllables. When asked what that was he answered, "My new cap." Then he whistled it again, clear and pure.<sup>3</sup> (The pitch is indicated by a line above the words.)

/ —	—	/ —	
(1) qó-dáàt	sérék	kôro	‘My new cap.’
1s-head	cloth	new	

<sup>2</sup>For example, many of the Gavião forms in the article are obviously in the idiosyncratic orthography of the New Tribes mission. The *h* they use to indicate length (see below) is imagined by Anonby to be a real voiceless fricative and he postulates that its absence in Zoró and Cinta Larga transcriptions is an indicator that this fricative was lost in those languages. Since the missionary transcription of Surui also uses *h* to mark length this is interpreted as showing a close relation between Surui and Gavião. Oddly enough, ‘shotgun’ is considered by Anonby to be a cognate between Surui and Gavião, though it could not have been an item of Proto-Mondé culture.

<sup>3</sup>The symbols *c* and *j* denote palatal affricates, *y* the palatal glide, and *s* and *z* dental affricates. The voiced bilabial fricative is indicated by *v* and the glottal stop by an apostrophe. The tone/length symbols are rather complicated and are illustrated in section 4. Nasalization is indicated by the ogonek beneath the vowel.

Within an hour the basic outline of the tone system seemed to be short and long syllables with height contrasts of high, low, and rising, though there was some question about possible mid tone, as in the word for ‘cloth’ above. Later it was seen that there were rising-falling long tones and also long falling tones. The four contrasting words were clearly combinations of the short tones:

(2) magap	magáp	mâgap	mâgáp
fat	egg	1s+fat	1s+egg

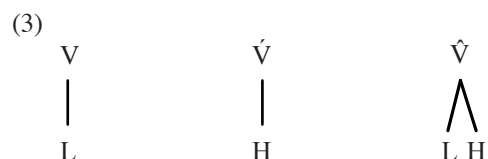
One simple test for checking whether speakers were perceiving tone or perceiving stress involved a minimal pair, ‘fat’ and ‘egg’, given above. When the two syllables were pronounced with low tones but with stress on the second syllable, consultants judged the word to be ‘fat’, giving importance to the tone and not the stress.

The local New Tribes missionary, who had been among the Gavião for nine years, was initially doubtful that the language was tonal, but then had to agree that it was and adopted whistling to investigate the suprasegmentals. He was the first to observe that high tones were downstepped to mids after certain long tones, but made the error of thinking that this occurred after all long tones and that tones which did not trigger downstep must, perforce, be short (in spite of many counter examples).

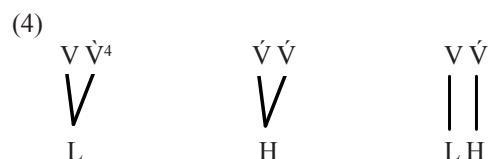
Elsewhere the SIL missionary with the Cinta Larga had already discovered that their language was tonal. However he had difficulty in his phonological analysis and left Brazil after being removed from the Cinta Larga by Brazilian authorities. As the news of tonality spread, the missionaries with the Surui revised their views and decided that the language was tonal, with a simple inventory of long and short syllables and two height contrasts. More recent studies (Meer 1985, Guerra 2004) basically agree.

**4. SUMMARY OF BASIC ANALYSIS OF GAVIÃO TONE/LENGTH.** The initial research on the Gavião language was carried out with a very low budget in a remote area of Brazil in the middle of the 1970s, before portable computers. The principal method used for obtaining phonetic accuracy--whistling--was a necessity at that time and place. It succeeded, and, having obtained phonetic accuracy it was possible to accumulate the facts of the Gavião system of tone/length, though a better understanding of the system had to wait for later autosegmental analysis. An analysis of Gavião tone and length and its motivation are presented in Moore 1999 and is too long to be repeated here. But the basic points can be summarized briefly. The summary will also serve to explain the transcription used here, which admittedly is adapted to the Brazilian keyboard and needs revision, in collaboration with the Gavião.

The short tones (tones attached to one short vowel) are low, high, and short rising, with the latter (rather marginal) arising from LH sequences.



These have long counterparts which are constant, without fluctuations conditioned by what followed.



But there are also two problematic long syllables. One of these falls when nothing follows and is high non-finally, causing any following high tones to downstep to mid. The other is a long syllable with a rising-falling tone when nothing follows and a rising tone non-finally, causing any following high tones to downstep to mid. One problem was to account for the final vs. non-final changes. Another was to account for the asymmetry: why in non-final position the tone of the second type of syllable is rising instead of low. The solution offered is that these two syllable types have a floating low tone after them.



If nothing follows, the floating low attaches to the preceding V, resulting in a low end point. If something does follow, the floating low tone attaches to it and does not cause a fall. If what follows the floating low is a high tone, then, by a general rule, the sequence H L becomes a mid tone, accounting for the downstep. The floating low tone also explains why the asymmetrical rising tone occurs: by a general rule a low tone long syllable rises before a following low tone, in a dissimilation consistent with the Obligatory Contour Principle. Examples, spoken and whistled:

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<sup>4</sup> The grave accent over the second V distinguishes long low-tone vowels from sequences of two short low-tone vowels. Long low-tone vowels can be distributed in two syllables, for example, *volò* 'come'. The grave accent is also used on the second vowel of the alternating tones which produce downstep. The generalization is that it marks syllables whose end point shows alternations conditioned by what follows.

kâỳ ‘burning’ Long Falling

‘burning’, whistled

kâỳ ‘old’ Long Rising-Falling

‘old’, whistled

kâỳ mága ‘there is burning’ Long High, Mid, Low

‘there is burning’, whistled

kâỳ mága ‘there is old’ Long Rising, Mid, Low

‘there is old’, whistled

There are no simple constraints on tone sequences. For example, in a three-syllable word all combinations can occur: LLL, HHH, HLH, etc. However there are significant canonical patterns related to the morphology. Methodologically, as study of the language progressed, knowledge of the canonical forms helped identify tone and length, since only a restricted selection appears in certain environments. For example, verb stems have level tone, with a long syllable or a reduplicated syllable finally.

(6) tígi ‘knock down’      kátaà ‘cut’      sáá ‘sew’      sonò ‘rot’

Adjective stems almost always end in long syllables which trigger downstep.

(7) sòtòt ‘rotten’      kâỳ ‘burning’      patii ‘heavy’

Bisyllabic unpossessed nature words have a lengthened penultimate syllable if the last syllable is long.

(8) iitii ‘deer’      kaasáal ‘macaw’      vaakôy ‘vulture’

There are four pronominal clitic classes in Gavião, and the tone of these is correlated with the tone of the first syllable of the stem. A general word-structure constraint is that short tones cannot follow long tones unless the short tones are on affixes.

Observed tone changes were noted in a slip file and the accumulated examples were examined periodically. Systematic testing of tone interactions verified hypotheses about tone rules. It is important to achieve accuracy since even a few errors are sufficient to mask a pattern.

**5. WHISTLE METHODS FOR DETAILED STUDY.** Two methods were used to determine the tone of each new word encountered. One was to place a standard word with known tones before or after the target word. One useful standard word in Gavião was the demonstrative *má* ‘other’, which was high and short and could appear before nouns, adjectives, transitive verbs, and auxiliaries. Another useful standard word was the particle *terè* ‘true’, whose tones were always low when nothing followed and which could occur after nouns, adjectives, and verbs. Since tone is relative this method is useful for determining the number of height levels. In isolation it is difficult to distinguish HL from ML or HM. To see if there are more than two levels it is necessary to produce a number of combinations of three syllables and see how many tones are necessary to account for the patterns seen, controlling for any possible processes of raising or lowering, which can be detected by observing the same word/morpheme with higher or lower tone in different environments.

The second method was to devise a set of standard words to include all known tones, and, in the case of bisyllabic words, all combinations of these tones. Longer standard words can be constructed by combining shorter ones. The consultant was asked to whistle the target word and then the standard word that was suspected of being the same. This method requires a more versatile consultant. It was usually easy to hear if the two whistles were identical or not and often consultants would say that they were or were not, after becoming accustomed to the task.

When transcribing texts each word was individually transcribed in isolation using whistling and then the whole sentence was whistled by the consultant as the linguist looked at the transcription to see if it matched the tone line being whistled. The linguist then whistled the whole sentence himself to see if the consultant agreed. Of course, transcriptions were checked from time to time to see if the consultant was consistent from one week to the next. Transcriptions were also checked with other consultants for independent verification. Years later, the whistle-based pitch transcription of recorded words was compared to the pitch in instrumental analysis of the same recorded words. There was strong agreement.

The general applicability of whistling as a means of hearing tone accurately depends on the details of how it is carried out. Points that may be helpful are given below.

1. Explanation can make the work more intelligible for the speakers and increase the prestige of their language. For the Gavião, it was explained that Portuguese had contrasts of stress, for example, *sábia*, *sabia*, and *sabiá*, which were different in intensity, whereas Gavião had something similar but with tone contrasts. It was explained that Chinese, Japanese, and many African languages were tonal, and that tone was natural and widespread, though the European languages usually were not tonal. For that reason the local *Jálâây* (non-indigenous people) had difficulty in hearing Gavião tone, though it was easy for the Gavião. One had to study linguistics and listen carefully to what the Gavião were telling him to do intelligent work with their tone language.
2. The tone is clearer if the whistling airflow is out and not in, and slow enough to be perceived and imitated readily.
3. If possible, it is better to eventually have consultants whistle tone without articulating consonants. The Gavião consultants were asked to “just whistle

the tone, not the letters.” Since whistled pitch is determined by tongue height, articulating consonants will alter the tone. In the case of the Cinta Larga the missionary linguist concluded that tone was always rising before palatal consonants, but this was an artifact which disappeared when only the tone was whistled. For some consultants it is unnatural to stop articulating consonants when individual words are being whistled, since the consonants give more clues as to what the words are in whistled speech and individual words lack clues from context.

4. As collaborators, native Amazonian women do not whistle and older men have difficulty in understanding the point of whistling individual words.
5. The whistling generally should not be done in front of others, since most people don't understand the purpose of whistling to determine tone and find it strange. If the consultant is accustomed to using whistled speech it is highly unnatural for him to whistle to a group in face-to-face contact.
6. A recording of someone speaking words in a tone language and then whistling them is useful as a model for what is needed. Before playing the recording, explain, “This is a really good recording. The speaker did it so well that even a white linguist could hear the tone and began to understand it.” Then whistle along with the recording a bit and say, “I can't hear the tone well when he speaks, but it is clear to me when he whistles. Let me try a few words in your language. This word X, is it like this (whistle a guess) or like this (whistle other guess)? Hmm, you do it and maybe I can get it. Wow! That's great. Now I can hear it. Let's try this other word that has been making me curious.”

**6. WHISTLING METHODOLOGY APPLIED TO OTHER LANGUAGES.** The analysis of the Gavião tone system was sufficient for the first author's doctoral dissertation, which focused on syntax. The later autosegmental analysis produced neat rules which accounted for the observed tone changes. Priority in recent years has been documenting and describing the tone and length in the other dialects and languages of the Mondé branch of languages. Whistled speech and the relation between Gavião tone and music is being investigated by the second author in collaboration with the first.

The whistling methodology was later used with other languages and was taught to student trainees of the Museu Goeldi. Further experience, with other Amazonian languages, has been positive, though the applicability in other world regions and other tone typologies is another question.

The language of the Karitiana, which belongs to the Arikém branch of the Tupi family, turned out to have predictable tone with two levels and long and short syllables. Collaborators could easily whistle tone even though it was not contrastive. The Karitiana say that they whistle to each other when hunting.

The tonal system of the Munduruku was investigated by Gessiane Picanço while still an undergraduate, using whistling. Within three days she had come to the conclusion that there were only two contrastive levels, with laryngealized vowels always having low tone. The accepted analysis at that time (Braun & Crofts 1965), which had prevailed for thirty



years, was that Munduruku contained four “accents,” one of which was laryngealization. A generation of Brazilian students had transcribed this imaginary system without noticing that it did not correspond to reality. Later the two-tone analysis was shown to be consistent with instrumental pitch analysis and the phonology was described (Picanço 2005).

Whistling in the Makurap (ISO: mpu) language of the Tupari branch of the Tupi family was initially difficult to obtain. The younger men said that they did not know how to whistle their language. But in conversation about the Gavião whistled speech in the forest one Makurap who was somewhat older stated that his people did that too, and whistled several animal names to illustrate. When this was applauded he produced more words and eventually a long lexical list spoken twice and whistled twice. That data is waiting to be analyzed.

Elderly Tupari (ISO: tpr) can still use whistled speech though this does not seem to be in common use any more. Snatches of this have been recorded but not yet analyzed.

The Zoró, a tribe who are neighbors of the Gavião and whose speech is highly similar to that of the Gavião, whistled a lexical list with little difficulty and observed that in certain environments the tone changed. Like the Gavião, the Zoró communicate frequently by whistling. Their stereotype of Gavião speech is that it is full of long, looping tones.

For reasons that are still not entirely understood, whistling yielded more problematical results among the Surui of Rondônia (Paíteer), where whistled speech by young people is more limited and infrequent. Individuals whistled the same words differently, and the same person changed from one day to the next. With practice and training some younger speakers became consistent.

**7. TONE AND ORTHOGRAPHIC QUESTIONS.** Given the challenges of analyzing a tone system and the time investment required, it is not surprising that many educators and many linguists discourage speakers of tone languages from indicating the tone in the orthography. The missionary with the Gavião at least tried to write the tone and length, in spite of his limited formal training. Unfortunately, his precipitous analysis created problems for the indigenous community when it was incorporated into the writing system. In this system the long syllables which do not provoke downstep are marked as short and those that do trigger downstep are marked with an *h*. As a result words that are clearly different are written as the same. For example, the following three words are all written as *aka*.<sup>5</sup>

(9)	aka	‘kill’	a-aka	‘kill himself’	aa-kaà	‘goes’
	kill		3c-kill		3c-go	

When the Gavião writing practices were surveyed the results were interesting. They showed that many of the speakers were hearing the long syllables which were to be written as short and were trying to indicate them in some impromptu manner.

- a. About one third wrote the long vowels as short, as taught, all *aka*.

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<sup>5</sup> The symbol 3c- denotes a cross-referencing or coreferential third person prefix.

- b. About one third wrote the long vowels with the *h*, though these do not provoke downstep: *aka, ahka, ahkah*.
- c. About one third wrote the long vowels with two vowels: *aka, aaka, aakaa*.

One obviously brilliant young Gavião teacher perceived the above problems but sought advice from the missionary, who would be reluctant to recognize any difficulties. It will now be a difficult task to make the orthography more adequate, given the mission's influence and the degree of confusion already installed.

The Zoró requested linguistic assistance from the JOCUM (JOvens Com Uma Missão-Youth With a Mission) mission, but the tone transcription was faulty. Then, following the orientation of a short-term linguistic consultant from Rio de Janeiro, they eliminated tone and length from the writing system, making it defective for documentation, since the pronunciation cannot be recovered from the writing.

The writing of the Surui language was sampled in 2011 (Nevins & Moore 2011). Methodologically, this is a useful procedure for initiating orthographic revision. Writing samples, using the same list of words, were taken from various members of the indigenous community and then compared, with the result then shown to the group. When there are inconsistencies in the writing the community is motivated to understand and correct the situation. The samples showed that after thirty years and four linguists the transcription of words was completely mixed, with great variety, which is troubling to the community, who would like to write down their traditional culture before it erodes. The Surui are also under pressure from short-term linguistic consultants to not indicate tone and length.

**8. DIACHRONIC TONE IN THE MONDÉ LANGUAGES.** In early attempts at reconstructing the tone and length of Proto-Mondé it appeared that reconstruction would be hopeless, given the multitude of correspondences. However, after correcting errors in published data through careful fieldwork, including Zoró data in the correspondences, and investigating some of the synchronic tonal alternation rules of Zoró and Surui, the correspondences became more apparent. As an example, the data below deal with correspondences to the Gavião long tone which rises and falls in final position and rises non-finally, causing downstep in immediately following high tones. This tone is analyzed (Moore 2009) in Gavião as an underlying long low tone followed by a floating low tone. In the following cognates the corresponding tone in Zoró is long low and in Surui it is long high.

(10)

English	Gavião	Zoró	Surui
armadillo	maazôòy	vəzooy	valóóy-aa
wild turkey	vaakôòy	vakooy	vakóóy-a:
rotten	sôòt	sot	i-ſôót

But in the next set of cognates the same Gavião long tone corresponds to long high tones in Zoró and to long low tones in Surui.

(11)

English	Gavião	Zoró	Surui
Capuchin (grey) monkey	alimé kòòt	alimé kóót	masáy koor
(finger/toe) nail	pí-kòòy	pí-kóóy	mí-koyoy
nose	ámíi	ámíi	ámii-aa

The two different correspondences are explained by assimilation of the tone in question in Zoró to the height of the tone of the preceding syllable and the dissimilation of the same tone in Surui to the height of the preceding syllable. The Zoró height assimilation is known to be a productive synchronic rule of Zoró phonology. It is not yet clear if the Surui dissimilation is synchronically active or a product of past alternations. One value of the diachronic investigation is that it raises hypotheses to be tested, as in the case of the possible Surui dissimilation rule. The implication of cases such as the above is that lists of cognates are not sufficient for tone/length reconstruction—a knowledge of synchronic rules or constraints is necessary to undo phonological alternations which complicate the correspondences. The conclusion of Moore (2012) is that the underlying forms in the tone/length system of the Mondé languages have not changed that much since Proto-Mondé, in spite of the profusion of phonetic correspondences. More data, especially from the Cinta Larga and Aruá dialects, is needed to carry out reconstruction.

## 9. NATURAL WHISTLED SPEECH IN GAVIÃO AND OTHER LANGUAGES

**9.1 TYPOLOGICAL PARAMETERS AND THE VALUE FOR LINGUISTICS.** As described in the preceding sections, the Gavião easily whistle the lexical tone carried by vowel nuclei. This ability is related to their natural whistled form of speech based on spoken pitch emulation.

Whistled forms of languages have developed all over the world and this kind of practice has been so far identified in more than 68 languages (Meyer accepted). Worldwide, whistled speech is used to emulate certain phonetic features (either segmental or supra-segmental) of the spoken language to make possible dialogues at a distance. Comparative studies have shown that whistlers make the choice to prioritize emulation of spoken speech in specific portions of the frequency spectrum of the voice as a function of the phonological structure of their language. Therefore, the frequency reduction at play in whistled languages divides them into typological categories.

A major distinction in strategy is noted for tonal vs. non-tonal languages (Stern 1957, Busnel & Classe 1976, Sebeok & Umiker-Sebeok 1976, Rialland 2005, Meyer 2005, Meyer 2008). For non-tonal languages (e.g. Greek, Karajá, Turkish, Spanish, Wayápi), in what is called formant-based whistling, whistlers approximate the vocal tract articulation used in spoken form; this provokes a whistled adaptation of vowel and consonant qualities carried by the timbre of the spoken voice. For tonal languages like Gavião (or Chinantec, Hmong, Akha, Mixtec, Mazatec, Moba, Suruí, Ewe), in what is called pitch-based whistling, the situation is different as whistles are not focused on emulating the timbre but rather the pitch of the voice, transposing the fundamental frequency of the vibration of the vocal chords to encode primarily the lexical tones. Therefore, in the whistled form of a tonal language, the vowel quality (encoded by timbre) is completely excluded (Rialland 2005, Meyer 2005,

Meyer 2008). This exclusion of timbre in whistled forms of tonal languages occurs even where the functional load of information carried by tones is lower than that carried by vowel quality (Bagemihl 1988).

When consonants are articulated during whistling, some basic segmental information is transmitted by the amplitude envelope of whistled forms. In whistling, vowels are energetic and continuous, whereas consonants fall into two classes: continuous or near continuous signal vs. clearly interrupted signal (in intervocalic position). In Hmong, for example, nasals and voiced laterals were found to be continuous (Rialland 2005, Meyer 2005), whereas all the other consonants were whistled as interrupted.

Gavião whistled speech was seen to be of scientific interest since it is used in several important daily activities of the community, such as hunting. It provides more details on surface tone than only whistling the vowel nuclei (which is more convenient for linguists to determine tone). For example, whistled speech is of particular interest for further studies on rhythmic aspects of the language. It is an endangered cultural practice with little inter-generational transmission in various regions of the world.

**9.2 METHODOLOGY.** The specific methodology of documentation developed for whistled speech in Gavião was multidisciplinary and adapted to its conditions of use, utilizing techniques and tools of language documentation, phonetics, phonology, psycholinguistics, bioacoustics and sociolinguistics.

The first step was to identify and survey the most skilled whistlers. Several important questions specific to whistled speech were asked during the study: where and when do the Gavião whistle? What is the intelligibility of the most common sentences they use in comparison to less common sentences? Can they whistle and understand everything? What are the different techniques and modes of whistling and in which contexts are each used? Do the Gavião whistle segments or not? A typology of whistlers' profiles and an evaluation of the state of vitality of the practice were then derived from this information (of the type presented in Meyer 2010).

As a representative sample of their skills, the most common sentences used by each whistler were recorded at a short distance (step 2 in the list below). Gavião whistlers still practice two different principal techniques of whistling: one is the classical bilabial whistling and the other various labio-manual whistling techniques. Both techniques were recorded. Next, the researchers recorded spontaneous whistled speech, accompanying the speakers during their everyday activities requiring whistled communications (dual video and audio recordings: from the point of view of each participant in the dialogue). On this basis, a set of Gavião simple sentences was built with the help of the linguistic consultants to perform an intelligibility test in semi-spontaneous and semi-natural conditions (again with dual distance recording). Common sentences were mixed with less common sentences, but all of them were coherent with the natural contexts of use (mostly hunting). We used two measures to score intelligibility data, one focusing only on nouns (the most common scoring measure in intelligibility rating), and the other on all words of the sentences.

Finally, lists of words were collected to increase the phonetic data, principally to analyze consonant whistling. The speakers were asked to pronounce words twice in spoken form and twice in whistled forms. For the measure of consonant closure multisyllabic words were chosen from a 400-word list, previously transcribed for other purposes, and

spoken and whistled forms were collected with several whistlers. We selected enough words to analyze from 10 to 40 instances of each consonant, depending of their frequency of occurrence in the word lists. In all, approximately 450 consonants occurrences were measured manually for their complete or partial closure.

Steps of the methodology developed during the study of Gavião whistled speech are summarized below.

1. Preliminary enquiry (who, where, when, how?) Identification of the remaining knowledgeable traditional whistlers. First recordings.
2. Elicitation, recording and annotation of the principal sentences of common use. These examples are treated like traditional linguistic texts, each whistled text being repeated in standard spoken speech and then transcribed with the help of the informants. Several techniques of whistling might be documented, depending of the whistlers' skills.
3. Recording of spontaneous whistled dialogues in natural contexts of use (video and audio recording). Transcription with informants.
4. Semi-spontaneous recordings at two distances (producer/receiver): intelligibility tests with prepared sentences (video and audio recordings). The interpretation of the reduced whistled signal of Gavião requires strategies by the whistler, such as the use of common sentences to facilitate understanding.
5. Complementary recordings of whistled/spoken word lists for detailed phonetic analysis
6. Detailed phonetic/phonologic analysis (pitch, duration, rhythm, segmental frame, intelligibility results)
7. Production of material for the community, DVDs, CDs (annotated videos useful for the school professors, for example to explain the importance of tone and vocalic quantity in the language)

**9.3 RESULTS.** *Social use:* basically, whistled speech in Gavião is extensively used by hunters: it is a major advantage for approaching prey as it allows human dialogues to go undetected by animals, many of which use similar acoustic signals. Whistled Gavião is also frequent in the villages for many other types of distant communication: for calling somebody, asking someone to bring something, or inviting people to an event (such as going to bathe, fishing or playing soccer). As whistling is highly detectable in natural ambient noise and resists well scattering due to sound propagation, it is also very efficient to signal an emergency or a danger.

*Pitch emulation:* Like the other tonal languages, Gavião developed a pitch-based whistled mode (Figure 2 and Figure 3). As expected, we found no influence of vowel quality on the whistled emulation of the tone in Gavião. It appears that pitch and timbre function as two independent perceptual levels in the spoken voice and the whistlers have to choose only one of these two perceptual attributes at a time. Indeed, in the articulation of

whistles separate control of F0 and resonance is not possible. As a phonological interpretation, in tonal languages spoken tones constitute an independent phonological entity which can be directly expressed by whistled pitch because tones and whistles share a common, quintessentially prosodic nature favoring a direct association.

*Consonant closure:* In Gavião, liquids, nasals and glides were found to be continuous or near-continuous whistles, while obstruents, either voiced or voiceless, were interrupted whistles (Figure 2 and 3). Moreover, voiced consonants are whistled with a shorter closure than voiceless (see and compare /b/ of Figure 2 with /t/ of Figure 3). Such tonal whistles encode therefore the gross frame of amplitude of the spoken signal, in addition to the pitch patterns. There were differences between the purely bilabial whistling mode and the hand whistling modes, mostly concerning palatals and dentals for which we observed clear pitch modulations in bilabial whistling but not in hand whistling (see /t/ in Figure 3).

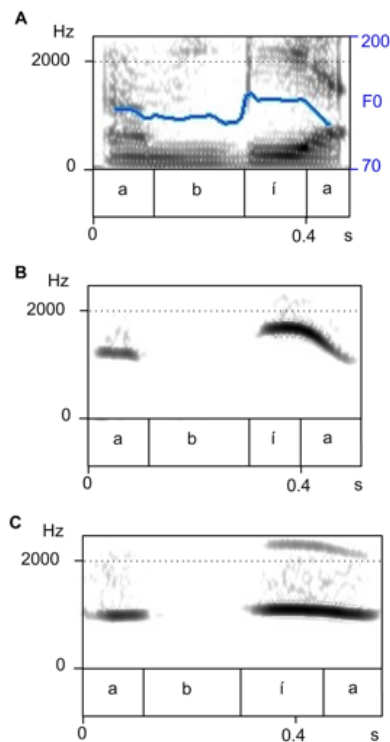


FIGURE 2: Spectrograms of the Gavião word *abía* in three modalities:

- A spoken, pitch was extracted in blue line
- B labial whistling
- C hand whistling

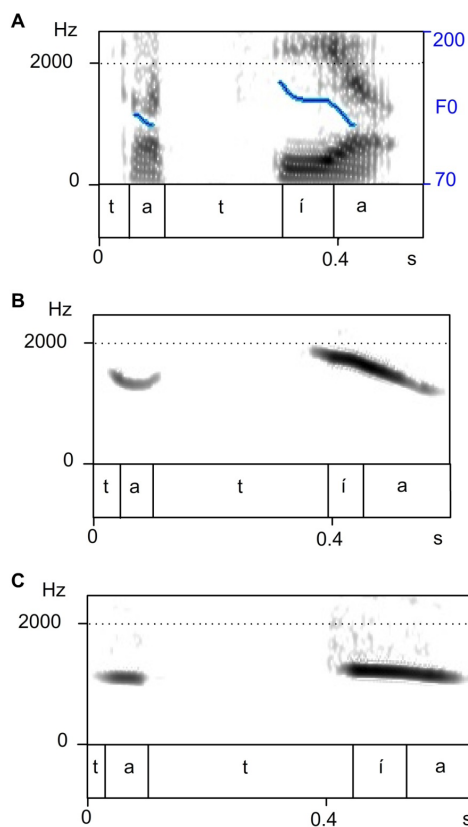


FIGURE 3: Spectrograms of the Gavião word *tatía* in three modalities:

- A** spoken, pitch was extracted in blue
- B** labial whistling
- C** hand whistling

*Intelligibility:* the efficiency of whistling depends partly on the whistling technique and partly on the proficiency of the whistler, which varies considerably when transmission of the practice is being lost. Whistled speech recognition based only on the pitch line requires cognitive recovering that is more demanding and difficult when there are fewer tone contrasts in the language. In the deep forest, where hand whistling (Figure 4, Video S1) is more common as it provides stronger levels than bilabial whistling, the Gavião whistlers use a rather limited number of common sentences that are clarified by the context of use (mostly description of the game during hunting, of its movements and activities, but also for danger (Video S1)). On these sentences all the skilled whistlers we tested reached scores above 90% of correct identification. We verified that normal speech is completely unintelligible at 50 meters because of scattering in the deep forest whereas whistled Gavião

remains fully recognized and very little degraded because such signals resist better reverberation and concentrate all the information in a sole narrow band of frequency situated in a frequency domain with the better auditory performance of human beings (Meyer 2008).



FIGURE 4. One of the hand whistling techniques used for natural whistled Gavião speech.

VIDEO S1. Whistled Speech



## 10. TONE AND LENGTH IN RELATION TO GAVIÃO INSTRUMENTAL MUSIC

**10.1 GAVIÃO PRACTICES IN COMPARATIVE TYPOLOGICAL PERSPECTIVE.** The Gavião make music by singing and also by playing instruments. Some types of instrumental music have no corresponding song. But some other types do and are said to be “speaking” through the instruments, in a sung form of the language. These songs that are associated with the instrumental music are learned by musicians, to help them remember the melody, but are not otherwise sung, though knowledgeable hearers understand them just by listening to the instrumental melody. One of the intriguing aspects of these associated songs is the relation of the sung melody to the suprasegmentals of the lyrics as usually spoken and to the melody played by the instruments. A casual observer would not suspect the existence of the associated songs, but this kind of practice is an ancient verbal art form that exists in several areas of the world, though it has been seldom studied in the Americas, in spite of being common in the Amazon region (Meyer & Moore 2013). A look at the other world regions puts the Gavião case in perspective.

The sung mode of musical instruments has been principally studied in West Africa and is recognized as one of the important characteristics of the musical patrimony of the cultures in this region (Carrington 1949, Sebeok & Umiker-Sebeok 1976, Nketia 1976, Locke & Agbeli 1981, Zemp 2004). This linguistic/musical phenomenon has been also noted as relatively common in Southeast Asia, involving various types of instruments (Stern 1957, Catlin 1982, Poss 2005, Meyer 2007), as well as in Papua New Guinea (Niles 2010). The notion of ‘sung mode of musical instruments’ has been defined for the first time by Nketia (1976) to distinguish, in the Akan culture of Africa, the drum beats used for telecommunication (emulating normal speech used during public discourses) from drum beats linked to songs (emulating sung speech). Such a distinction between speaking and singing mode of drums exists also in the Bora culture of West Amazon (Thiesen 1969). Among the Gavião of Rondônia, a parallel distinction also exists between natural whistled speech, that emulates normal speech for long distance dialogues as we have just described in the preceding section, and the instrumental speech forms we describe in this section, that express songs dedicated to some specific musical instruments.

The Gavião use three different traditional musical instruments that they identify as “speaking” ones and that are characterized by a very tight music-lyric relation through similar pitch patterns: a flute (called *kotiráp*), a pair of mouth bows (*iridináp* (Figure 5)), and three large bamboo clarinets (*totoráp*, played by three different players, each one playing a single-note clarinet (Video S2)). Linguistic analysis illuminates the music-language relation.

Documentation and study of these culturally important practices is rather complex. It is also urgent given the endangered status of the practices, which involve various skills. The capacity to play instruments that imitate the sounds of associated songs requires complex traditional knowledge involving mastering various different techniques that range from manufacturing the instruments to learning a large repertoire of ancient songs (often involving archaic speech forms, which produce an august, poetic feeling). The technique for playing musical notes to match the lyrics also sometimes implies a precise coordination between different players as some instruments are played by various musicians, or, in

special festive events, the simultaneous performance of dances. All these aspects are very visual and are appropriate data for video documentation. Culturally, the texts that are played with the singing instruments regularly refer to the traditional cosmogony and to the Amazonian natural environment in their daily lives. For example, the lyrics of a common *kotiráp* flute song tells a short version of the origin of the end of the friendship between boa constrictors and the Gavião people. For this reason these practices suffer from the invasive and destructive pressure of religions imported recently, that depreciate and sometimes forbid them. When the practices are stigmatized they enter the underground of traditional beliefs that often exists in missionized villages and are more difficult to detect and study.

#### VIDEO S2. Totorap Clarinets

**10.2 METHODOLOGY FOR STUDYING GAVIÃO INSTRUMENTAL SPEECH.** The specific methodology that was adopted registered all the aspects of instrumental speech. Each step was observed and recorded in video and/or audio.

The first step was to identify the instruments involved by making an enquiry with various traditional indigenous collaborators in various villages. After the identification of the instruments and of the good players, the second step consisted in documenting the players' preparation for playing: gathering the materials in the forest, manufacturing the instruments, and tuning the notes that they produce.

In the third step, documentation was carried out of each musical piece and its associated song in various ways, each focusing on a different aspect. First, the instrumental music was played, recorded, and described in its natural context, or, at least in a simulation of the natural context. Second, the associated song, without the instrumental music, was sung, recorded, and transcribed. The content of the lyrics was described ethnographically.

Fourth, the lyrics of the songs were recorded in their standard spoken form (not sung). They were then transcribed as texts using the methods of scientific descriptive linguistics, implying a reasonably complete description of the language and the help of an indigenous

consultant to pronounce and translate the words, to respond to analytic questions, and to help identify some aspects of the language used for singing, which is different from normal use. One problem in this step is the difficulty in suppressing the impulse of the informants to sing the lyrics instead of speaking them. Another interesting difficulty is identifying and understanding the archaic or rare forms in the lyrics that are quite common in old songs. Lastly, the three melodies were compared, that of the music played by instruments, that of the associated song, and that formed by the tone and length of the associated song lyrics as they are normally spoken.

The methodological steps are summarized below.

1. Preliminary enquiry (who, where, when, how?). Identification of the instruments which have associated songs. Identification of the remaining good traditional players of these instruments. Collection of detailed information about contexts of use, repertoire of songs, acoustic characteristics of each instrument.
2. Documentation of the manufacture of the instruments (selection of material, tuning of the notes).
3. Various recording sessions for each song are necessary, focusing successively on the three different production types: the instrumental form, the sung form and the spoken form.
4. Transcription and translation of the sung and spoken forms (beginning on the field and continuing with indigenous consultants in the laboratory).
5. Preliminary edition of video documentation.
6. Correction of the videos with indigenous school teachers and other indigenous consultants.
7. Multidisciplinary detailed analysis (acoustics, phonology, musicology) to determine the dominant acoustic patterns of the three forms (instrumental, sung, spoken), as well as the similarities and differences between these three forms.
8. Final edition of material for the community and for the national archives (CDs, DVDs), with clear explanation of every step of the manufacture and the playing of the instruments, to help preserve the practices.

**10.3 RESULTS.** During the first step of our enquiry we identified the three different types of instruments that have associated songs. We also verified that there is a large diversity of styles in the musical repertoire of the Gavião: for example, there are also songs that are not played on musical instruments, with a freer relation to linguistic pitch pattern. There is also music that is only played and not sung and that has therefore little to do with tone.

The recording and transcription sessions of music, associated songs and spoken lyrics confirmed the indigenous claim that the *kotiráp* flute, the *totoráp* clarinets and the *iridináp*

mouth bows are expressing the language, and more precisely, the singing mode of speech. The key to this relation is the tone and length in Gavião phonology. All the steps described in the methodology helped identify what the relation is between the music, the song and the normal pronunciation of the lyrics. Such a relation was extensively described for the three Gavião instruments in a recent paper (Meyer & Moore 2013).

Basically, the finding was that the melody of the associated songs was essentially the same as that of the music played by the instrument, to the point that it reflected the limits of the instrument. For example, tones in the songs were level, without the curves of normal Gavião speech. The tone of the sung lyrics of the associated song also was very similar to their tone in normal speech. This can be seen in Figure 5, in which the pitch of sung lyrics, diagrammed in the second line, matches closely the pitch of the mouth bow music diagrammed in the third line. The pitch of the second line is also obviously related to that of the pitch of the lyrics as normally spoken, diagrammed in the first line, though it is adapted to the limitations of the instrument. Note, for example, that the initial long rising syllable in the first line is sung and played as two short lows. Interestingly, even the Gavião tone downstep is reflected in the song and the music (see Meyer & Moore 2013: 320), though that is not relevant in the example of Figure 5.

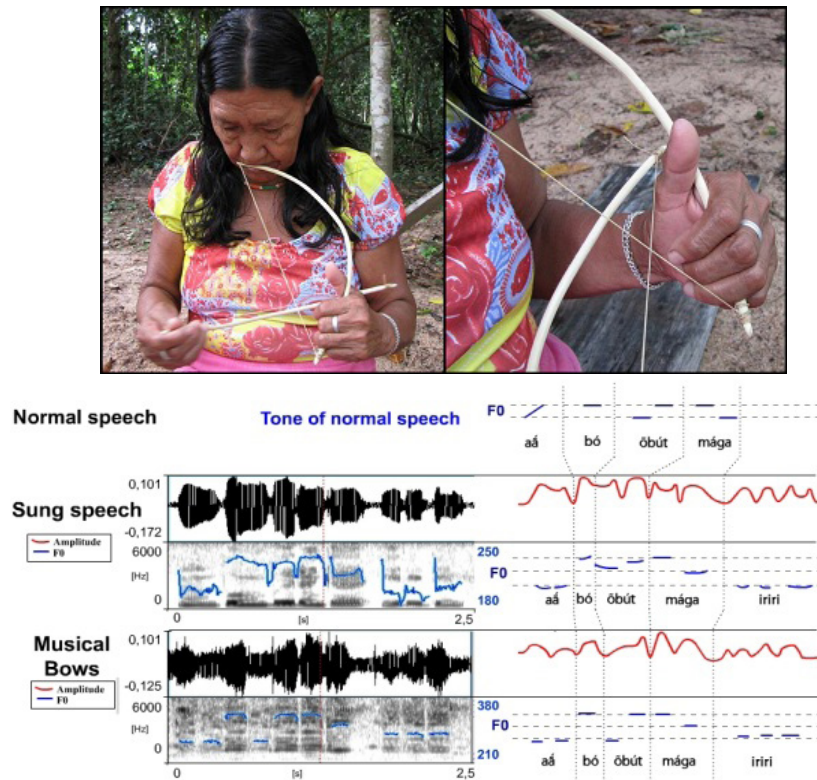


FIGURE 5. Example of a love song played on the Gavião mouth bows (meaning ‘This [hunter] is mine’, *iriri* is just a musical rhythm). Spectrograms and simplified charts are given, with the amplitude and F0 similarity between speech and music highlighted).

The lyrics of the associated songs contained archaic forms, which is highly intriguing. For example, there were lexical items in the lyrics that do not exist in the modern Gavião language, such as the verb *bósara* translated as ‘going to bed (retiring to a hammock)’. More unexpected were ancient morphological forms, such as the form *ô-bút* (*o-bít* in the transcription of this paper) ‘1s-thing+DIM’ that retains the prefix *o-* (Figure 5). In the evolution of the languages of the Mondé family, this prefix has disappeared in Gavião and Zoró, but persists in Suruí and is optional in Aruá). Since contemporary music composed by the Gavião does not contain these archaic forms they may indicate that the composition of the associated songs occurred centuries ago. However the Gavião can pronounce these old lexical items in normal speech and they conform to modern Gavião phonological patterns.

Speech type in Gavião	Linguistic characteristics of the pitch for encoding tones
Standard/normal speech	Flat and curved pitch, long/short vocalic quantity
Whistled speech	Flat and curved pitch, long/short vocalic quantity
Songs associated with instruments, described in this paper	Flat pitch (only), long/short vocalic quantity, and some limited aesthetic alterations that do not affect the tonal system (simple changes in voice register and repetitions)
Musical melodies of the instruments described in this paper	Flat pitch (only), long/short vocalic quantity, and some limited aesthetic alterations that do not affect the tonal system (simple changes in voice register and repetitions)

TABLE 1. Adaptation of the lexical tone to different speech styles of Gavião

**11. CONCLUSION/SUMMARY.** In this paper many observations about the methodology for dealing with tone and related phenomena have been offered in the hopes that they will be useful for other linguists, especially young linguists engaged in field research. A primary difficulty in tone language analysis and description is achieving phonetic accuracy. Whistling tone and length (a method invented by a Gavião consultant, not the linguist) has shown itself in a variety of cases to be efficient and accurate, though it requires a good relation with the language consultant and a knack for explaining the task. In our experience the only problem with inconsistency was with some speakers of the language of the Suruí of Rondônia, who generally do not whistle in the villages.

Where whistled speech is used in the villages, as in the case of the Gavião and Zoró, it was relatively easy to obtain the whistling of words for phonetic transcription, the main problem then being eliminating the articulation of consonants. The relation between whistling words for phonetic study and whistled speech is not simple. There are cases, such as that of the Mundurucu and the Karo (both of which have tone contrasts), in which very useful whistling of words was obtained in the absence of whistled speech in contemporary villages. An anonymous reviewer kindly observed that (s)he was able to get whistled

words in Amazonian groups who do not use whistled speech. In our experience it was also possible to obtain useful whistled words in languages which are not known to have tone contrasts, such as Karitiana and Makurap. Interestingly, in these two cases only two levels were whistled, high and low. While these two groups do not now use whistling in the villages, they do use it in the forest.

Given the complexity of analyzing systems of tone and length, such as that of the Gavião, one would expect that orthographic representations of such systems are often not as adequate as they could be. This is borne out by the cases described in section 7. It is interesting to see native speaker attempts to express the tone and length contrasts that they can feel but that are not represented in the writing system. The tendency of educators and short-term linguistic consultants to discourage orthographic representation of tone and length in Brazil is sometimes accepted by indigenous peoples whose experience with writing is mainly with Portuguese, which, of course, does not mark tone. Since orthography, like religion and politics, is seldom subject to rational discussion, the methodological suggestion here is that when native communities request consultants about orthographic questions the discussion is usually better taken up directly with the indigenous people, not with linguists. Methodologically, a survey of actual writing practice and results is a useful beginning step as it focuses on concrete results, with less attention to emotional attachments to certain symbols (Nevins & Moore 2011).

The presence of whistled speech and instrumental speech (including sung forms) is often overlooked. It is not easy to determine if a group has whistled speech or not. There may be generational differences in the knowledge and use of whistling for communication. The contexts in which it is used may be reduced. At least in Amazonia the first place to look for it is among hunters in the forest, though true whistled speech must then be distinguished from the use of a small set of fixed signals. Whistled speech based on tone must be distinguished from that based on vowel timbre. Whistled conversations, while flexible and unpredictable, are limited to the immediate context. They are not used for abstract discussions or recounting events of the past, for example. Whistling is very effective for distance communication. Manual-labial whistling techniques produce a more reduced signal than labial techniques. Specific procedures for investigating whistled speech were given above.

Instrumental speech among the Gavião is found in the songs associated with certain instruments. These seem to be archaic. Tone and length are fundamental as the dimensions linking the melody played by the instruments, the melody of the associated songs, and the suprasegmentals of the lyrics as normally pronounced. The relation of the tone and length of the lyrics in normal speech to the melody of contemporary songs composed by the Gavião is under study. The field procedures for the study of instrumental speech are given in section 10 above. It is worth noting that the study of whistled and instrumental speech among the Gavião noticeably increased their pride in these traditional practices. Whistled speech in particular leaves observers amazed and impressed.

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