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Prosody as a means to express Tense in the Kaingang language

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Abstract

This study describes a prosodic process used in the Brazilian Indigenous language Kaingang (Je family, Macro-Je stock), to distinguish tense in a specific verb class ended by consonantal segments. Pitch distinguishes past and future tenses in that verb class, in both declarative and in interrogative sentences. A psycholinguistic experiment and acoustic analyses showed that Kaingang, considered an accentual language in the existing literature, displays a grammatical tone functioning as a morphological feature, in addition to a set of particles and morphemes. A rising contour of fundamental frequency or a high tone on the domain of the word verb indicates future tense whereas a falling contour or a low tone indicates past tense.

Index Terms: Tense, Kaingang language, Tone languages, Speech perception.

1. Introduction

The Kaingang language is one of the more than 150 indigenous languages, spoken by the 239 indigenous peoples. of Brazil. Kaingang is spoken by a population of about 30,000 divided among 32 indigenous lands, spread in the three southern states of Brazil as well as in the São Paulo state. This language presents a dialectal variation that could be classified between four to five variants. Following [1], within the Jê languages family, Kaingang forms a well-distinguished branch, with similarities with Xokleng. Together, they form the southern branch of the family.

We can distinguish four regional languages in Kaingang [2]. This research is centered on the language spoken among the Nonoai community, located in the north of "*Rio Grande do Sul*" state, and amounting to about 2.500 speakers. Typologically, Kaingang is an isolating language, and its pattern word order is SOV – Subject, Object, Verb. The subject is morphologically marked by different particles (subject "tỹ" for declaratives or "mỹ" for interrogatives, gender "fi" for female, etc.). Kaingang is described in the literature as an accentual language, but presents a case of prosodic or melodic inflections to mark time in verbs which end by consonants, like:

(1) "han" [do]
(2) "krãn" [plant]
(3) "nũr" [sleep]
(4) "kusũg" [paint]
(5) "kym" [cut]
(6) "kãtĩg" [come]
(7) "jẽn" [feed]
(8) "jẽnkrig" [clean]

This process is accomplished by means of a fundamental frequency (F0) inflection that does not follow Kaingang's standard description of lexical stress, nor utterance-level intonation. Contrasting to these two levels, this F0 inflection is implemented at the level of verb morphology, as proposed in our analysis, which is elaborated in [3].

A perception test was designed at the Experimental Psycholinguistics lab of the Federal University of Rio de Janeiro (LAPEX/UFRJ), and was taken by members of the Kaingang Nonoai village. The experiment tested if a melodic inflection could distinguish tense, opposing past and future in non-morphologically inflected verbs, ending in consonants and which do not receive suffixes.

To support the perceptual results, an acoustic analysis is proposed, making explicit and confirming the hypothesis that melodic height is the distinctive feature opposing past and future tenses for such type of verbs.

2. Corpus and Methods

2.1. Corpus

The data is based on two sets. All were read aloud by an L1 Kaingang female speaker in a sound proof room for creating the recording material. The first set is used for the perceptual experiment and the first acoustic analysis; it consists of 64 utterances, divided in 32 interrogative utterances and 32 declarative utterances.

In order to verify if the melodic inflection was due to the domain of the verb word or to the domain of the sentence, a second set was recorded, adding an adverb at the end of the sentences. This set contains 32 utterances: 16 assertive utterances presenting at the end of the sentence the rẽkétá adverb (meaning 'yesterday') and 16 sentences presenting the adverb vajkỹ (meaning 'tomorrow'), also at the end of the sentence. The interrogative utterances were also distributed in the same way, using the same time adverbs in the end of the sentences. The second set was used for the second acoustic analysis.

Example with verb "jẽnkrig" [clean]:

(1) Fẽrá fi tỹ ĩn jẽnkrig rẽkétá.
Fẽrá Fem. DECL. house clean yesterday
'Fẽrá cleaned the house yesterday'

(2) Fẽrá fi tỹ ĩn jẽnkrig vajkỹ.
Fẽrá Fem. DECL. House clean tomorrow
'Fẽrá will clean the house tomorrow'

(3) Fẽrá fi mỹ ĩn jẽnkrig rẽkétá?
Fẽrá Fem. INT house clean yesterday?
'Fẽrá cleaned the house yesterday' ?

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(4) Fẽrá fi mỹ ĩn jẽnkrig vajkỹ?
Fẽrá Fem. INT house clean tomorrow?
'Fẽrá will clean the house tomorrow?'

The inclusion of the adverbs at the end of the assertive and interrogative sentences allowed us to prevent the verb to occupy the sentence final position without changing the sentence structure. This procedure made it possible to identify the precise profile of the prosodic inflection.

2.2. Experimental paradigm

The perceptual experiment is based on the Self Paced Listening paradigm followed by a judgment of compatibility between an interrogative sentence and an assertive sentence. The experimental design included symmetrical and asymmetrical conditions in which the relevant verbs in the two sentences could be prosodically inflected for past or future tenses. Four conditions were used: (1) Interrogative utterance in the Past followed by a Past Tense Response (PPRP), (2) Interrogative utterance in the Future followed by a Future Tense Response (PFRF); (3) Interrogative utterance in the Future followed by a Past Tense Response (PFRP); and (4) Interrogative utterance in the Past followed by a Future Tense Response (PPRF). Both PPRP and PFRF are symmetrical, while PFRP and PPRF are asymmetrical. Subjects evaluated whether the two sentences they heard in each trial are compatible for tense or not. The dependent variables included both non-chronometric (acceptability rates) and chronometric (average decision times) measures. After listening to the two sentences, subjects were asked to immediately press either a *yes* or a *no* button to decide whether both sentences were compatible. The Psyscope program registered both the yes/no decision and the timing (ms). Sentences were distributed in a Latin Square Design consisting of four versions, to guarantee that subjects were exposed to all conditions, but not to the two versions of the same sentence, which were distributed between subjects. Each version was applied to 8 native speakers of Kaingang, totaling 32 subjects.

Results confirmed our hypotheses, showing that both symmetrical conditions for past (PPRP) and future tense (PFRF) obtained the highest acceptability rates and the fastest decision times, while the asymmetrical conditions (PFRP and PPRF) received the lowest – as indicated in Table I.

Table 1. *Acceptability rates (Nb) and Decision Times (mean and standard deviation: std) for the 4 conditions – for Yes (Y) and No (N) answers*

	PF RF		PF RP		PP RP		PP RF	
	Y	N	Y	N	Y	N	Y	N
Nb	109	19	52	76	109	19	55	73
Mean	2288	3130	3347	2151	3040	4533	5293	4450
Std	3289	1693	2373	2889	4708	4710	8194	6690

2.3. Symmetrical and Asymmetrical conditions for Future Tense

The categorical variable Acceptability Rates indicated that the Future Tense symmetrical Condition (PFRF) obtained 109 positive observations, whereas the Asymmetrical one (PFRP) obtained 52 positive observations, a difference yielding a highly significant Chi-square ($\chi^2(1,163)=40.4$, $p<0.05$), that led to the conclusion that the preference for the symmetrical condition is due to the manipulated variable, melodic inflection.

The analysis of the continuous variable (average decision times) indicated that the Future Tense symmetrical condition (PFRF) was judged in 2288ms, while the PFRP condition was judged in 3347ms. This is also a significant difference according to a T-test ($t(159)=2.08$, $p<0.05$). We can infer from these results that the yes answer in the symmetrical condition was significantly faster than in the asymmetrical conditions, thus validating the hypothesis.

2.4. Symmetrical and Asymmetrical conditions for Past Tense

The categorical variable Acceptability Rates indicated that the Past Tense symmetrical Condition (PPRP) obtained 109 positive observations, whereas only 55 for the Asymmetrical one (PPRF), a difference yielding a highly significant Chi-square ($\chi^2(1,163)=35.6$, $p<0.05$), that led to the same conclusion than for the future: the preference for the symmetrical condition is due to the manipulated variable, intonation.

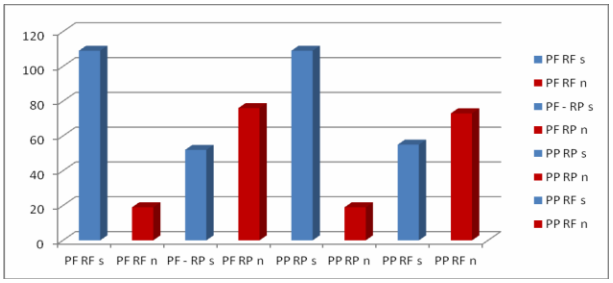

Figure 1: *Decision Rates for the symmetrical and asymmetrical conditions*

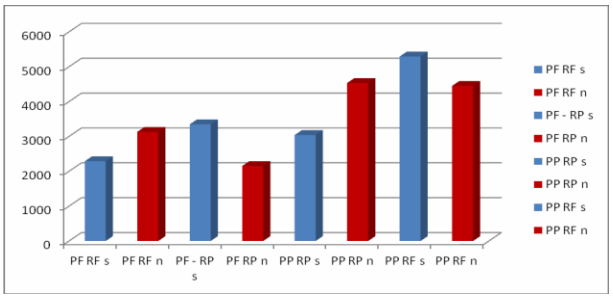

Figure 2: *Average Decision Times for the symmetrical and asymmetrical conditions*

The analysis of the average decision times also indicated that in the symmetrical PPRP condition, positive observations were given in an average time of 3040ms, whereas the asymmetrical condition in the Past Tense (PPRF) obtained only 55 positive observations, which were responded in average decision times of 5293 ms. This difference in average decision times between the conditions produces significant results in the T-test: $t(162)=2.235$, $p<0.05$. Therefore, to say yes for the symmetrical condition in the past was significantly faster than to say yes for the asymmetrical condition in the past, as predicted by the hypothesis. These results can also be observed in Figures 1 and 2.

The psycholinguistic experiment demonstrates the presence of a perceptive contrast between present and future

tense, in this type of verbs – when this difference is presented only via melodic inflection. Both measures – the increased acceptability of symmetrical pairs as the shortest processing time of symmetrical pairs compared to asymmetric – can be interpreted in this manner.

Next section describes the acoustic changes that can be observed in this data and correspond to what listeners had perceived during the perception test

3. Mapping of the Prosodic Inflection

3.1. Acoustic Analysis I

Based on the autosegmental metric model proposed by [4], an analysis of the prosodic inflection was performed using the Praat software. It was observed that an F0 rising contour (H*H%) and a falling F0 contour (L*L%) mark the contrasting opposition between the Past tense nuclear accent and the Future tense nuclear accent, in both assertive and in interrogative utterances, as illustrated in Figures 3 and 4. Figures 5 and 6, below, show the same pair of utterances, one assertive and the other interrogative, but this time with the rising F0 contour in the nuclear accent marking Future tense.

It was also observed that, in the Future Tense, the assertive/ interrogative modality contrast is obtained by means of an melodic contrast on the tone of the subject particle: high (H*) for the assertive subject particle ‘tỹ’; rising (L+H*) for the interrogative particle ‘mỹ’.

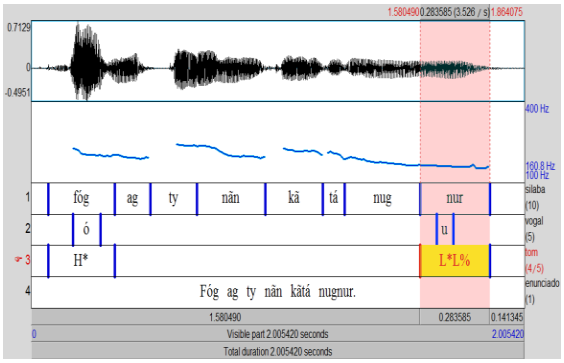

Figure 3: *Assertive utterance in the Past Tense APP3 (Fóg ag tỹ nãn kãtá nũgnũr)*

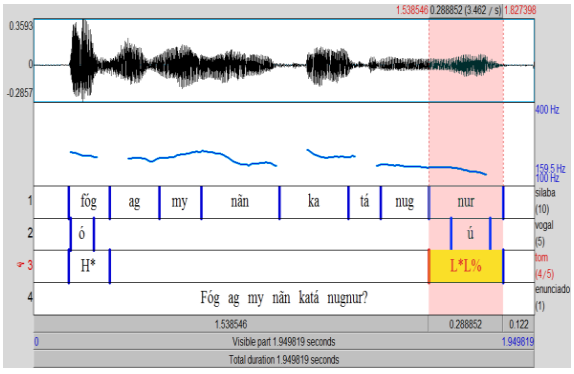

Figure 4: *Interrogative utterance in the Past Tense - PP3 (Fóg ag mỹ nãn kãtá nũgnũr)*

These results demonstrate that a rising F0 contour (marked with the nuclear accent H*H%) is observed in all the cases of future tense in the corpus (32 cases, both in interrogative and assertive utterances). Likewise, the falling F0 contour (marked with the nuclear accent L*L%) is observed consistently in all the 32 past tense cases, both in interrogative and assertive utterances. The sentence modality is distinguished by the tone of the particles: high (H*) for the subject assertive particle ‘tỹ’; rising (L+H*) for the interrogative particle ‘mỹ’.

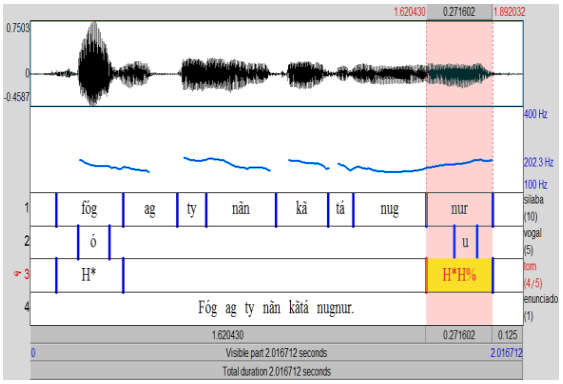

Figure 5: *Future Tense assertive utterance - APF3 (Fóg ag tỹ nãn kãtá nũgnũr)*

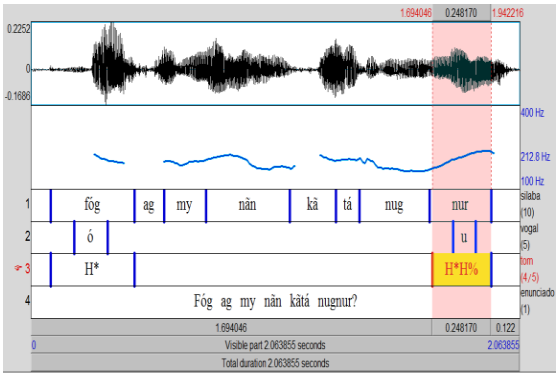

Figure 6: *Future Tense Interrogative Utterance-PF3 (Fóg ag mỹ nãn kãtá nũgnũr)*

3.2. Acoustic Analysis II

In order to obtain a quantitative analysis of this phenomenon, we deemed necessary to perform a mapping of the prosodic inflection, by means of acoustic analyses, also made with the Praat program. The working hypothesis was that the F0 inflection marking the distinction between Past and Future tenses in Kaingang would occur at the level of the verb, indicating a case of verb tone since this class of verbs is distinguished of other verb classes by its non-inflectional morphology.

In order to compare the melodic curves of different sentences, one has to normalize the F0 values. We used the algorithm described in [5] and based on [6] normalization method: a fixed number of 70 F0 measures was extracted from each sentence. These vectors of F0 measures for each sentence were then averaged for each sentence having the same mode (declarative or interrogative) and tense (past or future). The result is depicted in figure 7. It allows to observe the melodic configurations of the verbs inside each type of

utterances. It may observe that rising and falling contours still occur in the verb, marking the temporal distinction of past and future in Kaingang, as predicted by the hypothesis.

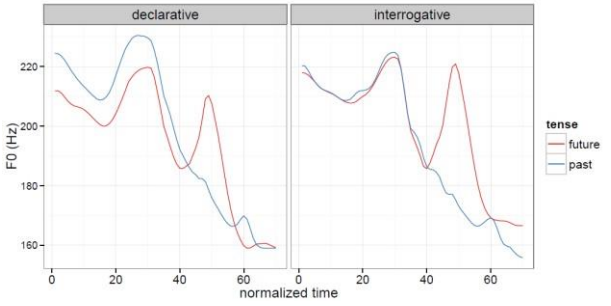

Figure 7: *Mean F0 values extracted from temporally normalized sentences, averaged for mode (left: declaratives, right: interrogatives) and tense (blue: past; red: future).*

To ensure this difference is significant, all pairs of individual normalized vectors of F0 were compared using a correlation between these contours; such correlation yields an objective measure of the perceptive similarity between each pair [7]. The Fisher transformation of correlations [7] was then used to fit an ANOVA having the type of modalities compared (Declarative, Interrogative, Asymmetric), the type of tenses compared (Past, Future, Asymmetric) and the individual sentences compared (64 levels) as fixed factors. The ANOVA table shows all factors are highly significant, but the opposition of tenses shows the largest effect size ($F(2,428)=369$, $p<0.001$, $\eta^2=0.63$), followed by variations in the performances of each sentence ($F(63,428)=4$, $p<0.001$, $\eta^2=0.40$), while the oppositions of modalities as a significant but comparatively small influence ($F(2,428)=21$, $p<0.001$, $\eta^2=0.01$). Similarities and differences in tenses is thus the main explanatory factor of the observed changes in F0 contours for this data. Past-tense sentences were the most coherent factor (with a mean correlation of 0.90), as compared with future tense sentences, significantly less coherent (with a mean correlation of 0.85), and with asymmetric comparison of tense, the less coherent (with a mean correlation of 0.74).

4. Discussion

This data shows that the prosodic inflection is in fact more directly related to the verb, indicating the occurrence of verb tone in Kaingang. According to Gussenhoven (personal communication) this phenomenon may be analyzed as a case of tonal morphemes as identified, for example in the Chechena language, as well as in the Xitshwa language, in which tone has a grammatical function, distinguishing Tense and Aspect [8].

In terms of the prosodic structure of the word, it can be said that there are basically two relevant phenomena, stress (accent) and tone. Since none is obligatory, there are four possibilities for a given language: 1- tone & stress; 2- tone & no stress; 3- no tone & stress; 4- no tone & no stress [9]. According to this typology, the Kaingang language seems to fall in type 1: a stress language with tonal subsystems in specific areas of the grammar, such as the verb inflection described here.

5. Conclusion

The Kaingang prosodic inflection presented in this paper shows a very specific case of interface with morphology, unlike languages in which prosody is typically restricted to the lexical level. Based on this analysis, we speculate that the Kaingang case may exemplify either the emergence of a tonal system or, on the other hand, the remnants of a tonal system, in a framework of language evolution. In any case, the facts discussed in this paper reveal an interesting linguistic phenomenon which should be explored further in order to improve our understanding of the prosody/morphology interface.

6. Acknowledgements

We are grateful to João Antônio de Moraes for very helpful discussion on the analyses of the F0 curves, as well as for insightful suggestions about the syntactic variation contexts to determine the melodic features in the levels of the sentence and of the word. We thank also Pablo Arantes for the discussion of the data and for the help with the normalized duration graphs and Albert Rilliard for generous comments and suggestions about the analysis and revision of this text. Last, but not least, we thank Carlos Gussenhoven for the interesting discussion about tonal stress and about the phonological status of the phenomenon presented in this paper.

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