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Tone restricts F_0 range and variation in Kammu

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Abstract

The aim of this study is to investigate whether the occurrence of lexical tones in a language imposes restrictions on its pitch range. We use data from Kammu, a Mon-Khmer language spoken in Northern Laos, which has one dialect with, and one without, lexical tones. The main finding is that speakers of the tonal dialect have a narrower pitch range, and also a smaller variation in pitch range.

Introduction

There is recurrent interest in comparing the F_0 range of different languages in the broad context of investigating language-specific use of F_0 . There has been general speculation that different pitch ranges and other characteristics of F_0 can comprise a part of the phonetic structure of a language and thus differ systematically between languages (see Traunmüller & Eriksson (1993) and Keating & Kuo (2010) for reviews). One question concerns the influence of lexical tone on intonation, and this has generated the hypothesis that tone languages may have an overall larger F_0 range than non-tonal languages by virtue of the additive effect of the lexical tones being superimposed on the intonation contour. Several studies have supported this hypothesis, while in other studies no difference in pitch range between tonal and non-tonal languages was found. In some studies, the opposite tendency has been observed where tone languages display a smaller F_0 range.

In many of the studies supporting the hypothesis, Standard Chinese has been compared with English. In a study of broadcast news speech (Yuan & Liberman, 2010), it was found that Standard Chinese has a wider pitch range and more F_0 fluctuations than English. This is discussed in terms of the effect of lexical tones.

In Zhang & Tao (2008), where a bilingual Chinese-English corpus was used to develop a mixed-language speech synthesis system, the pitch range of the English words was larger in the bilingual corpus than in the English one. These results are discussed in terms of the influence of the Chinese lexical tones on the corpus.

In Keating & Kuo (2010), Standard Chinese was found to have a larger pitch range than English in single-word utterances. However, this

effect was not seen in prose passages. These results highlight the effect of speech material. Eady (1982) found no difference in F_0 standard deviations between English and Standard Chinese.

Another interesting and relevant area of study is the modification of F_0 which takes place in infant directed speech. Grieser & Kuhl (1988) reported an exaggeration of F_0 range in infant directed speech in Standard Chinese. However, in a study comparing infant directed speech in Australian English to Thai (Kitamura et al., 2001) it was found that F_0 range was more exaggerated in Australian English than in Thai. These results are discussed in terms of restriction on pitch excursions in infant directed speech due to lexical tone.

Lexical tone can thus be seen to either restrict F_0 range or enhance it, varying across language, speech material, and speaking style. By investigating a language in which lexical tone is a characteristic of one dialect but absent from another dialect, we aim to study the effect of lexical tone on F_0 range.

Kammu is a Mon-Khmer language spoken by some 600,000 people, mainly in Northern Laos, but also in adjacent areas of Vietnam, Thailand and China. One of its main dialects has lexical tones (high or low) on each syllable, while the other main dialect lacks lexical tones. The tones have developed by the merger of voiceless and voiced initial consonants. Other differences between the dialects are marginal, and speakers of different dialects understand each other without difficulty (Svantesson, 1983; Svantesson & House, 2006).

Earlier studies of Kammu have shown a compressed F_0 range in the tonal dialect as compared to the non-tonal dialect in spontaneous speech (Karlsson et al., 2011), as well as in planned speech (House et al., 2009;

Karlsson et al., 2010). In this study we make a more systematic study of F_0 range differences in a planned speech material.

Method

Recordings of 14 speakers of the tonal dialect and 9 speakers of the non-tonal dialect were used in this investigation. The subjects were recorded in Laos and Thailand using a portable Edirol R-09 digital recorder and a lapel microphone. The utterances were digitized at 48 kHz sampling rate and 16-bit amplitude resolution and stored in .wav file format. Most of the speakers were recorded in quiet hotel rooms. One speaker was recorded in his home and one in his native village.

Since Kammu is an unwritten language, the material was presented written in Lao or Thai, and the speakers were asked to translate it into Kammu. Almost all Kammu speakers in Laos and Thailand are bilingual and have received their school education in Lao or Thai, respectively. Thus there was some variation in the recorded material. The resulting utterances were checked and transcribed by one of the authors, Damrong Tayanin, who is a native speaker of Kammu.

The following sentences from our material were used in this investigation (given in both dialect forms):

Tá? Kām kùuŋ táaj ʔòʔ.
Ta? Kām guuŋ taaj ʔoʔ.
Mr Kām saw my brother.

Táaj ʔòʔ kùuŋ tá? Kām.
Taaj ʔoʔ guuŋ ta? Kām.
My brother saw Mr Kām.

Məʔ məlat kʰɔŋ ʔòʔʔ Tá? Kām məlat kʰɔŋ ʔòʔ.
Məʔ məlat kʰɔŋ ʔoʔʔ Ta? Kām məlat kʰɔŋ ʔoʔ.
Who took my things? Mr Kām took my things.

Kəə məh məʔʔ? Kəə məh kɔŋ ʔòʔ.
Gəə məh məʔʔ? Gəə məh kɔŋ ʔoʔ.
Who is he? He is my child.

Kii məh məh? Kii məh kláaŋ.
Gii məh hməh? Gii məh klaaŋ.
What is this? This is an eagle.

Kii məh məh? Kii məh tàaŋ.
Gii məh hməh? Gii məh daaŋ.
What is this? This is a lizard.

The underlined words were used in the investigation. For each of these words, the maximum and minimum F_0 value was measured, using the *Praat* program, and the F_0 range over the word was computed as the difference (in semitones) between the maximum and the minimum.

Results

Table 1. Means and standard deviations of the F_0 ranges (semitones).

word	mean	sd	N
Kām/Kām	2.20/1.88	1.72/1.32	16/15
kùuŋ/guuŋ	1.09/1.77	1.15/0.97	16/15
ʔòʔ/ʔoʔ	1.40/1.85	1.07/1.32	16/15
kùuŋ/guuŋ	1.45/1.90	2.05/0.74	32/18
Kām/Kām	1.33/3.76	1.21/3.50	32/18
məʔ/məʔ	1.36/1.58	1.44/1.63	24/16
ʔòʔ/ʔoʔ	0.39/2.70	0.44/2.29	7/16
Kām/Kām	2.08/4.23	1.63/3.29	19/15
ʔòʔ/ʔoʔ	0.38/1.87	0.56/1.50	19/15
kəə/gəə	0.68/1.33	0.91/0.92	28/20
məʔ/məʔ	1.42/1.76	1.35/1.19	28/20
kəə/gəə	0.29/1.29	0.46/1.09	28/18
kɔŋ/kɔŋ	0.55/0.61	0.57/0.69	28/18
ʔòʔ/ʔoʔ	1.79/2.03	1.38/1.90	28/18
kii/gii	0.03/1.86	0.17/1.59	28/23
məh/hməh	1.84/4.23	2.04/2.95	28/23
kii/gii	0.07/1.65	0.22/1.61	29/14
kláaŋ/klaaŋ	3.88/6.66	3.34/3.68	29/14
kii/gii	0.25/0.32	0.388/0.393	30/20
məh/hməh	2.59/3.87	2.41/3.01	30/20
kii/gii	0.27/0.91	0.44/1.35	34/15
tàaŋ/daaŋ	2.89/3.68	1.88/2.55	34/19

The results of the measurements are shown in Table 1, which shows the mean and standard deviation of the range for each word in the material, shown in the table in the same order as they are presented above. The number of repetitions of each word is shown as well. The word or number before the slash refers to the tonal dialect, and those after the slash refer to the non-tonal dialect.

It can be seen from the table that except for one word (the very first word *Kàm/Kam*), the mean of the range is greater for the non-tonal dialect than for the tonal dialect. In 21 cases of 22, the non-tonal speakers have greater mean range than the tonal ones, and a binomial test gives a highly significant result ($p < 0.0001$). The standard deviation is larger for the non-tonal dialect in 18 cases of 22 (exceptions are *Kàm/Kam* (1) *kùuŋ/guūŋ* (1), *kùuŋ/guūŋ* (2) and *məʔ/məʔ* (2)), giving a significant result of the binomial test ($p = 0.0043$).

Discussion

The results show that the F_0 range over a word (measured in semitones) is, on the average, larger in the non-tonal dialect than in the tonal dialect. Furthermore, there is greater variation in the ranges in the non-tonal dialect than in the tonal dialect, as the standard deviations show. This is consistent with earlier findings (House et al., 2009; Karlsson et al., 2010; 2011; Karlsson, 2011), which also show, in different situations, that the F_0 range is smaller in the tonal than in the non-tonal dialect. These results are also in line with those found for infant-directed speech in Kitamura et al. (2001) where F_0 range was more exaggerated in Australian English than in Thai. It could be that in more engaged speech, e.g. infant-directed and spontaneous, lexical tones become more restrictive in their influence on the intonation contour.

Our result is opposite to what was found for Chinese when compared to English (Yuan & Liberman, 2010; Zhang & Tao, 2008) where the presence of lexical tones results in an expanded F_0 range. One explanation could be that Kammu has a simpler tone system with only two level tones while Chinese has a more complex system with contour tones. In Kammu the difference between the low and high tone is often relatively small (Svantesson & House, 2006) which may also restrict the use of large pitch excursions.

In Karlsson et al. (2010), we present data that strongly suggest that the intonational systems of the two Kammu dialects are basically identical, but also that there is a prosodic hierarchy, where lexical tone is stronger than sentence accent, which in its turn is stronger than focal accent. It seems to be necessary to uphold the contrast between the lexical tones in the tonal dialect, and when this conflicts with other uses of F_0 , such as for marking sentence or focal accent, this may be inhibited.

These restraints on the use of F_0 for intonation may be the explanation for the results found here, that there is generally a smaller pitch range in the tonal dialect than in the non-tonal dialect, and also for the fact that there is less variation in the range.

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