HOW MANY TONAL CONTRASTS IN IKEMA RYUKYUAN?

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ABSTRACT

In this paper we will show that Ikema, a dialect of Miyako Ryukyuan, has a three-tone system, where three tonal classes, Types A, B, and C, are lexically distinguished, contra the previous studies which have claimed that it has a *two*-tone system. The results of our quantitative analysis of production data also revealed that Type A words are remarkably small in number, indicating that Type A words are in the process of merging into Type B, as a result of ongoing linguistic change.

Keywords: Ryukyuan, lexical tone, three-tone system

1. INTRODUCTION

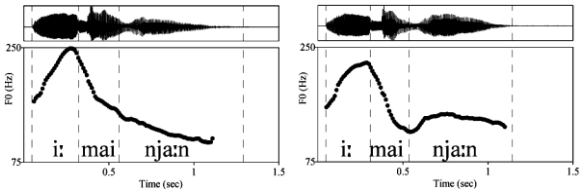
Ikema is one of the dialects of the Miyako Ryukyuan language, which constitutes one of the three subgroups of Southern Ryukyuan. Southern Ryukyuan together with Northern Ryukyuan forms a single group of languages, the Ryukyuan languages, the only languages proven to be genetically related to Japanese. Ikema is an endangered dialect spoken by about 1000 people on Ikema island, in Sarahama on Irabu island, and in Nishihara on Miyako island (Okinawa Pref., Japan). Our data were all recorded in Nishihara.

Some of the Ryukyuan languages have lexically contrastive tones, while others do not [2]. The tonal systems in the languages with lexically contrastive tones can be divided into two: a *three-tone system*, where three tonal classes are lexically distinguished, and a *two-tone system*, where two classes are distinguished. Many Northern Ryukyuan languages have a three-tone system. Among Southern Ryukyuan, Yonaguni was thought to be the only dialect with a three-tone system, until Tarama was recently shown to have a three-tone system [6]. Ryukyuan dialects with lexical tones exhibit regular correspondences in tonal classes, and it is generally accepted that Proto-Ryukyuan had a three-tone system [2, 6].

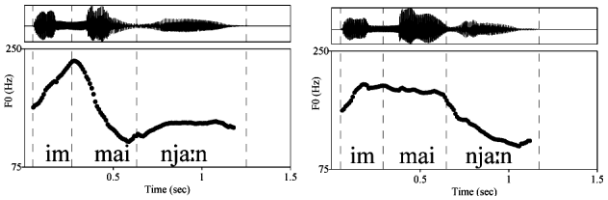
As observed in Hirayama, et al. [4], it has been long believed that Ikema has a *two*-tone system, and that the tonal distinction is being lost as a result of linguistic change. Hayashi, et al. [3], however, have shown that the lexical tones are preserved even in the speech of the younger generations. They also found that the two-way distinction can be clearly observed when the words are followed by one or more bimoraic particles.

We found, however, that when words with one or more bimoraic particles are followed by a predicate, the dialect exhibits a *three*-way lexical tonal distinction [5]. The phonetic realization of the three tonal classes (Types A, B, and C, henceforth) is illustrated in Figure 1, showing the fundamental frequency (F0) contours of a set of minimal pairs contrasting in tonal classes, followed by a bimoraic particle and a predicate.

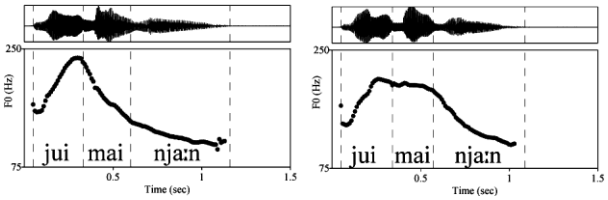
Figure 1: Waveforms and F0 tracks for minimal pairs in tone, embedded within a frame sentence *X mai nyaan* 'there is no X, either' (produced by one speaker). Vertical lines indicate word boundaries.



(a) Type A *ii* 'west' (left) vs. Type B *ii* 'drill' (right)



(b) Type A *ii* 'west' (left) vs. Type B *ii* 'drill' (right)



(c) Type A *yui* 'mutual aid in labour' (left) vs. Type C *yui* 'dinner' (right)

In a Type A word, F0 falls from the end of the word to the particle, and then it falls even lower from the particle to the predicate. In a Type B

word, F0 falls from the end of the word to the particle, and then it rises from the particle to the predicate. In a Type C word, a flat high F0 prevails from the end of the word to the particle, and then falls from the end of the particle to the predicate.

While the tonal realization rules of Ikema are not fully understood, it is clear that the three-word window (word + bimoraic particle + predicate) is one of the conditions where the three-way contrast is fully realized. When two- or three-mora words are produced in isolation (Ikema has no mono-moraic lexical words), the distinction between A and B is neutralized. Four-mora words produced in isolation lose the contrast between B and C. When produced with a bimoraic particle, four-mora words show no neutralization, while two- or three-mora words exhibit only a two-way distinction where A and B are neutralized. This restricted contrastive distribution has been responsible for the mistaken conclusion in previous studies that Ikema has a two-tone system.

The description above, however, is mainly based on qualitative analysis. No evidence has hitherto been presented showing that Ikema has a three-tone system, based on quantitative analysis. The aim of this study is to confirm that Ikema Ryukyuan exhibits three-way lexical tonal contrasts, by means of quantitative analysis of production data.

2. METHODS

2.1. Speakers

Three male native speakers of Ikema in their 60s participated in the recordings. They will be referred to as T, K, and H, respectively.

2.2. Speech materials

Data were collected during fieldwork carried out in Nishihara, Miyako Island in January 2011. Of more than 500 different words collected, we selected 121 different words as the test words, on the basis of the following criteria.

1. Those with two or three morae.
2. Those in which no inter-speaker variability in tonal classes was observed.
3. Those in which cognate words in the Tarama dialect could be found.
4. Those produced in the same frame sentence.

Criterion 1 was set, firstly because words with more than three morae behave differently from two- or three-mora words, and secondly because there were only a limited number of such words in our corpus. Criterion 3 was necessary to show that there are regular correspondences in tonal classes between Ikema and Tarama, and that the three-tone system in Ikema is not an independent innovation. Tarama data were adopted from Matsumori [6].

Test words were embedded within the following carrier sentences: X *mai nyaan* ‘There is no X, either.’ (for speakers T and K) or X *mai arii duu* ‘There is X, too.’ (for speaker H), where X stands for a test word.

Table 1: 121 test words and their putative tonal classes, as well as the tonal classes of Tarama cognates [6]. Meanings are omitted due to lack of space, except for homonyms. The transcription is phonemic (y [j], sy [ʃ], c [ts], cy [tʃ], hn [n̥n]). Tr. and Ik. stand for Tarama and Ikema, respectively.

Words	Tones		Words	Tones		Words	Tones	
	Tr.	Ik.		Tr.	Ik.		Tr.	Ik.
agai	A	A	cyaa	B	B	kazɨcɨ	C	C
butu	A	A	ii	B	B	hnu	C	C
tibi	A	A	iiki	B	B	kuu	C	C
nsɨ	A	A	yadu	B	B	maai	C	C
syaaka	A	A	yunaka	B	B	maasu	C	C
tuzɨ	A	A	cɨn	B	B	madu	C	C
akacɨ	A	B	kyuu	B	B	magu	C	C
akai	A	B	midun	B	B	makai	C	C
asin	A	B	nna	B	B	minaka	C	C
ffa	A	B	nagani	B	B	mihana	C	C
ffacɨ	A	B	nai ‘fruit’	B	B	naba	C	C
fudami	A	B	taku	B	B	nakazya	C	C
in ‘dog’	A	B	uzzya	B	B	hira	C	C
zzu	A	B	icyufu	B	C	sɨbai	C	C
yudai	A	B	nnama	B	C	sɨkama	C	C
yucɨ	A	B	hai	B	C	cicɨɨ	C	C
kaa	A	B	nuuma	C	B	saba	C	C
kazya	A	B	akizɨ	C	B	sana	C	C
kyuusɨ	A	B	zzaku	C	B	sanazɨ	C	C
kuusu	A	B	kangi	C	B	syasi	C	C
kuba	A	B	nkyadi	C	B	sata	C	C
mai	A	B	aasa	C	C	sauki	C	C
mucɨɨ	A	B	adan	C	C	siigu	C	C
nai‘quake’	A	B	agu	C	C	sina	C	C
nnagu	A	B	aka	C	C	isagu	C	C
sanin	A	B	ara	C	C	tagu	C	C
saba	A	B	accya	C	C	taya	C	C
suu	A	B	auda	C	C	tida	C	C
sudi	A	B	baaki	C	C	cyuuka	C	C
ccyucɨ	A	B	basa	C	C	taufu	C	C
uru	A	B	dakyau	C	C	uyubi	C	C
zyuu	A	B	aagu	C	C	uya	C	C
dusɨ	A	C	gamaku	C	C	ukama	C	C
nzɨ	A	C	zɨɨpa	C	C	umacɨ	C	C
sabani	A	C	gusyan	C	C	mmaga	C	C
sura	A	C	ibira	C	C	utaki	C	C
kutusɨ	B	A	in ‘sea’	C	C	waa	C	C
azya	B	B	yaani	C	C	zɨmami	C	C
acya	B	B	yarabi	C	C			
bata	B	B	yacyu	C	C			
cɨzɨ	B	B	kausɨ	C	C			

2.3. Measurements and analysis procedures

All the measurements were performed manually in a simultaneous display of the waveform, wide-band spectrogram, and F0 track, using Praat [1]. Three points in F0 contours, Pt1, Pt2, and Pt3 were measured. Pt1 was the highest F0 value in the test word. Pt2 was the value at the end of the particle. Pt3 was the value in the middle of the predicate.

The recordings were made using Marantz PMD 660 in a room at the speakers' house, and saved onto a memory card at a 44.1 kHz sampling rate.

Tonal classes of each test word were first classified as Type A, B, or C, by means of auditory impression as well as the visual inspection of F0 contours. The results of the auditory analysis are provided in Table 1. This putative classification was validated by quantitative analyses in two steps. Firstly, we investigated, based on Analyses of Variance (ANOVAs), if F0 *level* at each of the three words significantly differs across the tonal classes. Secondly, we examined, by means of cluster analyses, if differences in F0 *movement* could clearly separate the putative tonal classes.

3. RESULTS

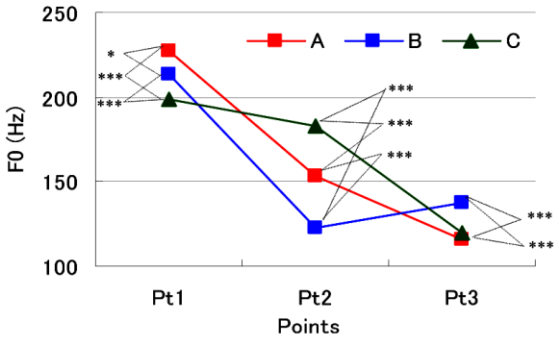
3.1. F0 level at each of the three words

Figure 2 shows means for F0 value at Pt1, Pt2, and Pt3. On these F0 values, we conducted two-way mixed-design ANOVAs, with Tonal Class (A vs. B vs. C) as the between-item factor and with Point (Pt1 vs. Pt2 vs. Pt3) as the within-item factor, separately for each speaker.

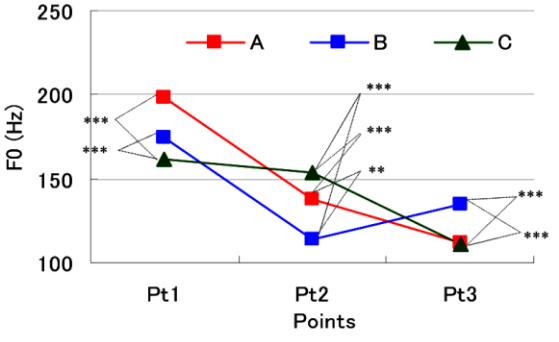
The result revealed a significant main effect of Point for all the speakers [for T, $F(2, 236) = 2418.74$, $p < 0.001$; for K, $F(2, 236) = 694.85$, $p < 0.001$; for H, $F(2, 236) = 1488.89$, $p < 0.001$]. The main effect of Tonal Class was significant for T and H [for T, $F(2, 118) = 22.26$, $p < 0.001$; for H, $F(2, 118) = 65.22$, $p < 0.001$], but was not significant for K [$F(2, 118) = 1.37$, $p = 0.258$]. The interaction between Tonal Class and Point was significant for all the speakers [for T, $F(2, 236) = 669.63$, $p < 0.001$, for K, $F(2, 236) = 257.84$, $p < 0.001$; for N, $F(2, 118) = 65.22$, $p < 0.001$].

Because the interaction was significant, post-hoc pairwise comparisons with a Bonferroni adjustment were conducted to examine differences in F0 value between A, B, and C, for each point separately. The results are indicated in Figure 2. For all the speakers, F0 value at Pt2 differed significantly across all the tonal classes (C > A > B, where X > Y means that X is higher than Y). The difference in Pt3 was significant between Types A and B and between Types B and C, for all the speakers (B > A, C). Inter-speaker variability was observed in Pt1. For T and K, the difference was significant across all the tonal classes, (A > B > C). For H, on the other hand, the difference was significant only between A and C (A > C).

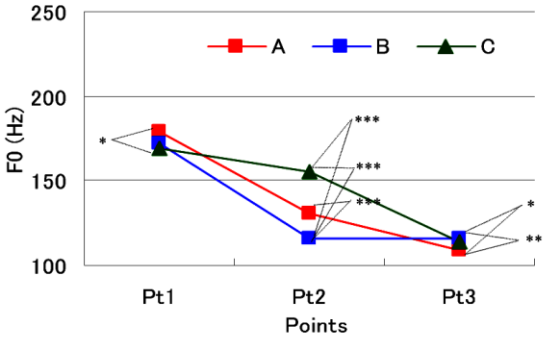
Figure 2: Mean F0 values at Pt1, Pt2, and Pt3, as well as the results of post-hoc pairwise comparisons. *, **, ***, respectively, designate significance at 0.05, 0.01, 0.001 levels.



(a) Speaker T



(b) Speaker K



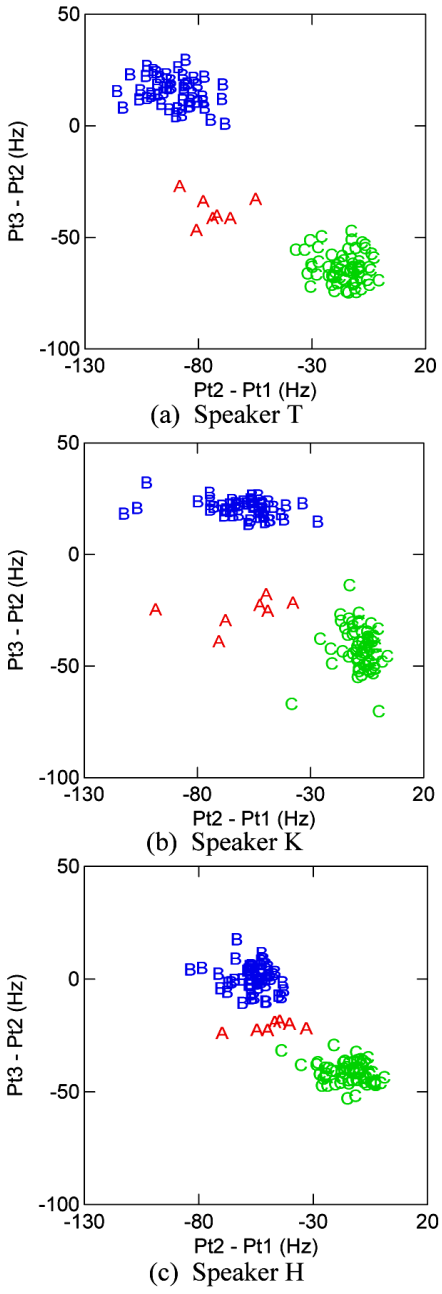
(c) Speaker H

In summary, the results of the F0 level analysis confirmed that the three putative tonal classes significantly differ from each other. The differences were consistently found in F0 level of the particle (C > A > B) and predicate (B > A, C). There was also a tendency that F0 level in the test word was lower in C than A and B.

3.2. F0 movements across the three words

Figure 3 illustrates F0 difference between Pt1 and Pt2 (Pt2–Pt1) plotted against F0 difference between Pt2 and Pt3 (Pt3–Pt2). Negative values indicate that F0 falls across the two words. We see that three putative tonal classes are clearly separated.

Figure 3: Distribution of P2-P1 values plotted against Pt3- Pt2 values. A, B, and C stand for putative tonal classes indentified on the basis of qualitative analysis.



(a) Speaker T

(b) Speaker K

(c) Speaker H

Hierarchical cluster analyses using Ward's method with the square Euclidean distance formed three clusters, and the clusters completely coincided with the putative tonal classes for all the speakers, except for a word *cyuuka* produced by H. Cluster dendrograms (not displayed) revealed that, while Type C words were placed far apart from Type A and Type B words, the distance between the latter types of words was quite close, suggesting acoustic similarity between A and B.

Thus, the results of the F0 movement analysis quantitatively confirmed the existence of the three distinct tonal classes.

4. DISCUSSION AND CONCLUSION

Quantitative analyses conducted in this study confirmed that Ikema has a three-tone system.

The three-tone system in Ikema should not be considered as an independent innovation in this dialect because there are correspondences in tonal classes between two varieties of Southern Ryukyuan [5]. The exception is Type A words. As shown in Table 1, only about 17% of Type A cognates in Tarama are Type A words in Ikema, and most of them are Type B words (about 47%). In addition, Type A words are remarkably small in number (six out of 121). From this pattern of correspondences, it would be safe to conclude that the Ikema tonal system is undergoing change, in which Type A is merging into Type B. This in turn may indicate the relative unmarkedness of Type B with respect to other classes.

The realization rules of the tone system in Ikema are not yet fully understood. They may be related to interactions between lexical tones and phrase-level rhythmic structure as found in the Irabu dialect of Miyako Ryukyuan [7], which itself has no lexical tones. This is an issue to be addressed in the future.

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