Tone or direction? Time dependency and phonetic representation of word level f_0 shape in Northern Shikoku Japanese dialects

(Category: phonetics/phonology)

1. Introduction: Shiki plus accent systems in Kansai and Shikoku Japanese

In the currently standard model of intonational phonology [1], f_0 movement patterns are modeled in terms of strings of tonal targets and smooth interpolation between them. While this model has also been proven highly successful in capturing lexically driven f_0 production patterns in Tokyo Japanese [2, 3], varieties of Japanese spoken in mid-western area (Kinki and Shikoku) of Japan are known to have another layer of lexical contrast in f_0 movement patterns, termed *shiki* in Japanese accentology, where shiki has been defined as "direction of pitch movement" [4] rather than the contrast in word initial tones [1, 2]. The present paper investigates the f_0 production patterns of three Japanese dialects having both shiki and accent (shiki-accent dialects) and examines which model (tone or direction) better captures the observed f_0 production patterns.

2. Methods: Two types of time dependency in falling f_0 patterns

The f_0 production patterns in three varieties of shiki-accent dialects were investigated: Kishiwada (4 speakers) in Kinki, and two dialects in Shikoku, Ibuki (4 speakers) and Mitoyo (3 speakers) [5]. Two models of the dependency of f_0 movements on duration during a stretch of f_0 fall were examined for Level and Falling (both unaccented) shiki types, as schematized in Fig. 1. In the "tone target & interpolation" model, the values of initial and final f_0 targets (T_1 and T_2) are constant while the duration of the f_0 fall gets longer: consequently, slope of f_0 fall becomes shallower. In the "direction" model, the rate of change in f_0 is constant: consequently, size of f_0 fall gets larger. Cho and Flemming [6] tested the time-dependencies on f_0 rise in Mandarin by manipulating the speech rate, as the domain of the rise is a syllable in Mandarin. In the present case, since the domain of shiki is a word which can be multi-moraic, word length was varied to induce the change in duration of f_0 fall (2-5 moras). The estimates of duration, slope and size of f_0 fall were determined by two-piece linear regression on the f_0 data of the experimental words produced in a frame sentence [2].

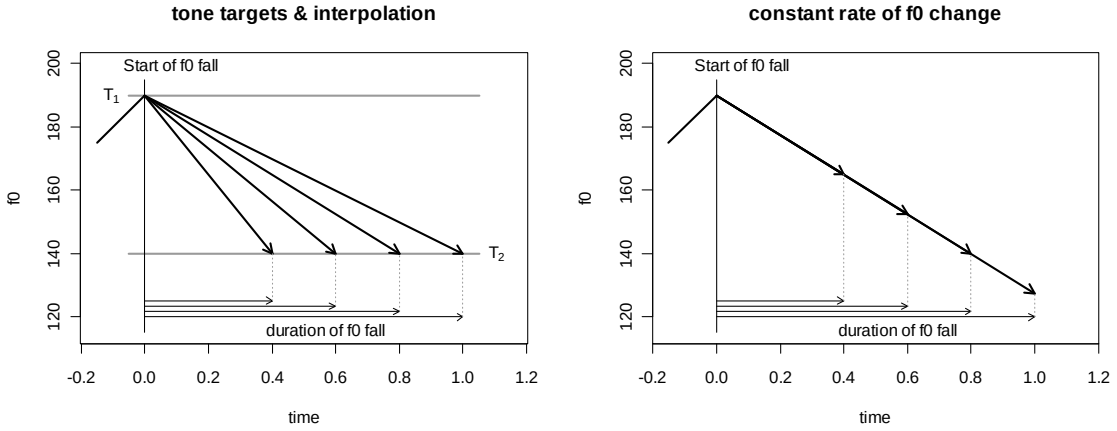

Fig. 1: Two models of falling f_0 pattern. X-axis indicates the time and y-axis, f_0 values. The thick arrows represent the change in f_0 movement as the duration of f_0 fall gets longer.

3. Results: Both tone target model and direction model are supported for Falling shiki

Table 1 summarizes whether significant correlation is found between the slope or size and duration of f_0 fall (tested with log- and linear-regression, performed for each speaker). For Level shiki type in the Kishiwada dialect, slope does not vary significantly as a function of duration of f_0 fall whereas the size of f_0 fall does vary, replicating the results for Osaka Japanese by Kori [7], which were interpreted as a manifestation of backdrop f_0 declination [2]. Level shiki in Ibuki does not reveal time dependency of size or slope consistently, which is as expected given that this shiki type has little f_0 fall: no f_0 declination [8]. By contrast, Falling shiki type in the two Shikoku dialects are characterized by a significant time dependency both for slope and size of f_0 fall.

Table 1: The results of regression analyses testing the two models of time dependency. Left: Slope of f_0 fall (log-linear fit); Right: Size of f_0 fall (linear fit). L0: Level shiki unaccented; F0: Falling shiki unaccented. * $p < .05$; ** $p < .01$, *** $p < .001$

Speaker	Shiki type	Slope of f0 fall				Size of f0 fall			
		R^2	*df*	*t*	*p*	R^2	*df*	*t*	*p*
Kishiwada1	L0	0.110	25	-1.75	0.092	0.541	25	5.428	0.000 ***
Kishiwada2	L0	0.007	30	0.47	0.644	0.269	30	3.320	0.002 **
Kishiwada3	L0	0.000	25	-0.07	0.941	0.432	25	4.357	0.000 ***
Kishiwada4	L0	0.161	37	2.66	0.011 *	0.208	37	3.113	0.004 **
Ibuki2	L0	0.289	17	2.63	0.018 *	0.065	17	1.086	0.293
Ibuki3	L0	0.028	15	0.66	0.518	0.006	15	-0.296	0.771
Ibuki4	L0	0.035	19	0.83	0.416	0.010	19	0.429	0.673
Ibuki5	L0	0.036	23	-0.93	0.362	0.217	23	2.525	0.019 **
Ibuki2	F0	0.672	43	9.38	0.000 ***	0.491	43	6.439	0.000 ***
Ibuki3	F0	0.489	25	4.89	0.000 ***	0.499	25	4.990	0.000 ***
Ibuki4	F0	0.001	33	0.19	0.849	0.364	33	4.343	0.000 ***
Ibuki5	F0	0.295	44	4.29	0.000 ***	0.504	44	6.680	0.000 ***
Mitoyo1	F0	0.223	56	4.01	0.000 ***	0.279	56	4.658	0.000 ***
Mitoyo2	F0	0.350	22	3.45	0.002 **	0.298	22	3.055	0.006 ***
Mitoyo3	F0	0.258	61	4.61	0.000 ***	0.304	61	5.163	0.000 ***

4. Conclusions: Phonological representation of shiki f_0 shape

We found that both "tone target & interpolation" and "constant rate of change" models are supported for the f_0 pattern of Falling shiki in two dialects in Shikoku, suggesting that each of the two models captures a certain aspect of f_0 production of shiki-accent dialects. In fact, a similar tendency has also been shown in high pitched stretch in Tokyo Japanese [3]. This is also in line with the recent trend in reconsidering the phonetic representation of f_0 production [6]. While the present results give another line of evidence for tone as a unit of f_0 representation found across various types of f_0 production, they also demonstrate that tone does not have to be only one correct representation [9]. In the case of shiki, the results indicate that the "direction of f_0 movement" within world level units can be another level of representation, which is actively controlled at least for the Falling shiki type in the two Shikoku dialects and constitutes a part of the phonetic knowledge of the speakers.

References

[1] Ladd, R. D. (2008). *Intonational Phonology: 2nd ed*. Cambridge University Press.

[2] Pierrehumbert, J. B. and Beckman, M. (1988). *Japanese Tone Structure*. MIT Press.

[3] Kubozono, H. (1994). *The Organization of Japanese Prosody*. Kuroshio Publishers.

[4] Uwano, Z. (1989). Accent of Japanese. In Sugito, M. (ed.) *Kooza nihongoto nihongo kyooiku*, Vol. 2, (pp. 178-205). Meiji Shoin. (in Japanese).

[5] Uwano, Z. (1999). Classification of Japanese accent systems. In Kaji, S. (ed.) *Proceedings of the symposium*: *Cross-linguistic studies of tonal phenomena*, *tonogenesis*, *typology and related topics*, (pp. 151-178). ILCAA.

[6] Cho, H. and Flemming, E. (2011). The phonetic specification of contour tones: the rising tone in mandarin. *Proceedings of 17th ICPhS, Hong Kong*, 112-115.

[7] Kori, S. (1987). The tonal behavior of Osaka Japanese: An interim report. *The Ohio State University, Working Papers in Linguistics*, Vol. 36, 31-61.

[8] Uwano, Z. (1985). The accent system of Ibukijima dialect. *Transactions of the Japan Academy*, 40-2, 75-179.

[9] Bybee, J. (2001). *Phonology and Language Use*. Cambridge University Press.