Phonological tone and phonetic intonation in Henan Mandarin: Perceptual evidence

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One of the central issues in intonation research concerns the extent to which surface f0 variation is due to phonological representations as opposed to paralinguistics. A complicating aspect is the systematic nature of the expression of paralinguistic meaning, such as when languages use the same intonation contour for questions and statements, while systematically pronouncing the interrogatives with a wider pitch range or in a higher pitch register [1]. The paralinguistic expression of the statement vs. interrogative distinction is a potential property of Chinese dialects.

Henan Mandarin has four syllabic lexical tones, two rises and two falls, besides a neutral tone. Both the two rising and the two falling tones are distinguished by an alignment difference for the beginning of the movement, which is either at the beginning (T1 or Early Rise, T3 or Early Fall) or the midpoint of the rime (T2 or Late Rise, T4 or Late Fall). Their pronunciation varies systematically with mode. Based on f0 measurements of sentence-final syllables, interrogatives have a higher pitch range than declaratives, while particularly T2 and T4 frequently have creaky voice in declaratives. T1, moreover, has a considerably weaker rise in the declarative than in the interrogative (Fig. 1). The lexical contrast is assumed to involve a phonological difference in alignment of HL or LH, with the first tone going either to the first or second mora (cf. [2]). If the intonation distinction is not representational in a similar sense, the results from an identification experiment with phonetic continua between tones may show sharper transitions than similarly obtained data from intonation continua. The question, therefore, is how sharply the lexical tone and intonation contrasts are discriminable.

Seven-step continua between the two lexical rises and between the two lexical falls in both interrogative and declarative intonations were created to form two 2 x 2 arrays (ST1-ST2; ST2-QT2; QT2-QT1; QT1-ST1 and ditto for T3 and T4), using the STRAIGHT morphing synthesis procedure [3]. The arrays were applied to three minimal tonal quadruplets, from recordings by a female speaker. The total number of stimuli is 3 (quadruplets) x 2 (lexical falls vs rises) x 7 (steps) x 4 (continua) = 168.

The results of a *pitch discrimination* experiment showed a weak tendency to discriminate less towards the interrogative end of the continua. There was no such end-of-continuum bias in the lexical pairs. Instead, a strong increase in sensitivity occurs in the centre of the continuum, in line with classic results for categorical perception (Fig. 2) [4]. Second, a *tone and intonation identification experiment* had listeners decide, first, which of two words a stimulus represented and, second, whether it was spoken as a declarative or as an interrogative. Only responses in which the correct word (for intonation continua) or the correct intonation (for word continua) was selected were processed, which caused 7% of responses to be discarded. Fig. 3 presents results which show poorer discrimination of intonation contrasts (left), with the lower tones (T2, T4) attracting fewer interrogative scores than the higher tones (T1, T3). The lexical tones have a fairly sharp discrimination function, in particular in the declarative intonation. A provisional conclusion is that unlike the lexical contrasts the intonation contrast is non-phonological, though highly systematic.

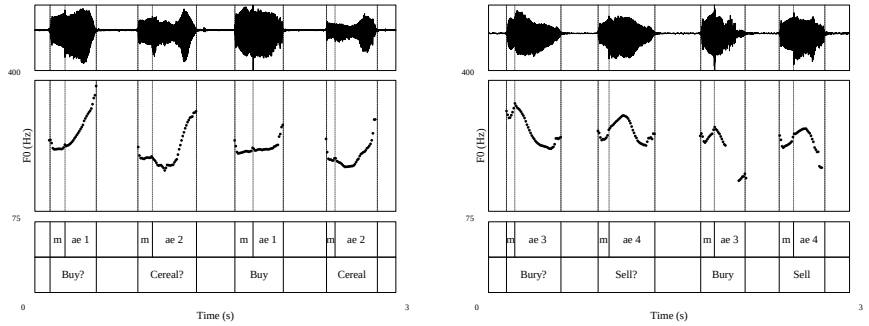

Figure 1. Interrogative and declarative pronunciations of [mae[1]] 'buy', [mae[2]] 'cereal' (left panel) and [mae[3]] 'bury', [mae[4]] 'sell' (right panel), spoken by a 23-year-old female speaker.

Table I. Three tonal quadruplets used in the experiments.

	[dii]	[lyy]	[mae]
T1: Early Rise	'bottom' 底	'aluminum' 铝	'buy' 买
T2: Late Rise	'opponent' 敌	'green' 绿	'cereal' 麦
T3: Early Fall	'low' 低	'donkey' 驴	'bury' 埋
T4: Late Fall	'earth' **地**	'to filter' 滤	'sell' 卖

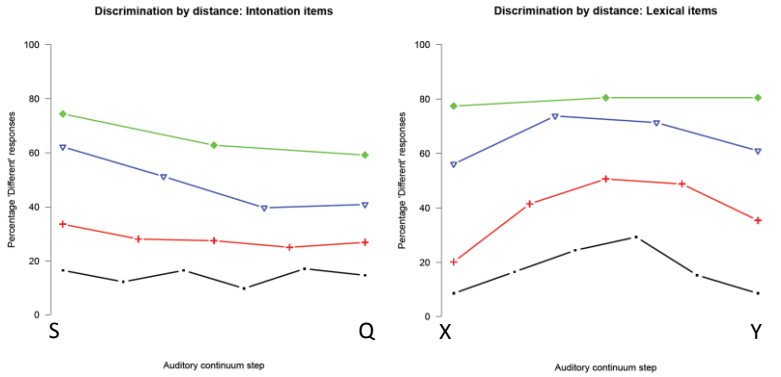

Figure 2. 'Different' judgments separatel for four step sizes for stimulus pairs from intonation continua (left) and stimulus pairs from lexical continua (right).

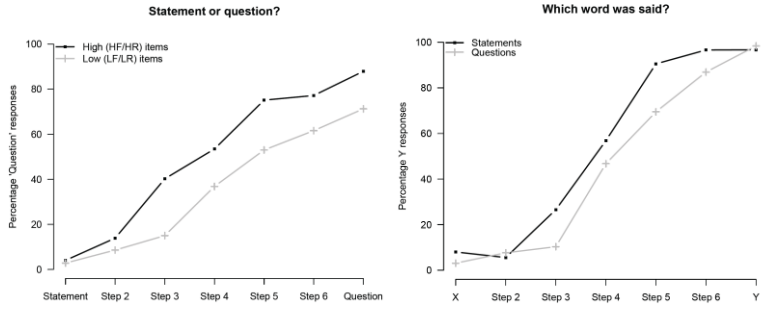

Figure 3. Identification of the intonation contrasts pooled over T1, T3 and over T2, T4 (left) and the lexical contrasts pooled over all four tones for declaratives and interrogatives separately.

[1] Bruce, G. (1977). *Swedish word accents in sentence perspective*. Lund: Gleerup.
[2] Duanmu S. 2007. *The Phonology of Standard Chinese*. Oxford University Press.
[3] Kawahara H, Masuda-Katsuse I, de Cheveigné A. 1999. Restructuring speech representations using a pitch-adaptive time-frequency smoothing and an instantaneous-frequency-based F0 extraction: Possible role of a repetitive structure in sounds. *Speech Communication* 27: 187–207.
[4] Liberman A, Harris K, Hoffmann H S, Griffith B. 1957. The discrimination of speech sounds within and across phoneme categories. *Journal of Experimental Psychology* 61: 379-388.