Dependent Pitch Cues in Tone Perception: Evidence from Mandarin Chinese

Ok Joo Lee[1] & Kyungmin Lee[2]

[1]Seoul National University (Korea), [2]Seoul National University (Korea)
ojlee@snu.ac.kr, leegmf4@snu.ac.kr

Pitch is known to be a primary phonetic and acoustic property of tone, while other articulatory features such as phonation, duration, and amplitude may also play an important role. Tones, therefore, are often defined by contrastive pitch height or movement such as 'high', 'low', 'rising', and 'falling' [1, 2, 3]. However, it has been witnessed that the production of tonal pitch is heavily influenced by neighboring tones, prosodic conditions, segmental properties as well as a speaker's pitch range and the tonal inventory of a native language [4, 5, 6]. Despite an increasing body of recent perception studies on tones [7, 8, 9], the questions of how listeners utilize seemingly unstable pitch cues and how different pitch cues interact with each other in perception are not fully understood.

The present study investigates two types of pitch cues in tone perception in Mandarin Chinese, namely, pitch height cues and pitch movement cues. As well known, Mandarin has four lexical tones, which are conventionally described as '55', '35', '214', and '51' in Chao's five-number scale or named Tone 1 through Tone 4 for ease of reference [10, 11, 12]. Among the four tones, Tone 3 surfaces as low tone when followed by Tone 1, Tone 2, or Tone 4. Therefore, pitch height cues can be crucial in identifying the high and low level tones (i.e., Tone 1 and Tone 3) in the non-final position, while pitch movement cues distinguish the rising and falling tones (i.e., Tone 2 and Tone 4). Of particular interest to this study is to explore how level and rising tones are identified when the pitch height and rising slope cues vary and how the pitch cues interact with each other in perception. Perceptual differences between native listeners (NM hereafter) and non-native listeners (i.e., native Korean listeners of advanced-level L2 Mandarin and those of beginning-level L2 Mandarin, NKA and NKB hereafter) are also examined.

A perception experiment that instructed a total of 91 participants to identify the tones in real disyllabic words of four tonal combinations (i.e., T1+T1, T1+T2, T3+T1, and T3+T2) was conducted for the study. The stimuli were created by synthesizing the F0 height on the level tone syllable and the F0 slope on the rising tone syllable, both on a 7-step continuum. The initial F0 height of the rising tone was also manipulated on a 7-step continuum. In total, 259 stimuli and 74 fillers were used in the experiment. Results of the study show: (1) the pitch height and slope cues were crucial in identifying level tones and rising tones, respectively, in NM and NKA. Neither cues were fully utilized by NKB who had a tendency to yield more Tone 1 judgements. (2) Nonetheless, the pitch cues on the adjacent tone had a significant impact on the tone identification, in that (a) the Tone 1 and Tone 3 judgements were influenced by the pitch slope of the following tone, and (b) the level tone and rising tone distinction patterns were strongly influenced by the pitch height of the preceding level tone. The pitch slope cues appeared to bear less importance in non-native perception. (3) Importantly, as shown in Figure 1, the F0 differences between the neighboring tones were the most salient cues by which both NM and NKA categorically distinguished two level tone types as well as level tones from rising tones. The findings suggest that although the pitch height cues and pitch slope cues may be the most crucial cues in identifying level tones and rising tones, respectively, in isolation, the tone perception is guided by the phonetic interactions between different types of pitch cues in connected speech. It is further suggested that the native language and L2 experience of a listener bear a substantial impact on the use of pitch cues in perception.

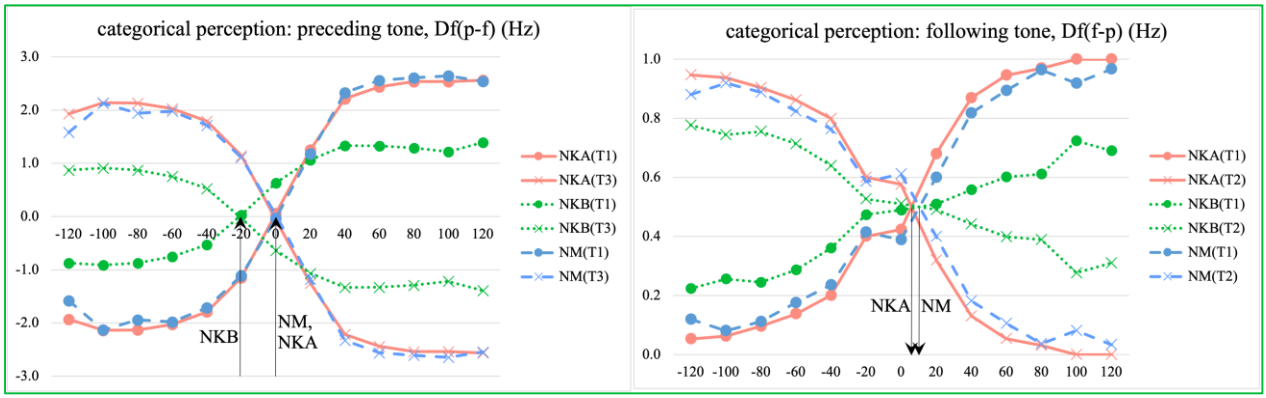

Fig.1. F0 difference cues in tone perception

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