Perceptual Boundaries of Mandarin Tones: Level vs. Rising and Level vs. Falling

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A number of studies have investigated perceptual boundaries among Mandarin tones. However, they have not fully examined whether the boundaries are consistent in different phonetic environments. This study examined the perceptual influences of register (the relative pitch in the speaker's vocal range when the syllable, word, or phrase is pronounced) and syllable duration in discriminating two kinds of tonal pairs: Tone 1 (high-level tone) vs. Tone 2 (rising tone); and Tone 1 vs. Tone 4 (falling tone). This study also investigated the magnitude of pitch rise required to be perceived as Tone 2, and that of pitch fall required to be perceived as Tone 4.

In our perceptual experiment, synthesized pitch contours were superimposed on a syllable [pa] in 9 (3×3) different environments: the variables were three registers (High, Mid and Low) and three vowel durations (350ms, 550ms and 750ms). Each environment included 13 stimuli whose onset or offset pitch values were step-wisely (by one semitone) shifted. 16 native Mandarin speakers participated in the experiment. They were asked to identify the tone from four choices: [pā], [pá], [pǎ], and [pà]. In order to avoid the influence of word familiarity, the experiment used Roman characters rather than Chinese characters.

The results of statistical analyses showed that the differences of registers and syllable durations significantly influenced perceptual boundaries of tones. In the experiment, perceptual boundaries between the two target tonal pairs shifted depending on the differences of registers and syllable durations. For example, as the vowel durations of syllables became shorter, the threshold values of Δf_o (|onset – offset|) necessary to identify Tone 2 and Tone 4 became smaller, although the duration differences were not statistically significant between 550ms and 750ms. We further found that the magnitude of pitch fall required to be perceived as Tone 4 was larger than that of pitch rise required to be perceived as Tone 2.

We conclude that register and duration are important factors for distinguishing tones in Mandarin Chinese.

Key words: Mandarin Chinese, perceiving the boundary, rising and falling tones, register, tone duration