

Stress-to-tone mapping of English polysyllabic loanwords in Mandarin

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Introduction: Stress-to-tone mapping refers to how stress in the source language is mapped to lexical tones of the borrowing language [1]. Primary stress is typically adapted as a high tone, a pattern that is well-attested in tonal languages such as Yoruba [2], Hausa [3], and Cantonese [4, 5]. In Cantonese, both primary and secondary stress are associated with high tones, whereas pretonic unstressed syllables are generally realized as mid tones and posttonic unstressed syllables as low tones [4, 5]. However, stress-to-tone mapping in Mandarin appears to be more complex. Mandarin has four lexical tones: high-level tone T1 (55), rising tone T2 (35), low-dipping tone T3 (214), and falling tone T4 (51) and one neutral tone T0, which is often described as a contextual tone rather than a lexical tone [6], realized with reduced duration and amplitude [7], and its pitch range varies with context [8]. While a previous study examined tonal adaptation in disyllabic loanwords with initial and final primary stress [1], it was found that primary initial stress in disyllabic words is mapped to T1, whereas primary final stress is mapped to T4. However, the mapping associated with secondary stress has not yet been systematically investigated. Thus, this study aims to examine the tonal mapping of primary, secondary stress and unstressed syllables by Mandarin monolingual listeners. We hypothesize that listeners' tonal adaptations are guided by average pitch height. Primary and secondary stress are characterized by higher pitch (together with longer duration and higher amplitude) and thus are predicted to be mapped to T1 in Mandarin. Unstressed syllables are predicted to map to T0 due to their reduced duration and amplitude.

Methodology: Twenty-one native speakers of Mandarin (4 males, 17 females) who learned English as a second language (median AoA = 6 years old), participated in the online tonal adaptation task. The stimuli consisted of 16 English polysyllabic pseudo-words featuring three stress types (unstressed, primary stress, and secondary stress), varying in stress position and word length (4-6 syllables). Participants listened to each word and were asked to select which tone was most similar to each syllable within the word by inputting numeric keys (0-4) corresponding to Mandarin lexical tone (T0-T4).

Results: A mixed-effects Bayesian multinomial model was fitted using the *brms* package in R. Across all stress types, T1 emerged as the dominant tonal choice, including for unstressed syllables (odds ratio [OR] = 3.32, 95% credible interval [CrI] [2.08, 5.34]; Fig. 1). Compared to unstressed syllables, the selection of T2 was credibly higher for primary stress (OR = 5.82, 95% CrI [4.13, 8.43]). We further examined whether primary stress in the penultimate and antepenultimate positions exhibited similar tonal adaptation patterns and found listeners credibly selected T2 more frequently in the penultimate position (OR = 2.03, 95% CrI [1.45, 2.89]; Fig. 2). For unstressed syllables, pretonic positions were predominantly mapped to T1, whereas posttonic positions did not show a consistent preference for any tone (Fig. 3). For secondary stress, no reliable positional effect was credibly observed (Fig. 4).

Discussion: While the results indicating primary and secondary stress were both primarily mapped to T1 conform to our hypothesis, the finding that unstressed syllables were also predominantly mapped to T1 was unexpected. A possible explanation is that the pitch movement realized on each syllable in our stimuli (Fig. 5) was less dynamic than that of Mandarin lexical tones (Fig. 6). This likely made T1 - the only non-dynamic level tone in Mandarin - the default choice, but this needs further verification in future studies. These results suggest that average pitch height may not be the primary cue that Mandarin listeners use in tonal assignment of English stress. According to tonal perception studies, pitch contour is an important cue for Mandarin speakers [9], thus it is possible that they rely on the same cue when perceiving English stress. Our findings also suggest that Mandarin stress-to-tone mapping is distinct from Cantonese.

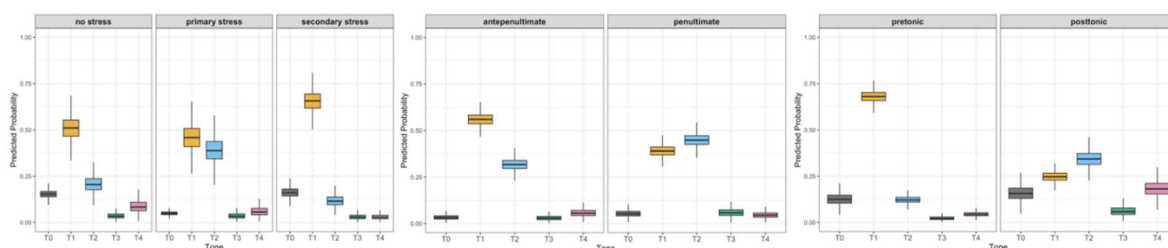


Fig. 1 (left). The model's predicted tone probabilities for different stress types.

Fig. 2 (middle). Antepenultimate and penultimate positions in primary stressed syllables

Fig. 3 (right). Pretonic and posttonic positions in unstressed syllables

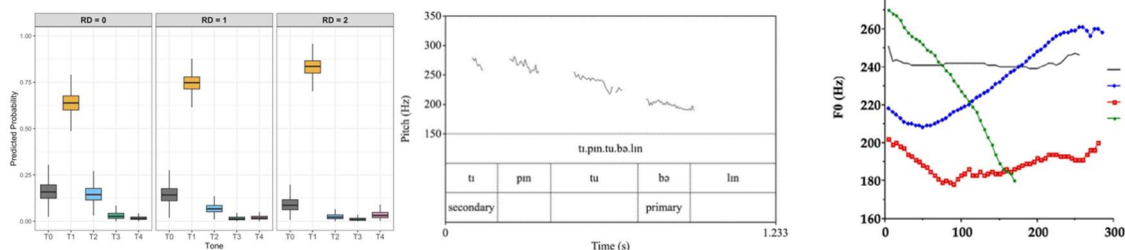


Fig. 4 (left). RD = 0, RD = 1 and RD = 2 positions in secondary stressed syllables (RD represents the relative distance to primary stress. E.g., RD = 1 represents the relative distance is one syllable.)

Fig. 5 (middle). Pitch movement of a stimuli example [ti.pn.tu.bə.ln]. The pitch contour on stressed (primary and secondary) syllables are both relatively flat compared to the pitch contour of Mandarin lexical tones (T2, T3, T4).

Fig. 6 (right). Mean F0 contours of four Mandarin tones by a female native speaker (Moore and Jongman, 1997) [10].

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