Can pitch be repurposed? Tone language speakers use their pitch sensitivity to identify voicing categories in a second language: A cue-based transfer approach

Keiji Iwamoto, Isabelle Darcy, and Kenneth de Jong
Indiana University Bloomington (USA)

We explored the informativeness of f0 cues in laryngeal contrasts in Japanese. f0 cues residing in post-stop vowels (covarying-cues with VOT cues) may be redundant but could be precious cues for L2 learners. The study examines three Japanese user groups with different native languages (L1 Japanese, L1 Mandarin, L1 English), where the languages differ in the degree of f0 cue usage for lexical contrasts (lexical pitch-accent, tone, intonation with lexical stress, respectively). We test to what extent the lexical function of f0 in L1 predicts the degree of f0 cue usage for laryngeal contrasts in the L2.

A gating paradigm was implemented to examine (1) if Japanese users (L1: English, Japanese, Mandarin) can identify laryngeal categories only by means of f0 cues on post-stop vowels, i.e., without typical primary cues (i.e., VOT cues: aspiration or pre-voicing), and (2) if there is a correlation between the lexical function of f0 in L1 and the weighting of f0 for laryngeal contrasts in the L2. Weighting is operationalized with *d'* scores in a gating task (higher *d'* = higher f0 informativeness/weighting). A gating task created contexts where VOT cues were masked by a pure tone and only f0 cues on vowels were available. Hence, an L1-L2 mismatch in the weighting of VOT cues becomes irrelevant, and listeners should attend to f0 cues to recover the laryngeal contrasts. Participants listened to gated stimuli (Japanese nonwords), and were asked to identify consonants (e.g., /t/ or /d/) when they heard /_asɯbi:/ or /haruɯ_a:sɯ/ (where '_' = pure tone maskers which replaced voiced/voiceless stops). Acoustics of the stimuli will be discussed in detail.

Three hypotheses were tested. The *Cue-Based Transfer Hypothesis* postulates that learners whose L1 utilizes f0 to signal paradigmatic lexical contrasts in L1 (tone languages) are more likely to attend to f0 cues in L2 than other cues even if f0 is used differently or in different prosodic domains in L1 and L2 [1]. This hypothesis predicts that L1 Mandarin-L2 Japanese learners attend to f0 cues more than non-tone language speakers (L1 English and Japanese native speakers). Also, among non-tone language speakers, pitch-accent language speakers (Tokyo-Japanese) would more likely attend to f0 cues than intonational pitch-accent language speakers (English speakers, [2]). In other words, the higher the lexical function of f0 in L1 is, the more informative f0 cues become in voicing contrasts (Fig.1A). The *Attenuation Hypothesis* predicts the reverse, assuming that the higher the lexical function of f0 in L1 is, the more listeners need to attenuate the weighting of f0 cues (i.e., down-weight f0 cues) for segmental contrasts so that they can preserve them for lexical contrasts (Fig.1B). The *Pitch-Saliency Hypothesis* postulates that f0 cues may be a language-independent cue thanks to its saliency because most, if not all, languages utilize f0 in some prosodic domain [3]. It predicts that the three groups will perform equally well (Fig.1C). Assuming that these three hypotheses can hold across prosodic positions, we test word-initial and intervocalic positions (high-pitch contexts) where f0 differences between voicing categories are categorical.

Results for *word-initial* position (27 participants) favor the *Cue-Based Transfer Hypothesis* (Fig.2: left). Conversely, the informativeness of f0 in *word-medial* position (23 participants; data collection is ongoing) appears to be low (Fig.2: right). Results will be discussed in terms of the three hypotheses. Accepting the *Cue-Based Transfer/Attenuation Hypothesis* implies that the initial L2 phonological state for voicing contrasts is characterized not only by the nature of L1 laryngeal contrasts ('true-voicing' vs. 'aspirating') but also by L1 lexical functions of f0. Additionally, possible acquisitional pathways (cue-reweighting) will be discussed: the possibility of repurposing sensitivity to cues acquired through L1 to facilitate L2 phonological acquisition.

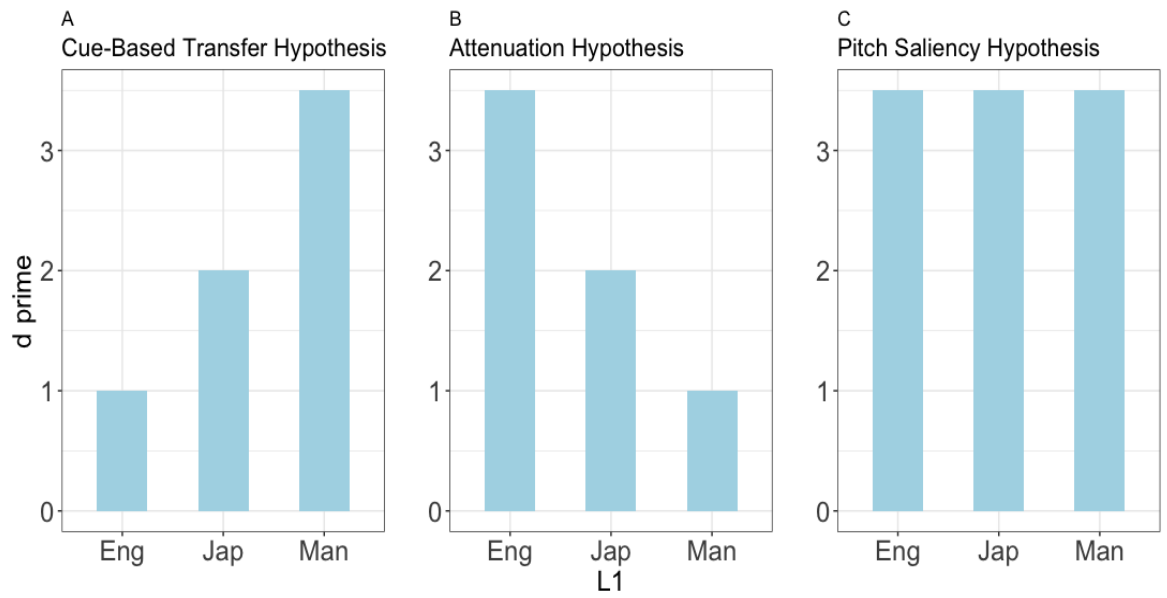

Figure 1. Informativeness predictions for each hypothesis (Eng: English, Jap: Japanese, Man: Mandarin)

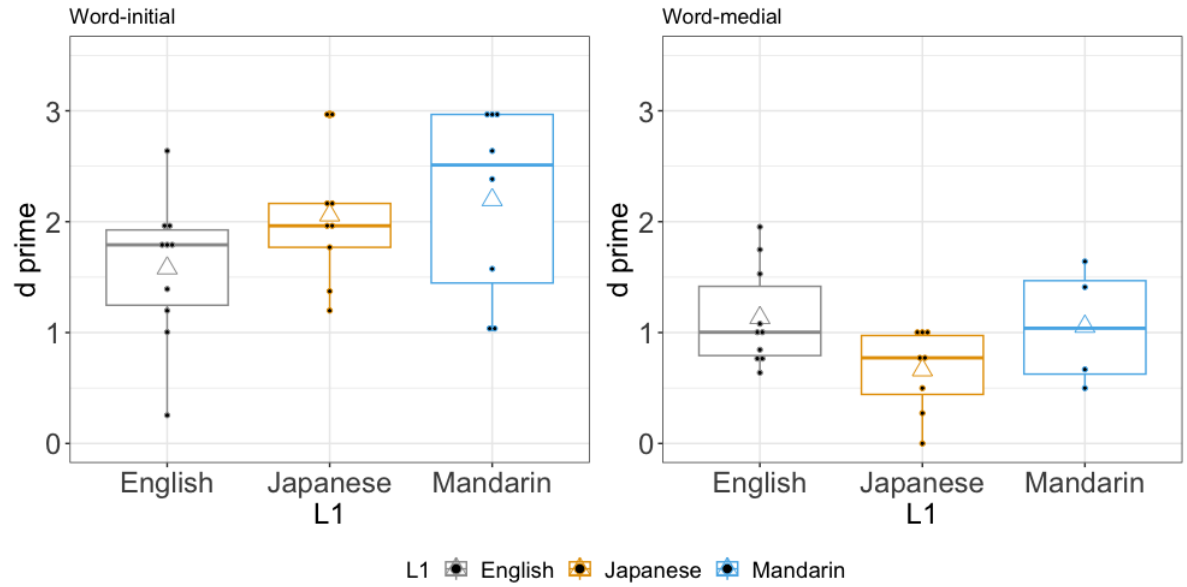

Figure 2. A dotted boxplot of *d'* (word-initial: left, word-medial: right) at the test gate where f0 cues are the only cue). Each black dot represents each participant's score. Triangles = Mean.

References

[1] Kim, H., & Tremblay, A. (2022). Intonational Cues to Segmental Contrasts in the Native Language Facilitate the Processing of Intonational Cues to Lexical Stress in the Second Language. *Frontiers in Communication, 7*, 1-12. https://doi.org/10.3389/fcomm.2022.845430

[2] Schaefer, V., & Darcy, I. (2014). Lexical function of pitch in the first language shapes cross-linguistic perception of Thai tones. *Laboratory Phonology, 5*(4), 489–522. https://doi.org/10.1515/lp-2014-0016

[3] Francis, A. L., Ciocca, V., Wong, V. K., & Chan, J. K. (2006). Is fundamental frequency a cue to aspiration in initial stops?. *The Journal of the Acoustical Society of America, 120*(5 Pt 1), 2884–2895. https://doi.org/10.1121/1.2346131