Phonological typology and perceptual distinctiveness of the [n-l] contrast in different vowel and tonal contexts

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Background: The perceptual properties of a segment are influenced by its phonetic context [10,11,14] and the perceptual distinction between sounds varies across phonetic contexts [6,9], e.g., two sounds in a contrast more distinct in one context than another [12]. The perceptual distinctiveness of sounds is found to correlate with phonological typology, with more distinct sound pairs more frequently observed [1,6,9]. The current study explores such a connection for the contrasts of two alveolar sonorants [n] vs. [l] in different vowel contexts and tonal contexts, which have diverse patterns across Chinese dialects [2,4], through typological surveys and perceptual experiments.

Typology surveys: Previous studies observed that cross-linguistically consonantal place contrasts appear less frequently in the [_i] context than in other vowel contexts [6,8,15]. For the [n-l] contrast, two typological surveys were conducted across 200 Chinese dialects, (i) one focusing on the presence/absence of the [n-l] contrast in different vowel contexts, i.e., [_a] vs. [_i], without considering tone, and (ii) the other focusing on the [n-l] contrast in different tonal contexts, e.g., a tone starting with H(igh) vs. a tone starting with L(ow). The results showed that (i) for vowel contexts, a [na-la] contrast is more frequently observed (89.0%) than a [ni-li] contrast (59.6%); (ii) for tonal contexts, a [n-l] contrast is more frequently observed with a H-initial tone (e.g., HH, HL) than a L-initial tone (e.g., LL, LH).

Perceptual experiments: For the typological patterns above, two perceptual experiments were conducted to examine their potential phonetic groundings. To evaluate the relative distinction of [n] vs. [l] in different contexts, the speeded AX discrimination task was adopted, which has been shown to be able to access the psychoacoustic distinction of sound pairs and bypass the influence of L1 phonology to a substantial extent [5,9].

Experiment 1 focused on vowel contexts, i.e., [_a] vs. [_i], recruiting 36 native Mandarin listeners. The audio stimuli were CV pairs [na-la] and [ni-li] manipulated from naturally produced tokens. The durations and intensities of the sonorant onsets and the vowels were controlled respectively referring to their mean values in natural speech [3,7]; a level F0 trajectory was superimposed to the syllables, corresponding to a mid-level tone. As the results, the [_a] context introduced a significantly shorter response time (RT) than the [_i] context ($X^2 = 5.588$, $df = 1$, $p < .05$), as in **Fig. 1**. Assuming a shorter RT to indicate a larger perceptual distinction, the results showed that a [na-la] contrast is perceptually more distinct than a [ni-li] contrast.

Experiment 2 focused on tonal contexts, recruiting 31 native Mandarin listeners. The audio stimuli were [ni-li] pairs bearing different tones, including H-initial ones (HH, HL) vs. L-initial ones (LL, LH). In addition to the stimulus manipulation as in Experiment 1, the relative intensities of different tones matched respectively their intrinsic differences, e.g., HH > LL [13]. The results showed that a H-initial tone (HH, HL) introduced a significantly shorter RT than a L-initial tone (LL, LH) ($X^2 = 8.939$, $df = 1$, $p < .01$), as in **Fig. 2**. This indicated that, for the [n] vs. [l] contrast, a H-initial tone (HH, HL) introduced more perceptual distinction than a L-initial tone (LL, LH).

Discussions and conclusions: Two typological surveys showed that, across Chinese dialects, the [n-l] contrast exists more frequently in [_a] than [_i] and more frequently with H-initial tone than L-initial tone. The results of two perceptual experiments indicated that a [n-l] contrast is psychoacoustically more distinct in [_a] and with a H-initial tone. This study confirms that the perceptual distinctiveness of the alveolar sonorants [n] vs. [l] can be influenced by vowel contexts as well as tonal contexts. In general, the results of this study support the contention that perceptual distinctiveness is relevant to the cross-linguistic typology of phonological contrasts.

Keywords: typology, perceptual distinctiveness, [n-l] contrast, vowel context, tonal context

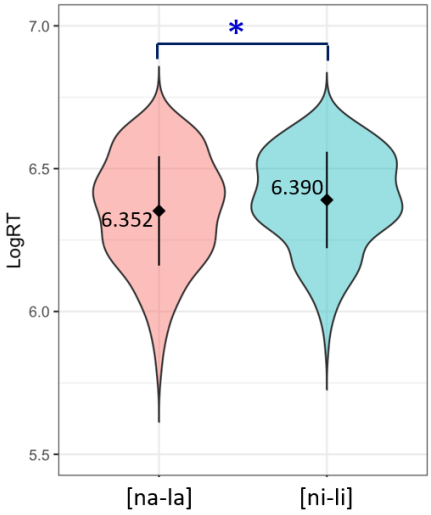

Fig. 1. Log response time (LogRT) of the [n-l] contrasts in different vowel contexts (Exp. 1), with the error bar around the mean values.

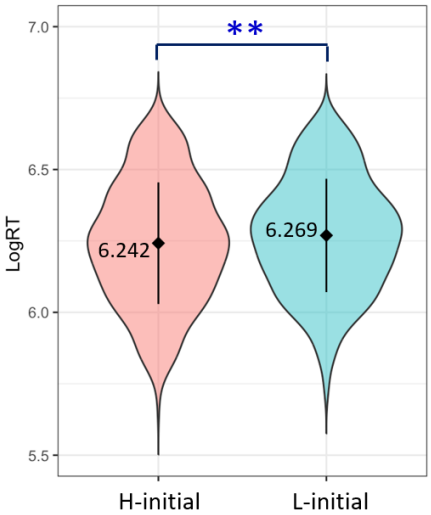

Fig. 2. Log response time (LogRT) of the [n-l] contrasts with different initial tones (Exp. 2), with error bars around the mean values.

References:

[1] Boersma, P. & Hamann, S. (2008). The evolution of auditory dispersion in bidirectional constraint grammars. *Phonology*, *25*, 217-270.

[2] Chen, M. (1967). *Nasals and nasalization in Chinese: Explorations in phonological universals*. PhD diss., Univ. of California, Berkeley.

[3] Feng, L. (1985). Duration of consonants, vowels and tones in colloquial Beijing Mandarin. In T. Lin & L. Wang (eds.) *Experimental studies in the sounds of Beijing Mandarin*. Peking Univ. Press.

[4] Ji, Y. (2006). *Sound pattern of stop onsets across Chinese dialects: A typological survey under the perspective of Sino-Tibetan languages*. PhD diss., Nankai Univ.

[5] Johnson, K. & Babel, M. (2010). On the perceptual basis of distinctive features: Evidence from the perception of fricatives by Dutch and English speakers. *J. Phon.*, *38*(1), 127-136.

[6] Lee-Kim, S-I. (2014). *Contrast neutralization and enhancement in phoneme inventories: Evidence from sibilant place contrasts and typology*. PhD diss., New York Univ.

[7] Lehiste, I. & Peterson, G. E. (1959). Vowel amplitude and phonemic stress in American English. *J. Acoust. Soc. Am.*, *31*(4), 428-435.

[8] Li, M. (2021). The typology of sibilant place contrasts in the high-front vowel context across Chinese dialects. *J. East Asian Linguist.*, *30*(4), 387-438.

[9] Li, M., & Zhang, J. (2017). Perceptual distinctiveness between dental and palatal sibilants in different vowel contexts and its implications for phonological contrasts. *Lab. Phonol.: J. Assoc. Lab. Phonol., 8*(1), 18, 1-27.

[10] Liberman, A. M., Delattre, P., & Cooper, F. S. (1952). The role of selected stimulus-variables in the perception of unvoiced stop consonants. *Am. J. Psychol.*, *65*(4), 497-516.

[11] Sereno, J. A., Baum, S. R., Marean, G. C., & Lieberman, P. (1987). Acoustic analyses and perceptual data on anticipatory labial coarticulation in adults and children. *J. Acoust. Soc. Am.*, *81*(2), 512-519.

[12] Steriade, D. (2001). Directional asymmetries in place assimilation: A perceptual account. In E. V. Hume & K. Johnson (eds.), *The role of speech perception in phonology*, 219-250. San Diego: Academic Press.

[13] Whalen, D. H. & Xu, Y. (1992). Information for Mandarin tones in the amplitude contour and in brief segments. *Phonetica*, *49*(1), 25-47.

[14] Winitz, H., Scheib, M. E., & Reeds, J. A. (1972). Identification of stops and vowels for the burst portion of /p, t, k/ isolated from conversational speech. *J. Acoust. Soc. Am.*, *51*(4B), 1309-1317.

[15] Zhang, J. & Li, M. (2022). The typology of voiceless fricatives across Chinese dialects. *Chin. J. Phon.*, *18* (2), 146-157.