Rounded or unrounded? An examination of high vowels in Taiwan Mandarin

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Taiwan Mandarin contrasts three high vowels with frontness ([i] and [y] being front) and roundedness ([y] and [u] being rounded) [1,2]. With the assignments of [round] and [back], it is suggested that sounds with the same feature value share the same articulatory gestures. However, whether or not these two sounds are identical in terms of their lip postures is not determined or specified by the assignment of their feature values. The +/− values only provide dichotomic categories between sounds; either all or nothing, but nothing in between. In particular, the [round] feature appears to provide rather simplistic interpretations of the lip postures for these high vowels as this feature is associated more with a narrowed aperture than with a specific lip posture. For example, both endolabial (e.g., [u] or [o]) and exolabial (e.g., [y] or [ø]) vowels bear the [round] features, but they contrast with each other in terms of aperture posture and the degrees of protrusion [3,4]. Insofar, whether postural differences are articulatorily achieved to distinguish the Taiwan Mandarin high vowels from one another remains unanswered. The current study investigates if there is any postural difference among the high vowels in Taiwan Mandarin and whether or not these subtle differences are consistently realized in production.

Eighteen native speakers of Taiwan Mandarin (9 F, mean = 23.44) participated in the experiment. The experiment involved a self-paced reading task. Critical stimuli consisted of the three high vowels in Taiwan Mandarin (i.e., [i], [y], and [u]), produced both in isolation (i.e., monosyllabic) and embedded in disyllabic words. Monosyllabic words were matched with a high level tone (Tone 1): [i1] ('*one*'), [u1] ('*house*'), and [y1] ('*mud*'). Disyllabic words all carried a low-dipping tone (Tone 3), following the same adjective with a falling tone (Tone 4): [ta4 i3] ('*big ant*'), [ta4 u3] ('*fifth-grader in college*'), and [ta4 y3] ('*heavy rain*'). The examinations of lip postures from the designated high vowels focused on *aperture postures* and *lip protrusion*. Aperture postures included horizontal distance, vertical distance, axial ratio, and aperture area; lip protrusion included the degrees of protrusion measured from both the upper and lower lips. These six measurements were then submitted to linear mixed models; with each measurement as dependent variable, and VOWEL ([i], [y], [u]) and WORD (isolation vs. disyllabic word) as fixed effects. Random slopes for VOWEL and WORD and random intercept for participant were also included.

The results showed that vowel [y] is postured significantly different from [i] in terms of aperture distances (both horizontal and vertical), axial ratio, aperture area, and lip protrusion (all $p < .01$), with [y] being associated with shorter aperture distances, lager axial ratio, smaller aperture area, and more protrusion. On the other hand, monosyllabic [y] only contrasted with [u] in horizontal distance, with the latter being shorter ($\beta = -0.34$, $p = .01$). No other differences with regards to aperture posture and lip protrusion were reported between [y] and [u] (all $p > .05$). Result figures are presented in Figures 1 ~ 6.

The current study compared perioral postures for the three high vowels in Taiwan Mandarin. While lip aperture characterizes the high front vowel [i], the difference between [u] and [y] did not reside in the degree of roundedness or protrusion, but rather in the postural difference at the corners of the mouth, which defines the horizontal distance in the aperture. The results show that [u] and [y], though both traditionally labeled as rounded, contrast with each other in horizontal distance between the mouth corners, yielding a more circular round posture for [u] and a more laterally compressed posture for [y]. Collectively, our results suggest that high vowels in Taiwan Mandarin are better distinguished along aperture area and lip posture. These observed postural differences for the three
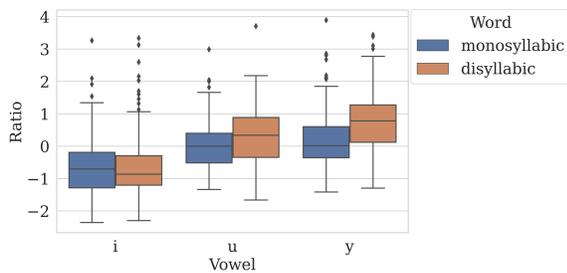
high vowels in Taiwan Mandarin ought to be available to the speakers and therefore may serve its function for perceptual identification, which would call for future research.
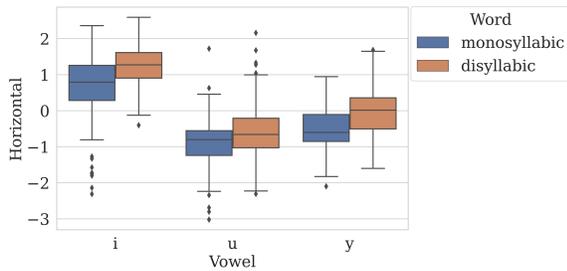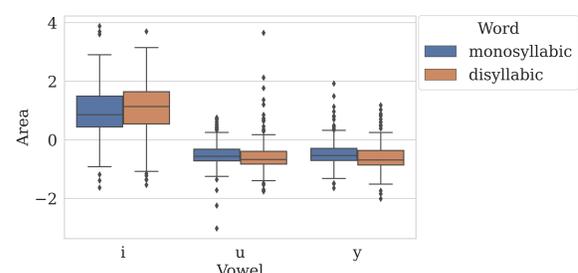

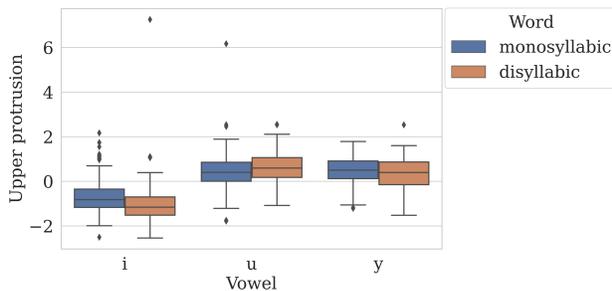**Fig. 1**: Horizontal distance (z-scored) by vowels and conditions
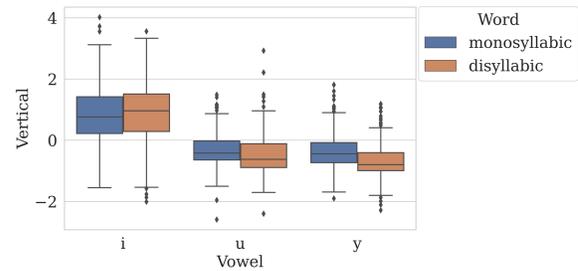
Fig. 2: Vertical distance (z-scored) by vowels and conditions
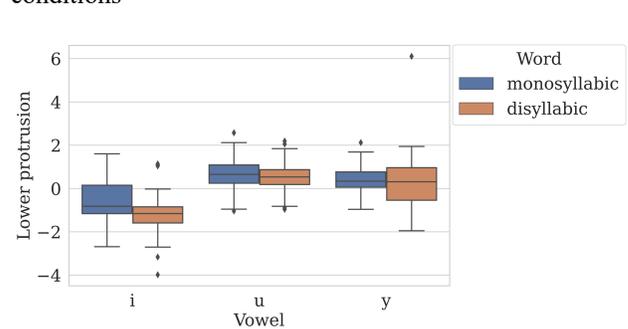

Fig. 3 Axial ratios (z-scored) by vowels and conditions

Fig. 4 Lip aperture (z-scored) by vowels and conditions

Fig. 5 Upper lip protrusion (z-scored) across vowels and conditions

Fig. 6 Lower lip protrusion (z-scored) across vowels and conditions

References
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