Talker- and listener-conditioned use of height-dependent vowel duration cue under sound change in progress: /o/ to /u/ raising in Daejeon Korean

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Background: All else being equal, higher vowels tend to be shorter than lower vowels. Production studies have investigated whether this intrinsic duration is solely a mechanical by-product of vowel height implementation or a phonologized target controlled by speakers [4,5]. In the present study, we investigate the use of intrinsic height-dependent duration in the perception of /o/ vs. /u/ contrast in Daejeon Korean. /o/ is undergoing raising, resulting in a height merger between /o/ and /u/ in numerous Korean dialects [1,2,3], including Daejeon Korean, where a recent perception study reports that younger speakers rely more on F2 than F1 for distinguishing between the two vowels [6]. Our goals are to investigate whether the duration cue is utilized in perceiving subtle height contrasts, and if so, whether its use varies by the talkers' and listeners' age and gender, mirroring the loss of height distinction led by the speech of younger female speakers. We predict that the duration cue will be more robust for older and male speakers than for younger and female speakers, in line with the direction of height merger.

Data and Analysis: Eighty-one speakers of Daejeon Korean born between 1932 and 2003 participated in the study (Table 1). A different set of four Daejeon Korean speakers varying in age and gender and representing different stages of sound change produced the speech materials: OM (most conservative), OF, YM, and YF (most innovative). Vowel stimuli were created from a token of /o/ manipulated to vary in F1, F2, and duration. The F1 and F2 ranges in z-transformed scale were determined based on pilots to encompass the entire distributions of /o/ and /u/ for all four talkers (Figure 1). The target vowel stimuli were embedded in a carrier sentence, "문장 맨 마지막 말은 __다." manipulated to vary in speech rate to match the target vowel duration (80% of the mean duration across all talkers for the short duration, 120% for the long duration). Stimuli were presented in a randomized order with no repetition, totaling 200 trials (= 5 F1 steps * 5 F2 steps * 2 duration steps * 4 talkers). Participants identified the vowel from four vowel options (o, u, ɨ, ʌ). A generalized mixed-effects model was built on 'o' vs. 'u' responses to determine the cue weights (duration, F1, & F2) and their interactions with the listeners' and talkers' age and gender (See (1)).

Results: Listeners used both F1 and F2 cues to distinguish /o/ and /u/: lower F1 and higher F2 favored /u/ across all talker*listener group conditions, although the effect size differed across them. See Figure 2. F1 interacted with the talkers' age and gender consistent with the direction of change: younger and female talkers induced responses with a steeper F1 slope than older and male talkers. There were significant five-way interactions of F1 with the four age and gender predictors, indicating that the talker-conditioned F1 use difference was not robust across different listener groups. F2, on the other hand, interacted with the listeners' age and gender in the expected direction of change, but not with the talkers' age and gender. Again, a five-way interaction indicates that the listener effect on F2 use was not consistent across different talker conditions. The main effect of duration was significant in a direction consistent with the height difference between the two vowels: the short duration favored /u/, the higher of the two vowels. Duration also interacted with listener- and talker-level predictors. Follow-up tests, as summarized in Table 2, show that significant duration effects were only found for some OM-talker conditions, the most conservative talker. Marginal effects were found for some OF- and YM-talker conditions, while no duration effects were found for any of the YF-talker conditions. Mirroring the sensitivity of F1 cue use to talker conditions, duration effects were found for the (presumed to be) more conservative talkers.

Conclusion: Listeners attend to the duration cue, even when varied independently of F1 and F2, even though duration is a redundant cue correlated with vowel height. We also observed a trend of reduced importance in the duration cue when listeners or talkers are presumed to be more advanced in the change, i.e., younger or female, supporting the idea that the intrinsic duration cue may be phonologized and socially indexed.

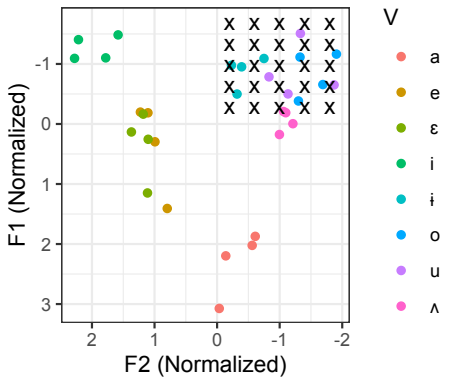

Fig. 1. The mean F1 and F2 values for 8 monophthongs produced by the stimuli talker (circles) and the distribution of synthesized target vowel stimuli (crosses).

Table 1. Invited speakers and discussants in thematic sessions.

	Older (50s +)	Younger (20s)
Male	20 (OM)	21 (YM)
Female	20 (OF)	20 (YF)

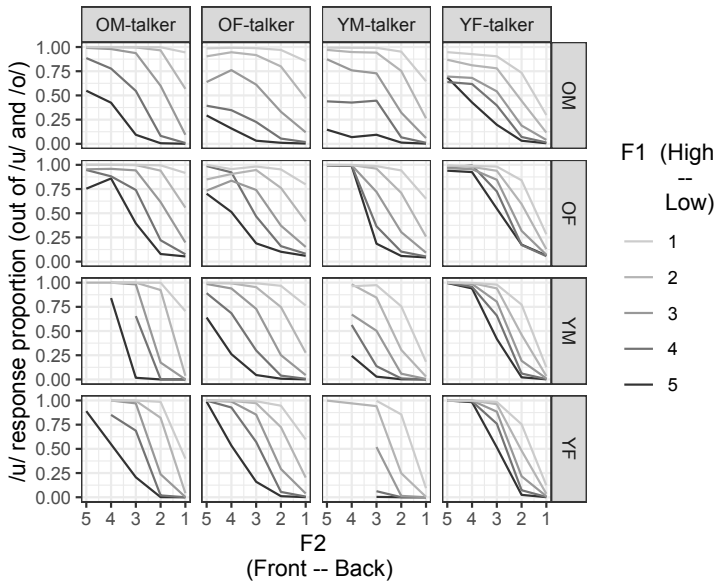

Fig. 2. The model prediction plots of /u/ response proportion by F1, F2, and the talker and listener's age and gender.

(1) glmer(resp~(rate+F1.step.norm+F2.step.norm)*gender*age*talker_gender*talker_age + (1+rate+F1.step.norm+F2.step.norm|speaker), data, family="binomial", control = glmerControl(optimizer = 'bobyqa', optCtrl=list(maxfun=2e6)))

Table 2. Summary of duration effect by talker and listener conditions

Listener	OM-talker	OF-talker	YM-talker	YF-talker
OM	n.s.	.	.	n.s.
OF	**	n.s.	n.s.	n.s.
YM	*	.	n.s.	n.s.
YF	n.s.	n.s.	.	n.s.

** p <0.01, * p<0.05, . p<0.1, n.s. p > 0.1

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