Appendix: Production data

This appendix includes the results of a production study reported in Kang, Schertz, and Han (forthcoming).

1. Participants, procedure, materials, and measurements

We report data from 194 speakers balanced for dialect (Hunchun, Dandong, or Seoul), age, and gender. Data was collected in a quiet room in Hunchun, Dandong, or Seoul in 2015-2016. Participants read words presented on a Microsoft Surface 3 tablet. Recordings were made using a high-quality lapel microphone (AT831B) and a Zoom H4N digital recorder (44.1 kHz, 16-bit).

Speakers produced di- or tri-syllabic Korean stop-initial words. The wordlist was balanced across laryngeal category (fortis, lenis, aspirated), place of articulation (p, t, k), and vowel height (low, non-low). Hunchun and Dandong speakers produced two such sets of words, one with H-initial pitch accent, and the other L-initial (this was only contrastive for Hunchun speakers), for a total of 36 words. Seoul speakers produced only one set of words (18 words). Each speaker produced two randomized repetitions of the wordlist. After omissions due to words being skipped, mispronounced, too noisy, or lacking a visible vowel (n = 289), 10,967 tokens were measured for VOT, f0, and H1-H2. Seven hundred eighty-nine further tokens which lacked a stable pitch track were omitted from f0 and H1-H2 analysis.

The following measurements are reported here.

1. Voice Onset Time (VOT): beginning at visible stop release in the waveform and ending at the onset of periodicity for the following vowel.
2. Fundamental frequency (f0), in semitones, at 20 ms after vowel onset.
3. H1-H2 (dB): intensity difference between first and second harmonics.

Table 1: Summary of participants by dialect, with mean year of birth (YOB) and standard deviation (in parentheses)

	Hunchun (n = 61)		Dandong (n = 66)		Seoul (n = 67)	
	n	YOB	n	YOB	n	YOB
Older	17 F, 13 M	1952 (8)	20 F, 14 M	1950 (9)	26 F, 16 M	1953 (10)
Younger	15 F, 16 M	1986 (8)	15 F, 17 M	1985 (10)	10 F, 15 M	1988 (8)

2. Results and statistical analysis

In this material, we include graphs of the data (2.1), a summary of the overall patterns (2.2), description and justification for the structure of the statistical models used here (2.3), and the statistical results themselves (2.4).

2.1. Summary of main findings from Kang et al. (forthcoming)

Table 2: Overall patterns (consistent across dialects), broad dialectal differences, and age- or gender-related differences within a dialect are summarized here. Statements are based on significance of main effects, interactions, and follow-up tests from the statistical models reported below.

Dimension and General patterns	**Within-dialect patterns**	**Between-dialect differences**
Voice Onset Time: Fortis < Lenis < Aspirated	Hunchun: Overall decrease in aspirated stop duration in younger speakers. Dandong: Lenis-aspirated merger in younger speakers (incomplete). Seoul: Lenis-aspirated merger in younger speakers (complete, led by females).	Lenis stops have shortest VOT in Hunchun and longest in Seoul. For-Len contrast: S > D > H Len-Asp contrast: H > D > S Merger further advanced in Seoul than in Dandong
f0: Lenis < {Fortis, Aspirated}	Hunchun: Fortis f0 is lower (patterns with lenis) for young speakers in low pitch-accent words only. Difference in f0 is overall decreasing in younger speakers. Dandong: Overall less use of f0, but increase in aspirated relative to fortis f0 in younger speakers. Seoul: Age-related increase in aspirated versus fortis f0 for males, but an overall larger difference for females, suggesting that the f0 enhancement in females is complete.	For-Len contrast: (S > D) > H (S > D for younger speakers) Len-Asp contrast: S > D > H

H1-H2: Fortis < Lenis < Aspirated (Hunchun and Dandong) Fortis < {Lenis, Aspirated} (Seoul)	Dandong: Small decrease in difference between aspirated and lenis for younger speakers.	Dandong shows a larger separation between lenis and aspirated stops, and a smaller separation between fortis and aspirated stops, than the other two dialects. Dandong and Hunchun show a significant difference between Lenis and Aspirated stop, whereas Seoul does not.

2.2. Graphs

Graphs for each dimension show by-speaker means for each laryngeal category and a best-fit regression line across the age range for each dialect and gender separately.

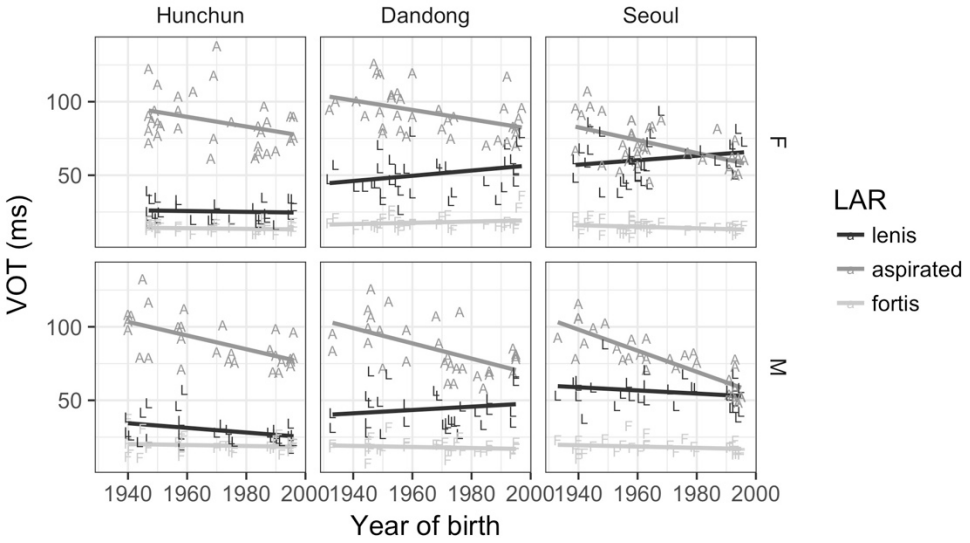

Figure 1: Voice Onset Time

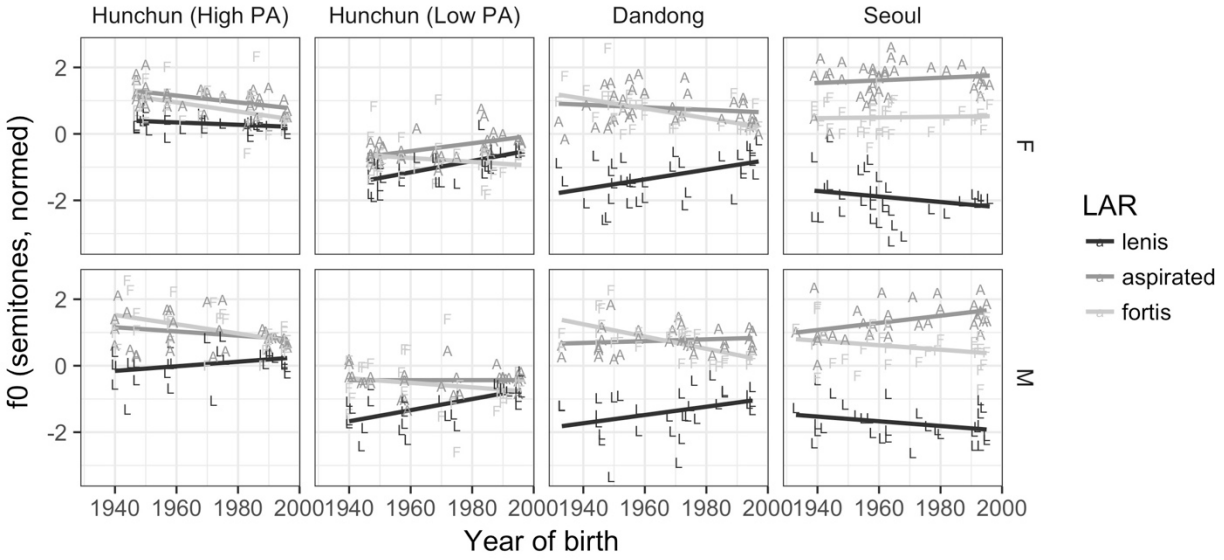

Figure 2: f0 (the Hunchun dialect has lexical pitch-accent; words beginning with high and low pitch-accent are shown separately).

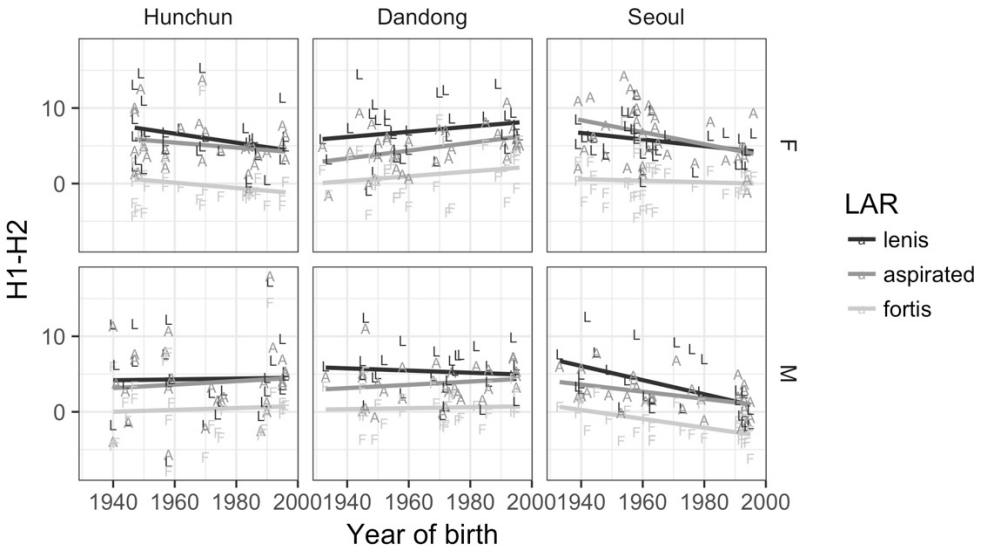

Figure 3: H1-H2

2.3. Model structure

We examined speakers' use of VOT, f0, and H1-H2 as cues to the Korean stop laryngeal contrast using linear mixed-effects models, with a separate model for each dialect and cue.

Models were structured to address our primary questions of how much speakers of each dialect 'use' each acoustic cue, and whether there are age-related differences in cue use that may signal diachronic change. The response variable was the acoustic cue: VOT (in ms), f0 (scaled to semitones, with 0

semitones corresponding to 100 Hz; statistical results are presented in units of 1/10 of a semitone for ease of presentation), and H1-H2 (in dB). Predictor variables were laryngeal category (LAR), speaker age (via year of birth: YOB), speaker gender, and all interactions. A fourth predictor, vowel height, was included as a control variable (without interactions) since vowel height has been shown to affect all three acoustic variables. The maximal random effects structure appropriate for the model was included: a by-speaker random intercept and slopes for laryngeal category and vowel height, as well as a by-word random intercept.

Predictor variables were transformed and/or coded as follows. Laryngeal category was simple-coded, with the reference level chosen depending on the cue (see below). Gender and Vowel Height were also simple-coded, with female and non-low as the reference levels. Year of birth was treated as a continuous variable and centered prior to analysis. Given this coding scheme, the intercept of a model can be interpreted as the average value of a given cue across both genders, all laryngeal categories, and the mean year of birth of the participants, while coefficients corresponding to main effects for each variable can be interpreted as the difference between the levels of that factor (for categorical variables) or for a one-unit increase in year of birth (for the continuous variable). Follow-up tests, where done using the phia package, with no p-value adjustment (De Rosario-Martinez, 2015). When we wanted to explore differences for younger and older groups separately, we used a median split to create a binary variable, with speakers born on or after 1970 consider 'younger' and those before 1970 considered 'older,' and ran models with this instead of the continuous YOB variable.

We interpret main effects and interactions for which the absolute *t*-value is greater than 2 as significant. As our main question of interest is how the use of cues patterns across laryngeal categories, we focus on main effects of LAR and its interactions with Age and Gender, setting aside overall effects of Age and Gender, although full results are presented in the statistical tables.

2.4. Statistical Tables

Each table below reports the results of a mixed-effects model of one of three acoustic dimensions: Voice Onset Time (ms), f0 (in 1/10 of a semitone), or H1-H2 (dB). Predictor variables were laryngeal category, year of birth, gender, and vowel height, and a separate model was run for each dialect. Coefficients for each main effect represent the difference in the dimension between the given level and the reference level (in italics). Beta-coefficients, standard errors, and *t*-values are given, and those factors considered significant ($|t| > 2$) are shaded.

Table 3: Voice Onset Time (ms)

	Hunchun			Dandong			Seoul		
	β	*SE*	*t*	*β*	*SE*	*T*	*β*	*SE*	*t*
Intercept	44.10	1.85	23.90	51.09	2.00	25.54	49.43	2.43	20.31
LAR Asp-*Len*	60.14	4.20	14.34	40.01	4.46	8.97	14.62	5.59	2.61
LAR For-*Len*	-11.16	3.94	-2.83	-29.74	4.38	-6.79	-42.41	5.65	-7.51
Year of birth (YOB)	-0.18	0.05	-3.46	-0.08	0.05	-1.55	-0.19	0.05	-3.88
Gender Male-*Female*	4.40	1.94	2.27	-4.13	2.10	-1.97	2.69	1.86	1.45
V. Height Low-*Nonlow*	0.94	3.18	0.29	1.33	3.44	0.39	9.50	4.53	2.10
LAR Asp * YOB	-0.33	0.09	-3.75	-0.57	0.09	-6.65	-0.63	0.06	-10.90
LAR For * YOB	0.06	0.05	1.39	-0.17	0.07	-2.52	-0.10	0.07	-1.56
LAR Asp * Gender	-1.83	3.33	-0.55	-0.34	3.35	-0.10	13.25	2.22	5.98
LAR For * Gender	0.88	1.74	0.51	5.77	2.60	2.22	8.17	2.56	3.20
YOB * Gender	-0.09	0.10	-0.93	-0.09	0.11	-0.80	-0.20	0.10	-2.09
LAR Asp * YOB * Gender	-0.02	0.17	-0.12	-0.13	0.17	-0.75	-0.03	0.12	-0.27
LAR For * YOB * Gender	0.11	0.09	1.19	-0.07	0.13	-0.52	0.29	0.13	2.17

Table 4: f0 (1 unit of f0 represents 1/10 of a semitone)

	Hunchun (H PA)			Hunchun (Low PA)			Dandong			Seoul		
	β	*SE*	*t*	*β*	*SE*	*t*	*β*	*SE*	*t*	*β*	*SE*	*t*
Intercept	59.25	2.14	27.72	44.71	2.16	20.70	56.39	1.89	29.8	67.94	2.14	31.68
LAR Len-*For*	-7.54	1.31	-5.77	-3.82	1.89	-2.03	-19.72	1.5	-13.11	-22.6	2.21	-10.23
LAR Asp-*For*	1.03	1.32	0.79	3.11	1.88	1.66	1.24	1.13	1.09	10.9	2.03	5.36
Year of birth (YOB)	0.28	0.11	2.53	0.34	0.11	3.24	0.02	0.10	0.20	0.26	0.10	2.49
Gender Male-*Female*	-69.03	4.21	-16.41	-67.67	4.07	-16.65	-63.81	3.71	-17.19	-65.08	4.00	-16.26
V. Height Low-*Nonlow*	-7.00	1.10	-6.38	-5.07	1.46	-3.48	-5.10	0.83	-6.16	-7.20	1.59	-4.54
LAR Len * YOB	0.14	0.05	2.89	0.26	0.05	4.72	0.19	0.05	3.64	-0.07	0.06	-1.19
LAR Asp * YOB	0.07	0.05	1.42	0.17	0.05	3.32	0.13	0.04	3.38	0.08	0.04	1.97
LAR Len * Gender	-5.85	1.84	-3.18	-4.31	2.08	-2.08	1.76	2.02	0.87	1.78	2.28	0.78
LAR Asp * Gender	-4.64	1.86	-2.49	-3.10	2.00	-1.55	0.07	1.46	0.04	-4.06	1.62	-2.50
YOB * Gender	-0.27	0.22	-1.23	-0.34	0.21	-1.61	-0.81	0.19	-4.25	-0.57	0.21	-2.72
LAR Len * YOB * Gender	0.12	0.10	1.26	0.00	0.11	0.03	-0.03	0.10	-0.33	0.13	0.12	1.11
LAR Asp * YOB * Gender	0.07	0.10	0.67	-0.09	0.11	-0.85	0.09	0.08	1.19	0.20	0.09	2.34

Table 5: H1-H2 (dB)

	Hunchun			Dandong			Seoul		
	β	*SE*	*t*	*β*	*SE*	*t*	*β*	*SE*	*t*
Intercept	3.26	0.53	6.11	3.80	0.34	11.09	2.64	0.41	6.38
LAR Asp-*Len*	-0.86	0.42	-2.04	-2.12	0.44	-4.84	-0.38	0.85	-0.45
LAR For-*Len*	-5.06	0.45	-11.17	-5.26	0.49	-10.73	-4.88	0.88	-5.52
Year of birth (YOB)	-0.01	0.03	-0.35	0.02	0.02	1.06	-0.06	0.01	-4.01
Gender Male-*Female*	-1.70	1.02	-1.66	-0.73	0.62	-1.18	-2.62	0.53	-4.98
V. Height Low-*Nonlow*	2.86	0.38	7.56	2.92	0.35	8.26	2.70	0.69	3.94
LAR Asp * YOB	0.02	0.01	1.60	0.03	0.01	2.13	0.00	0.02	0.10
LAR For * YOB	0.02	0.02	1.28	0.01	0.02	0.82	0.04	0.02	1.76
LAR Asp * Gender	0.23	0.52	0.44	-0.28	0.52	-0.53	-1.90	0.68	-2.79
LAR For * Gender	1.69	0.61	2.79	-0.29	0.66	-0.43	0.26	0.83	0.32
YOB * Gender	0.05	0.05	0.96	-0.03	0.03	-0.85	-0.02	0.03	-0.89
LAR Asp * YOB * Gender	-0.01	0.03	-0.43	0.00	0.03	0.11	0.09	0.04	2.59
LAR For * YOB * Gender	-0.02	0.03	-0.57	0.01	0.04	0.4	0.00	0.04	-0.06

2.5. Direct cross-dialectal comparisons

The following statistical models perform a direct cross-dialectal comparison on the data above, for each two-way pairwise comparison separately, in order to formulate predictions that are parallel with the perception analysis. For each of the three acoustic dimensions, we built three models representing each of the pairwise comparisons (e.g., aspirated vs. lenis), for a total of nine models. Only high pitch-accent tokens were included for Hunchun. The response variable was again the acoustic cue, and predictors were the same as above but also included Dialect, with the reference level for dialect set as the numerically intermediate category. All interactions were included. Reference levels are in italics; all categorical factors were simple-coded. Significant effects of laryngeal category and its interactions with dialect (and any significant higher-order interactions including these) are highlighted.

The main findings, focusing on dialectal differences, are summarized below each table.

Table 6: VOT

	Fortis vs. *Lenis*			Fortis vs. *Aspirated*			Aspirated vs. *Lenis*		
	β	*SE*	*t*	*β*	*SE*	*t*	*β*	*SE*	*t*
Intercept	31.15	1.75	17.75	50.49	1.92	26.34	64.16	2.2	29.13
Dialect: Hunchun vs. *Dandong*	-10.18	1.18	-8.65	-0.82	1.39	-0.59	-8.96	1.88	-4.77
Dialect: Seoul vs. *Dandong*	3.65	1.19	3.07	-6.07	1.4	-4.34	-1.84	1.89	-0.97
LAR	-27.31	3.45	-7.92	-66.17	3.77	-17.53	38.69	4.2	9.22
Year of Birth (YOB)	0	0.03	0.18	-0.25	0.03	-8.4	-0.2	0.04	-5.08
Gender M vs. *F*	0.51	0.97	0.52	2.23	1.14	1.96	0.04	1.54	0.03
Vowel Low vs. *Nonlow*	-0.36	3.39	-0.11	2.04	3.68	0.55	5.9	4.14	1.42
Dialect Hunchun * LAR	17.32	1.64	10.58	-0.51	2.28	-0.23	19.47	2.13	9.14
Dialect Seoul * LAR	-8.79	1.77	-4.97	9.57	2.35	4.07	-20.91	2.21	-9.48
Dialect Hunchun * YOB	-0.12	0.06	-1.99	-0.01	0.07	-0.1	-0.12	0.1	-1.28
Dialect Seoul * YOB	-0.07	0.06	-1.12	-0.11	0.07	-1.56	-0.14	0.1	-1.41
LAR * YOB	-0.06	0.04	-1.57	0.44	0.05	9.1	-0.51	0.05	-11.12
Dialect Hunchun * Gender	7.76	2.35	3.3	7.72	2.78	2.78	9.82	3.76	2.62
Dialect Seoul * Gender	2.44	2.36	1.04	9.38	2.76	3.4	8.11	3.75	2.16
LAR * Gender	5.14	1.37	3.74	1.68	1.88	0.89	3.57	1.76	2.03
YOB * Gender	-0.09	0.05	-1.74	-0.12	0.06	-1.96	-0.18	0.08	-2.2
Dialect Hunchun * LAR * YOB	0.18	0.08	2.17	-0.02	0.12	-0.2	0.26	0.11	2.33
Dialect Seoul * LAR * YOB	0.03	0.09	0.35	0.15	0.12	1.23	-0.06	0.11	-0.5
Dialect Hunchun * LAR * Gender	-3.88	3.27	-1.19	-4.7	4.56	-1.03	-1.37	4.25	-0.32
Dialect Seoul * LAR * Gender	2.53	3.38	0.75	-11.55	4.58	-2.52	13.66	4.31	3.17
Dialect Hunchun * YOB * Gender	0.02	0.12	0.16	0.05	0.14	0.36	-0.06	0.19	-0.31
Dialect Seoul * YOB * Gender	-0.05	0.12	-0.43	-0.03	0.14	-0.19	-0.2	0.19	-1.06
LAR * YOB * Gender	0.11	0.07	1.59	0.15	0.1	1.55	-0.06	0.09	-0.65
Dialect Hunchun * LAR * YOB * Gender	0.07	0.17	0.41	0.04	0.24	0.17	0.12	0.22	0.54
Dialect Seoul * LAR * YOB * Gender	0.25	0.17	1.45	0.26	0.24	1.09	0.09	0.22	0.42

VOT as a cue to the fortis-lenis contrast: The dialectal differences seen in the graphs are significant: Seoul shows the greatest difference, followed by Dandong, followed by Hunchun. The difference in use of VOT to signal the fortis-lenis contrast between Hunchun and Seoul is even greater in younger speakers, due to the age-related VOT changes in Seoul.

VOT as a cue to the fortis-aspirated contrast: The contrast is well-separated in all dialects, with no difference between the degree of separation in Dandong and Hunchun, but a smaller difference in Seoul than Hunchun due to the lower aspirated stop VOT in Seoul, and this difference is of a greater magnitude in female speakers.

VOT as a cue to the aspirated-lenis contrast: The dialectal differences seen in the graphs are significant: Hunchun shows the greatest difference, followed by Dandong, followed by Hunchun. The difference in use of VOT to signal the aspirated-lenis contrast between Hunchun and Dandong is greater in younger speakers, due to the ongoing merger in Dandong, and the difference between Seoul and Dandong is greater for female speakers.

Table 7: f0

	Fortis vs. *Lenis*			Fortis vs. *Aspirated*			Aspirated vs. *Lenis*		
	β	*SE*	*t*	*β*	*SE*	*t*	*β*	*SE*	*t*
Intercept	56.97	1.2	47.4	67.54	1.26	53.5	59.24	1.21	48.82
Dialect: Hunchun vs. *Dandong*	4.44	2.83	1.57	-1.87	2.95	-0.63	4.96	2.8	1.77
Dialect: Seoul vs. *Dandong*	8.49	2.77	3.06	14.99	2.9	5.17	13.29	2.74	4.85
LAR	16.6	0.97	17.05	-4.47	0.93	-4.79	21.03	1.07	19.66
Year of Birth (YOB)	0.18	0.06	3.09	0.17	0.06	2.77	0.22	0.06	3.78
Gender M vs. *F*	-65.66	2.29	-28.64	-66.07	2.39	-27.62	-66.82	2.27	-29.48
Vowel Low vs. *Nonlow*	-7.16	0.82	-8.69	-6.15	0.88	-7.01	-5.25	0.92	-5.69
Dialect Hunchun * LAR	-14.27	1.56	-9.15	-0.66	1.2	-0.55	-12.49	1.49	-8.37
Dialect Seoul * LAR	2.98	1.56	1.91	-9.21	1.22	-7.52	13.48	1.49	9.03
Dialect Hunchun * YOB	0.25	0.15	1.74	0.28	0.15	1.86	0.2	0.14	1.39
Dialect Seoul * YOB	0.17	0.14	1.19	0.32	0.15	2.14	0.16	0.14	1.12
LAR * YOB	-0.09	0.03	-2.64	-0.1	0.03	-4.04	-0.01	0.03	-0.18
Dialect Hunchun * Gender	-4.38	5.65	-0.77	-3.71	5.9	-0.63	-6.03	5.59	-1.08
Dialect Seoul * Gender	1.05	5.53	0.19	-1.57	5.77	-0.27	-0.68	5.47	-0.12
LAR * Gender	1.02	1.26	0.81	3.18	0.96	3.3	-1.58	1.2	-1.31
YOB * Gender	-0.57	0.12	-4.75	-0.55	0.12	-4.45	-0.51	0.12	-4.37
Dialect Hunchun * LAR * YOB	0.14	0.08	1.78	0.09	0.06	1.53	0.06	0.08	0.81
Dialect Seoul * LAR * YOB	0.3	0.08	3.82	0.06	0.06	1.01	0.24	0.07	3.19
Dialect Hunchun * LAR * Gender	3.24	3.06	1.06	3.43	2.32	1.48	1.09	2.93	0.37
Dialect Seoul * LAR * Gender	-3.04	3.01	-1.01	3.35	2.29	1.46	-5.27	2.88	-1.83
Dialect Hunchun * YOB * Gender	0.57	0.29	1.93	0.49	0.31	1.62	0.55	0.29	1.88
Dialect Seoul * YOB * Gender	0.23	0.29	0.82	0.21	0.3	0.71	0.27	0.28	0.95
LAR * YOB * Gender	-0.07	0.07	-1.05	-0.12	0.05	-2.38	0.04	0.06	0.59
Dialect Hunchun * LAR * YOB * Gender	-0.11	0.16	-0.66	0.05	0.12	0.4	-0.16	0.15	-1.04
Dialect Seoul * LAR * YOB * Gender	-0.11	0.16	-0.68	-0.08	0.12	-0.71	-0.03	0.15	-0.2

F0 as a cue to the fortis-lenis contrast: Lenis stops are overall lower than fortis stops, but this difference is much smaller in Hunchun than the other two dialects. For younger speakers only, there is a larger difference in Seoul than Dandong.

F0 as a cue to the fortis-aspirated contrast: Seoul shows greater use of f0 as a cue to this contrast (with aspirated higher than lenis stops) than the other two dialects.

F0 as a cue to the aspirated-lenis contrast: There is a clear and significant difference between all three dialects, with Hunchun showing the least and Seoul showing the greatest difference. The Seoul-Dandong difference is greater for younger speakers.

Table 8: H1-H2

	Fortis vs. *Lenis*			Fortis vs. *Aspirated*			Aspirated vs. *Lenis*		
	β	*SE*	*t*	*β*	*SE*	*t*	*β*	*SE*	*t*
(Intercept)	2.7	0.28	9.79	2.17	0.26	8.28	4.67	0.26	17.83
Dialect: Dandong vs. *Hunchun*	0.88	0.54	1.64	0.27	0.53	0.52	0.36	0.57	0.63
Dialect: Seoul vs. *Hunchun*	-0.96	0.54	-1.78	-0.6	0.53	-1.13	-0.77	0.57	-1.35
LAR	-5.01	0.4	-12.61	-3.97	0.35	-11.44	-1.05	0.3	-3.54
Year of Birth (YOB)	-0.02	0.01	-1.74	-0.01	0.01	-0.98	-0.02	0.01	-1.72
Gender M vs. *F*	-1.2	0.43	-2.76	-1.4	0.43	-3.27	-2.18	0.46	-4.71
Vowel Low vs. *Nonlow*	2.7	0.37	7.31	2.9	0.35	8.41	3.06	0.29	10.63
Dialect Dandong * LAR	-0.22	0.49	-0.45	1.17	0.43	2.74	-1.23	0.4	-3.09
Dialect Seoul * LAR	0.54	0.52	1.04	-0.17	0.46	-0.38	0.78	0.43	1.84
Dialect Dandong * YOB	0.03	0.03	1.21	0.03	0.03	1.23	0.04	0.03	1.3
Dialect Seoul * YOB	-0.03	0.03	-0.99	-0.04	0.03	-1.38	-0.06	0.03	-1.87
LAR * YOB	0.02	0.01	2.2	0.01	0.01	0.57	0.02	0.01	1.94
Dialect Dandong * Gender	-0.7	1.07	-0.65	-0.48	1.06	-0.45	0.16	1.14	0.14
Dialect Seoul * Gender	-1.45	1.07	-1.35	-2.41	1.06	-2.28	-1.05	1.14	-0.92
LAR * Gender	0.73	0.4	1.8	1.38	0.36	3.89	-0.56	0.33	-1.68
YOB * Gender	-0.01	0.02	-0.39	0.01	0.02	0.28	0	0.02	0.1
Dialect Dandong * LAR * YOB	-0.01	0.03	-0.41	-0.01	0.02	-0.65	0	0.02	0.16
Dialect Seoul * LAR * YOB	0.01	0.03	0.51	0.04	0.02	1.84	-0.03	0.02	-1.25
Dialect Dandong * LAR * Gender	-0.94	0.97	-0.97	-1.59	0.85	-1.87	0.38	0.8	0.48
Dialect Seoul * LAR * Gender	-1.08	1.01	-1.07	0.65	0.89	0.73	-1.72	0.83	-2.07
Dialect Dandong * YOB * Gender	-0.09	0.06	-1.63	-0.08	0.06	-1.39	-0.1	0.06	-1.69
Dialect Seoul * YOB * Gender	-0.11	0.06	-1.98	-0.06	0.06	-1.07	-0.06	0.06	-1.01
LAR * YOB * Gender	0	0.02	0.07	-0.03	0.02	-1.36	0.03	0.02	1.71
Dialect Dandong * LAR * YOB * Gender	0.04	0.05	0.76	0.02	0.04	0.43	0.03	0.04	0.72
Dialect Seoul * LAR * YOB * Gender	0.02	0.05	0.42	-0.08	0.05	-1.71	0.11	0.04	2.54

H1-H2 as a cue to the fortis-lenis contrast: No significant dialectal differences.

H1-H2 as a cue to the fortis-aspirated contrast: Dandong shows less separation than the other two dialects.

H1-H2 as a cue to the aspirated-lenis contrast: Dandong shows more separation than the other two dialects. There are small differences between Seoul and Hunchun, which differ based on gender and age, but when broken down into follow-up tests, none of these differences are significant, and their direction is not consistent or predicted.

References

De Rosario-Martinez, H. (2015). Package 'phia' v. 0.1. https://github.com/heliosdrm/phia.

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