The production-Perception link in tonogenetic sound change in three dialects of Korean

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Overview

- Sound change in **aspirated**-**lenis** stop contrast in three dialects of Korean
- Relationship between production and perception
- Implications for the mechanism of (tonogenetic) sound change

Korean stops

Aspirated (heavily aspirated)	**Lenis** (slightly aspirated)	**Fortis** (unaspirated)
/p^h t^h k^h/	/p t k/	/p' t' k'/

/t^hal/ 'mask' /tal/ 'moon' /t'al/ 'daughter'

Korean stops

Aspirated (heavily aspirated)	**Lenis** (slightly aspirated)	**Fortis** (unaspirated)
/p^h t^h k^h/	/p t k/	/p' t' k'/

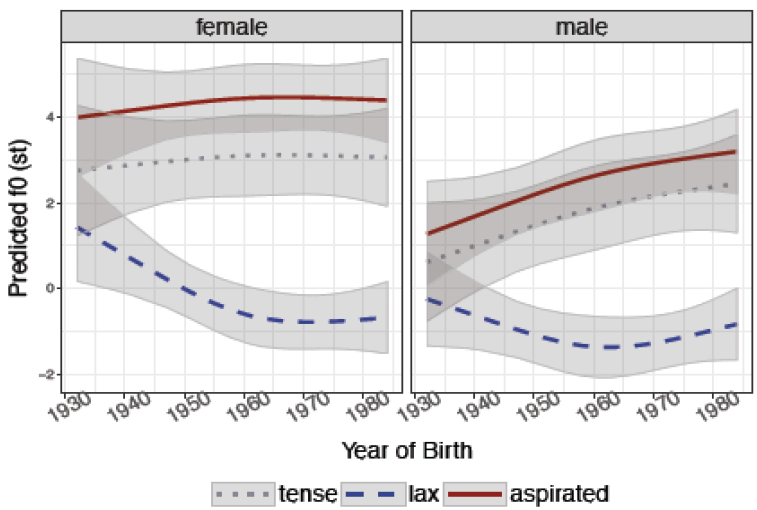
/t^hal/ 'mask' /tal/ 'moon' /t'al/ 'daughter'

Sound Change in Seoul Korean

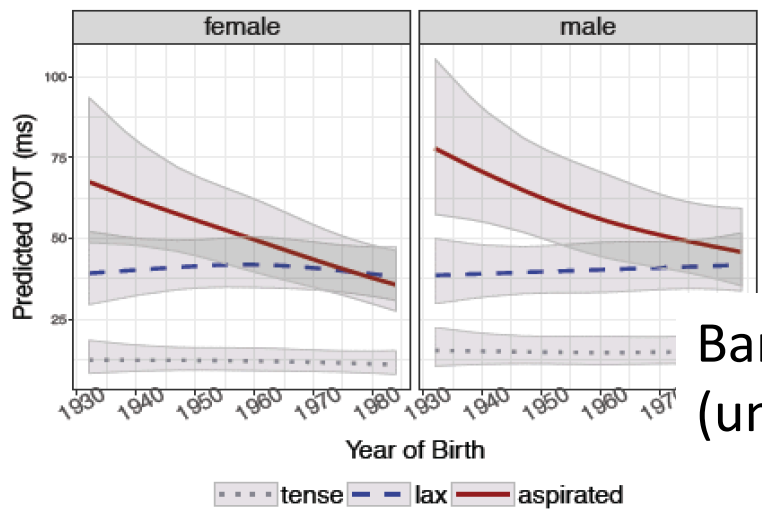
- A primary cue for Aspirated vs. Lenis stop contrast is shifting from **VOT** to **F0**.
- Limited to phrase-initial position.
- Female speakers lead the change.

Kim et al. 2002, Silva 2006, Wright 2007, Kang & Guion 2008, Kong 2009, Park & Iverson 2008, Kang & Han 2012, Beckman, et al. 2014, Kang 2014, Schertz 2014

F0



VOT



Bang, et al. (under revision)

Dialects

- A similar VOT merger is reported for:
  - Jeju, Shenyang China, Arlington TX, Toronto

Silva 2006, Jin 2008, Kong 2009, Holliday & Kong 2011, Kang and Nagy 2016

- Pitch accent dialects are further behind.
  - Kyeongsang: larger VOT difference

M. Cho 2004, Kenstowicz and Park 2006, Holliday and Kong 2011, Jang 2012, H. Lee and Jongman 2012

  - Yanbian China: largest VOT difference

Zhang and Li 2005, Ito and Kenstowicz 2008, H-K. Kim 2009, E. Chung 2011, Kang and Han 2012b, Oh and Yang 2013

Mechanisms of tonogenesis

- Listener-driven change
  - Perceptual reanalysis of consonant-induced f0 as tonal
  - Failure to compensate for coarticulatory influence of consonants on vowel f0
  - A perceptual innovation can start without change in production.

Ohala 1981, 1993, Hombert et al. 1979 (cf. Beddor 2009, 2012, Baker et al. 2011)

Mechanisms of tonogenesis

- Speaker-driven change
  - Talker-oriented hypoarticulation bias (reduction of VOT contrast)
  - Listener-oriented cue enhancement (increasing f0 contrast) to preserve contrast

Kirby 2013, Bang, et al. under revision (cf. Lindblom 1990, Lindblom, et al. 1995)

Time course of change

- Cases of perception changing ahead of production in sound change in progress
  - Kleber, Harrington, and Reubold (2011):
    - /ʊ/ fronting in Standard Southern British English
  - Kuang and Cui (2016):
    - Cue shifts in phonation contrast in Southern Yi
- Interpreted as support for the perception-driven model of sound change

Perception

- Perception reflects the ***listener's*** own production characteristics.

Ladefoged & Broadbent 1957, Janson 1983, Miller & Grosjean 1997, Hay et al. 2006, Drager 2011, Fridland & Kendall 2012, Kendall & Fridland 2012

- Listeners adjust their perception according to the (perceived) identity of the ***talker***.

Johnson et al. 1999, Strand 1999, Niedzielski 1999, Hay et al. 2006a,2006b, Koops et al. 2008, Drager 2010, Schertz et al. 2017

- Perception ~ listener's production

  + **talker**'s (expected) production

Listeners during sound change

- If sound change is already advanced enough to develop indexicality, listeners may adjust their perception according to the talker age.
- An older listener adapting their perception to a younger talker speech will give the appearance of perceptual innovation (perception leading production in change), when in fact, the misalignment is a consequence of sound change that already took place.

Perception of Korean stops

- Perception reflects the **listener**'s own production characteristics, conditioned by dialects, age, etc.

Lee and Chung 2000, M. Kim, et al. 2002, M. Kim 2004, K. Kang 2009, Lee & Shin 2010, Kong et al. 2011, H. Jang 2012, H. Lee et al. 2013, Schertz 2014, Lee & Shin 2010, H. Jang 2012, Schertz, et al. under revision, K. Kang 2009

- Seoul Korean listeners are sensitive to gender and age of the talker.

Kong et al. 2011

Where to look

- The change in Seoul Korean is too advanced.
- An early stage of change before indexicality develops is a better place to look for evidence of perceptual innovation.
- Chinese diasporas (Dandong and Hunchun) expected to show a much earlier stage of change based on our previous study (Kang and Han 2012)

Methods: Participants

	Hunchun (n= 60)	Dandong (n=64)	Seoul (n=65)
Pitch accent	Yes	No	No
Older (> 60 yrs)	10 F, 7 M	14 F, 9 M	9 F, 10 M
Mid (35-60 yrs)	9 F, 10 M	10 F, 12 M	15 F, 12 M
Young (< 35 yrs)	13 F, 11 M	10 F, 9 M	9 F, 10 M

Methods: Production

- Stop-initial words controlled for
  - Laryngeal feature (aspirated, fortis, lenis)
  - Place of articulation (labial, coronal, dorsal)
  - Pitch accent (H-, L-): relevant for Hunchun only
  - Total: 18 (Seoul) ~ 36 (Hunchun, Dandong) words
- Word reading, part of a larger word list
- 2 repetitions in random order

Analysis: Production

- Acoustic measurements
  - VOT (ms)
  - F0 at vowel midpoint (semitone, ref=100 Hz)

Methods: Perception Stimuli

- Coronal stop-initial monosyllables
- Two talkers:
  - Younger female (in her 20s):

    expected to be the most advanced in change
  - Older male (in his 70s):

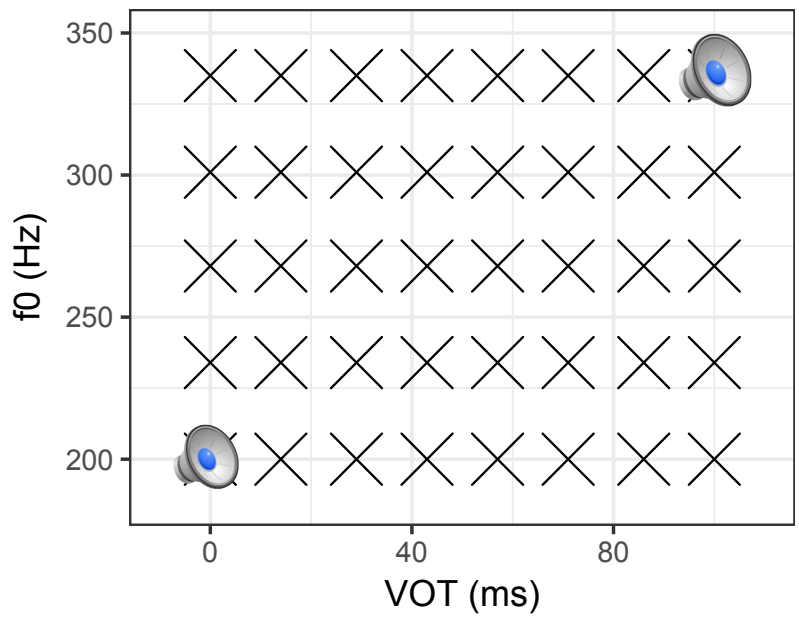
    expected to be the least advanced in change

Methods: Perception Stimuli

- Manipulations
  - **VOT**: 8 steps (0 ~ 100 ms)
  - **F0**: 5 steps

  (M: 135~200 Hz, F: 200~335 Hz)
  - Two base vowels
  - Two repetitions
  - 4 tokens per "cell" per speaker

Female talker stimuli space



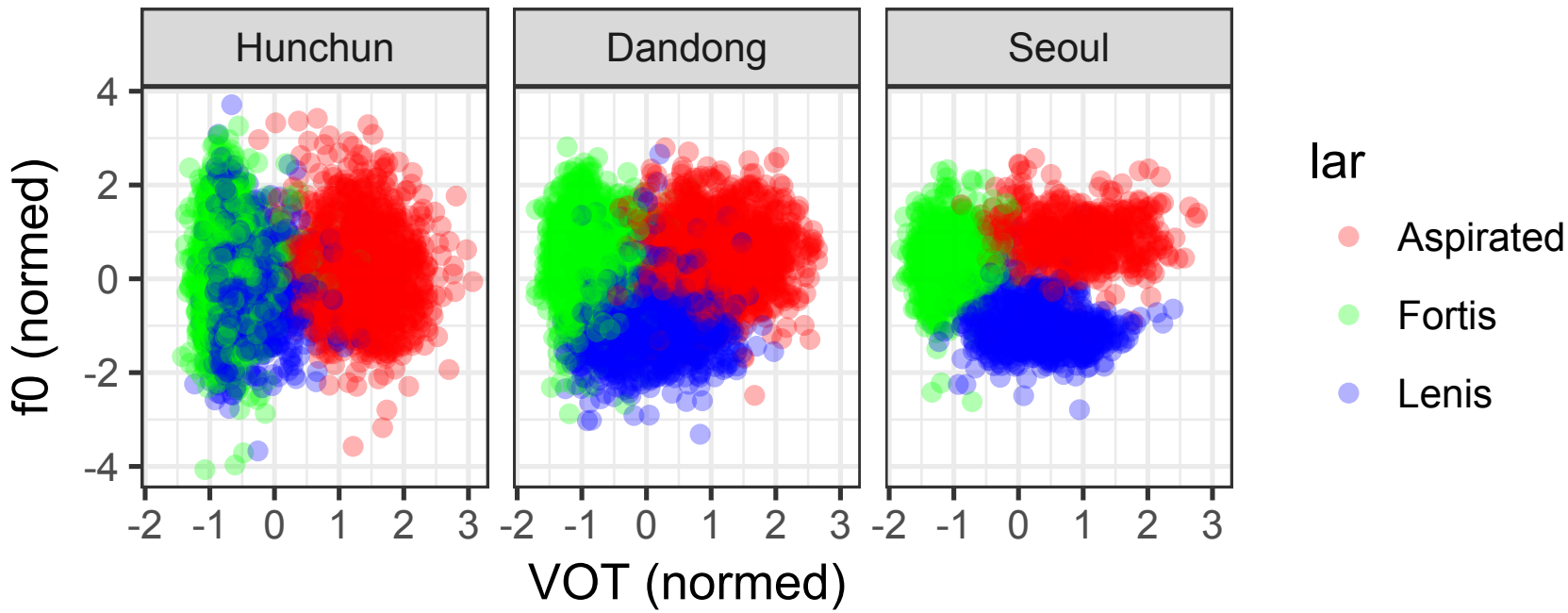
Methods: Perception Task

- 3-alternative forced choice (/t/, /t'/, /t^h/)
- Talker age/gender
  - Chinese Korean: Between-subject factor
    - Half heard the older talker and half heard the younger speaker.
    - Participants were specifically told that they will hear a speaker from their local area.
  - Seoul Korean: Within-subject factor
    - Everybody heard both speakers, in separate blocks, with the order counterbalanced.

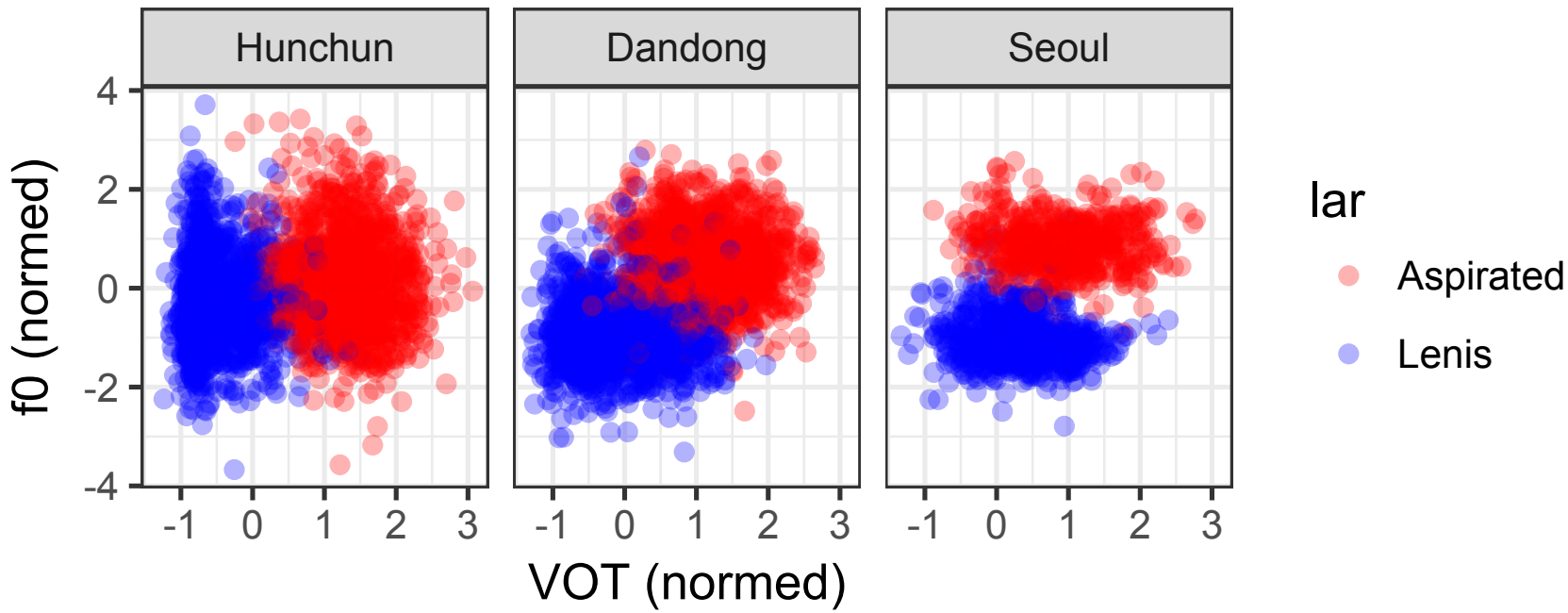
Normalization

- VOT (ms) values were z-score normalized by speaker.
- F0 (st) values were z-score normalized by speaker and for Hunchun, also by pitch accent.
- To compare the weights of two acoustic cue (VOT, F0)
- To control for inter-speaker differences in speech rates and pitch levels

Results: Production



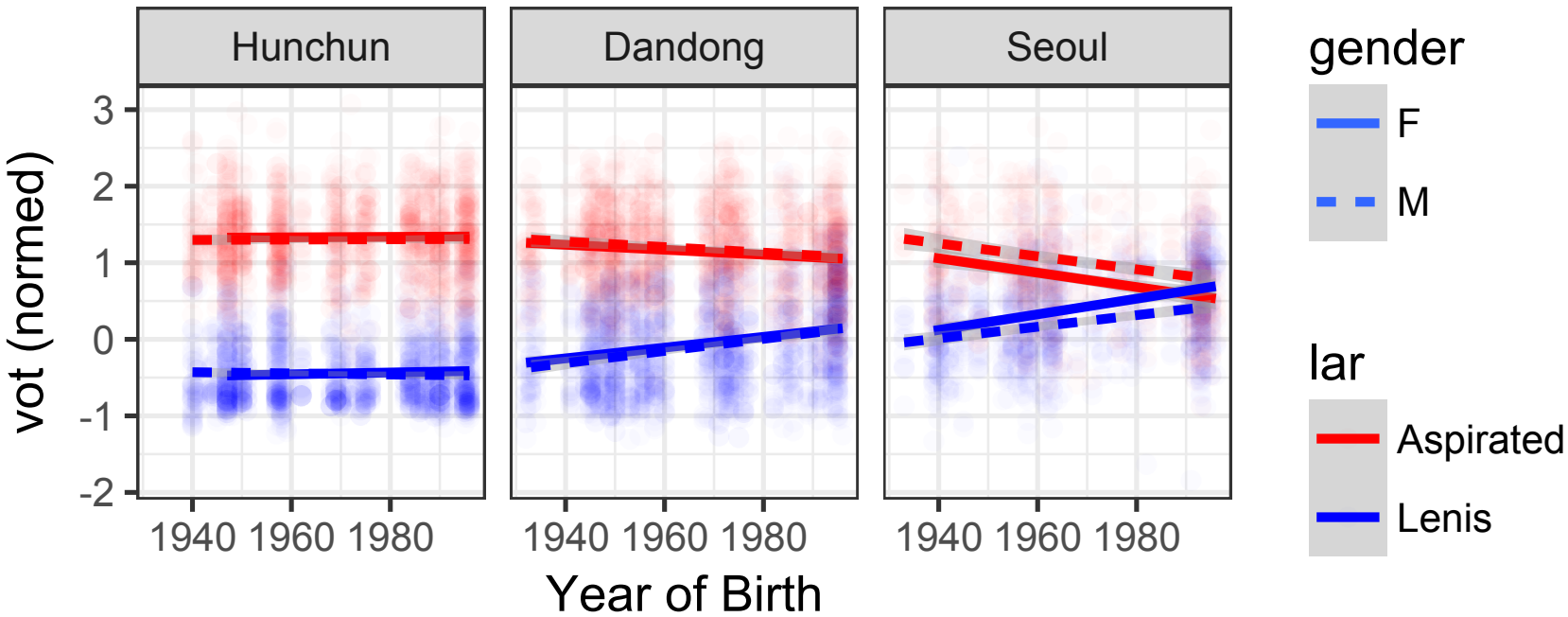
Results: Production



Statistical Analysis: Production

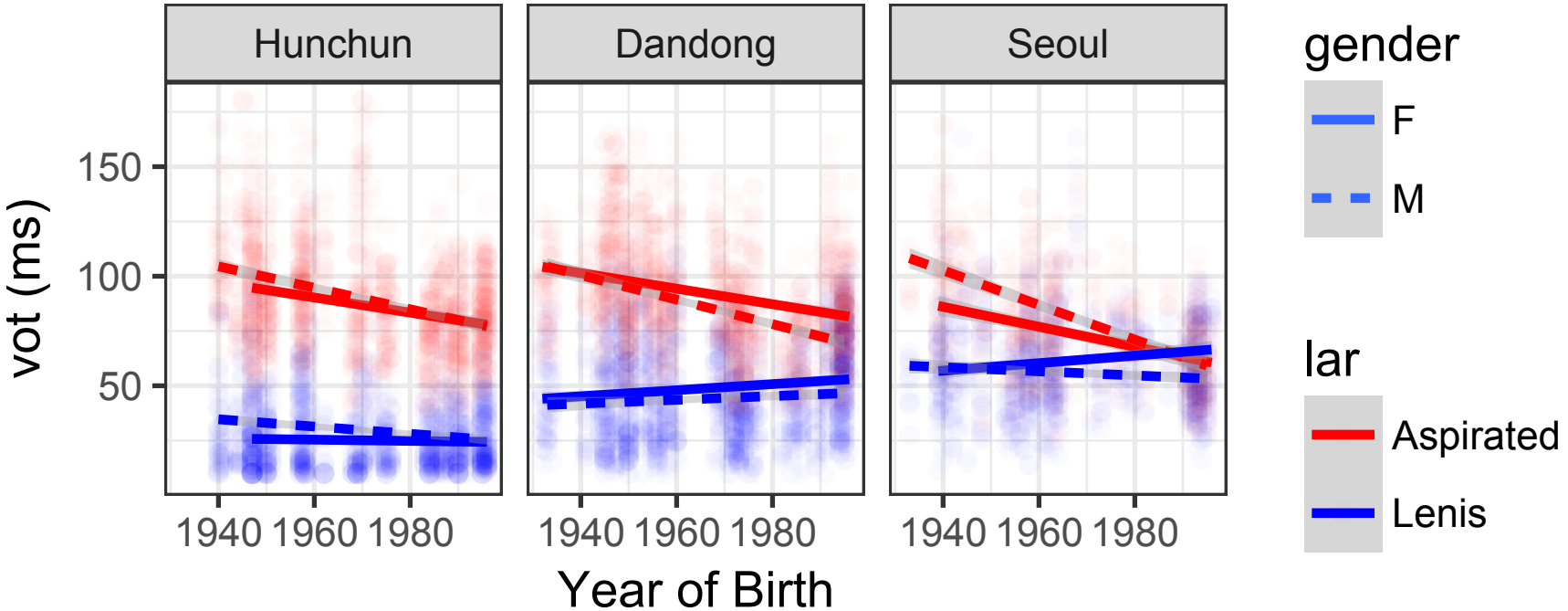
- Linear mixed-effects models
  - Dependent Variables: VOT, F0
  - Predictor Variables:
    - Word-level: Laryngeal (Aspirated vs. Lenis)
    - Speaker-level: Dialect, Age, Gender
    - Interactions
  - Random effects: Subject, Word
  - Post-hoc tests used the *phia* package

Production: VOT (normalized)



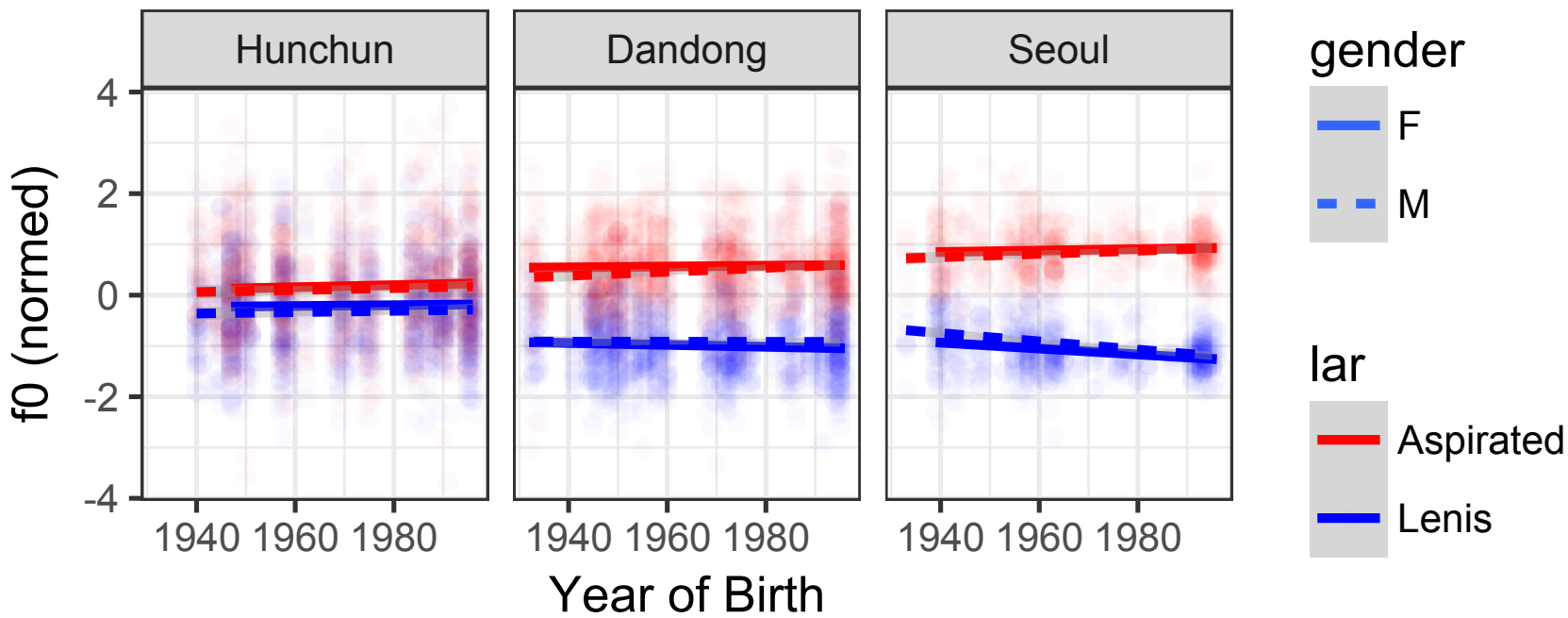
	Hunchun	Dandong	Seoul
Lar * YOB	No change	Old > Young	Old > Young

Production: VOT (ms)



	Hunchun	Dandong	Seoul
Lar * YOB	**Old > Young**	Old > Young	Old > Young

Production: F0



	Hunchun	Dandong	Seoul
Lar * YOB	No change	(Old < Young)	Old < Young

Summary

VOT	Hunchun	Dandong	Seoul
Production (Speaker Age)	✗	✓	✓

F0	Hunchun	Dandong	Seoul
Production (Speaker Age)	✗	✓	✓

Predictions for Perception

- Perception without innovation

VOT	Hunchun	Dandong	Seoul
Production (Speaker Age)	✗	✓	✓
Perception (Listener Age)	✗	✓	✓
Perception (Talker Age)	✗	✓	✓

F0	Hunchun	Dandong	Seoul
Production (Speaker Age)	✗	✓	✓
Perception (Listener Age)	✗	✓	✓
Perception (Talker Age)	✗	✓	✓

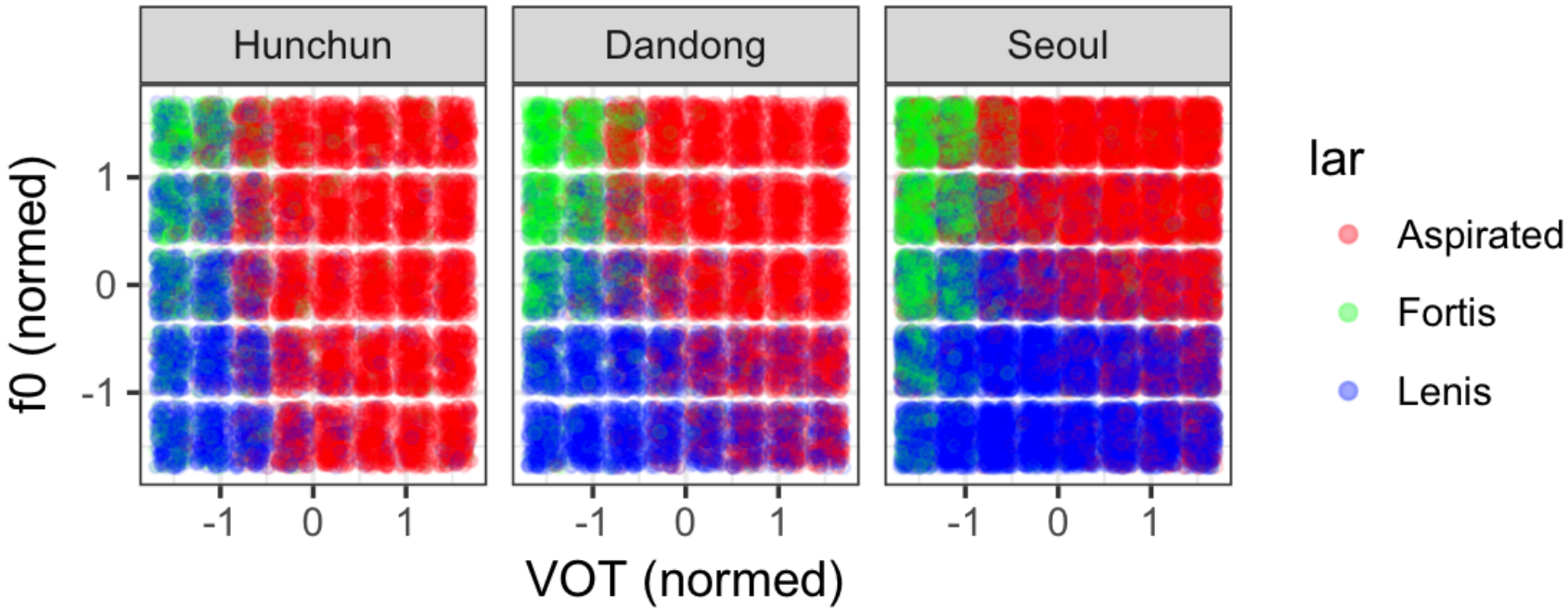
Predictions for Perception

- If younger listeners innovate perception:

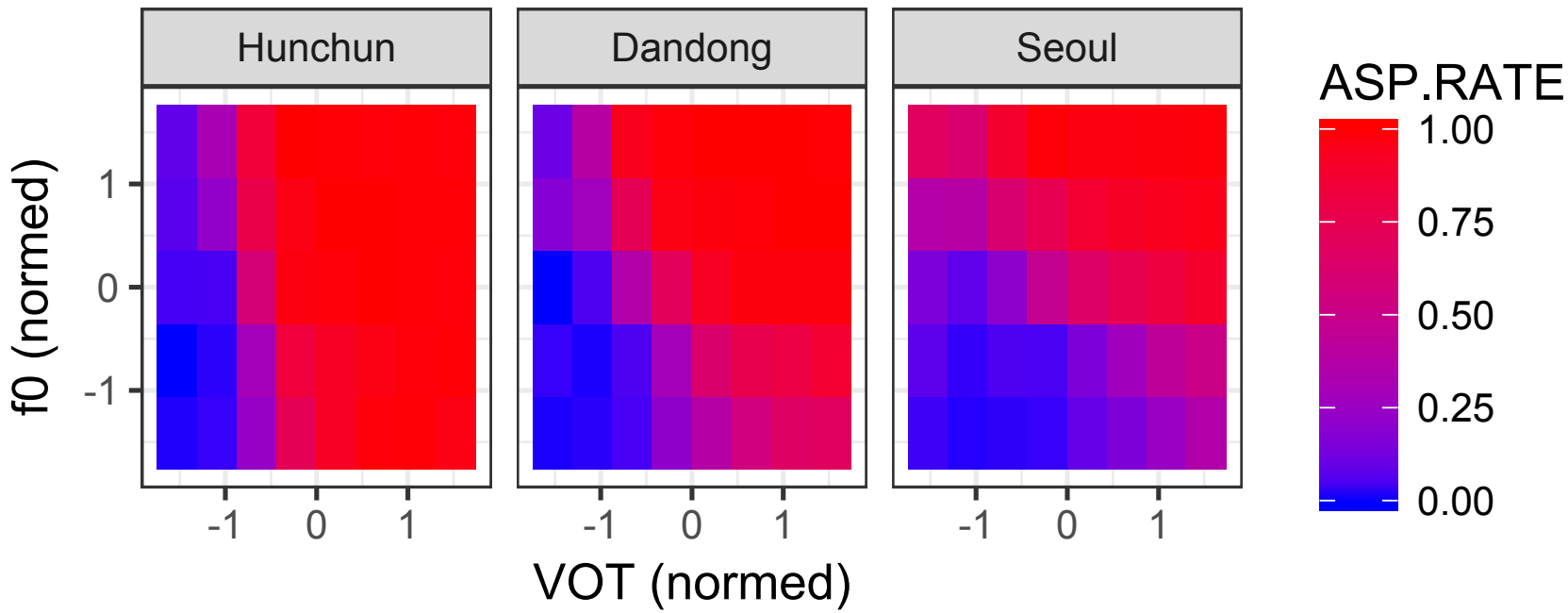
VOT	Hunchun	Dandong	Seoul
Production (Speaker Age)	✗	✓	✓
Perception (Listener Age)	✓	✓	✓
Perception (Talker Age)	✗	✓	✓

F0	Hunchun	Dandong	Seoul
Production (Speaker Age)	✗	✓	✓
Perception (Listener Age)	✓	✓	✓
Perception (Talker Age)	✗	✓	✓

Results: Perception



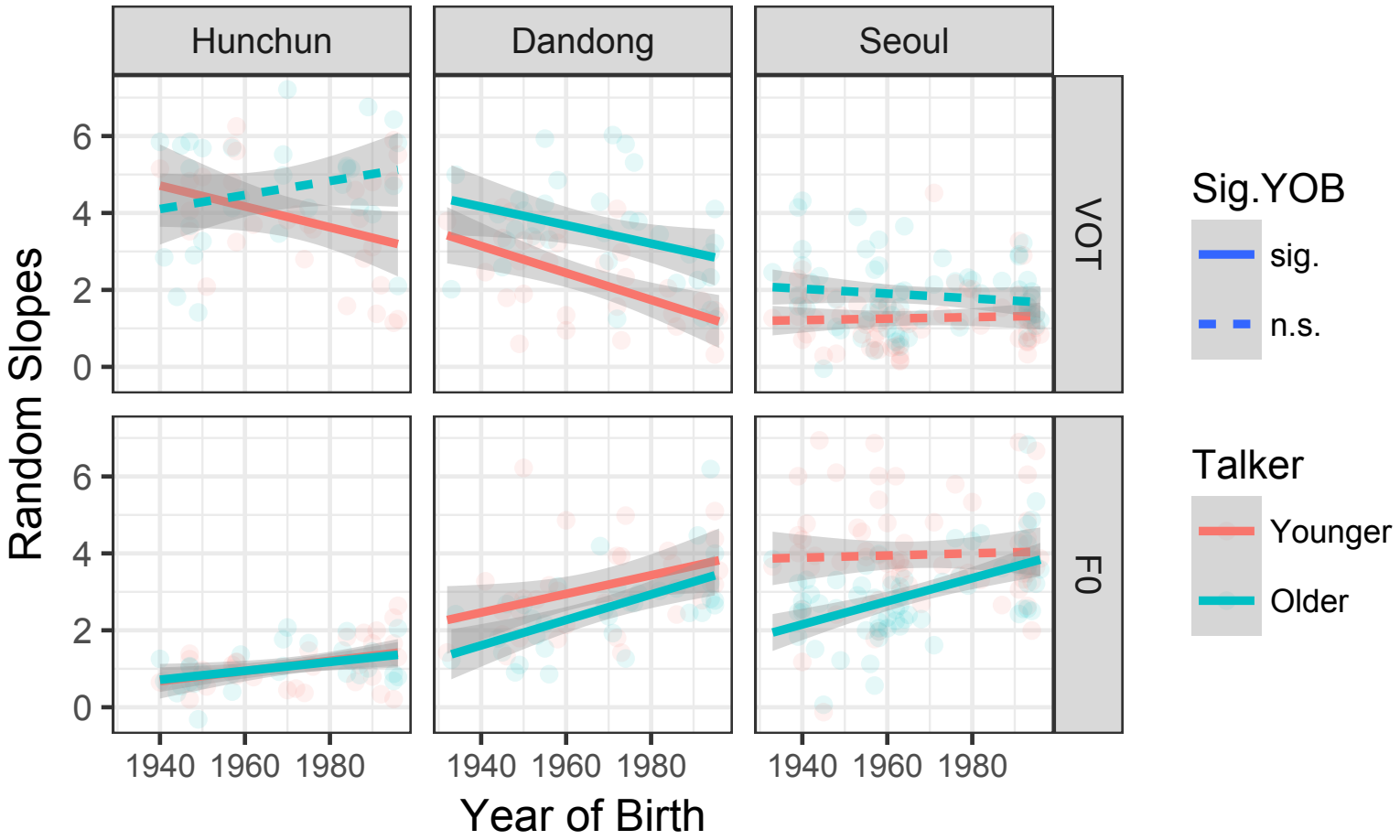
Results: Perception



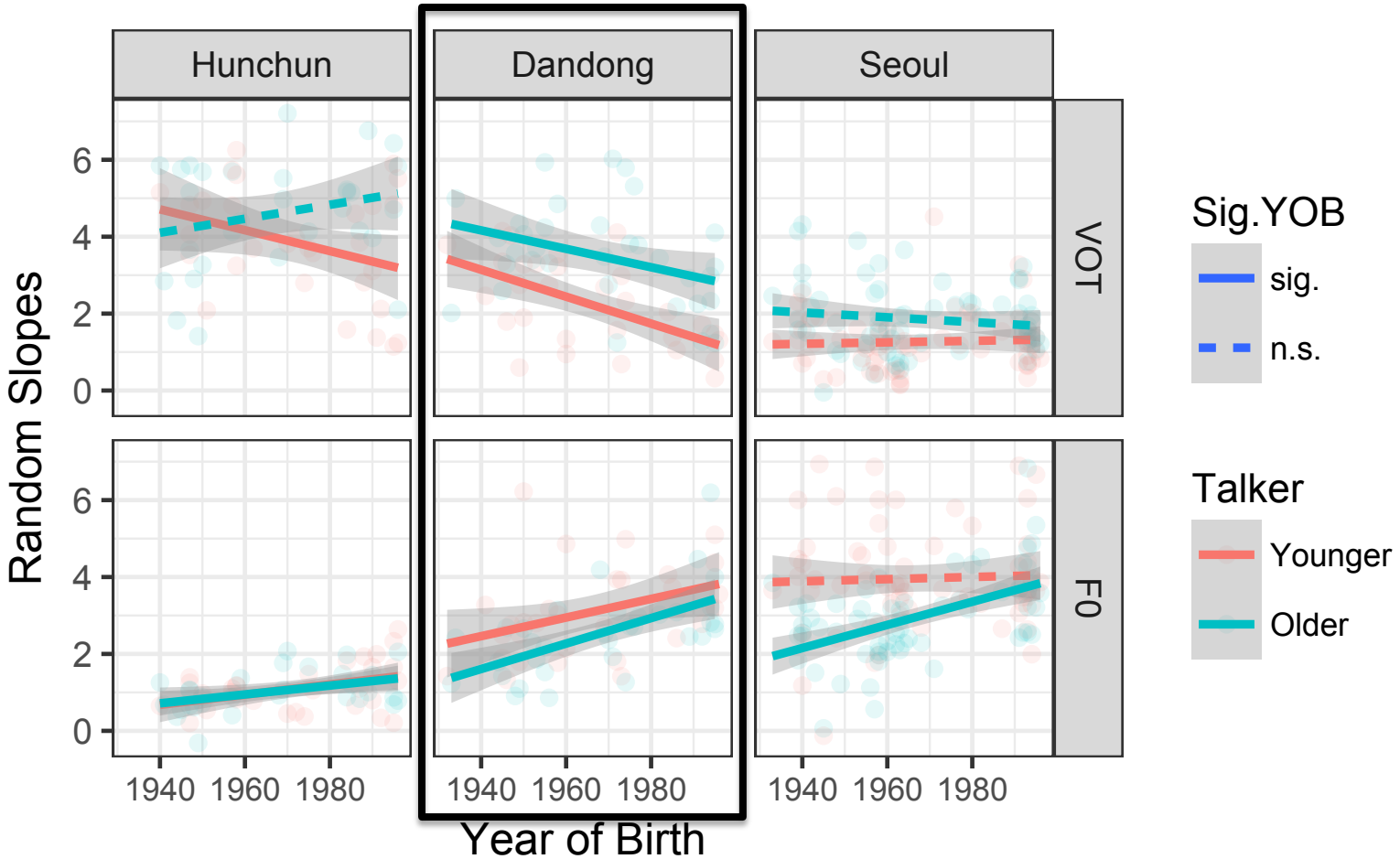
Statistical Analysis: Perception

- Logistic mixed-effects models (separate for each dialect)
  - Dependent Variables: Laryngeal (Asp vs. Lenis)
  - Predictor Variables:
    - Acoustic: VOT, F0
    - Listener-level: YOB
    - Talker: TalkerAge (Old/M vs. Young/F)
    - Interactions
  - Random effects: Subject

Perception cue weights



Perception cue weights

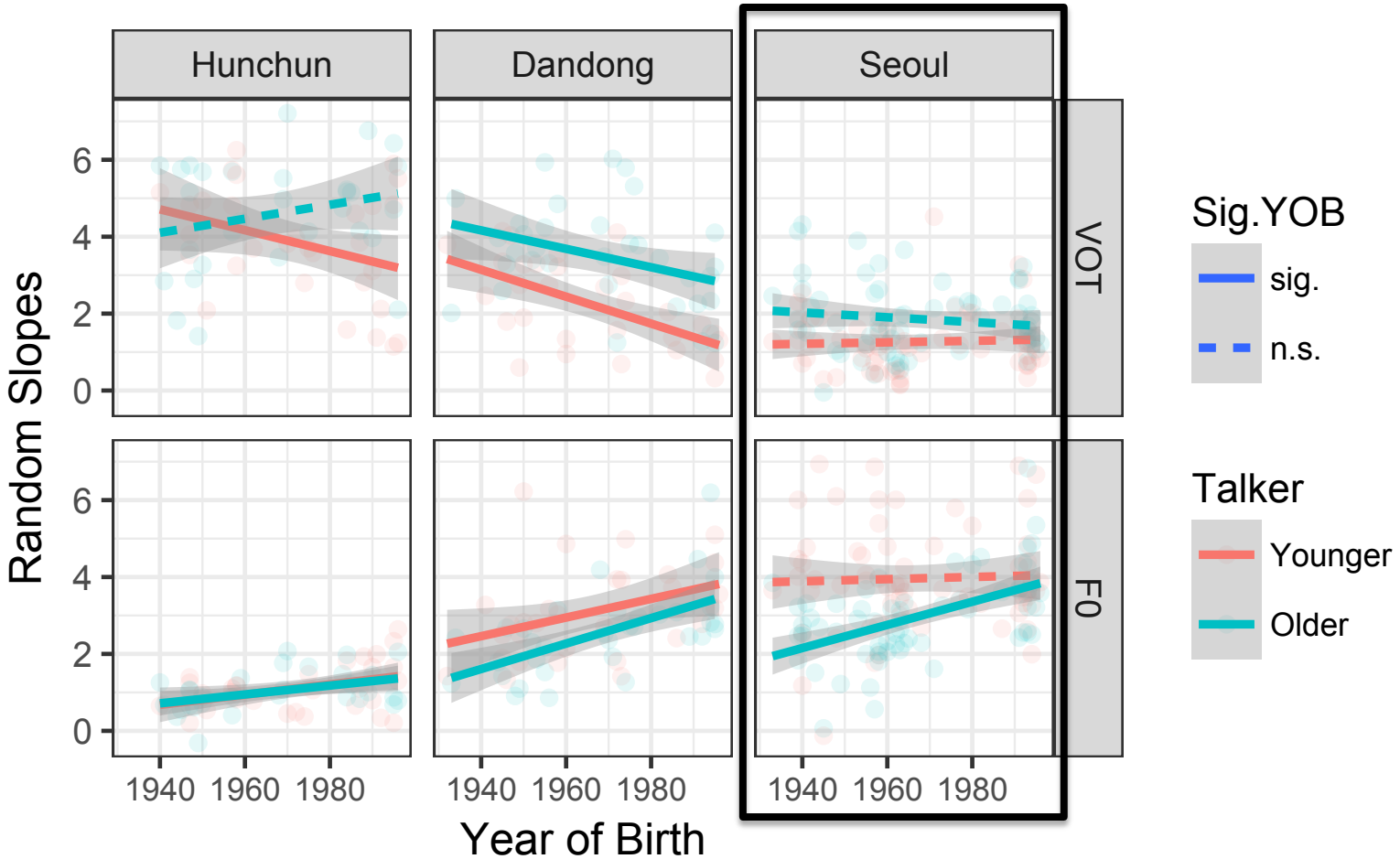


Perception results

VOT	Hunchun	Dandong	Seoul
Production (Speaker Age)	✗	✓	✓
Perception (Listener Age)		✓	
Perception (Talker Age)		✓	

F0	Hunchun	Dandong	Seoul
Production (Speaker Age)	✗	✓	✓
Perception (Listener Age)		✓	
Perception (Talker Age)		✓	

Perception cue weights

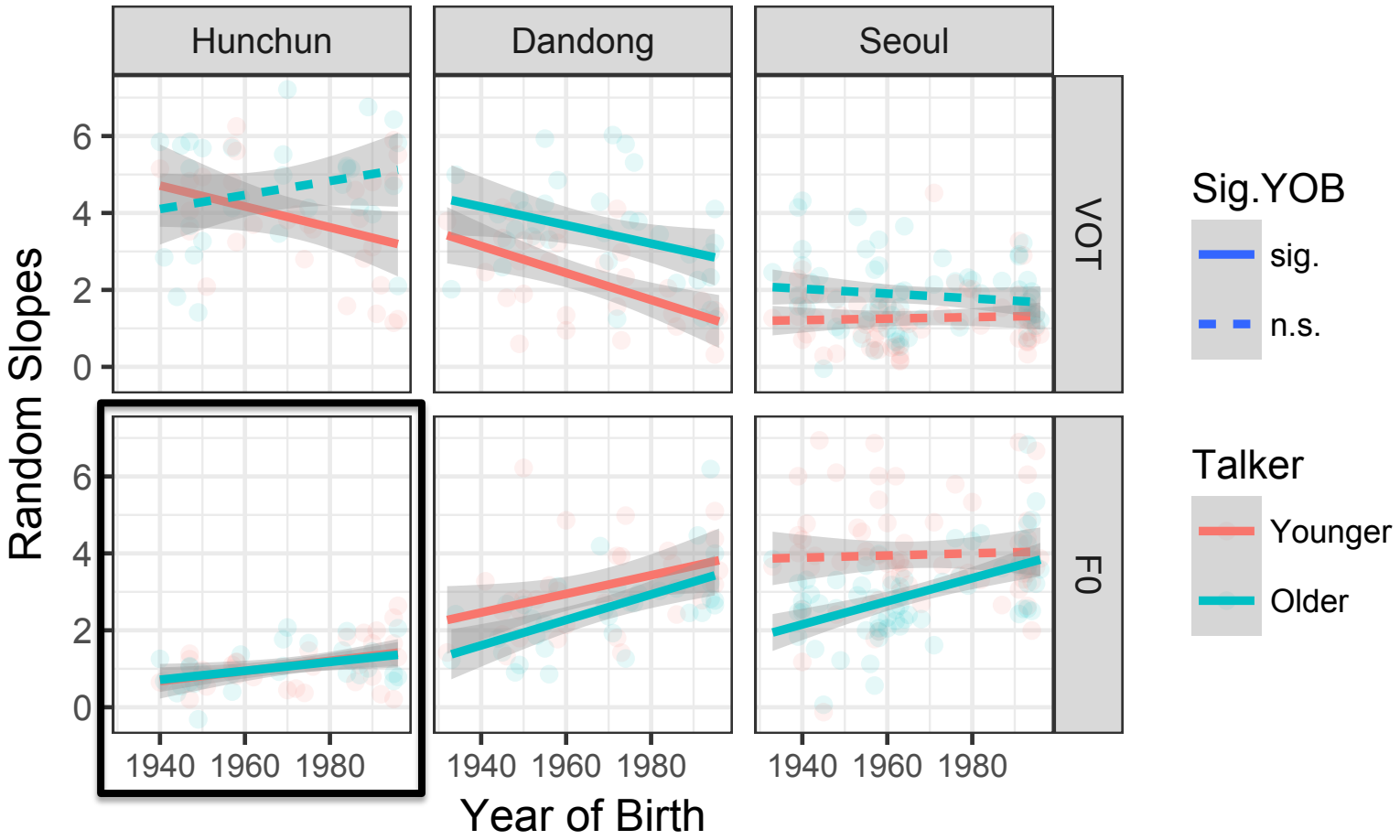


Perception results

VOT	Hunchun	Dandong	Seoul
Production (Speaker Age)	✗	✓	✓
Perception (Listener Age)		✓	✗ (floor)
Perception (Talker Age)		✓	✓

F0	Hunchun	Dandong	Seoul
Production (Speaker Age)	✗	✓	✓
Perception (Listener Age)		✓	✓, ✗ (ceiling)
Perception (Talker Age)		✓	✓

Perception cue weights

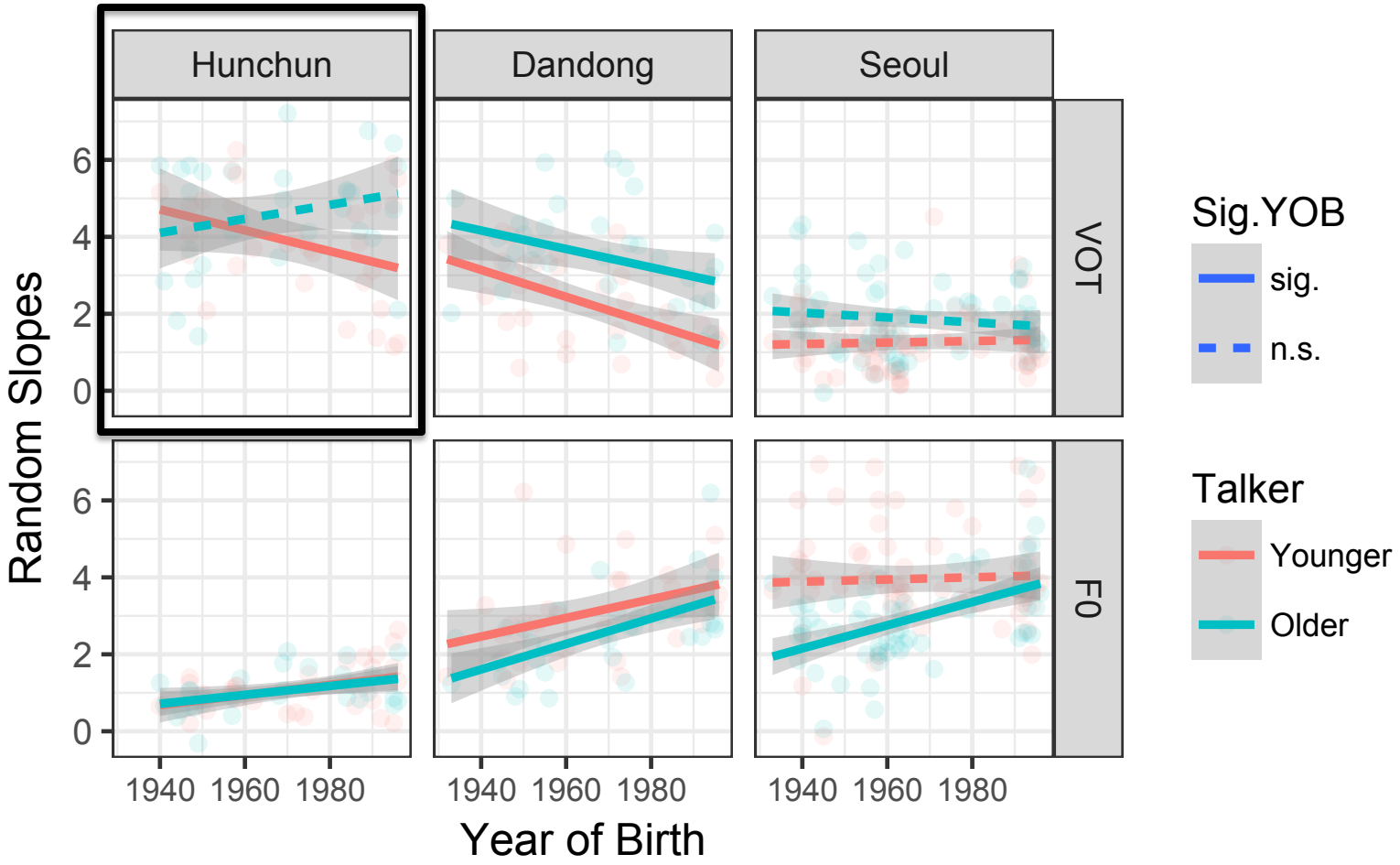


Perception results

VOT	Hunchun	Dandong	Seoul
Production (Speaker Age)	✗	✓	✓
Perception (Listener Age)		✓	✗ (floor)
Perception (Talker Age)		✓	✓

F0	Hunchun	Dandong	Seoul
Production (Speaker Age)	✗	✓	✓
Perception (Listener Age)	✓ (listener innovation)	✓	✓, ✗ (ceiling)
Perception (Talker Age)	✗	✓	✓

Perception cue weights



Perception results

VOT	Hunchun	Dandong	Seoul
Production (Speaker Age)	✗	✓	✓
Perception (Listener Age)	**Interaction ???**	✓	✗ (floor)
Perception (Talker Age)		✓	✓

F0	Hunchun	Dandong	Seoul
Production (Speaker Age)	✗	✓	✓
Perception (Listener Age)	✓ (listener innovation)	✓	✓, ✗ (ceiling)
Perception (Talker Age)	✗	✓	✓

Listener * Talker interaction

- Older Hunchun listeners compensate for the speech rate differences across generations in VOT perception.
  - For these listeners, there is no change across generations and they exhibit no talker effect in perception.
- Younger Hunchun listeners fail to compensate for the speech rate differences across generations and perceive the raw VOT values literally.

  (cf. Johnson and Garrett 2013)
  - For these listeners, there is change in progress across generations and hence they exhibit the talker effect in perception.

Conclusion

- We saw an emergent perceptual change for F0 in Hunchun.
  - Younger listeners assign a higher weight to f0 than older listeners in perception without actually producing larger f0 contrasts.
  - This is in line with the Ohalean view of f0 cue developing through perceptual innovation.

Conclusion

- We also observed that hypo-articulation bias of younger speakers (faster speech rate and VOT reduction) may play a role in tonogenetic sound change (Kirby 2013, Bang, et al. under revision)
- But, the VOT reduction did not cause a simultaneous enhancement of f0 cue in production (contra Kirby 2013).
- The f0 enhancement came in the perception, instead.

Thank you!

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