Individual differences

Perceivers as producers of coarticulation and members of speech communities

Supported by NSF

Pam's office hour (105 Olson)

Wednesday, July 3: 3-4 pm

or send me an email message (beddor@umich.edu) to arrange a time tomorrow

Perception

- is malleable
  - cue-dependent and context-dependent
    - e.g., 1440 Hz burst followed by different vowels (/pi ka pu/)
      perception of different cues for /di de da do du/
      compensation for coarticulation
      duplex perception
  - language-dependent (e.g., categorical perception boundaries)
  - multi-modal (e.g., McGurk & McDonald 1976)
  - word-dependent (e.g., Ganong 1980, J. Exp. Psy. Hum. Perc. Perf. 6, 110-125)
  - listeners can both ignore and be sensitive to within-category variation (e.g., eye-tracking data from McMurray et al 2002)
  - today and next week: sensitivity to talker information (and more)

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  - listeners can both ignore and be sensitive to within-category variation (e.g., eye-tracking data from McMurray et al 2002)
  - to come … sensitivity to talker information (and more)

Perception

- evolves in real time as input acoustic signal unfolds
  - Listeners tend to use information as soon as available
  - Listeners continuously integrate available information

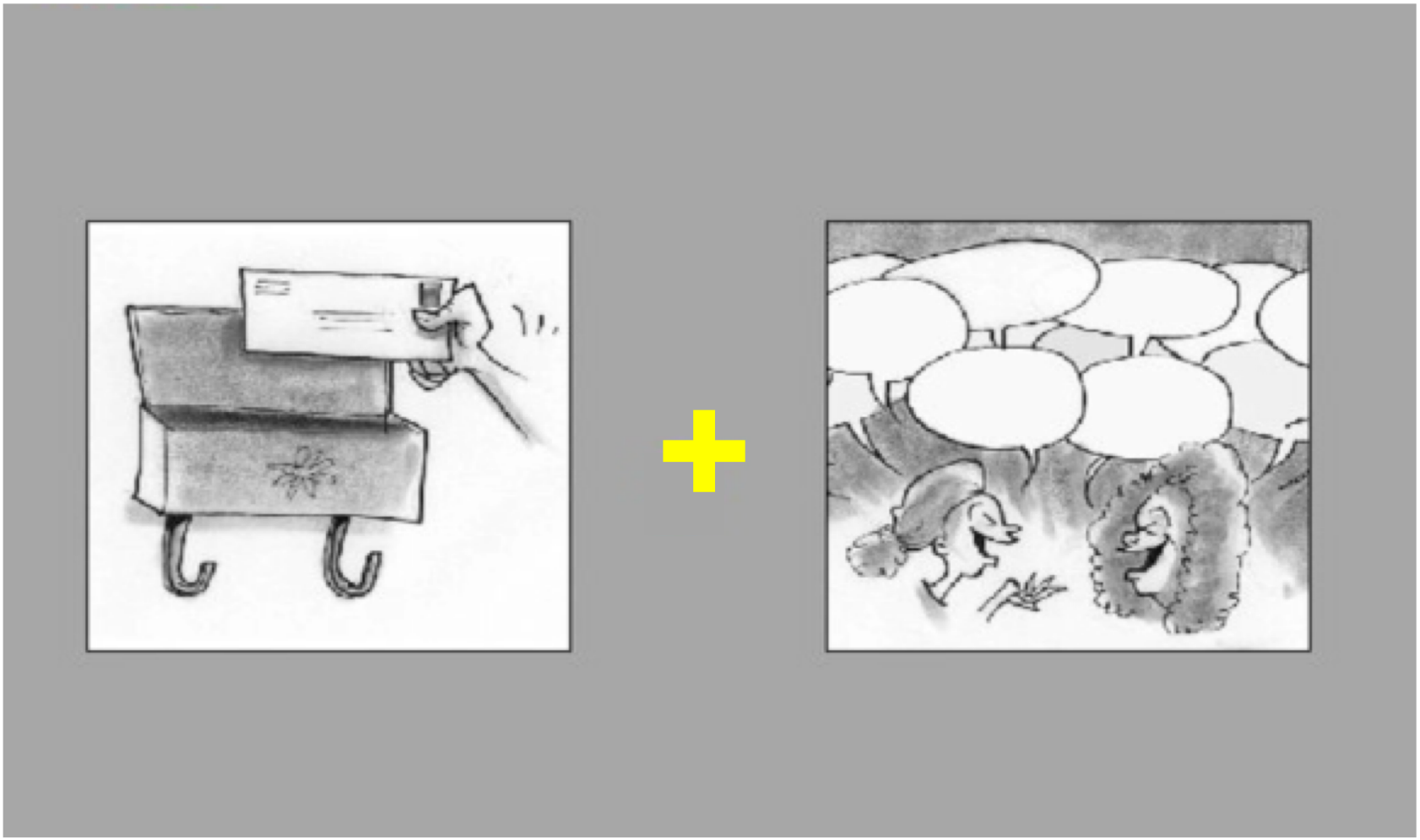
E.g., visual world paradigm:

tracks moment-by-moment processing of acoustic events

In our lab:

time course of processing anticipatory coarticulatory information

Perception – use of coarticulatory vowel nasalization



send **said**

From Beddor et al. 2018

Perception

- evolves in real time as input acoustic signal unfolds

> Do participants look at the target image on basis of coarticulatory information?

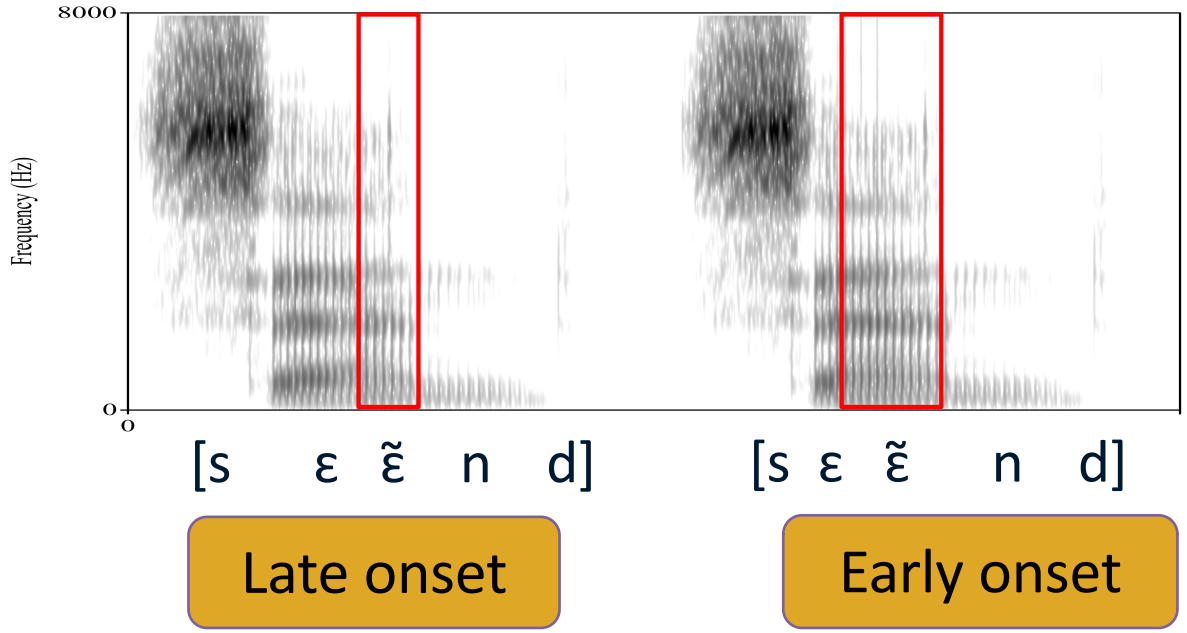
  - Cannot simply align acoustic signal with eye movements over time
  - Takes time to execute eye movement (usual estimate: 200 ms)

Perception

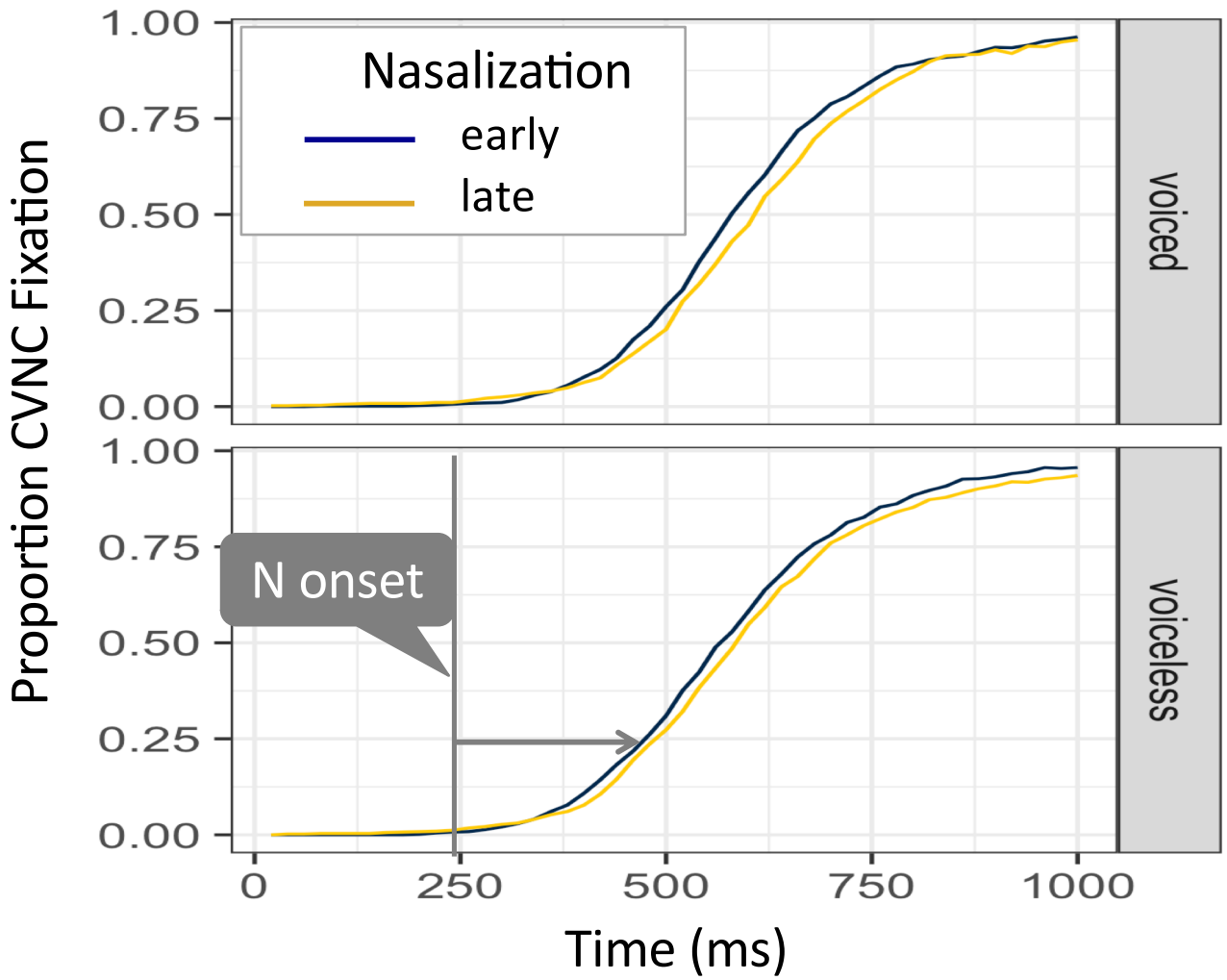
- evolves in real time as input acoustic signal unfolds

> Do participants look at the target image on basis of coarticulatory information?

- But can compare time course of eye movements to late and early onset of coarticulatory information for upcoming N:



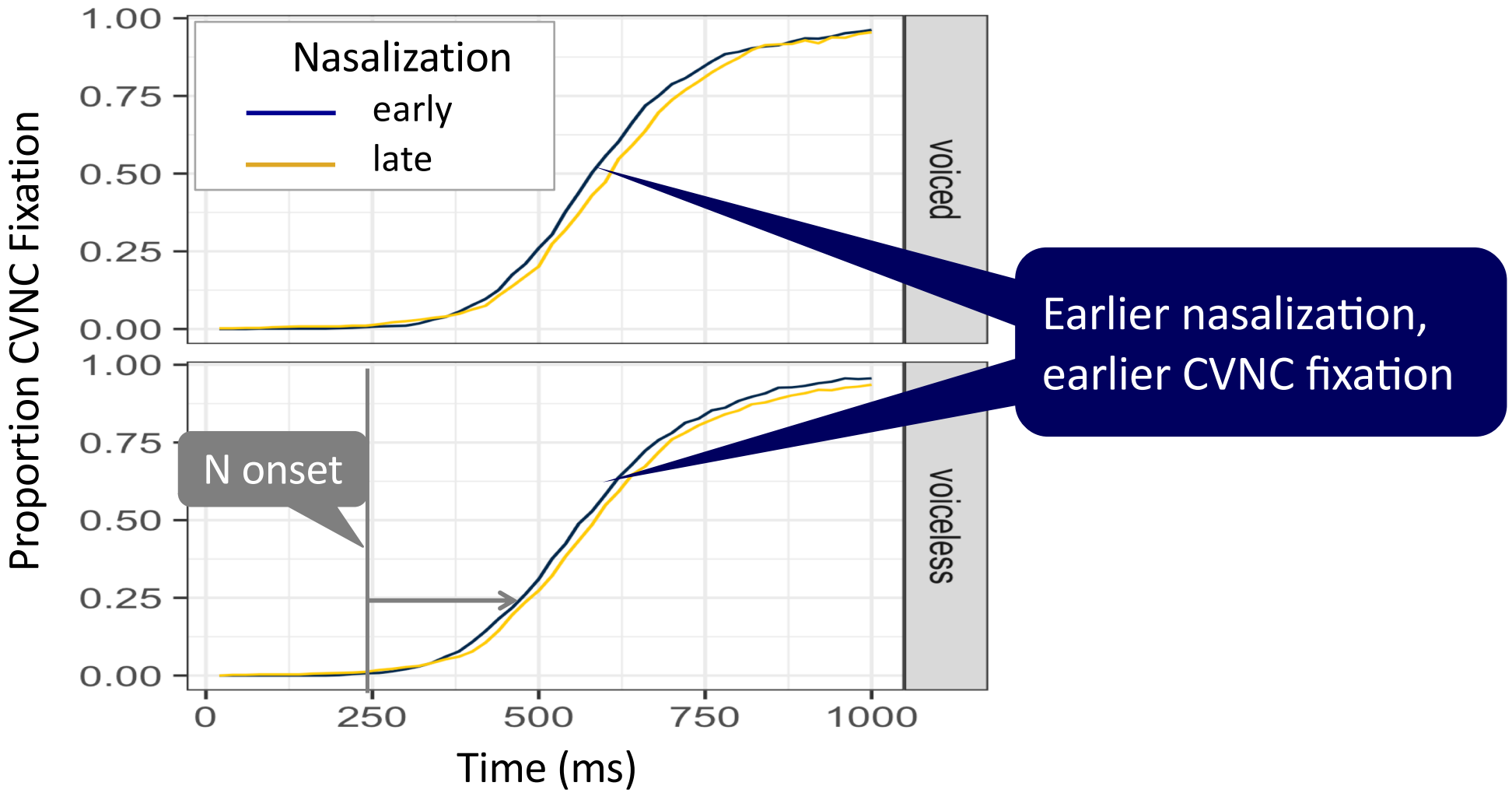
Proportion looks to nasal image over time



Listeners begin to fixate CVNC (rather than CVC) before N begins

Beddor et al. (2018)

Proportion looks to nasal image over time



Beddor et al. (2018)

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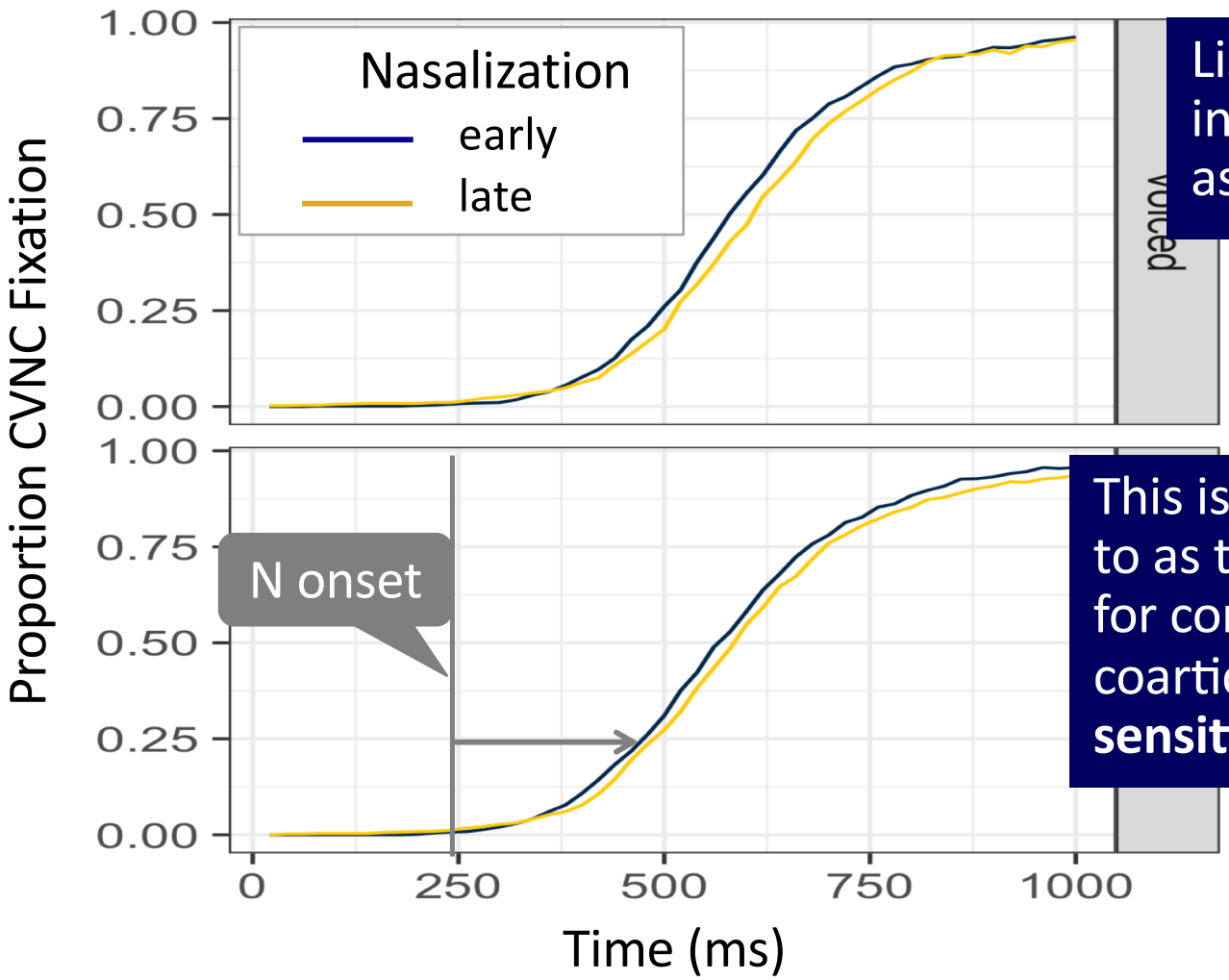


Listeners use coarticulatory information nearly as soon as it becomes available.

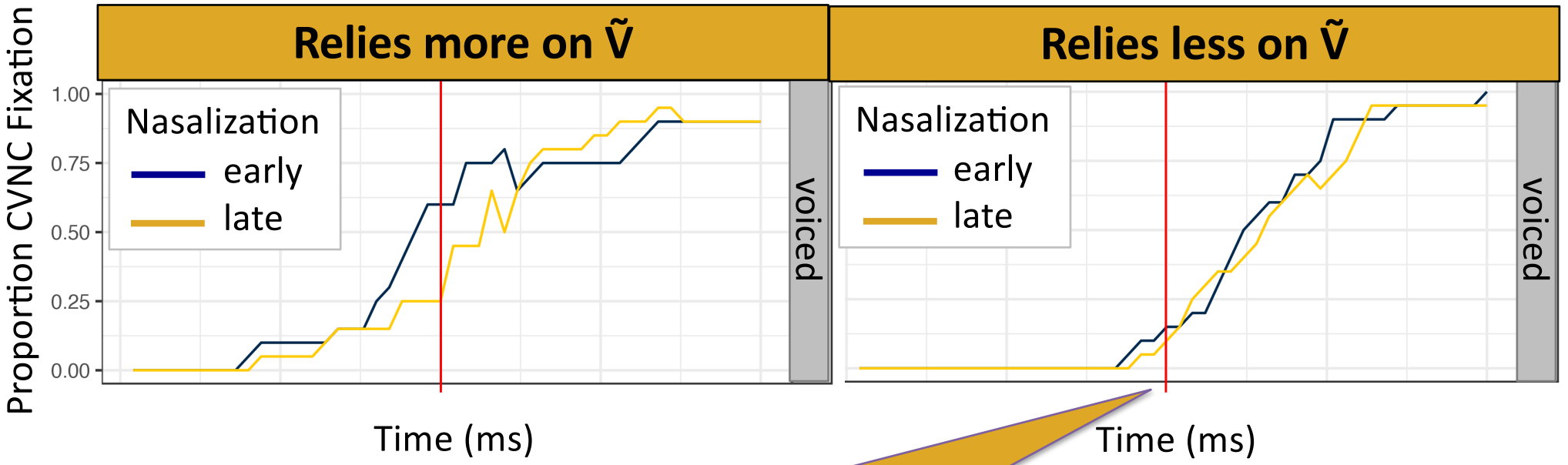
This is what has been referred to as the "companion finding" for compensation for coarticulation: **listeners remain sensitive** to coarticulatory cues.

Beddor et al. (2018)

Perception:

- Malleable – adjusted for phonetic and non-phonetic factors
- Evolves over time
- Differs across individuals

Differences between listeners



- Fixates later on target image
- No difference in response to early, late onset of coarticulatory cues

Individual listeners differ systematically in their attention to different informational properties of the input

Differences across listeners are

- Pervasive (not one or two outliers)
- Consistent over time (e.g., Idemaru et al. 2012)
- Consistent across tasks (e.g., Beddor 2009, Yu et al. 2014)

Production differs for individual speakers

Speakers

- Differ systematically in ***timing*** of coarticulatory overlap
  - lip rounding (Can. French: Noiray et al. 2011; Cantonese: Yu 2016)
  - tongue body position (English: Magen 1997, Grosvald 2009)
  - velum lowering (English: Krakow 1989, Coh…990, Beddor et al. 2018)

Some speakers: little to no anticipatory influences of one vowel on another

Other speakers: anticipatory effects span 3 syllables

Is there a systematic relation between individuals' production and perception?

Interest in the perception-production relation has long-standing tradition

We already know this!

Some theorists argue for parity between forms of speaking and listening.

- Motor theorists and direct realists; but many others as well (e.g., Casserly & Pisoni 2010, Schwartz et al. 2012)

For some theorists, this relation is not limited to sufficient similarity between signals produced and signals received, but extends to production-perception relation **within individual language users.**

- Some exemplar models: perception-production loop in which phonetic details of perceived input are reflected in production (e.g., Pierrehumbert 2001)

Interest in the perception-production relation has long-standing tradition

Studies of listeners' contributions to sound change
(e.g., Ohala 1981, Harrington et al. 2008, Yu 2010, Beddor 2009, Beddor et al. 2018)

- also typically assume that variants that listeners are particularly sensitive to will be manifested in listener-turned speakers' subsequent productions

But are perceptual weights manifested in production?

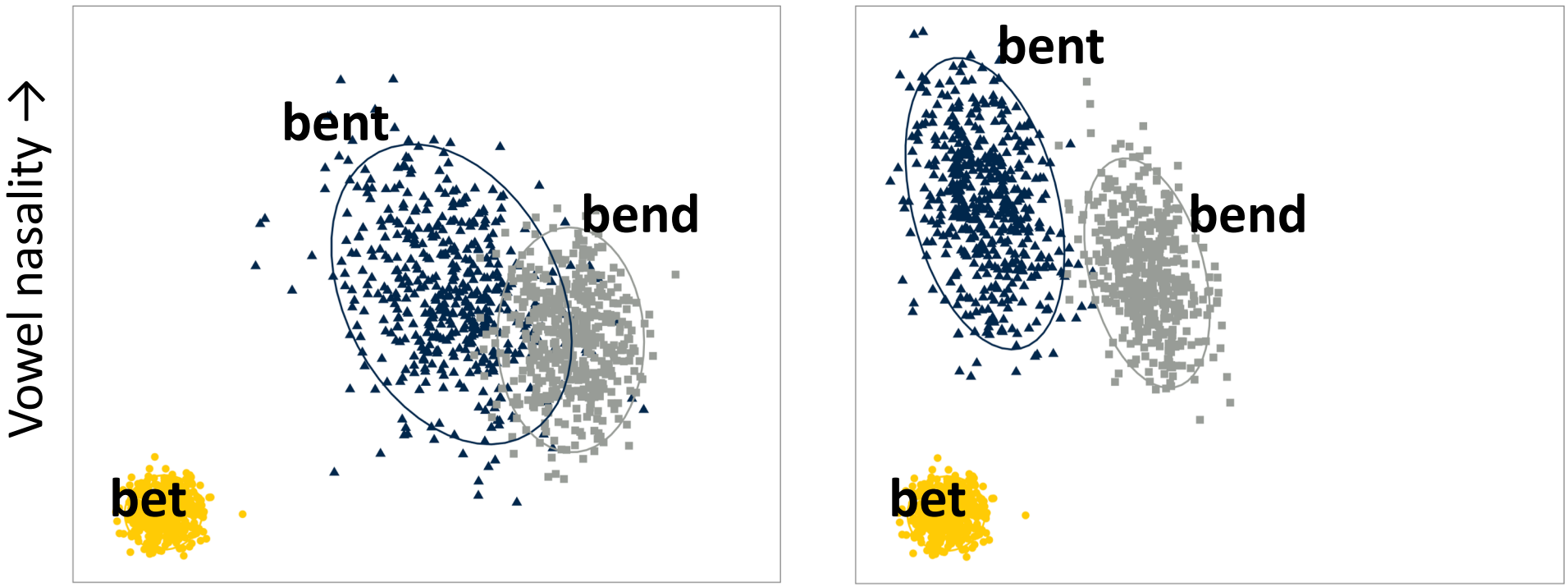
But are perceptual weights manifested in production?

They should be, ***if***

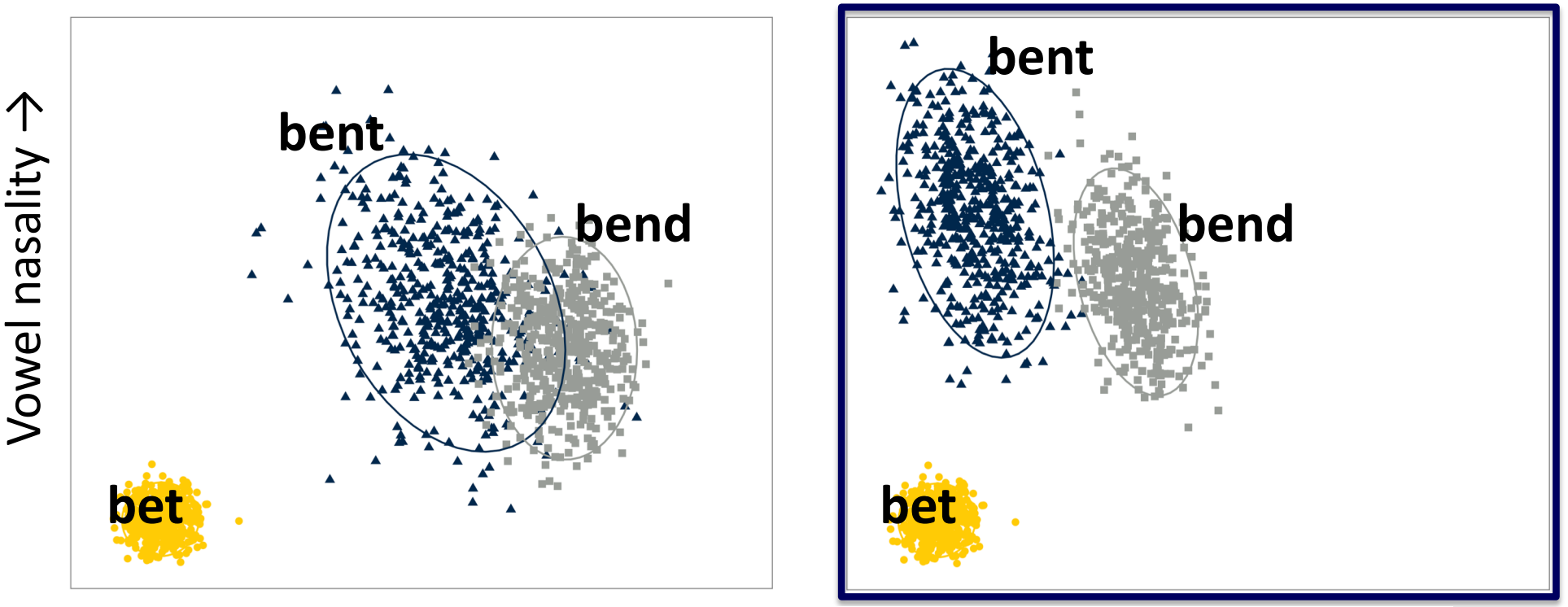
- perceptual theories that assume this relation are correct
- perceptual weights have consequences for sound change

If listener's percept is to contribute to *SOUND* change, it must be publicly manifested.

Schematized differences in Ṽ / N perceptual weights



Schematized differences in Ṽ / N perceptual weights



Kevin, I, and our collaborators argue yes!

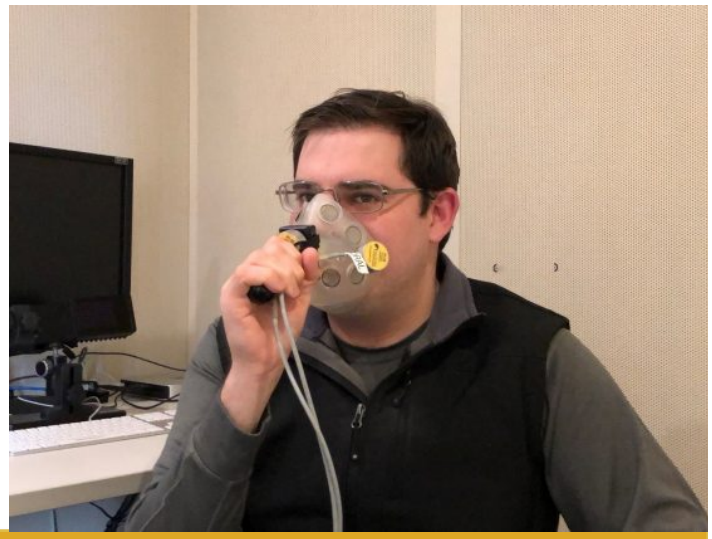
Do the perceptual weights of this listener have the potential to contribute to sound change?

Is there a systematic relation between individuals' production and perception?

Yes – as measured via the time course of production and perception of coarticulatory vowel nasalization in American English (Beddor et al. 2018)

Compared individual participant's

- Production of nasal airflow, over time, for CVC and CVNC words
- Perceptual use of anticipatory nasalization as that information becomes available over time.



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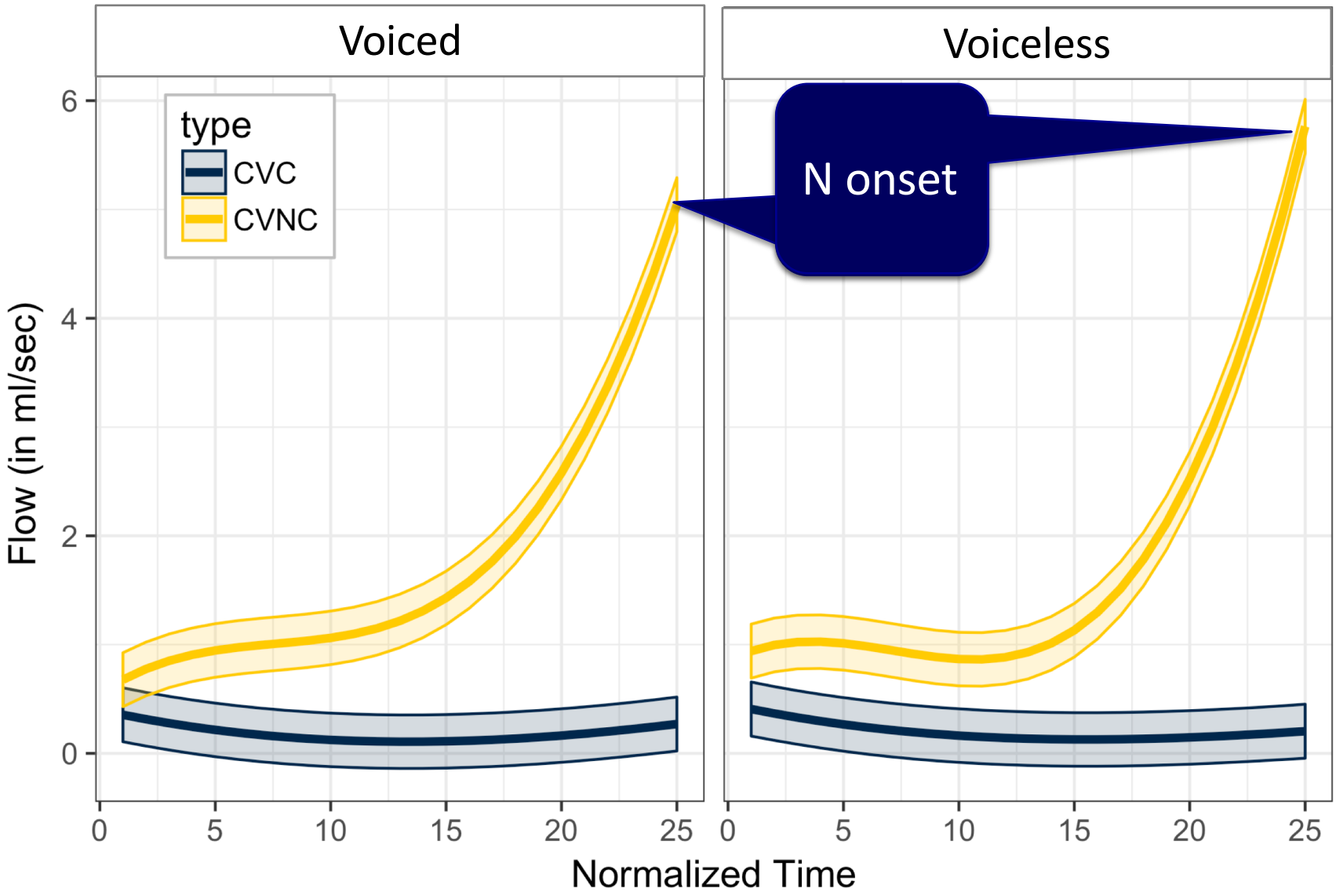
Hypothesis:

Listeners who closely attend to the coarticulatory information will, as speakers, consistently and more extensively produce that information in their own speech.

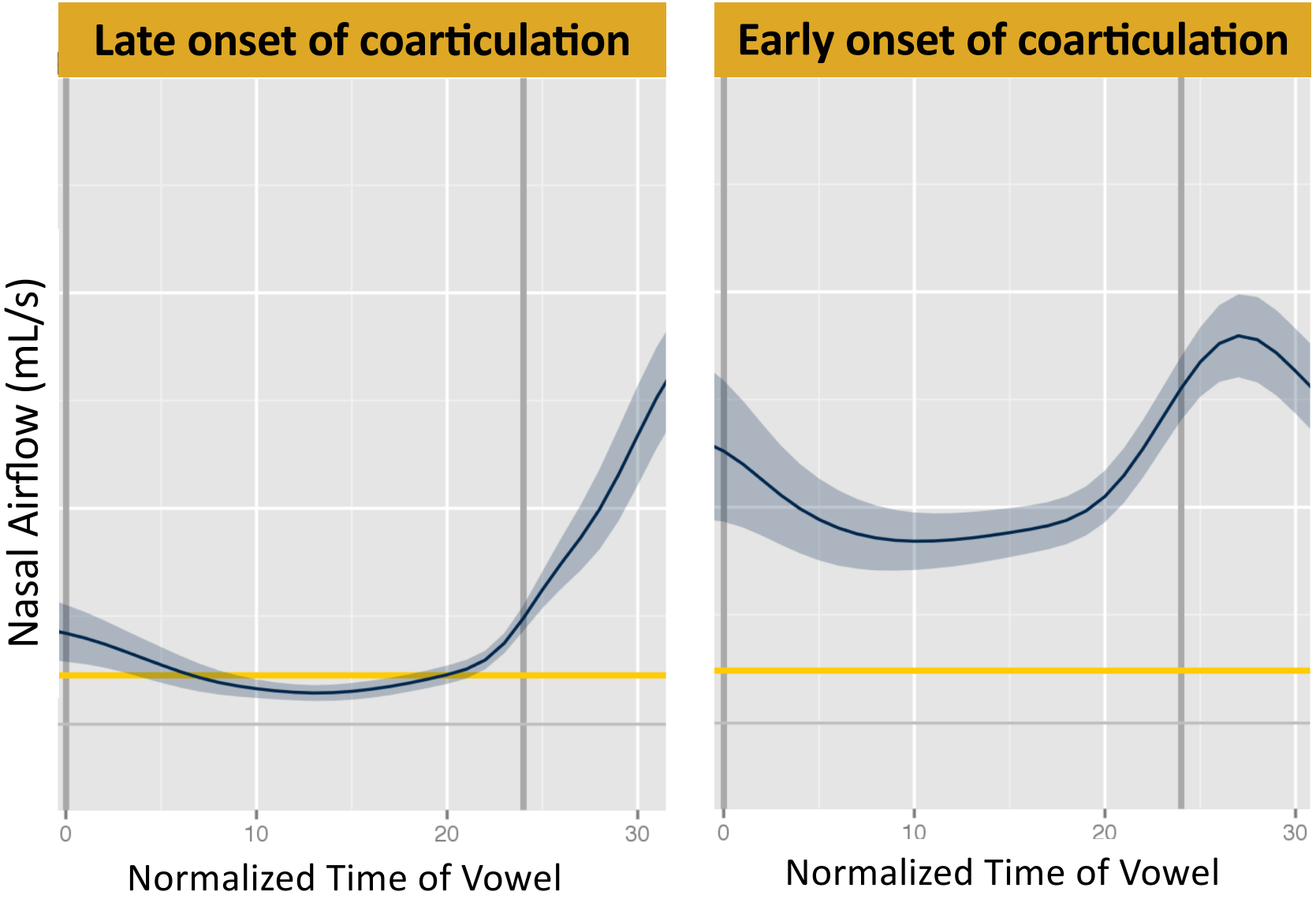


Linear Mixed Effects Model

- Time modeled with b-splines with 3 dfs; Fixed: Time*Voicing
- Adding Participant as random intercept improved fit

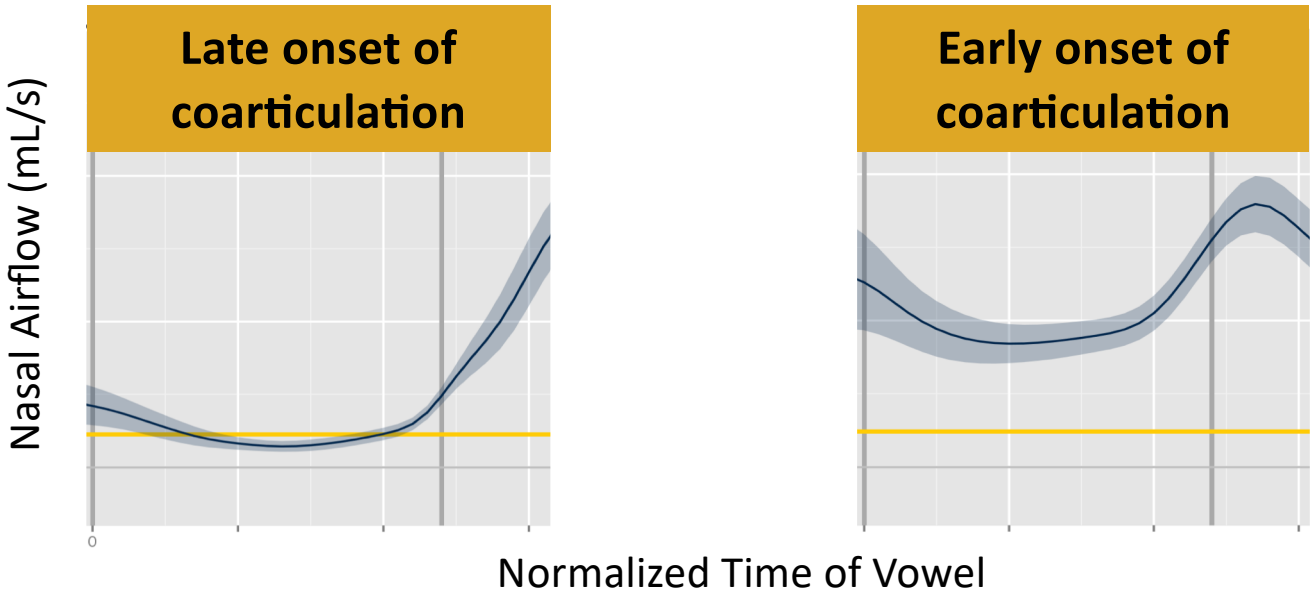
Beddor et al. (2018)

Anticipatory nasalization differences between 2 speakers (CVNT)

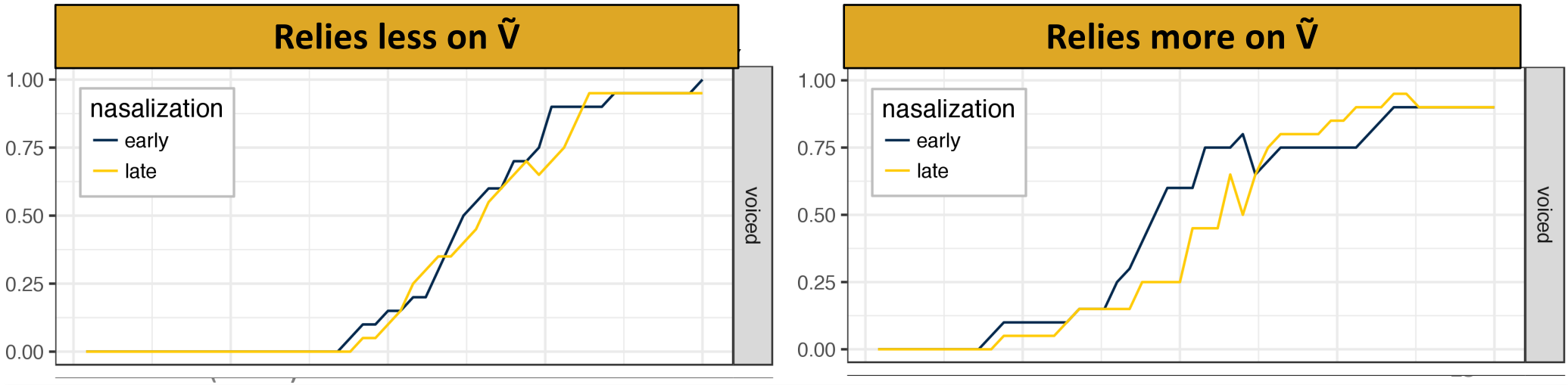


Beddor et al. (2018)

Is there a link between this …

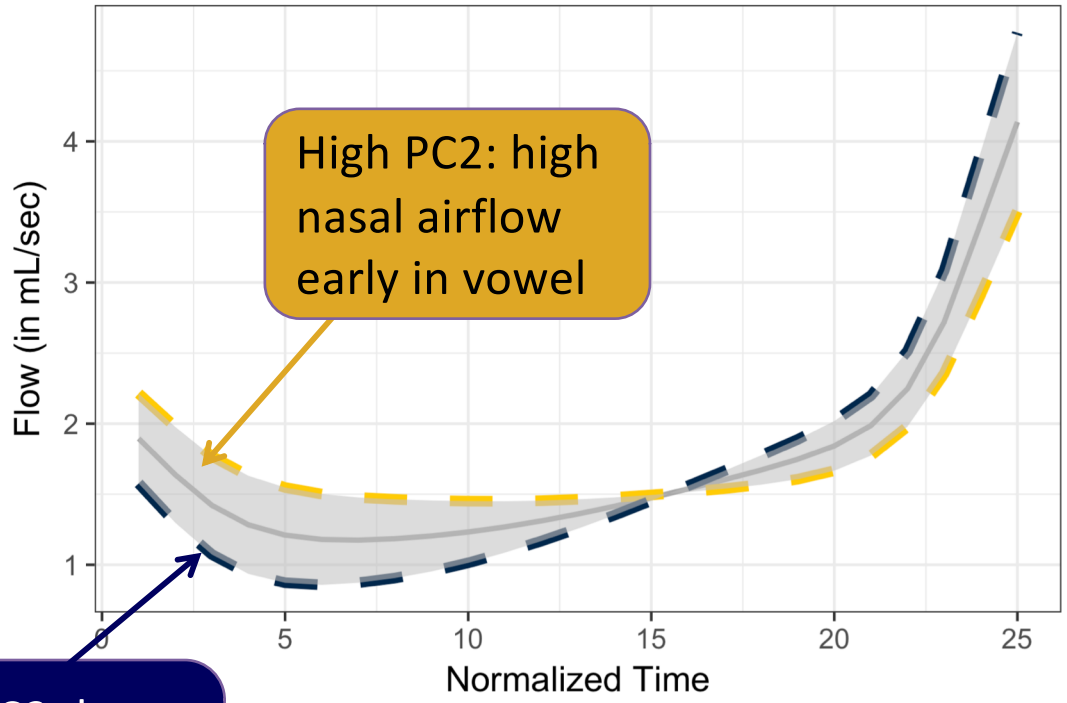


… and this?



To capture nature of individual production differences, conducted a functional Principal Component Analysis (fPCA) on CVNC data

PC2: early vs. late onset of nasalization



Beddor et al. (2018)

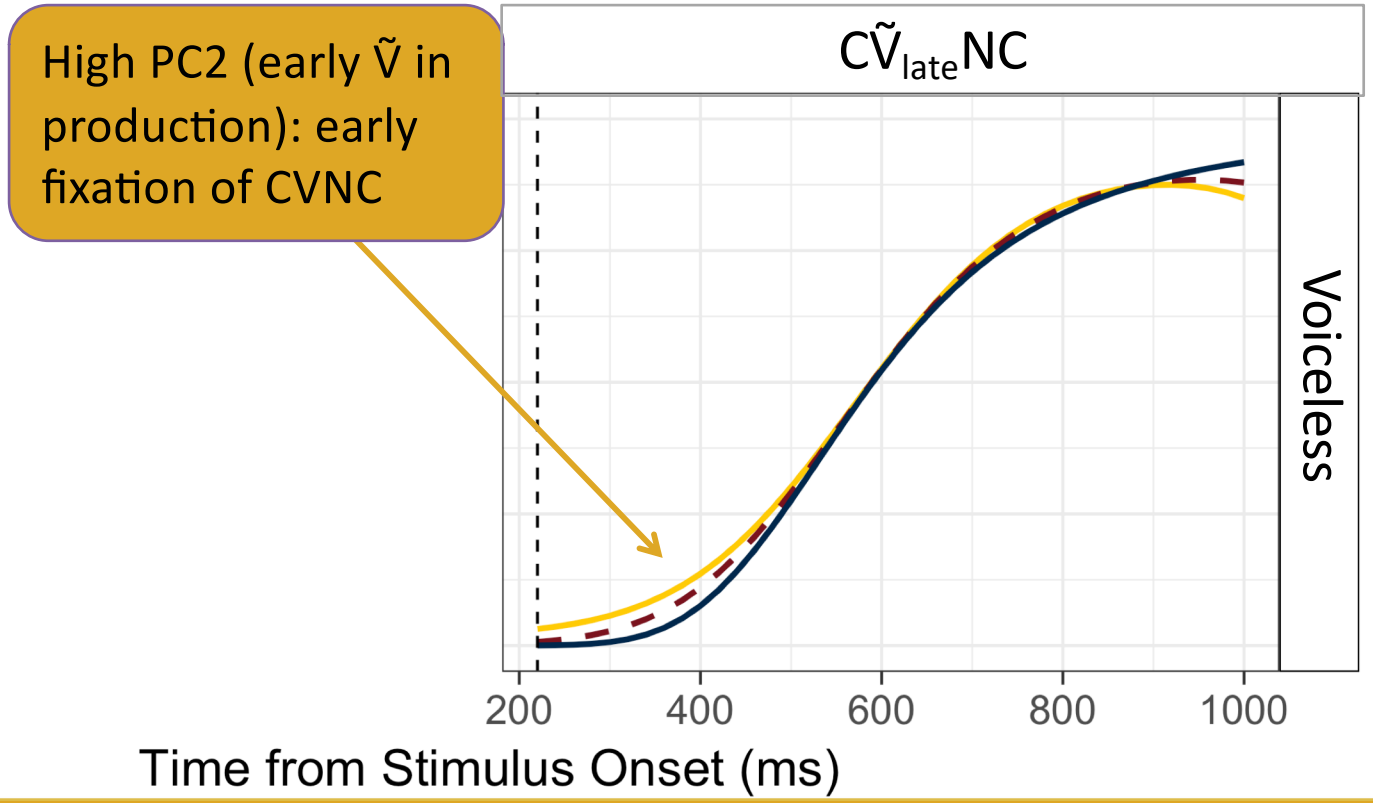
Testing for Production/Perception link:

Tested whether PC2 values—i.e., time course of nasal airflow – predict participants' *perceptual* use of coarticulatory nasalization.

Beddor et al. (2018)

Perception-production relation: results

mcmcGLMM: Fixed effects: Time (b splines; 3 dfs)*Nasalization*Voicing***PC2**
Random intercepts: Participant, Word
Random slopes: Word by Time and Nasalization



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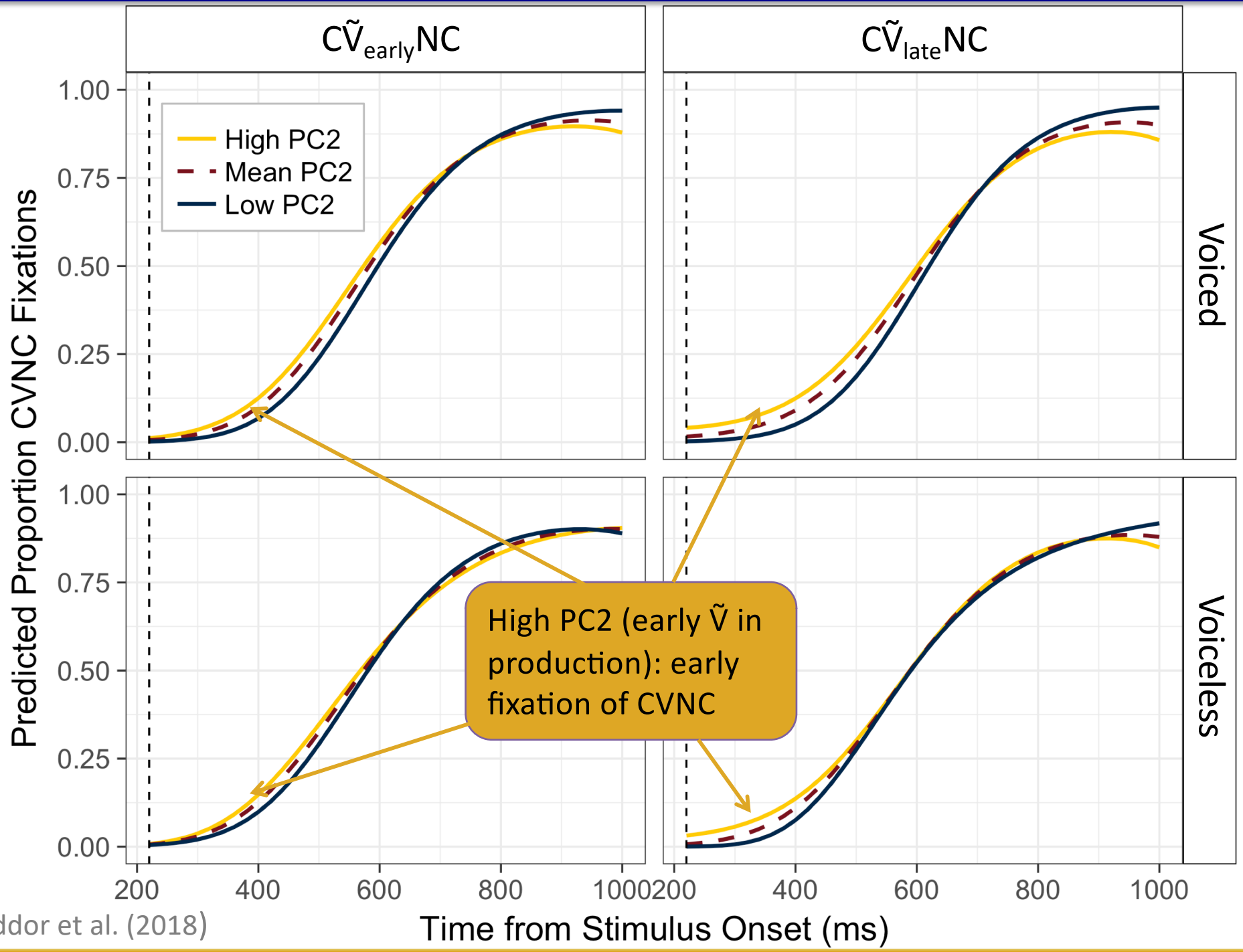
Perception/production relation: results



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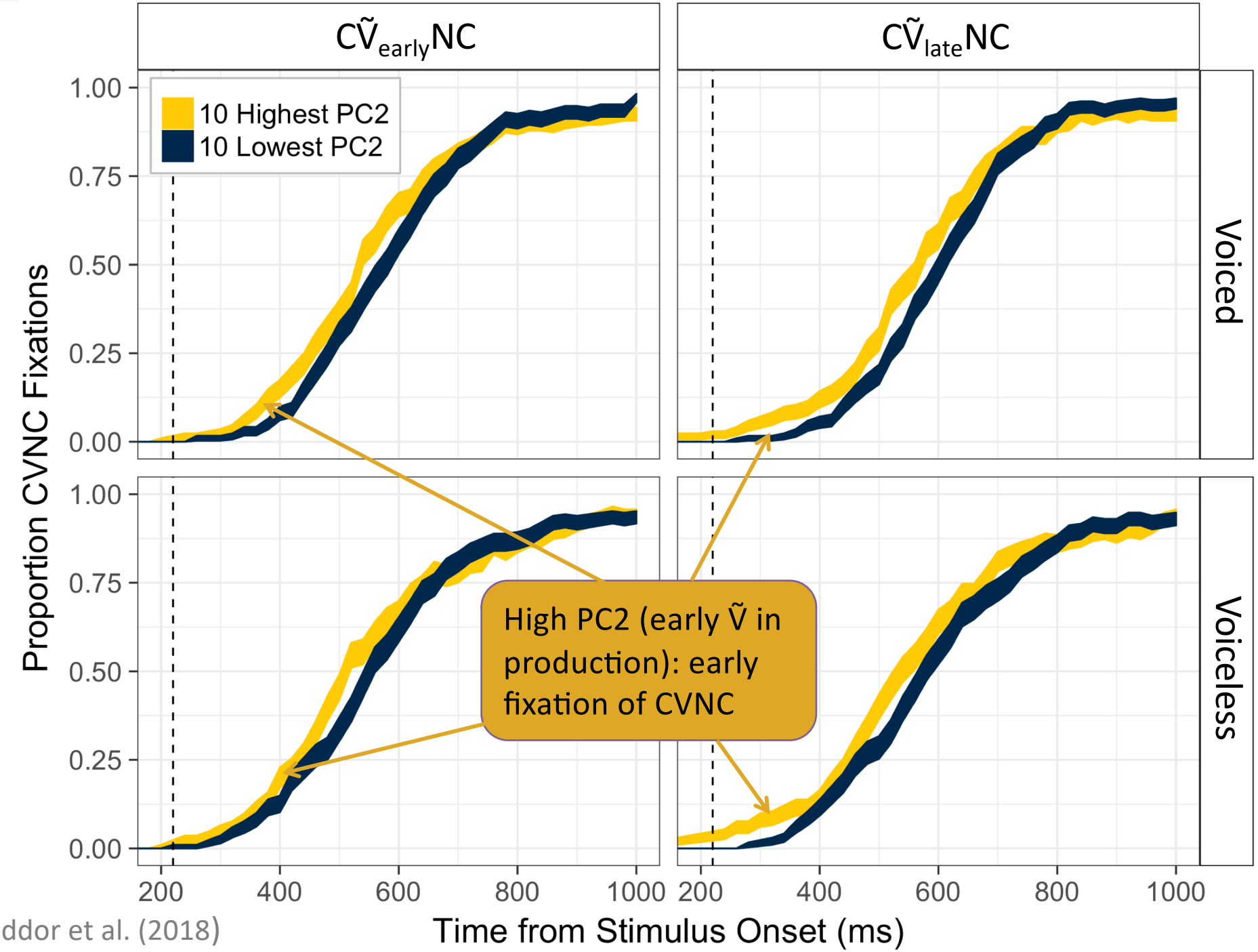


Beddor et al. (2018)

- Individuals differ in
  - the time course of their *production* of anticipatory nasalization
  - the *perceptual* usefulness of vowel nasalization in anticipating an upcoming nasal consonant.
- This variation is individually structured:

> Individuals who produce especially early onset of anticipatory nasalization track this coarticulatory property particularly closely in perception.

Beddor et al. (2018)

Implications for listener-motivated sound change:

- Assuming "innovative" listeners are speech community members who assign particularly heavy weights to the predictable, coarticulatory information (here, Ṽ), then …
- Innovative community members tend to be innovative in *both* their perception and production of coarticulatory variation.

Why do listener-speakers differ as they do?

- Experiences that each individual brings to bear on communicative interactions
- Cognitive processing styles (Yu 2010, 2013)
- Social awareness (Hay & Drager 2006, Babel 2012, Garrett & Johnson 2013)
- And more

What happens when coarticulatory variation is socially stratified? (Coetzee, Beddor, Styler, Tobin, and others)

- Two varieties of Afrikaans (South Africa)
- Different degrees of anticipatory nasalization

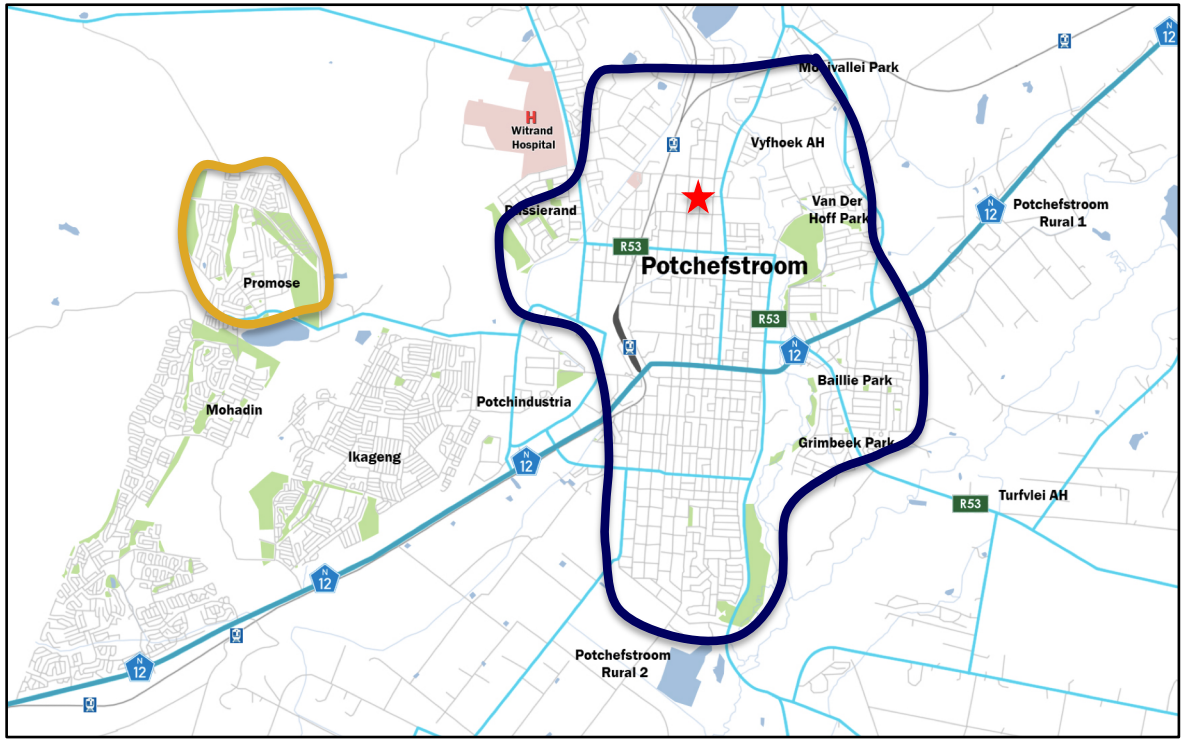
  Kleurling speakers: late onset of nasalization

  White speakers: early onset

Socially stratified coarticulatory variation

North-West University

Predominantly Kleurling



Predominantly White

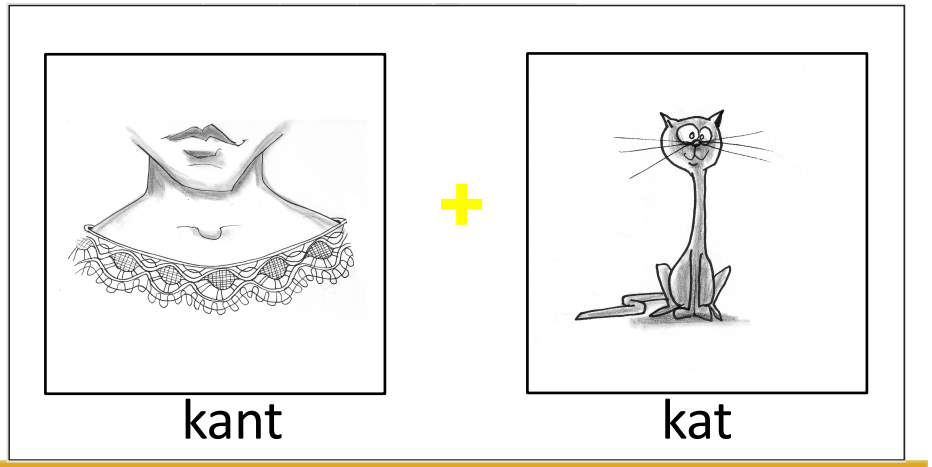
Participants: 40+ speakers each of Kleurling and White Afrikaans

Production (Airflow)

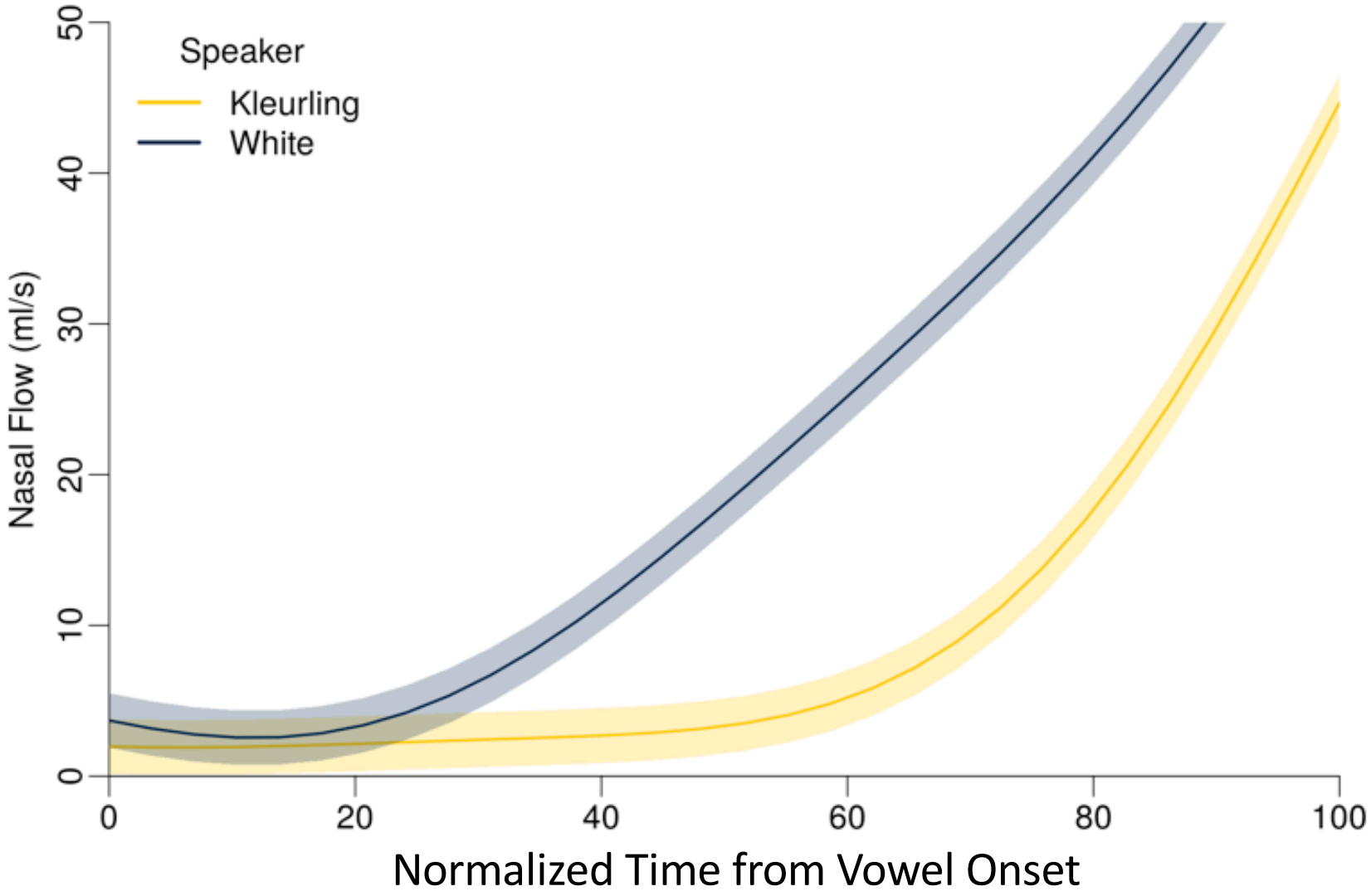
- Recorded CVC *kat* 'cat' *bos* 'forest'
  CVNC *kant* 'lace' *bons* 'bounce

Perception (Eyetracking)

- Eye movements as participants looked at images of CVC or CVNC words
- All listeners heard both Kleurling and White voices (blocked)
- Kleurling CVNC stimuli: ~25-30% anticipatory vowel nasalization
  White CVNC stimuli: ~75-80%

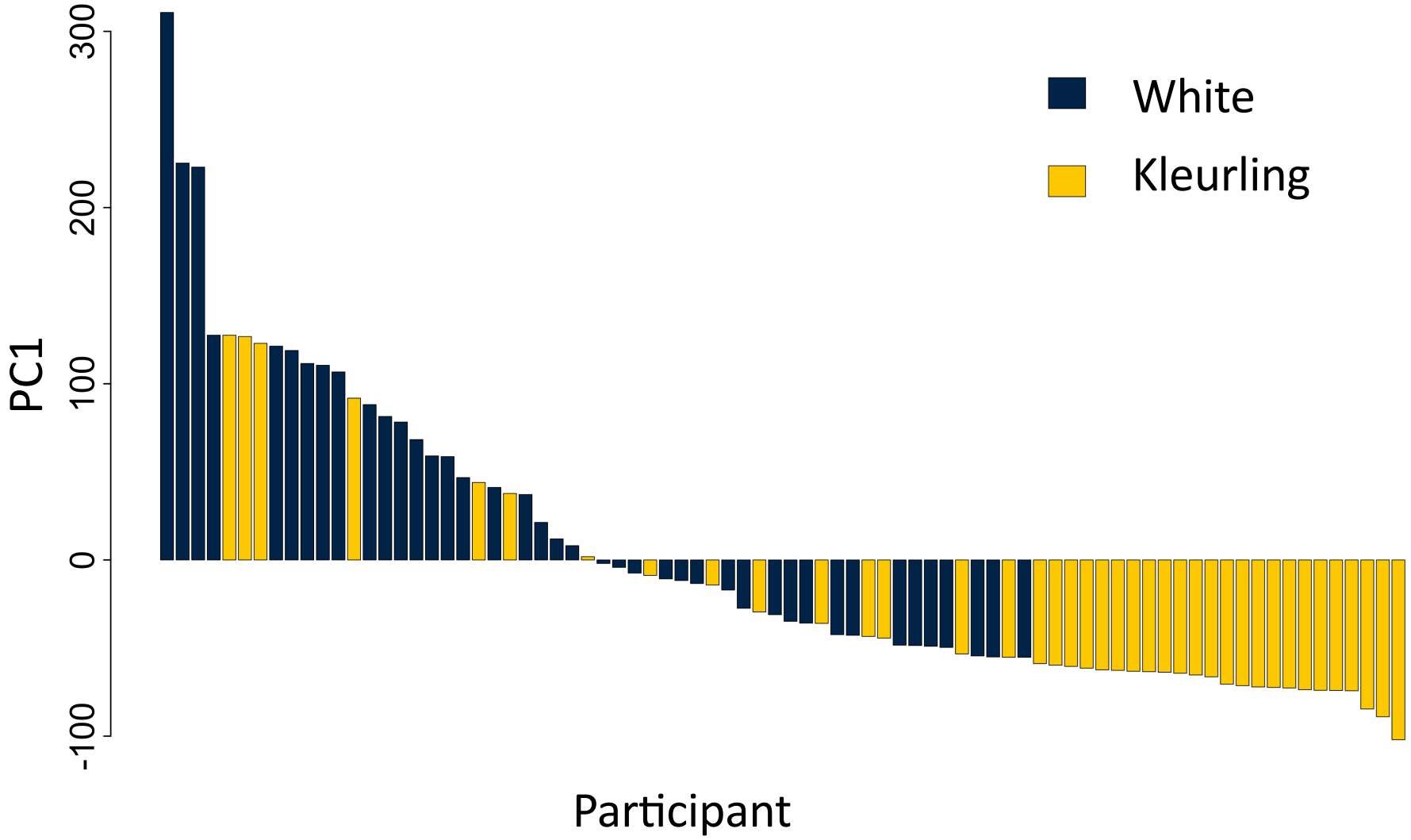


Production: Model derived nasal airflow



GAMM: Fixed factors: Race (Kleurling, White)*Normalized Vowel Duration (smooth)
Random effect: Participant-wise slopes for Word.

Production: PC1 by speaker ethnicity

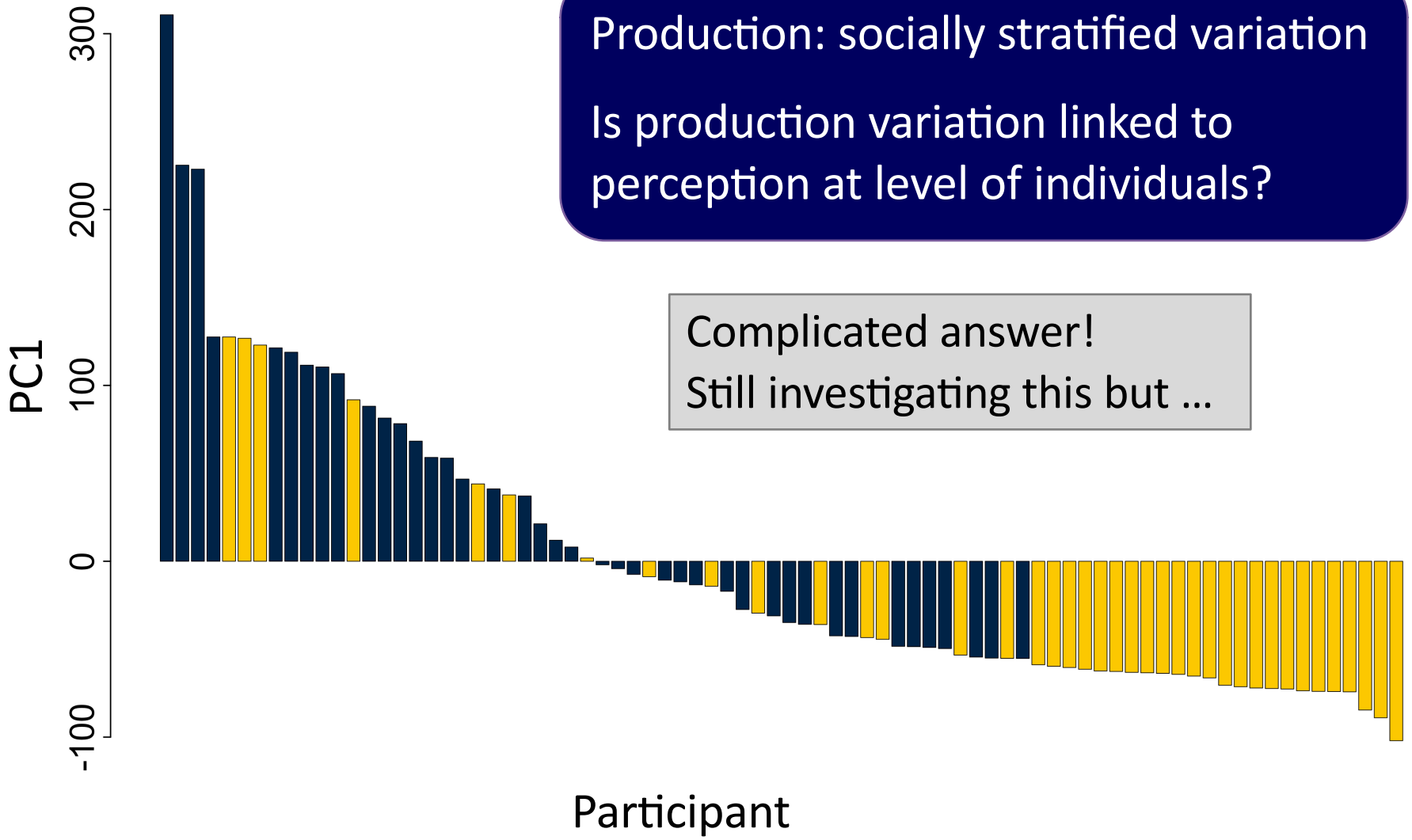


Production: PC1 by speaker ethnicity

Production: socially stratified variation

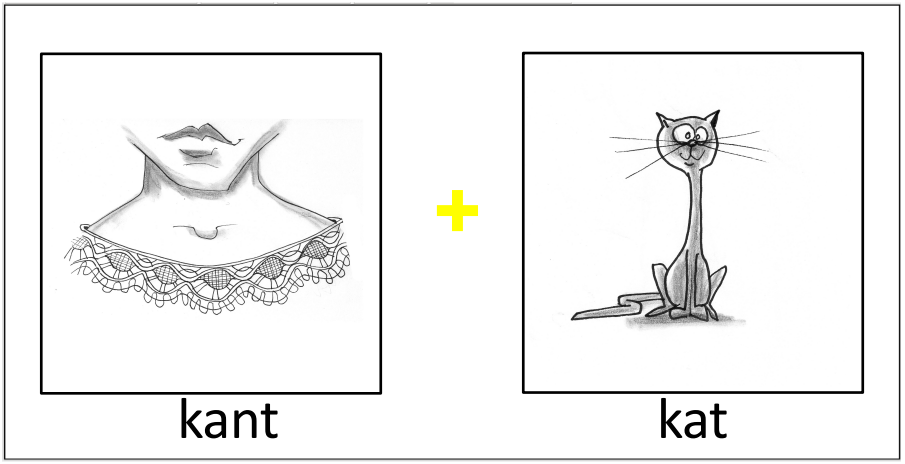
Is production variation linked to perception at level of individuals?

Complicated answer!
Still investigating this but …



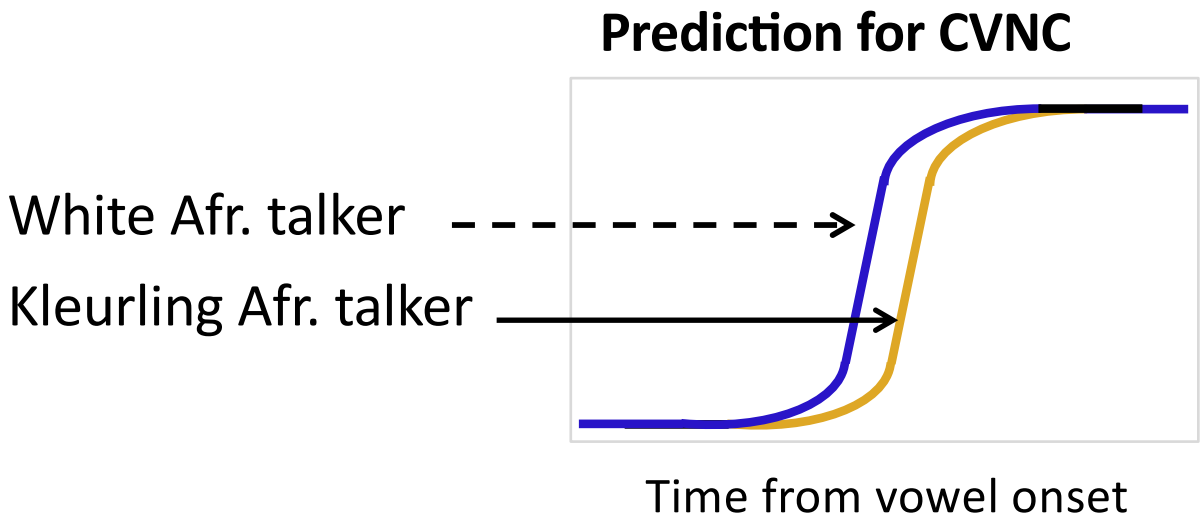
Perception

- Same basic design as English study – but with a twist
- Tested for listeners' *expectations* about coarticulatory nasalization for Kleurling and White voices
  - First stimulus block: CVC, fillers
  - Followed by mixed block: CVNC, CVC, fillers
- If listeners have knowledge of early onset of nasality for White but not Kleurling Afrikaans speech then, *prior to hearing any CVNC*, may fixate **CVC** earlier for White Afrikaans than Kleurling Afrikaans talker.



Perception

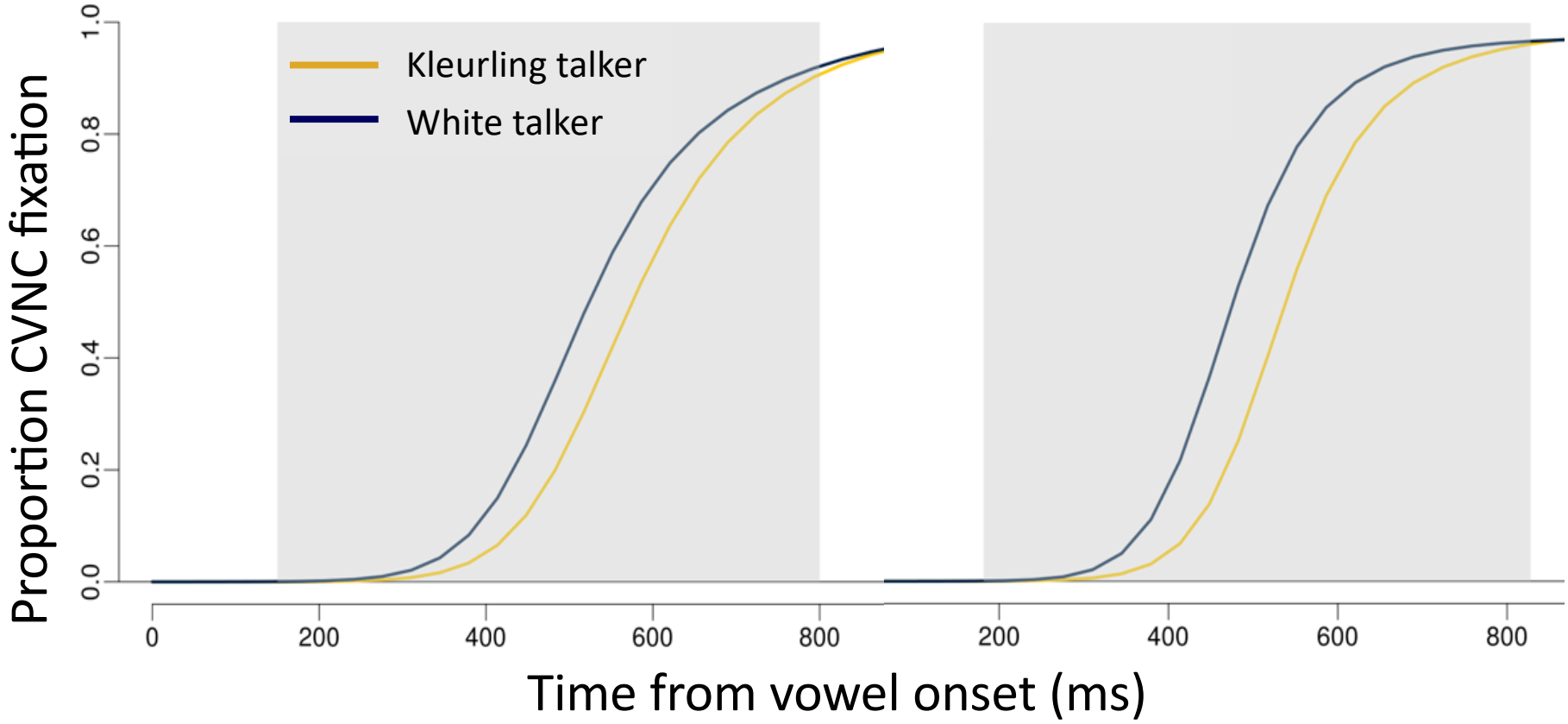
- **CVNC stimuli**:
  Prediction: All listeners use coarticulatory information



Model Derived Perception: nasal (CVNC) stimuli

Kleurling Afrikaans-Speaking Listeners

White Afrikaans-Speaking Listeners

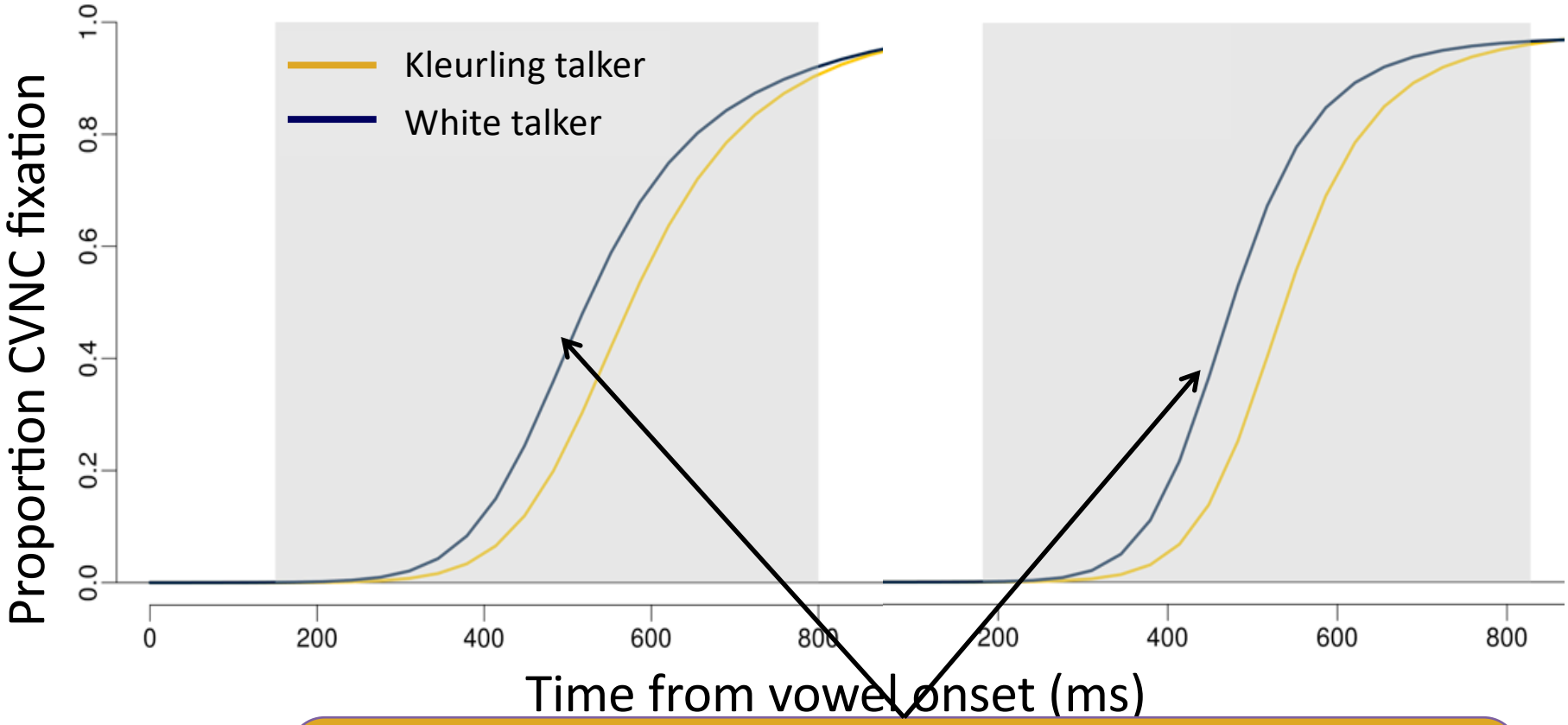


Shaded portions: significantly different

Model Derived Perception: nasal (CVNC) stimuli

Kleurling Afrikaans-Speaking Listeners

White Afrikaans-Speaking Listeners



Both listener groups use the coarticulatory information: fixate CVNC **earlier** for White than Kleurling talker.

Perception

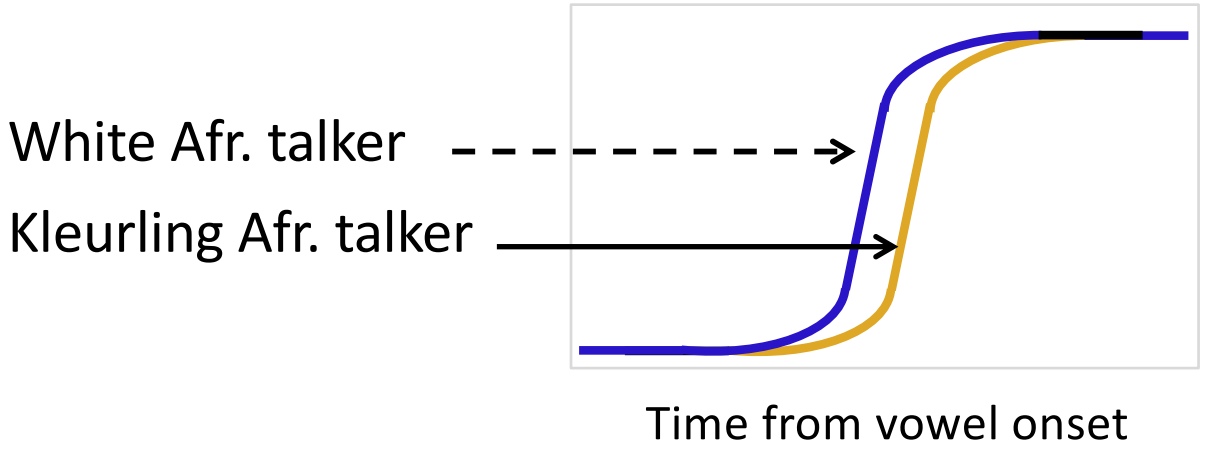
CVNC stimuli:

✓ Prediction: All listeners use coarticulatory information
Should look earlier to CVNC for White Afr. talker's stimuli

CVC stimuli:

Prediction: Listeners have coarticulatory *expectations*
In oral block, should look to **CVC** faster for White than Kleurling Afrikaans stimuli

Prediction for CVC (oral block)



Perception

CVNC stimuli:

✓ Prediction: All listeners use coarticulatory information
Should look earlier to CVNC for White Afr. talker's stimuli

CVC stimuli:

Prediction: Listeners have coarticulatory *expectations*
In oral block, should look to **CVC** faster for White than Kleurling Afrikaans stimuli

Result : Expectations appear to depend on ethnicity, gender, and production patterns

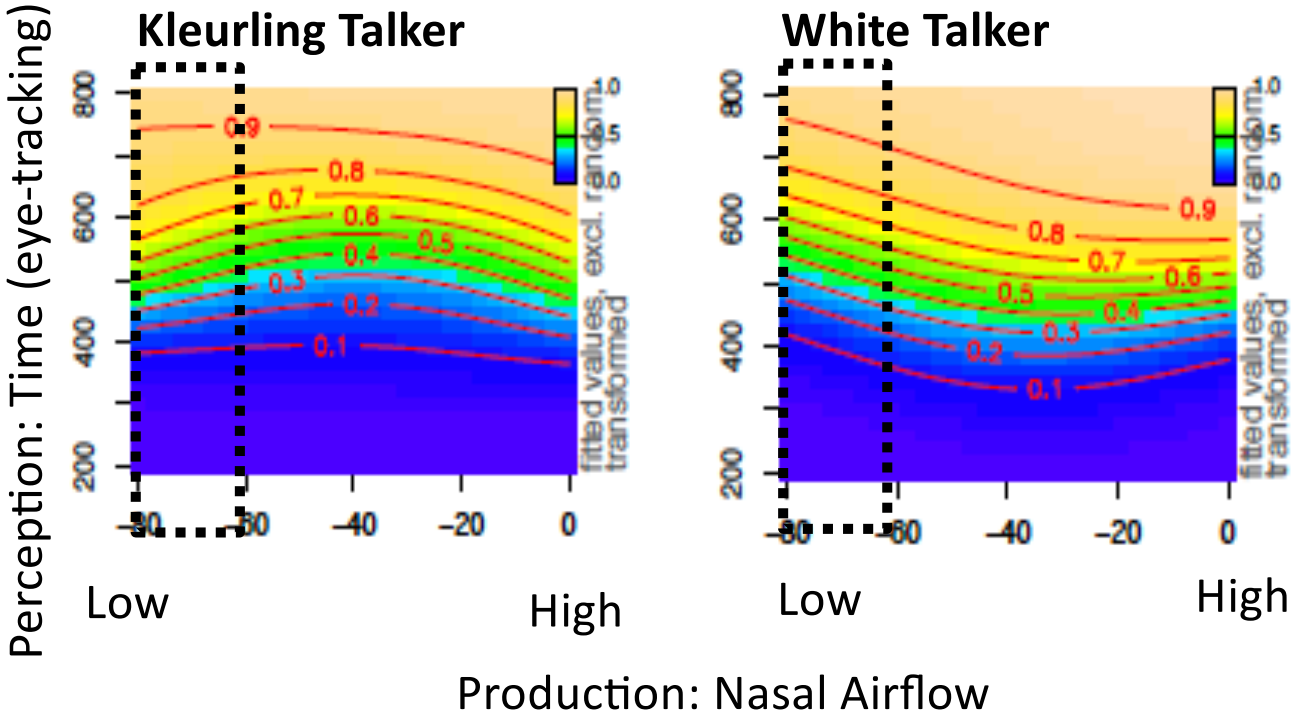
Analyses to date (subject to change …):

Suggest that, for female Kleurling speakers, the more they produce anticipatory nasalization (higher PC1), the more sensitive they are to ethnicity-specific coarticulation patterns

Oral (CVC) only block

- If listeners bring knowledge of difference between K and W Afrikaans, then …
- Earlier Oral target fixations for White than Kleurling Afrikaans talker's CVC

Female Kleurling Listeners



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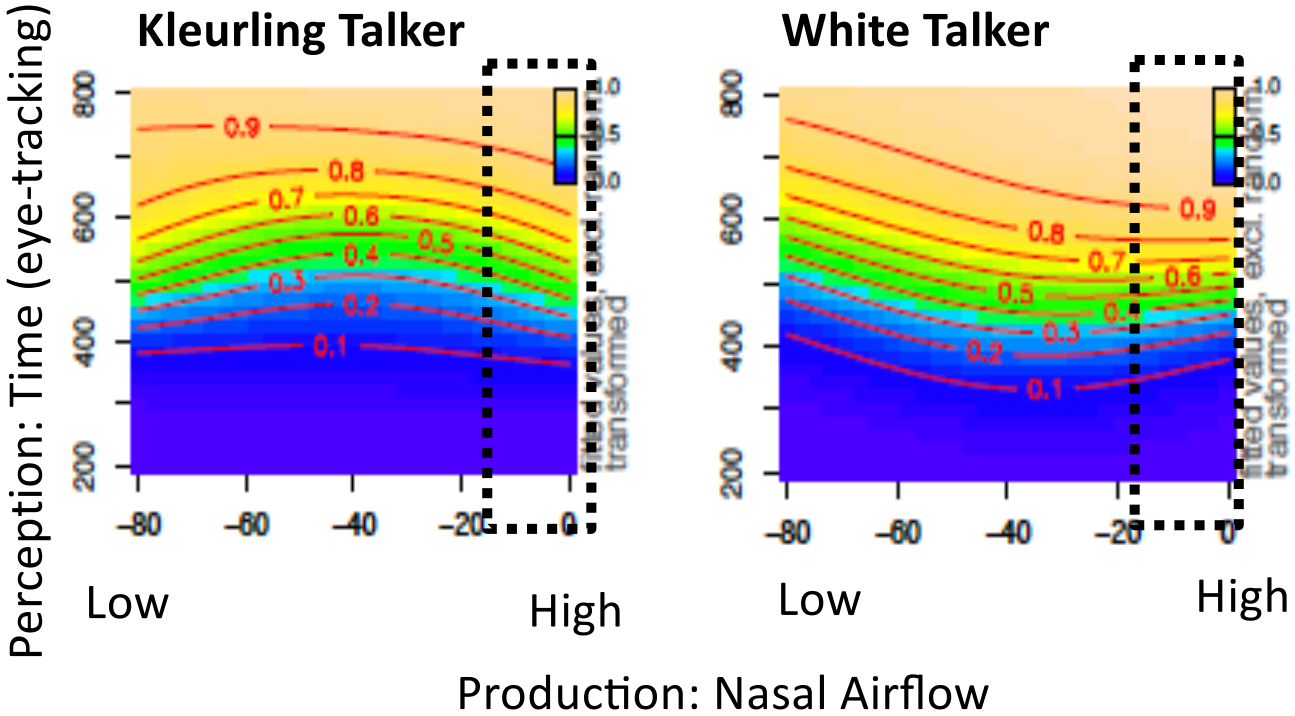
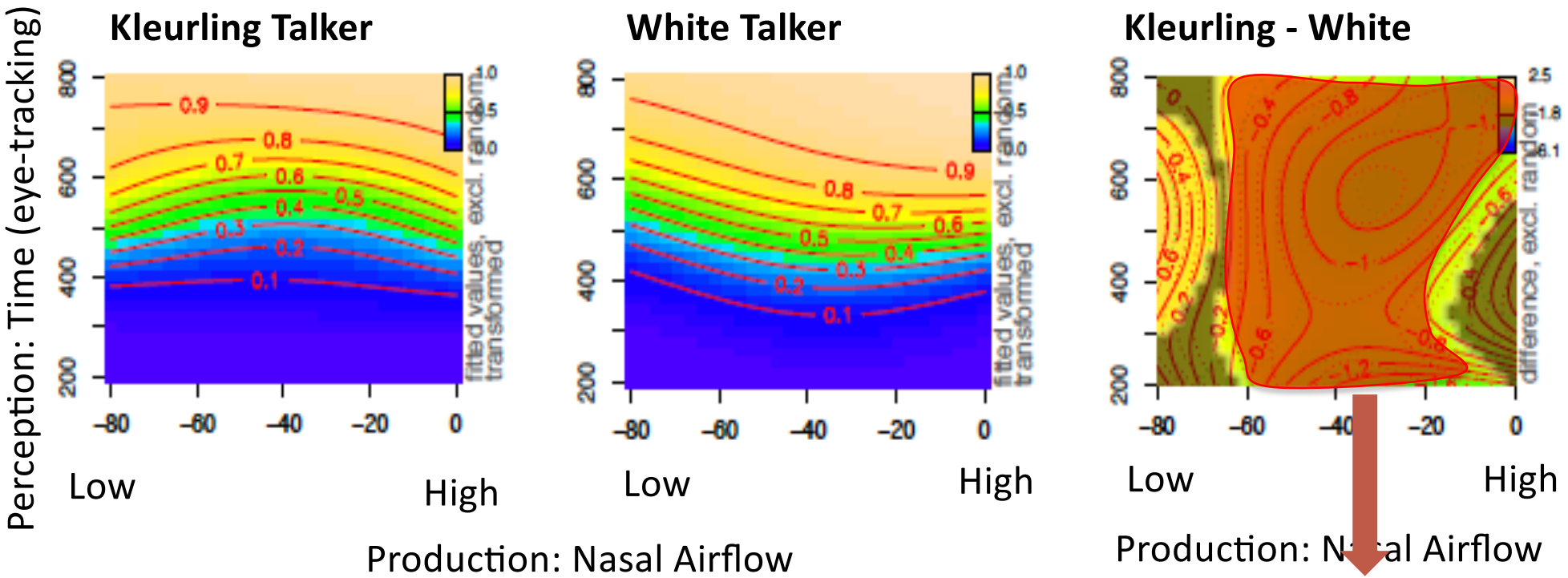


Female Kleurling Afrikaans speakers who produce more nasalization (high PC1) bring expectations about nasality to the perceptual task.

Oral (CVC) only block

- If listeners bring knowledge of difference between K and W Afrikaans, then …
- Earlier Oral target fixations for White than Kleurling Afrikaans talker's CVC

Female Kleurling Listeners



Region of significant earlier Oral target fixations for White Afrikaans talker's CVC

Expectation-based adjustment of perceptual strategies

- Particularly female Kleurling listeners

Speakers of Kleurling Afrikaans have more knowledge of both varieties

- Social structure of speech community implies unequal exposure to varieties

Female speakers more likely to accommodate to interlocutor?

- Female speakers often lead sound change (Labov 2001, etc.)

Yet bigger picture (relative to sound change)

- Challenge: To "link the initiation of sound change within individual cognitive grammars with the diffusion of novel variants through the community" (Stevens & Harrington, 2014:2)
- Goal: to take up this challenge for perceptually motivated changes involving coarticulation:

  VN > Ṽ

  vowel harmony

  tonogenesis from voicing distinctions
- Proposal: *some* innovators are language uses who
  - as listeners find coarticulatory information especially useful
  - as speakers produce extensive coarticulatory cues
- Work in progress:

  Does socially-conditioned variation contribute to stronger or weaker -- or simply different -- perception/production links?

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References

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