Covert URs
Evidence from nasality in Panjabi

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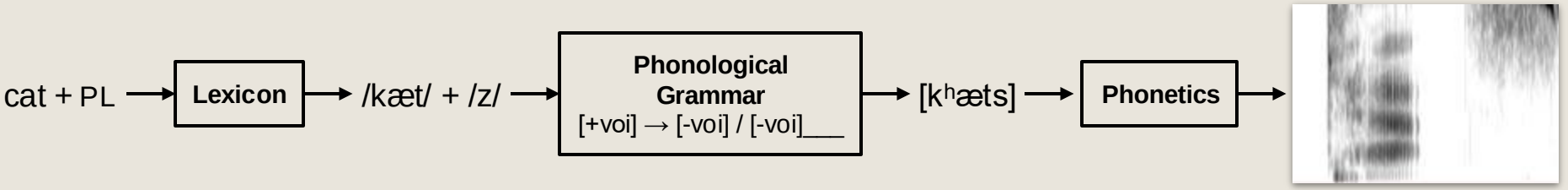
The Classic Generative View

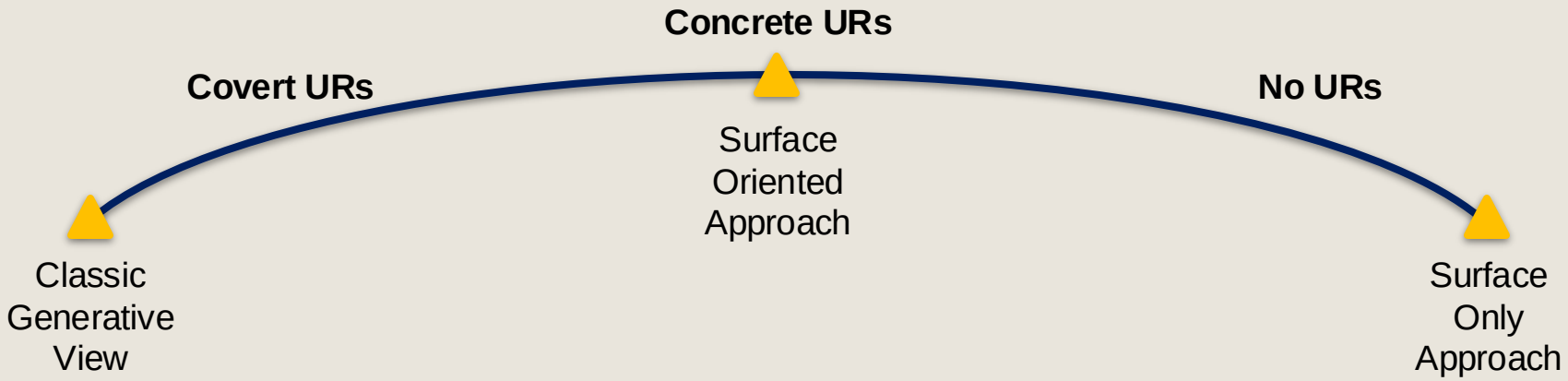


Challenges to the Generative View of URs

- **Surface-Oriented view** (Albright, 2002)
  - The level of abstraction of URs is constrained
  - URs must be concrete

- **Surface-Only view** (Burzio, 1996; Goldinger, 2007; Johnson, 2007)
  - URs do not exist
  - Abstraction (if it exists) is derived from statistical averaging over surface forms

Continuum of views on Underlying Representations



Overview of the Talk

- Research Questions:
  - Do underlying representations exist?
  - If so, how abstract can they be?

- Two experiments exploring representation of vowels before nasal consonants in Western Panjabi
  - Experiment 1: How are pre-N vowels realized?
  - Experiment 2: How do pre-N vowels behave phonologically?

- Does the realization and phonological behavior of pre-N vowels tell us anything about URs?

Key Results

- Two experiments measuring nasality in Western Panjabi vowels
  - Experiment 1: contrastive nasal (CṼṼ) and non-contrastive pre-N (CVVN) vowels are indistinguishable in terms of nasality
  - Experiment 2: contrastive nasal and pre-N vowels trigger nasal harmony differently
- **Results support the existence of Covert URs**

Background on Panjabi

- Native language of more than 78 million people in Pakistan
  - (Bashir & Conners, 2019)
- Spoken by around 33 million people in India.

Background on Panjabi Phonology

		Front			Central			Back		
		short	long	nasal	short	long	nasal	short	long	nasal
High	tense		ii	ĩi					uu	ũũ
	lax	ɪ						ʊ		
Mid	tense		ee	ẽẽ					oo	õõ
	lax		ɛɛ	ɛ̃ɛ̃	ə				ɔɔ	ɔ̃ɔ̃
Low	tense									
	lax								ɑɑ	ɑ̃ɑ̃

The Panjabi vowel inventory (Shackle, 2003)

Background on Panjabi Phonology

- Vowel nasality is only **contrastive in the word-final syllable** (Bashir & Conners, 2019, p.45)
- Nasality **contrast is neutralized before a nasal consonant** (Zahid & Hussain, 2012)

tãã̃	‘that’	vs.	tɑɑ	‘fever’
no	tãã̃n	vs.	*tɑɑn	

- Very few cases in which a VVN sequence straddles a morpheme boundary
  - Learners have little to no experience with pre-N vowels except before a nasal consonant

Background on Panjabi Phonology

- Nasal harmony (Bhatia, 1993)
  - Leftward transmission of nasalization triggered by a nasal vowel
  - Vowels and glides (/j/ and /ʊ/) are targets
  - All other non-nasal consonants serve as blockers

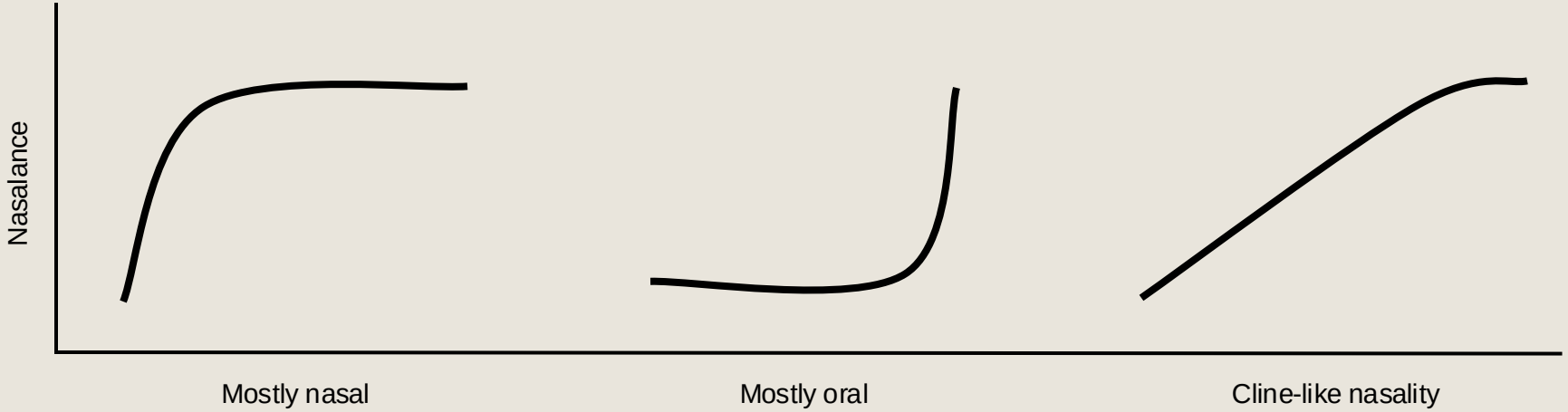
paaʊẽẽ	→	[pããʊ̃ẽẽ]	‘whether’
ʃaaxãã	→	[ʃaaxãã]	‘branches’

- Unclear whether nasal harmony is triggered by pre-N vowels

aaʊaam	→	?[aaʊããm]/[ããʊ̃ããm]?	‘public’
siijaan	→	?[siijããn]/[sĩĩ̃jããn]?	‘recognition’

Experiment 1: How is pre-N VV realized?

- Research Question: What is the surface representation of pre-N vowels in terms of nasality?



- Nasalance: Amount of nasal airflow in the system as a proportion of the total amount of airflow

$$\frac{A^n}{A^n + A^o}$$

Experiment 1: participants and stimuli

- 20 native Panjabi speakers
  - 11 men and 9 women
  - Ages ranged from 22-79 (μ = 39.7)
- Stimuli
  - 67 monosyllabic tokens separated into three conditions

CVV(C) (26)	CṼṼ(C) (20)	CVVN (21)
tʰɑɑ ‘was’	tʰãã ‘room’	tʰɑɑn ‘piece of cloth’
seek ‘warmth’	sẽẽk ‘termite’	
doo ‘two’		doon ‘ropes on a knitted cot’
	pĩĩg ‘swing’	piin ‘to drink’

Experiment 1: Measurements

- Dual Chamber Oro-nasal airflow mask from Glottal Enterprises
- Measures oral and nasal airflow separately
- Outputs two time-aligned waveforms

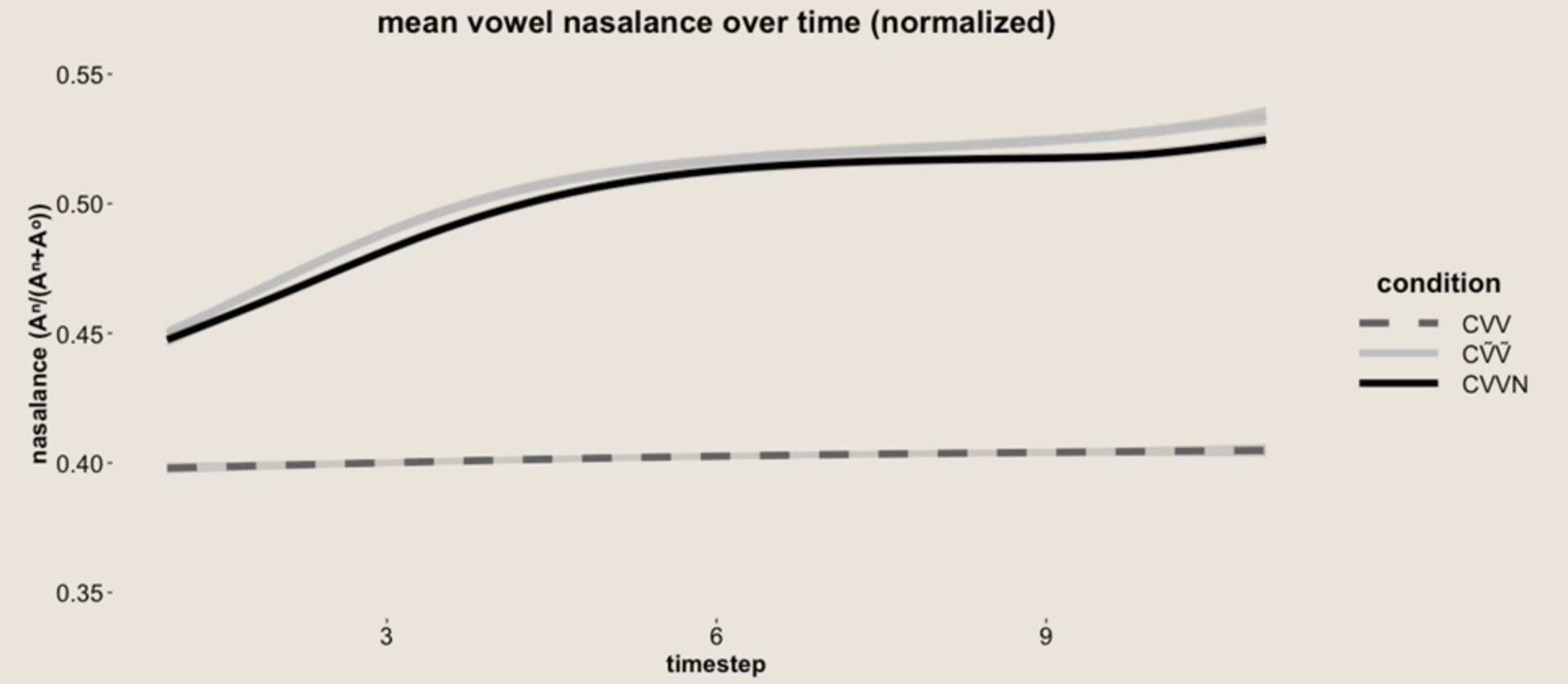
Experiment 1: Procedure

- Recorded individually in a soundproof room at a university in Rawalpindi, Pakistan
- Words presented to speakers in Shahmukhi script in randomized order using Python GUI
- Each word was produced 4 times while wearing the mask
  - 2 slow
  - 2 fast
- 5-minute training session to ensure accurate measurements
- All instructions given in Panjabi by a native speaker consultant

Experiment 1: Analysis

- Vowel boundaries hand-annotated in Praat
- Nasalance ($A^n/(A^n+A^o)$) measured at 11 normalized time points across each vowel token
- Currently have analyzed data for ten of the twenty participants
  - 2,640 tokens = 67 tokens x 4 repetitions x 10 speakers - 40 low quality tokens
- Slow vs. fast productions did not affect results

Experiment 1: Results



Experiment 1: Results

- Linear Mixed-effects model

lmer(mean nasalance ~ condition +
(1 + condition|speaker) + (1+ condition|word)

Effect	Estimate	95% CI	*t*	*p*
CṼṼ (intercept)	.505	[.496, .514]	114.57	< .001 ***
CVVN	-.004	[-.014, .005]	-.95	.35

- **Takeaway**: CṼṼ and CVVN vowels are indistinguishable in terms of nasality

Experiment 2: Does pre-N VV trigger harmony?

- **Research Question**: Since pre-N vowels are indistinguishable from CṼṼ vowels in terms of nasality, do they trigger nasal harmony in the same way?

- Bhatia (1993): nasal harmony is triggered by nasal vowels

  pɑɑʋẽẽ → [pããʋẽẽ] ‘whether’

  ʃɑɑxãã → [ʃɑɑxãã] ‘branches’

- **Hypothesis 1**: pre-N vowels trigger nasal harmony

  ɑɑʋɑɑm → [ããʋããm] ‘public’

- **Hypothesis 2**: pre-N vowels do not to trigger nasal harmony

  ɑɑʋɑɑm → [ɑɑʋããm] ‘public’

Experiment 2: participants and stimuli

- 16 native Panjabi speakers
  - 11 men and 5 women
  - Ages ranged from 18-43 (μ = 28.2)

- Stimuli
  - Three main conditions based on vowel type: VV, ṼṼ, and VVN
  - Words either di- or trisyllabic followed by a CV postposition
  - Every word contained a vowel-glide-vowel sequence across the final two syllables

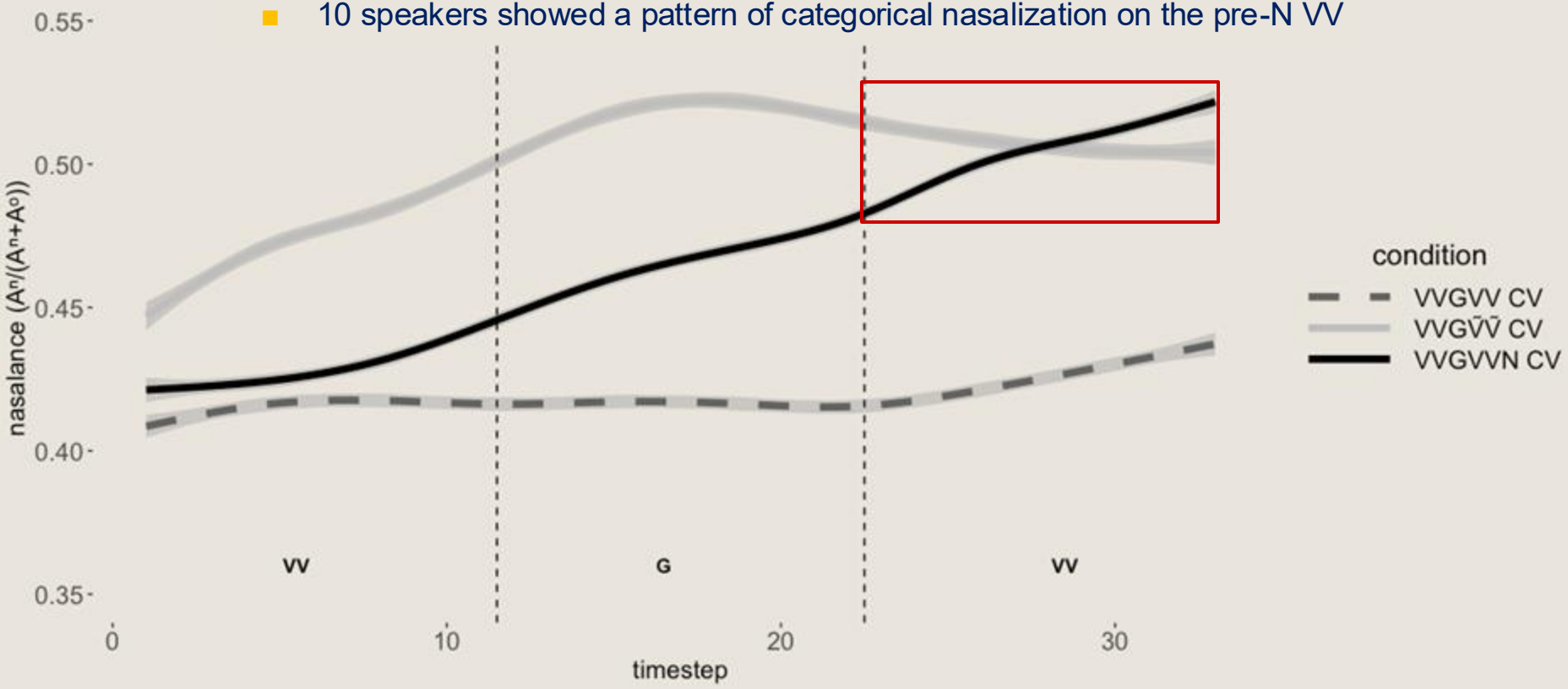
VVGVV CV (10)	VVGṼṼ CV (8)	VVGVVN CV (8)
pɑɑʋee də cot leg"	ʧɑɑʋẽẽ də ‘pumicstone’	ədʒəʋɛɛn də "omum seed"
tɑɑʋuu də "paternal uncle”	sɑɑʋãã də "breaths"	ɑɑʋɑɑm də "public"
sətɑɑjii də "27"	tiiʋĩĩ də "woman"	geejɑɑn də "knowledge"

Experiment 2: procedure and analysis

- Procedure and analysis the same as in experiment 1.
- Currently have analyzed data for twelve of the sixteen participants
- 2,496 tokens (52 tokens x 4 repetitions x 12 speakers)

Experiment 2: results

- 10 speakers showed a pattern of categorical nasalization on the pre-N VV



Experiment 2: post-G vowels

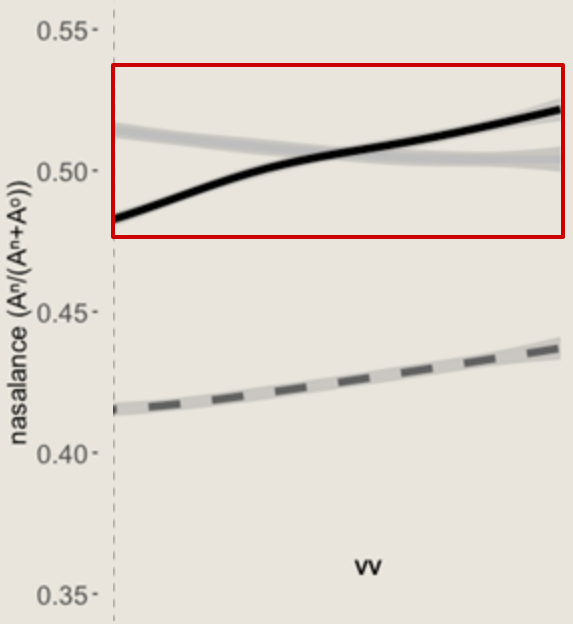
- post-Glide ṼṼ and post-Glide pre-N vowels

  lmer(mean nasalance ~ condition + condition*timestep
  (1 + condition|speaker) + (1|word)

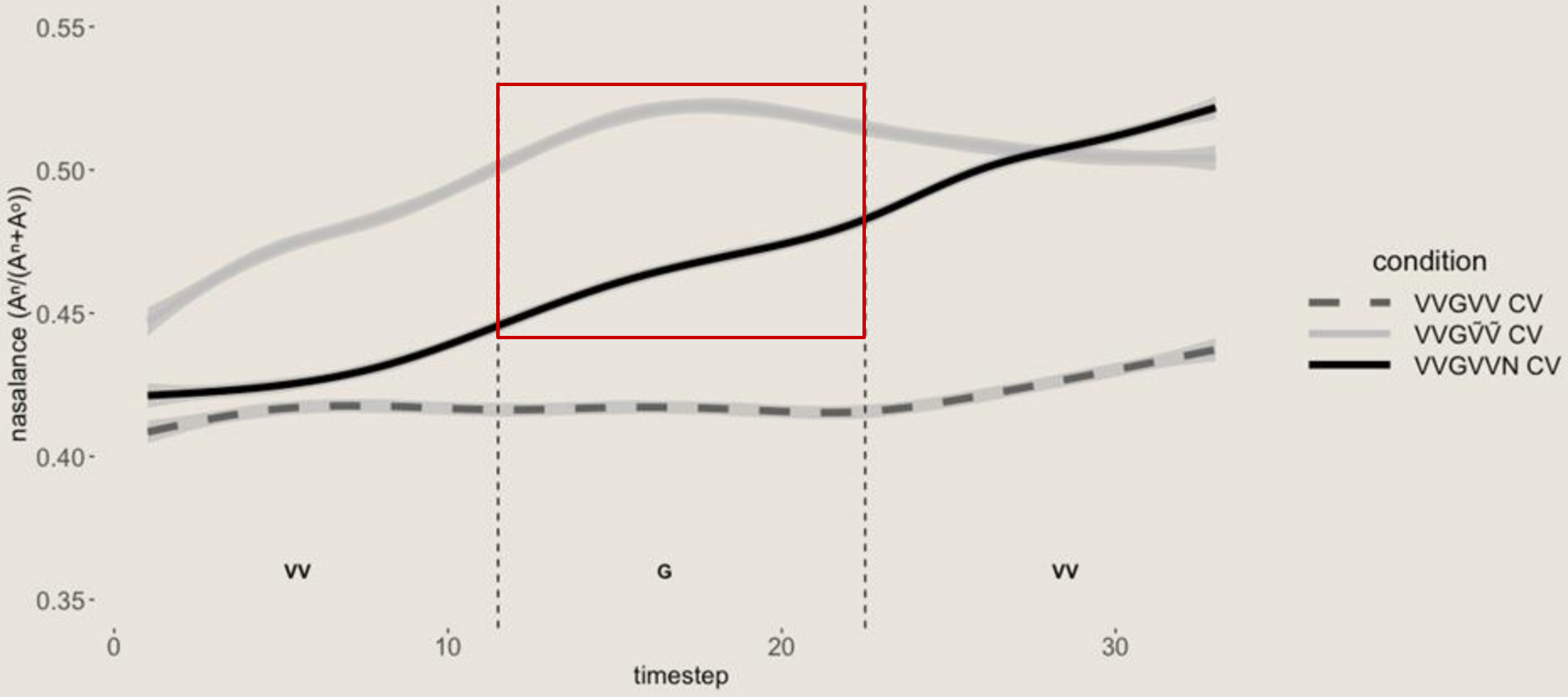
- No significant difference between pre-N VV and ṼṼ conditions at any of the three timesteps

- pre-N VV and ṼṼ are not statistically equivalent

- **Takeaway**: contrastive nasal and pre-N vowels are indistinguishable in terms of nasality



Experiment 2: Glides

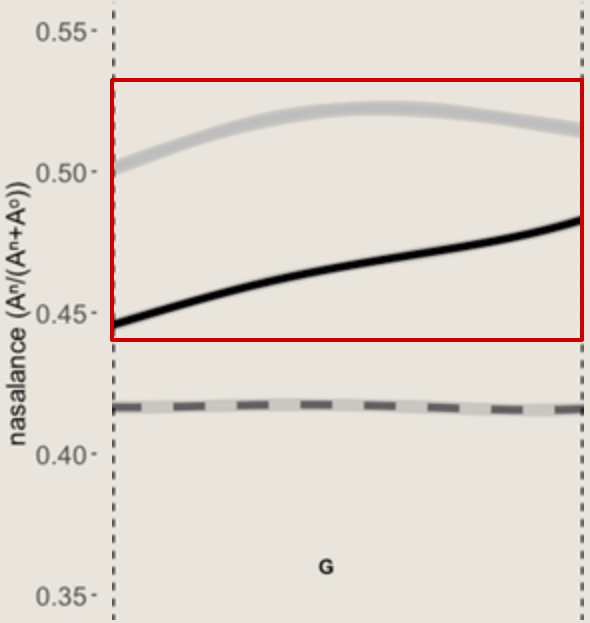


Experiment 2: Glides

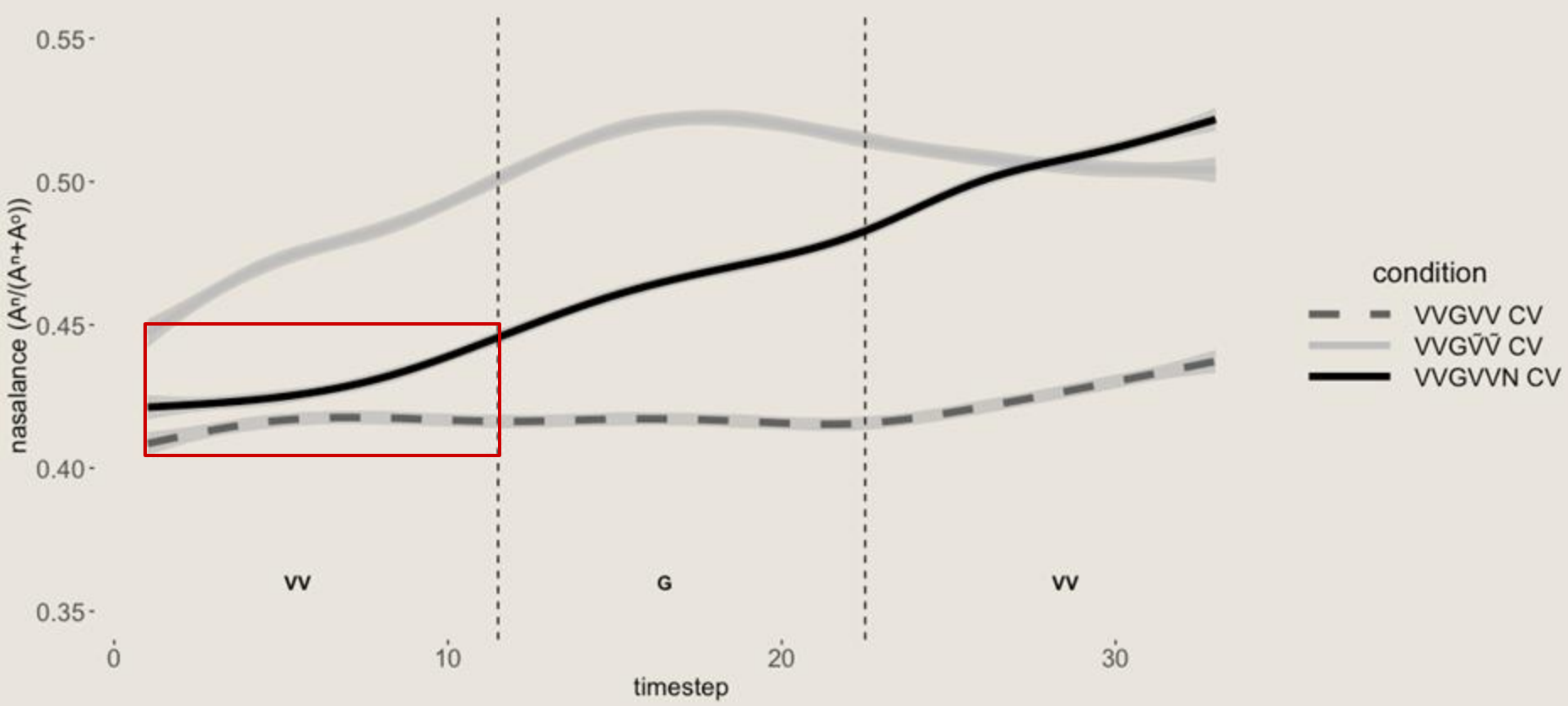
- Glides in ṼṼ and pre-N conditions

  lmer(mean nasalance ~ condition
  (1 + condition|speaker) + (1|word)

- Significant difference between pre-N VV and ṼṼ conditions



Experiment 2: pre-Glide vowels

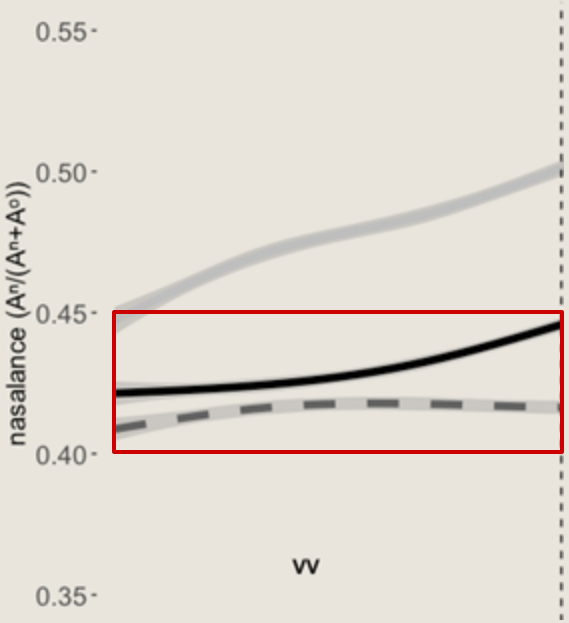


Experiment 2: pre-G vowels

- pre-G vowels in oral and pre-N conditions

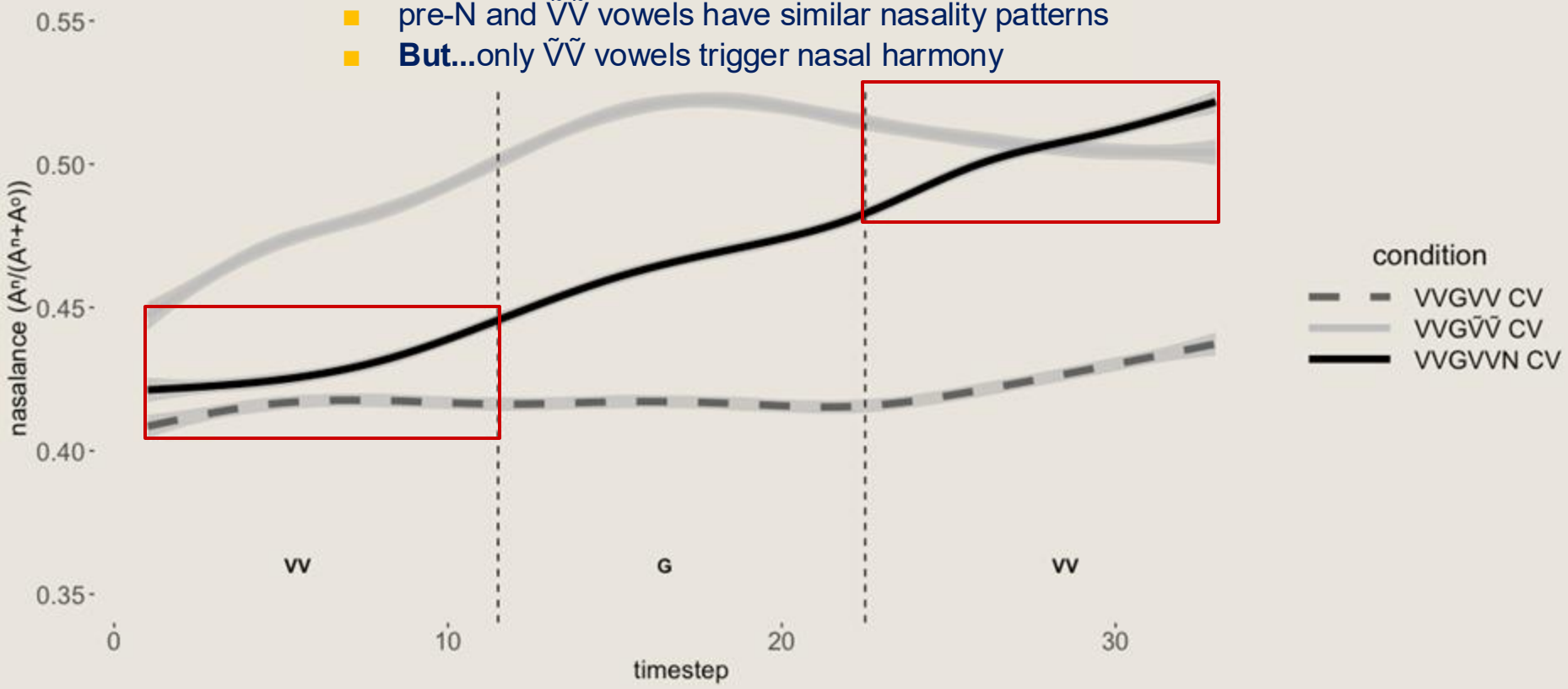
  lmer(mean nasalance ~ condition
  (1 + condition|speaker) + (1|word)

- **No significant difference** between pre-N and oral conditions



Experiment 2: Takeaways

- pre-N and ṼṼ vowels have similar nasality patterns
- **But...**only ṼṼ vowels trigger nasal harmony



Hypotheses

- **Hypothesis 1**: pre-N vowels trigger nasal harmony

  ɑɑʋɑɑm → [ããʋ̃ããm] ‘public’

- **Hypothesis 2**: pre-N vowels do not to trigger nasal harmony.

  ɑɑʋɑɑm → [ɑɑʋ̃ããm] ‘public’

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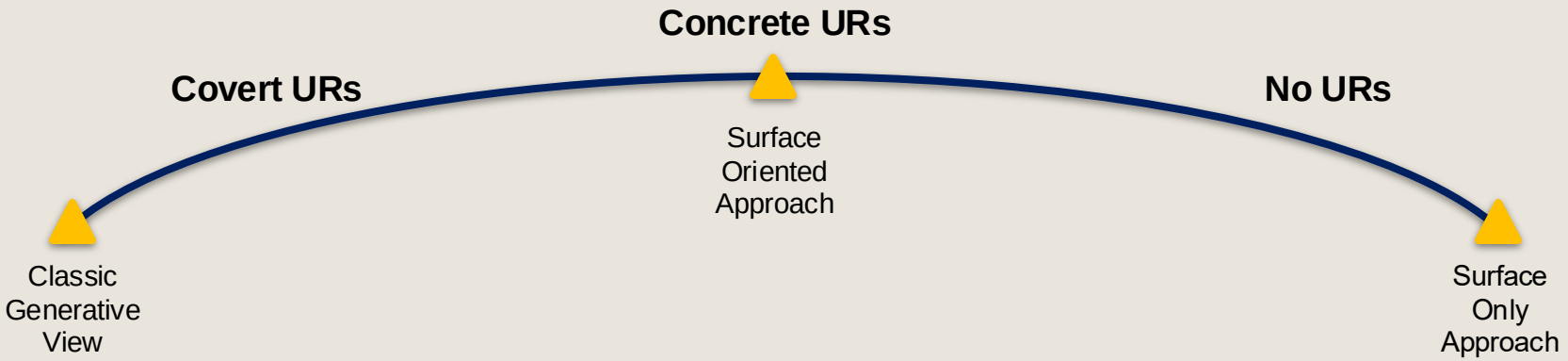
Discussion

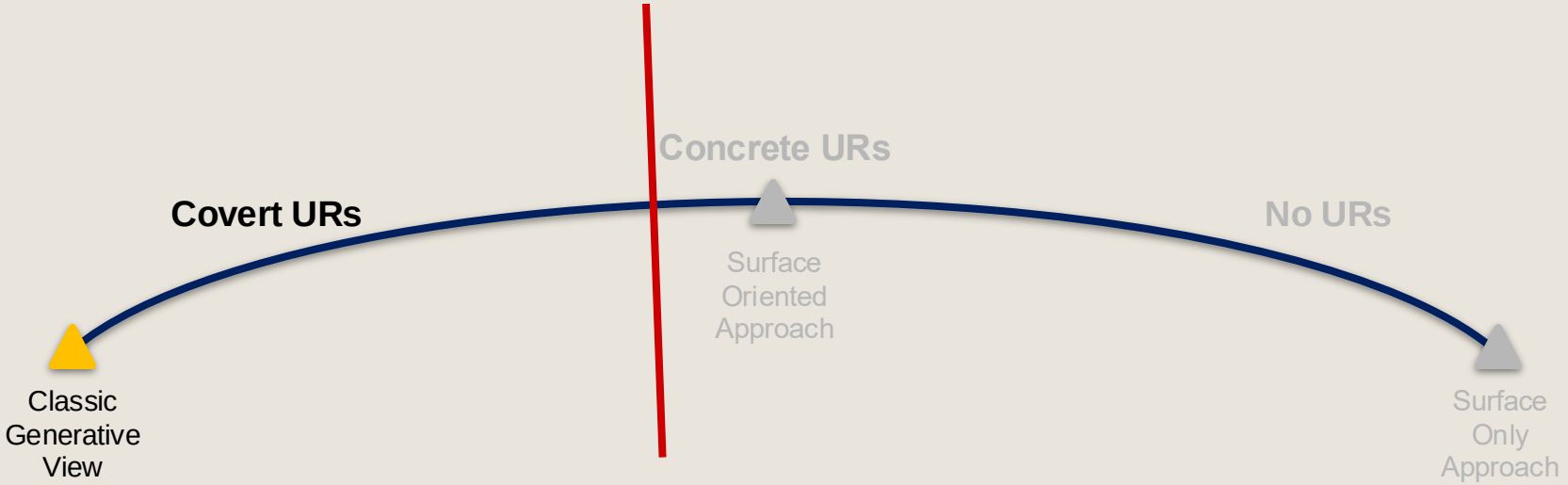
- **Surface-based approaches:** cannot account for the opaque interaction between pre-N vowel nasality and regressive nasal harmony
- **If covert URs are acceptable...**

UR	a. /sɑɑʊãã/	b. /ɑɑʊɑɑm/
(1) Nasal Harmony	sããʊ̃ãã	-
(2) V → [+nas]/__N	-	ɑɑʊããm
Surface Form	[sããʊ̃ãã]	[ɑɑʊããm]

Continuum of views on Underlying Representations



Continuum of views on Underlying Representations



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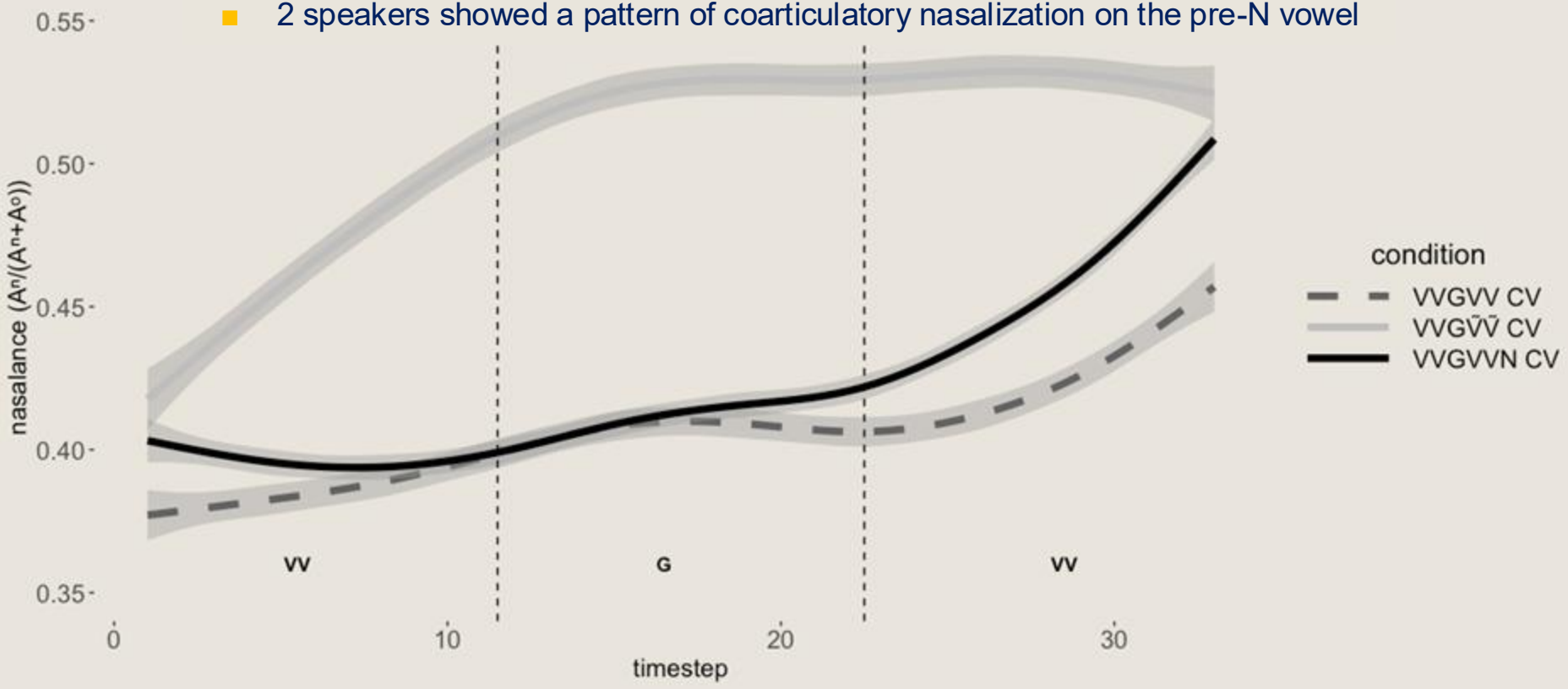
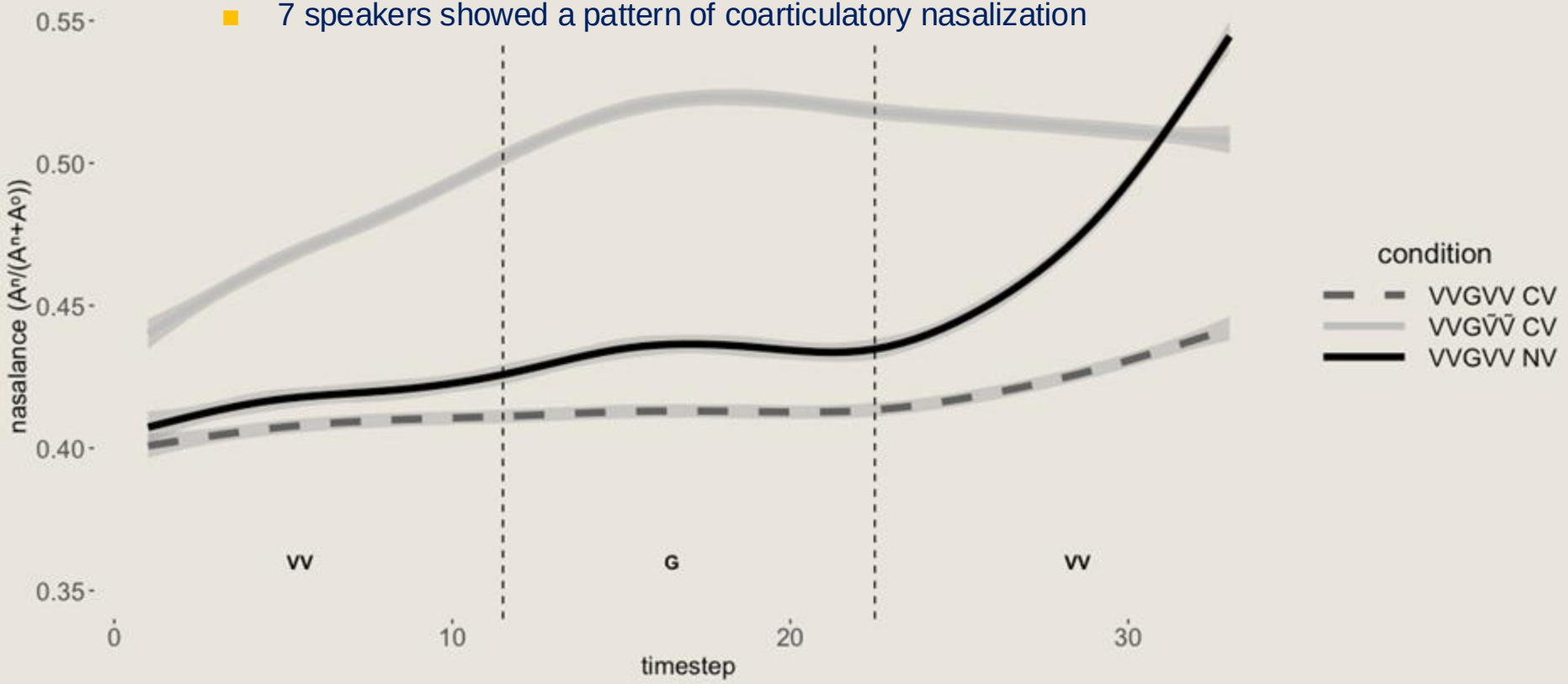
Appendix: Coarticulation of VVGVVN CV

- 2 speakers showed a pattern of coarticulatory nasalization on the pre-N vowel



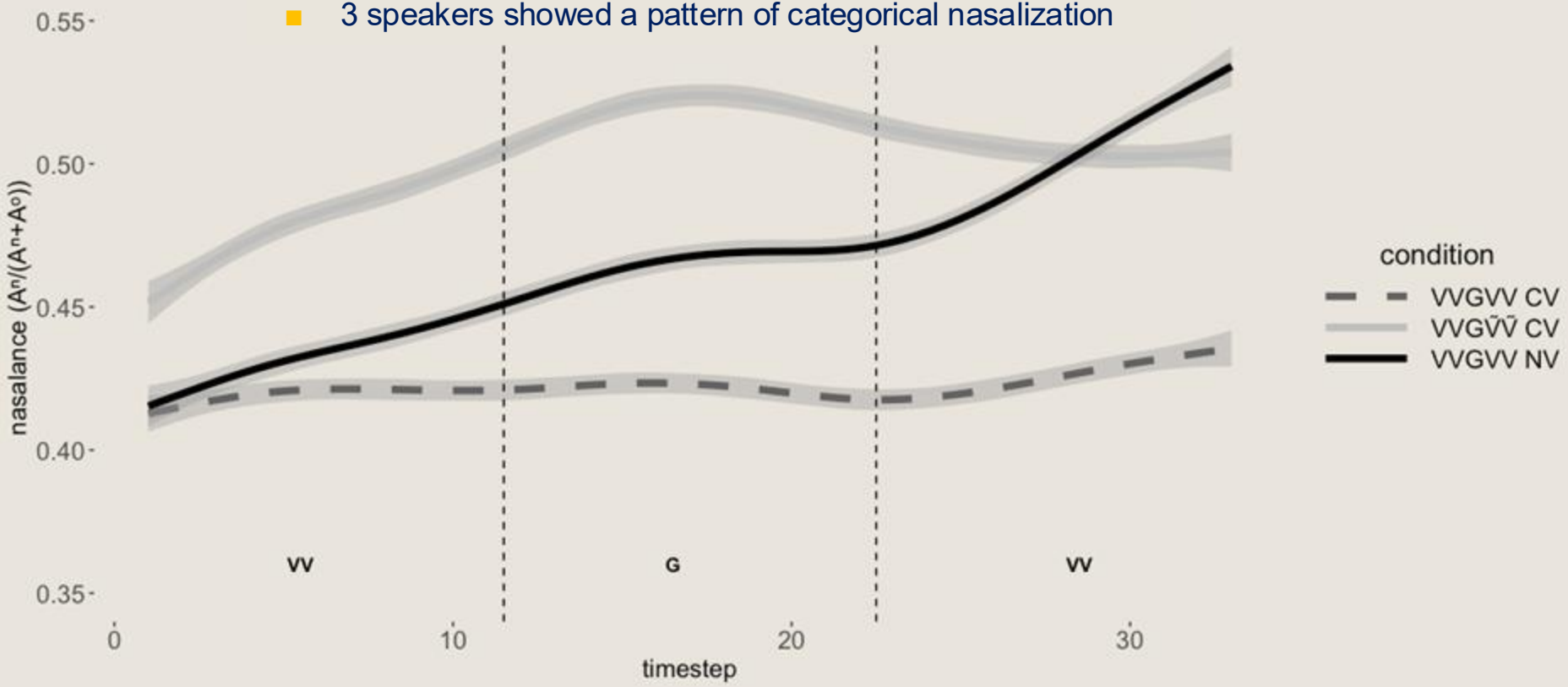
Appendix: VVGVV NV

- 7 speakers showed a pattern of coarticulatory nasalization

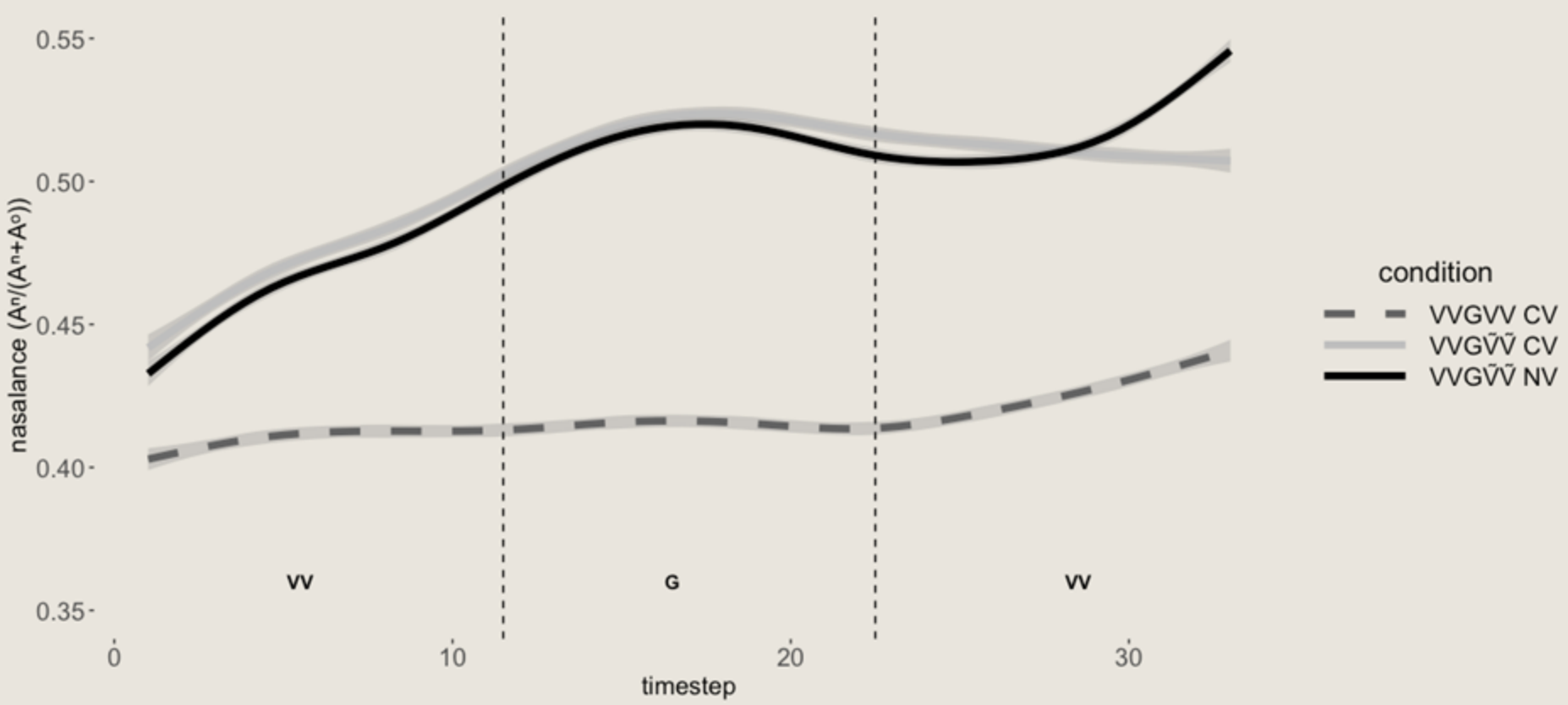


Appendix: VVGVV NV

- 3 speakers showed a pattern of categorical nasalization

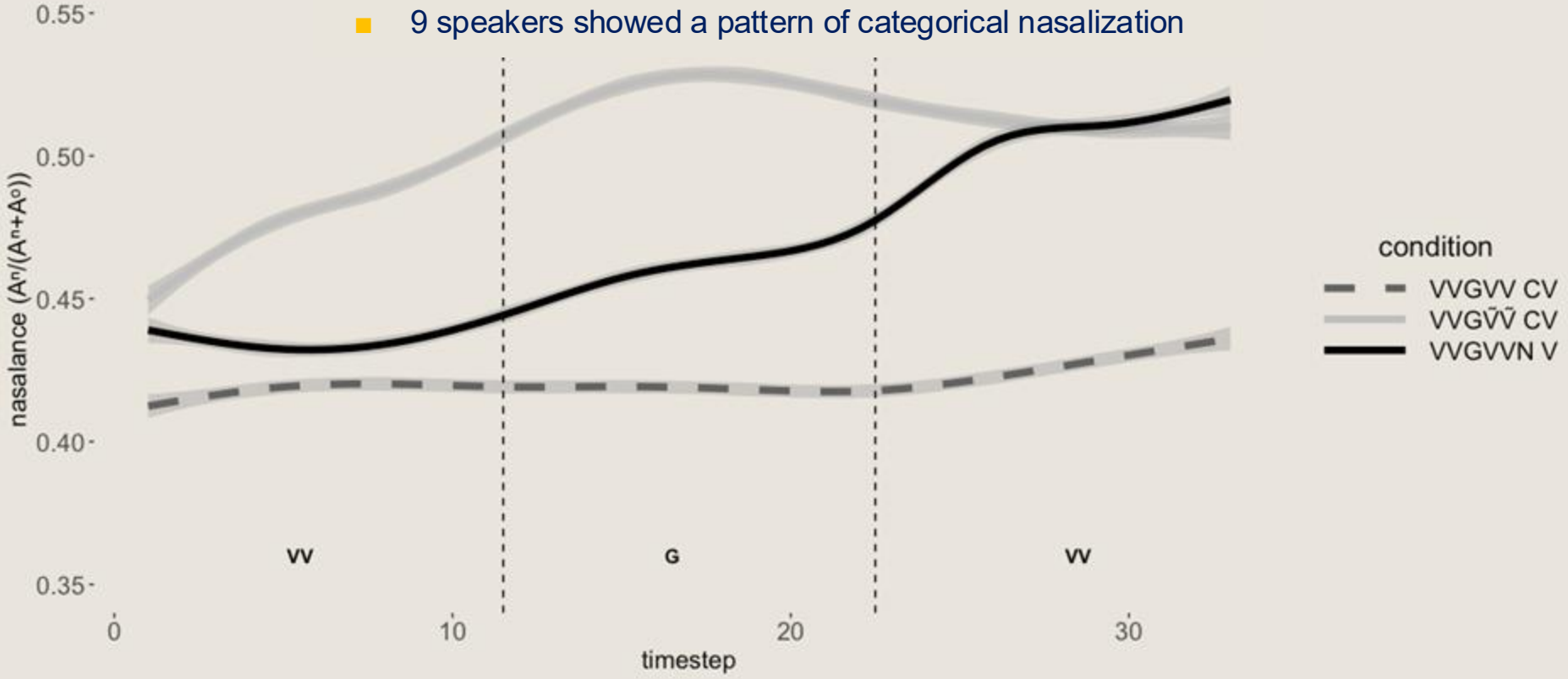


Appendix: VVGṼṼ NV



Appendix: VVGVVN VCV

- 9 speakers showed a pattern of categorical nasalization



Appendix: VVGVVN VCV

- 1 speaker showed a pattern of coarticulatory nasalization