



VARIATION IN MANDARIN PRENUCLEAR GLIDE SEGMENTATION

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THE SEGMENTATION QUESTION

Bridge missing

- What language-acquiring children hear: continuous speech signal
- What linguists transcribe: discrete IPA symbols

Questions

- How does a learner slice a continuous speech signal into discrete units of sound?
- Do learners who are exposed to the same signal make the same slicing decision?

THE SEGMENTATION QUESTION

- The question in the literature: *Is it one segment or two?*
- Homorganic NC sequences (Downing 2005)
- Perception: Affricates in Quebec French (Béland & Kolinsky 2005)
- Computational: Complex segment learner (Gouskova & Stanton 2021)

THIS PROJECT

- Mandarin Chinese: sound segmentation is not a trivial problem.
- The segment status of the prenuclear glide is subject to perennial debate.
- **My approach** to the segmentation question: a language game experiment
- **My finding**: there is interspeaker and intraspeaker variation in the segmentation of the Mandarin glide.

THE MANDARIN GLIDE

- Palatal glide /j/, bilabial glide /w/, labiopalatal glide /ɥ/.
- A Mandarin syllable: **C**GVX (X = nasal or offglide)

(I) Glide examples

a. njaw 'bird'

c. kwo 'wok'

e. lɥe 'to omit'

b. ɕja 'shrimp'

d. swan 'sour'

f. ɕɥɛn 'to select'

THE MANDARIN GLIDE

- A source of segmentation ambiguity

(2) Distribution of /j/

/j/ contrastive after non-palatal consonants

a. lja 'two people'

b. la 'to pull'

/j/ obligatory after palatal consonants

c. ɕja 'shrimp'

d. *ɕa

- **Question:** How do Mandarin speakers analyze the palatal consonant-glide sequence?
- Is it one segment or two?

THE MANDARIN GLIDE DEBATE

Hypothesis	Syllable Segmentation	Independent Segment?	'to hunt'	'shoe'	'snow'
Independent segment (Lin 1989)	CGV	Yes	[lje]	[ɕje]	[ɕʏe]
Secondary articulation of consonant (Duanmu 2002)	C^GV	No	[lʲe]	[ɕʲe] (/sʲe/)	[ɕ ^ʏ e] (/s ^ʏ e/)
Double representation of glide	C^GGV	Yes	[lʲje]	[ɕʲje]	[ɕ ^ʏ ʏe]
Natural palatal CV transition (Ladefoged & Maddieson 1996)	CGV/CV	No	[lje]	[ɕe]	[ɕe]

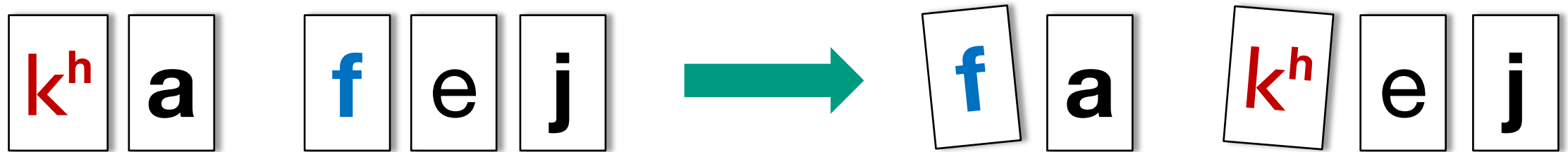
- **Question:** Which glide segmentation hypothesis corresponds to Mandarin speakers' phonological grammar?

LANGUAGE GAME METHOD

- Mandarin speakers are invited to disassemble the syllable in an artificial setting.
- How they segment the glide will influence their decision on how to disassemble the syllable.
- Adapted from *fanqie* 反切 secret languages (see Chao 1931)

THE CODEWORD LANGUAGE GAME

- **The task:** swap the initial consonants of a disyllabic word to form a codeword.



Original word: 'coffee'

Codeword

- Barnes (2002) employed the same method to investigate palatalization in Bulgarian.

THE CODEWORD LANGUAGE GAME

EXAMPLE TEST ITEM: 'STAR ANISE'

- Depending on the glide segmentation, speaker might choose different responses.



Independent glide segmentation: CGVX



Secondary articulation segmentation: C^GVX



Double representation segmentation: C^GGVX

THE EXPERIMENT

Demonstration phase

- Listen to glide-less disyllabic words and their codeword.
- Figure out what the encoding method is.

Training phase

- Try to encode glide-less words.
- Say the codeword out loud.
- Get feedback.

Experiment phase

- Encode 100 words
 - 64 glide items
 - 36 glide-less items
- No feedback.

- 42 participants, 33 data analyzed.
- 26 native speakers + 6 heritage speakers + 1 who self-report to be somewhere-in-between.
- Audio stimuli produced by a native Mandarin speaker who has no knowledge of the experiment purpose.

POTENTIAL PREDICTORS

- What factors might influence speaker decision in the language game?
 - Neighbor to G's left: Consonant place
 - Neighbor to G's right: Vowel alternation

POTENTIAL PREDICTORS: CONSONANT PLACE

(2) Distribution of /j/

/j/ contrastive after non-palatal consonants

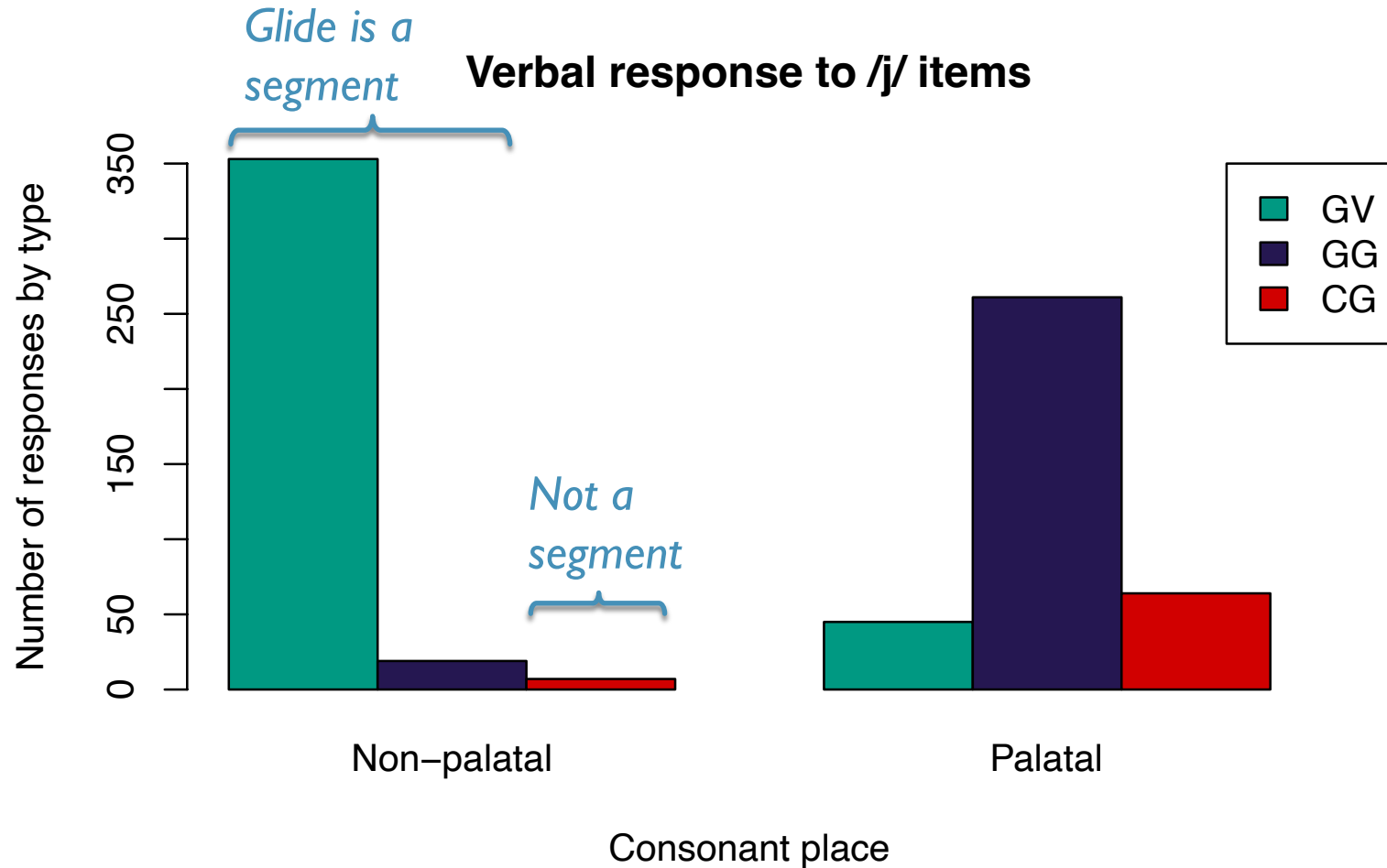
- a. lja 'two people'
- b. la 'to pull'

/j/ obligatory after palatal consonants

- c. ɕja 'shrimp'
- d. *ɕa

- **Hypothesis:** Glide segmentation is sensitive to the place of articulation of the initial consonant.
 - /j/: non-palatal vs. palatal
 - /ɥ/: non-palatal vs. palatal
 - /w/: non-velar vs. velar
 - Testing Wan's (1999) observation from Mandarin speech error data: Kw move as a single unit.

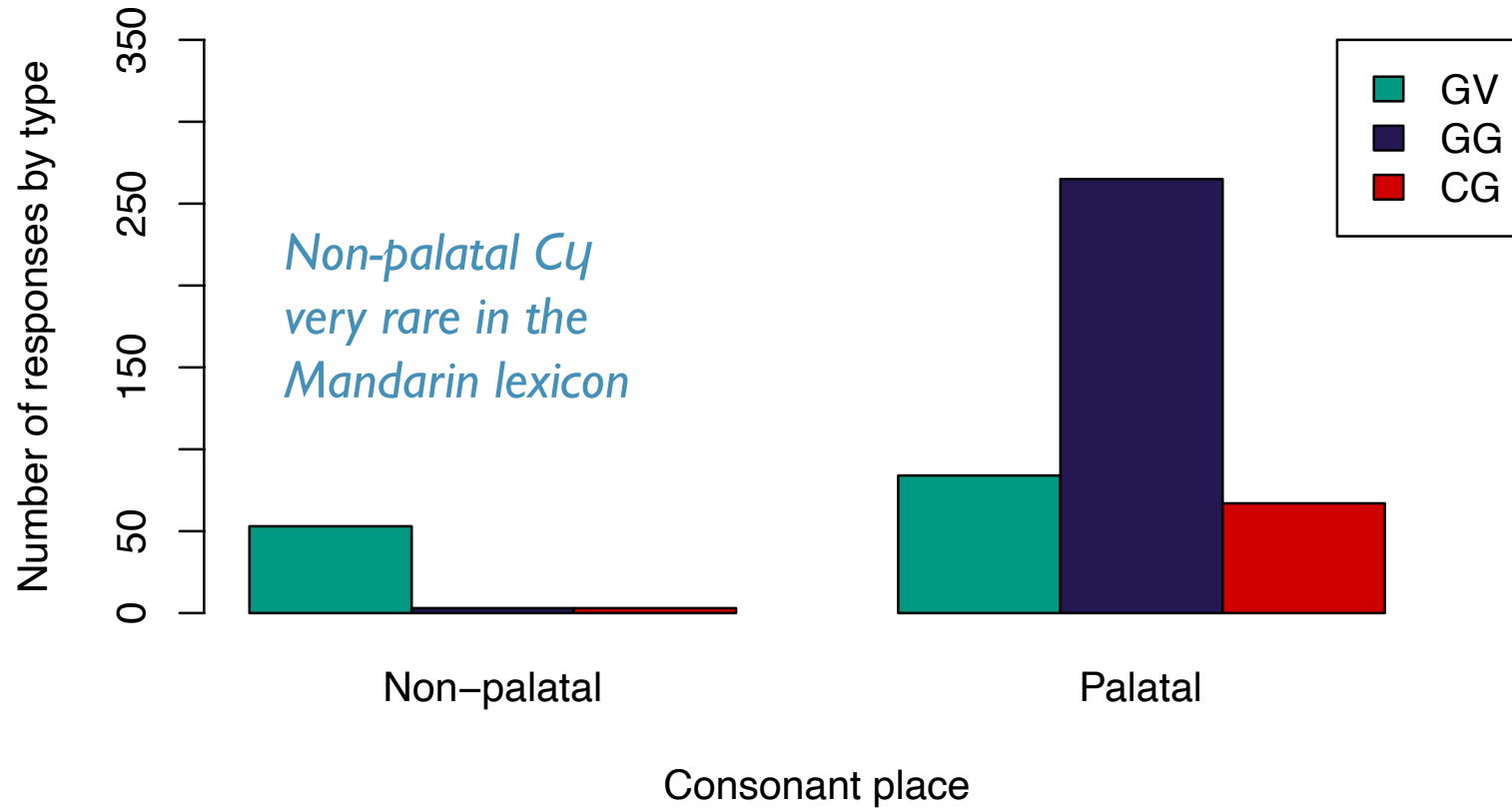
RESULTS: CONSONANT PLACE EFFECT



After non-palatal C:
/j/ more likely to be treated
as an independent segment

RESULTS: CONSONANT PLACE EFFECT

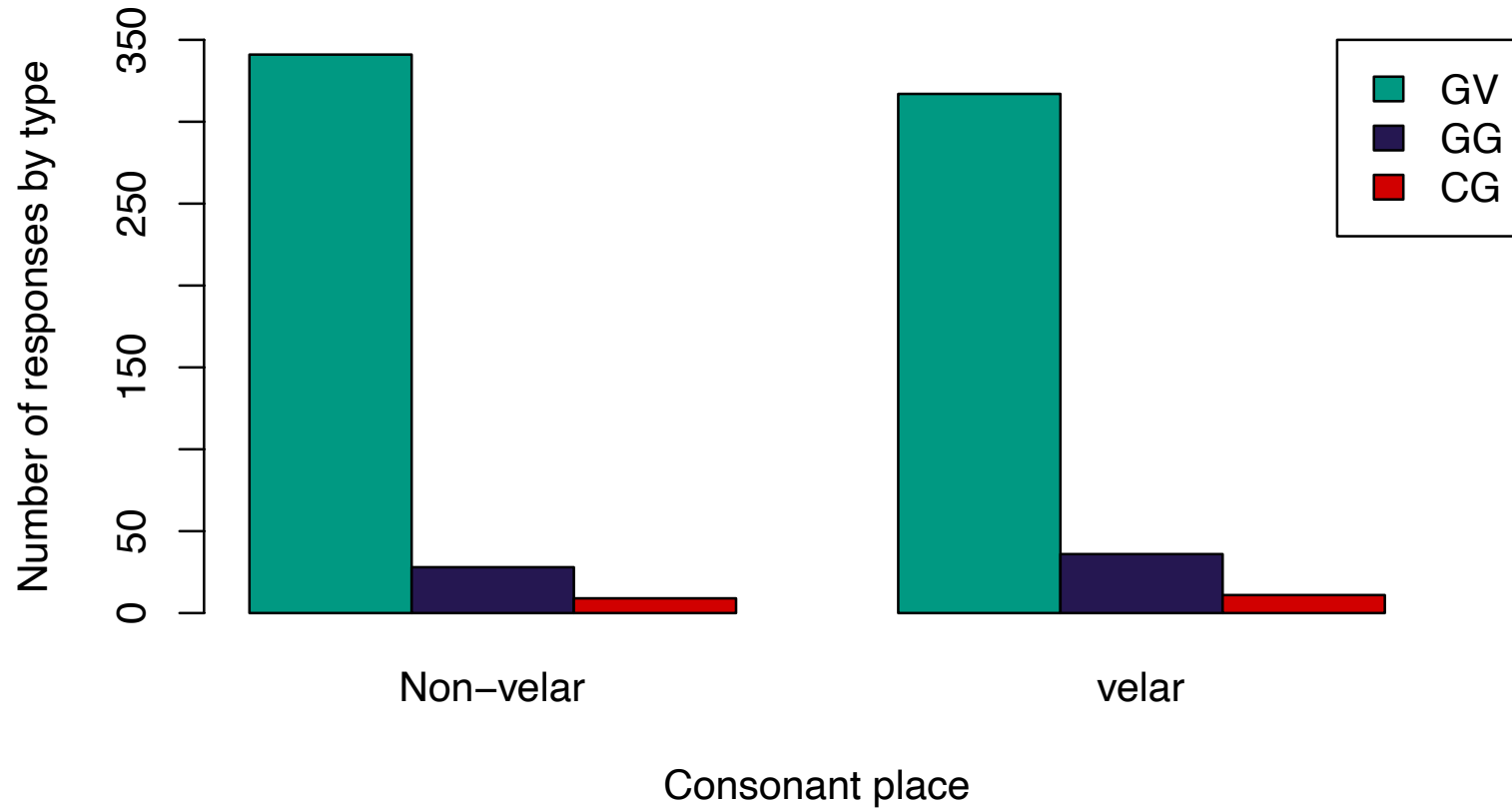
Verbal response to /ɥ/ items



Replicates /j/'s consonant place effect.

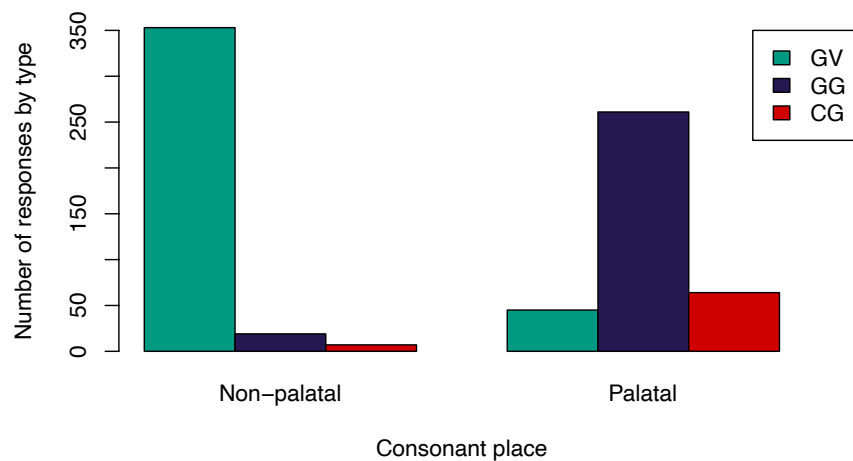
RESULTS: CONSONANT PLACE EFFECT

Verbal response to /w/ items

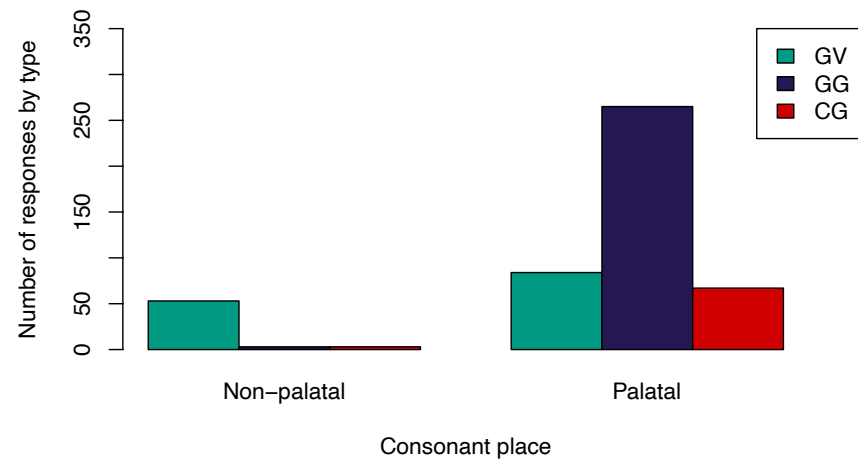


/w/ segmentation not sensitive to consonant place.

Verbal response to /j/ items



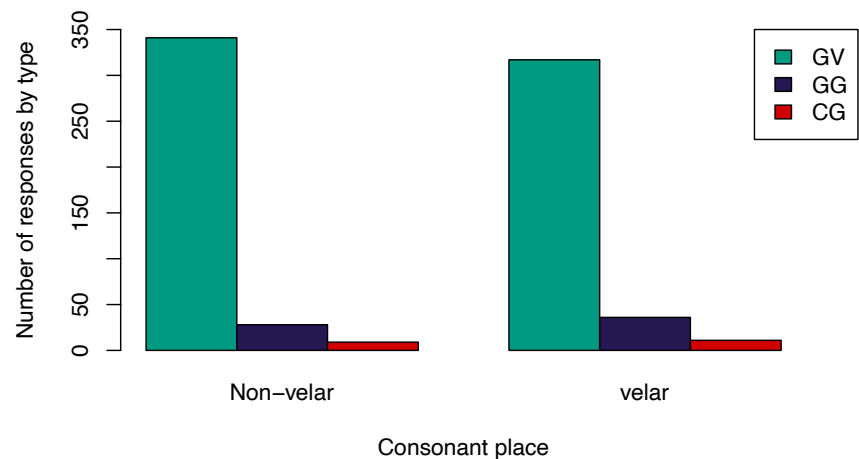
Verbal response to /ɥ/ items



CONSONANT PLACE EFFECT

- /j/: Yes
- /ɥ/: Yes
- /w/: No

Verbal response to /w/ items



POTENTIAL PREDICTORS: VOWEL ALTERNATION

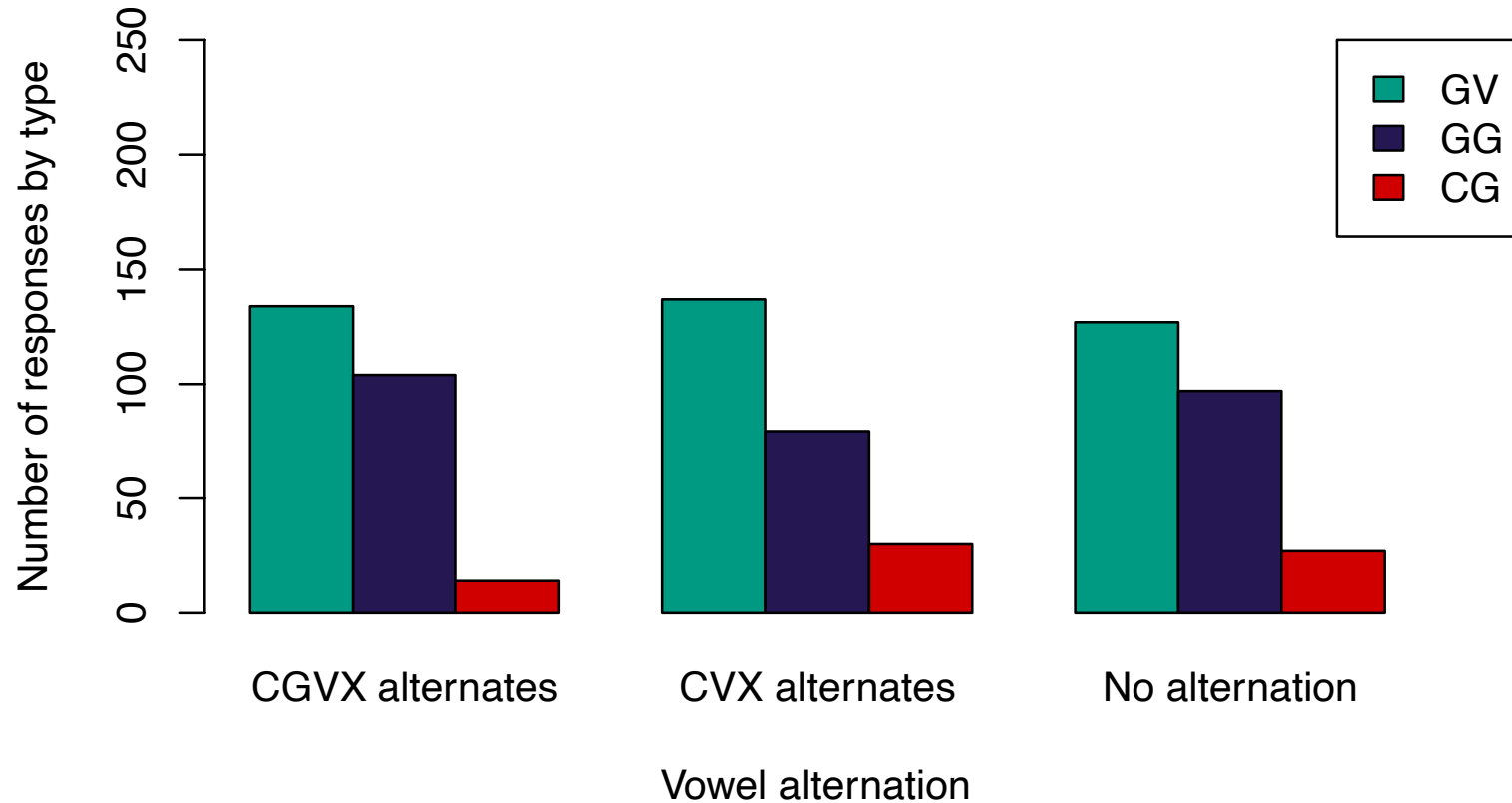
- Low vowel raising:

	CV		CwV		CjV		CɥV	
/a/	k a n	'dry'	lw a n	'messy'	tj ɛ n	'shop'	ɕɥ ɛ n	'to select'

- The language game task might remove the glide trigger.
- [tjɛn paw] 'telegraph' → CG response: [*pɛn tjaw]
 - Option (a): [*pɛn tjaw] violates markedness constraint
 - Option (b): [p**a**n tjaw] violates faithfulness constraint
 - Option (c): [pj**ɛ**n tjaw] well-formed and faithful, but it is now a GG response.
- Hypothesis:** To prioritize vowel faithfulness and avoid markedness, the participant might choose to retain the glide if the following vowel alternates. GV and GG preferred over CG.

RESULTS: VOWEL ALTERNATION EFFECT

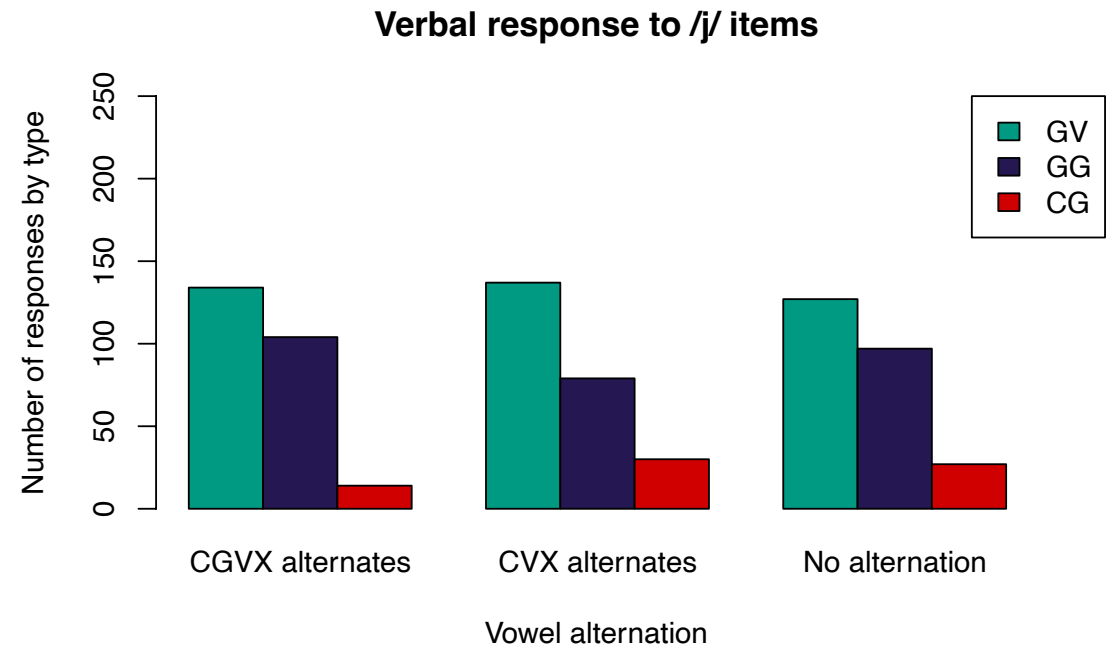
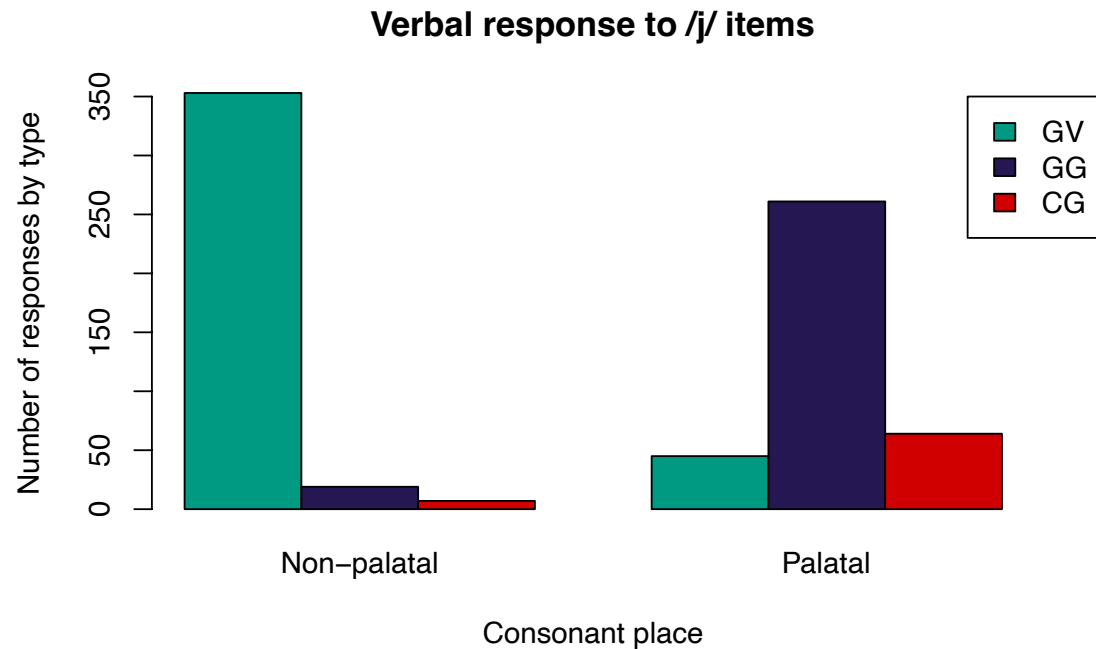
Verbal response to /j/ items



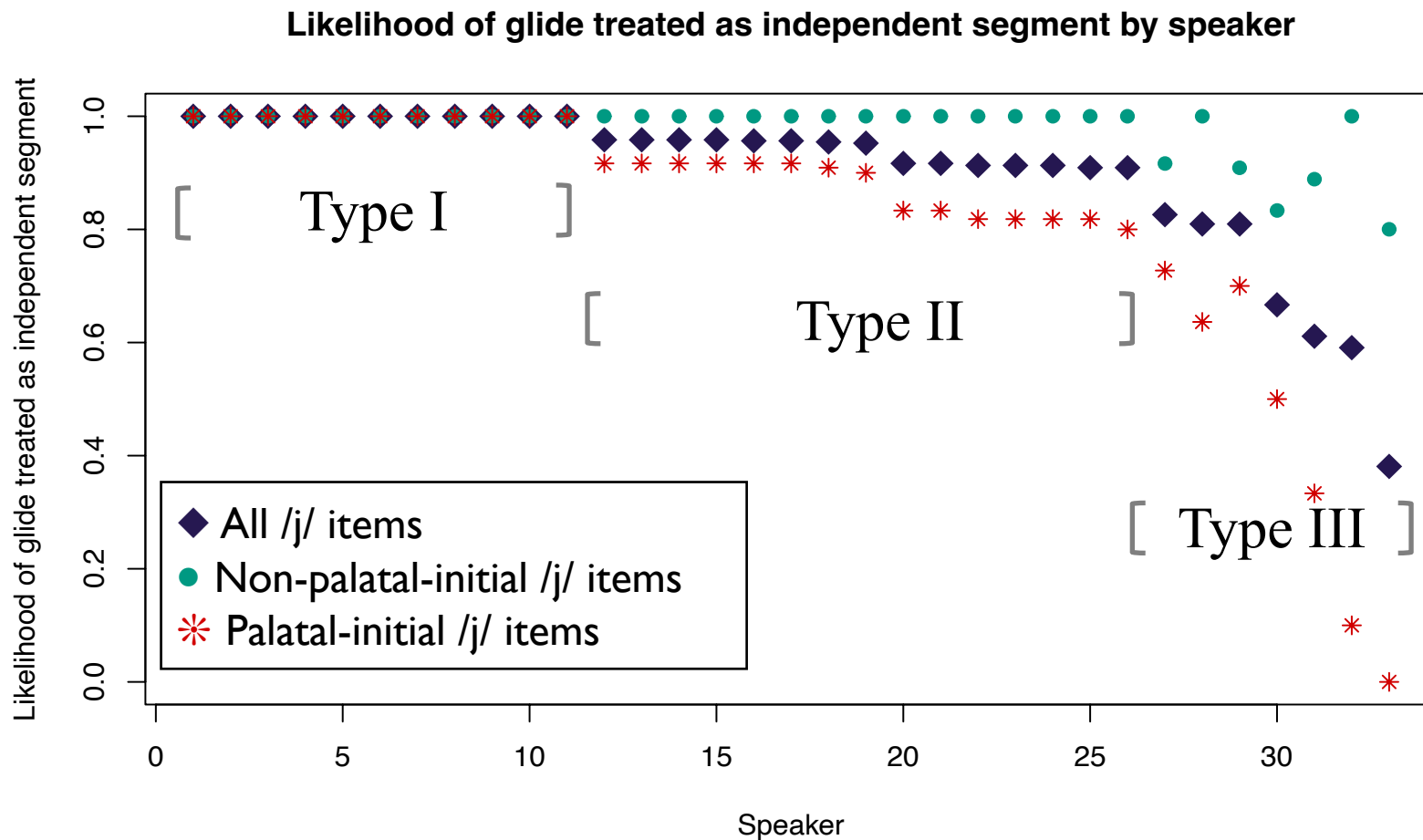
If CGVX alternates:
/j/ more likely to stay in
its original syllable

CONSONANT PLACE & VOWEL ALTERNATION

- Consonant place is main predictor of speaker response.
- Vowel alternation plays a relatively small role in determining participant behavior.



SPEAKER VARIATION IN /j/ SEGMENTATION



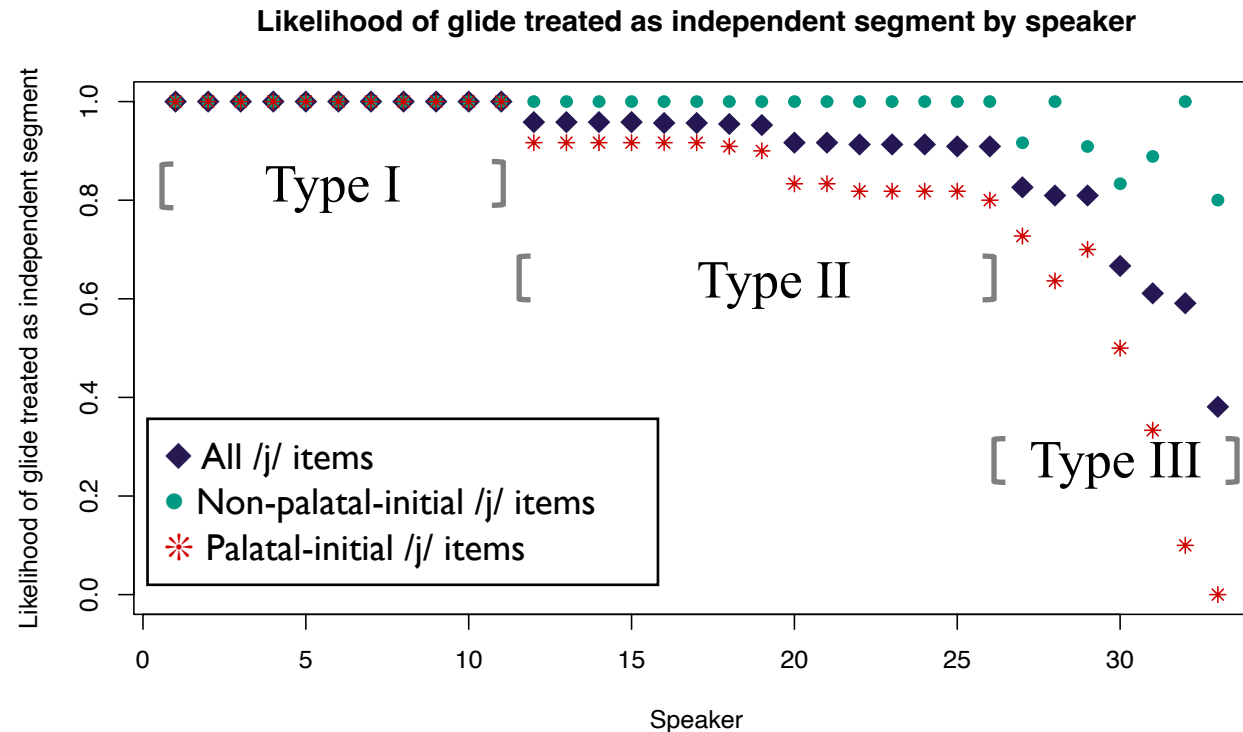
CONCLUSION

- **Question:** Which glide segmentation hypothesis corresponds to Mandarin speakers' phonological grammar?
- **Answer:** Depends on which speaker you ask.

- **Question:** Do learners who are exposed to the same signal make the same slicing decision?
- **Answer:** No.
- Mandarin speakers are exposed to the same phonological input, yet they display variation in glide segmentation.

SOURCE OF VARIATION

- Speakers mostly agree on how to segment non-palatal CG sequences.
- Speakers disagree on how to segment palatal CG sequences.
- Variation in glide segmentation comes from ambiguous phonological input.



FUTURE DIRECTION

- Typology:
 - Explore whether other languages also show similar segmentation variation.
- Computational:
 - Identify a computational learning model that can predict the observed variation.

THANK YOU!

References:

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APPENDIX I: EXPERIMENT MATERIALS

- 24 /j/ items + 24 /w/ items + 16 /ɥ/ items + 36 fillers = 100 items
- 10 demonstration items + 10 training items with no glide
- Audio stimuli produced by a native Mandarin speaker from Shanghai (not aware of experiment purpose)

Factors	24 /j/ items	24 /w/ items	16 /ɥ/ items
Consonant place	12 non-palatal C 12 palatal C	12 non-velar C 12 velar C	2 non-palatal C (rare) 14 palatal C
Vowel alternation	8 CGΔVX CVX 8 CGVX CΔVX 8 CGVX CVX	8 CGΔVX CVX 8 CGVX CΔVX 8 CGVX CVX	16 CGΔVX CΔVX
Glide position	12 CGVX CVX 12 CVX CGVX	12 CGVX CVX 12 CVX CGVX	8 CGVX CVX 8 CVX CGVX



APPENDIX II: ALTERNATIVE ACCOUNTS OF OBSERVED VARIATION IN LANGUAGE GAME

VARIATION IN GLIDE SEGMENTATION OR TASK INTERPRETATION DIFFERENCE?

- **Alternative account 1:**
- With no explicit instruction on how to encode words, participants might have interpreted the task in two ways:
 - Task interpretation (a): Swap the initial consonants
 - Task interpretation (b): Swap the entire onsets, including complex onsets CG
- For Bulgarian, Barnes (2002) disambiguates the two tasks with examples.
- For Mandarin, there are no complex onsets like [pʰ], [tr], etc., which leaves the task open to ambiguity.
- **Prediction:** if some participants have understood the task to be swapping onsets, as opposed to initial consonants, then they will consistently move CG as a unit, no matter the context.

VARIATION IN GLIDE SEGMENTATION OR TASK INTERPRETATION DIFFERENCE?

- **Prediction:** if some participants have understood the task to be swapping onsets, as opposed to initial consonants, then they will consistently move CG as a unit, no matter the context.
- Speaker 42 is one of the participants who favors the CG response.
- Even they did not produce CG responses across the board.

Response Type	/j/ items		/ɥ/ items		/w/ items	
	Non-palatal	Palatal	Non-palatal	Palatal	Non-velar	Velar
GV	8	0	0	0	11	10
GG	0	0	0	4	0	1
CG	2	11	2	10	1	1

VARIATION IN GLIDE SEGMENTATION OR CONSTRAINT RANKING DIFFERENCE?

- **Alternative account 2:**
- Every speaker of Mandarin has the same segmentation.
- Variation in participant response is solely the result of constraint ranking difference.

/law tɕje/ 'old street'	AGR-CG	AGR-GV	ID-C	ID-V	DEP
a. GV: [tɕaw lje]	*				
b. GV': [tɕaw lje]			*		
c. CG: [tɕjaw le]		*			
d. CG': [tɕjaw lə]				*	
e. GG: [tɕjaw lje]					*

VARIATION IN GLIDE SEGMENTATION OR CONSTRAINT RANKING DIFFERENCE?

- **Scenario:** what about test items where there is no vowel alternation?
- There is no potential violation to markedness or faithfulness constraints.
- Example test item: /j/ item with non-palatal consonant, and no vowel alternation.

/ta ljaw/ 'star anise'	AGR-CG	AGR-GV	ID-C	ID-V	DEP
a. GV: [la tjaw]					
b. CG: [lja taw]					
c. GG: [lja tjaw]					*

- **Prediction:** Participants will produce both the GV and CG response, but never the GG response since it is harmonically bound.

VARIATION IN GLIDE SEGMENTATION OR CONSTRAINT RANKING DIFFERENCE?

- **Scenario:** what about test items where there is no vowel alternation?
- There is no potential violation to markedness or faithfulness constraints.
- Example test item: /j/ item with palatal consonant, and no vowel alternation.

/ta tɕ ^h jaw/ 'big bridge'	AGR-CG	AGR-GV	ID-C	ID-V	DEP
a. GV: [tɕ ^h a tjaw]	*				
b. GV': [tɕ ^h a tjaw]			*		
c. CG: [tɕ ^h ja taw]					
d. GG: [tɕ ^h ja tjaw]					*

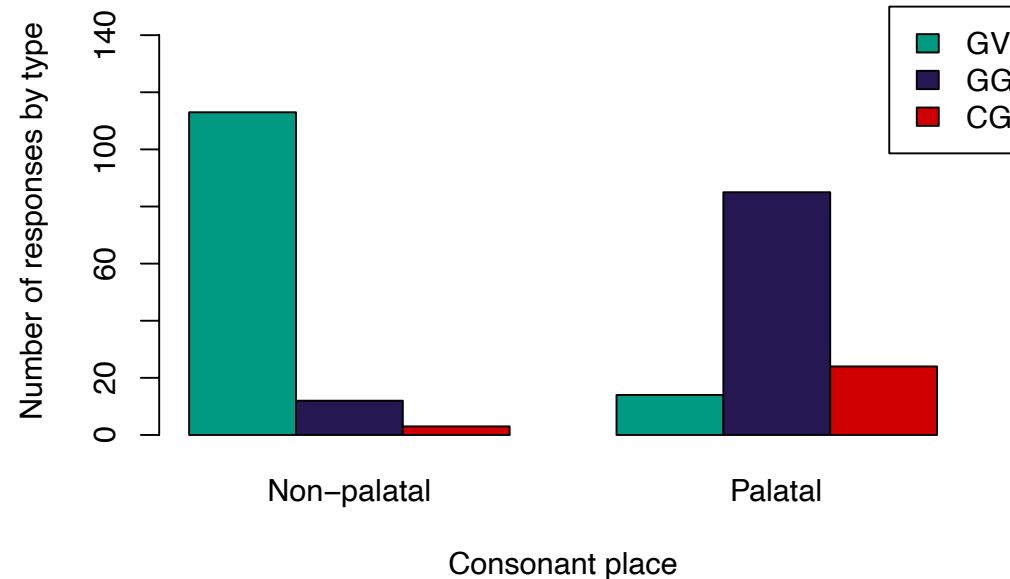
- **Prediction:** Participants will always produce the CG response, since it is the only candidate that violate no constraint.

VARIATION IN GLIDE SEGMENTATION OR CONSTRAINT RANKING DIFFERENCE?

- What the constraint ranking account predicts for /j/ items with no vowel alternation →

Non-palatal			Palatal		
GV	GG	CG	GV	GG	CG
Yes	No	Yes	No	No	Yes

Verbal response to /j/ items with no vowel alternation



- Prediction not borne out.
- Constraint ranking difference alone cannot account for the response variation observed in the experiment.