Perception of phonations in Zapotec:

effect of timing, proportion, and length of creaky voice

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Phonetics lab meeting

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Background

- Many Zapotec varieties feature multiple phonations types involving glottalization:

Zapotec language	Has checked phonation?	Checked phonation contrastive?	Name of checked phonation in sources	Name of other non-modal phonation in sources	Minimal pair
Teotitlán	Y	Y	glottalized	creaky [V̰]	[ruʔ] "mouth" [rṵ] "carry"
Isthmus	Y	Y	checked	laryngealized [V̰]	[giʔ] "excrement" [ʒì] "nose"
Choapan	Y	Y	checked	laryngeal <V̰>	[-baʔ] "3rd person animal" [baʔa] "flat"
Yalálag	Y	Y	checked	rearticulated [VʔV]	[gaʔ] "green" [gaʔa] "basket"
Betaza	Y	Y	glottalized	laryngealized [VʔV]	[bèʔ] "wind" [béʔe] "this morning"
Texmelucan	Y	Y	glottalized	laryngealized <VV>	[zaʔ] "fresh corn" [zaʔa] "bean"
Guienagati	Y	Y	checked	rearticulated [V̰]	[baʔ] "throat" [baʔa] "cemetary"
Zoogocho	Y	Y	checked	creaky <VV>	[jaʔ] "reed" [jaʔa] "steam bath"
Tabaa	Y	Y	cut *cortada*	broken <V'V> *quebrada*	[laʔ] "my name" [laʔa] "beans"
Mitla	Y	Y	cut *cortada*	broken <VV> *quebrada* breathy <Vj> *aspirada*	[saʔ] "wedding" [saʔa] "good"

Chai, 2022; Table 2.6

Background

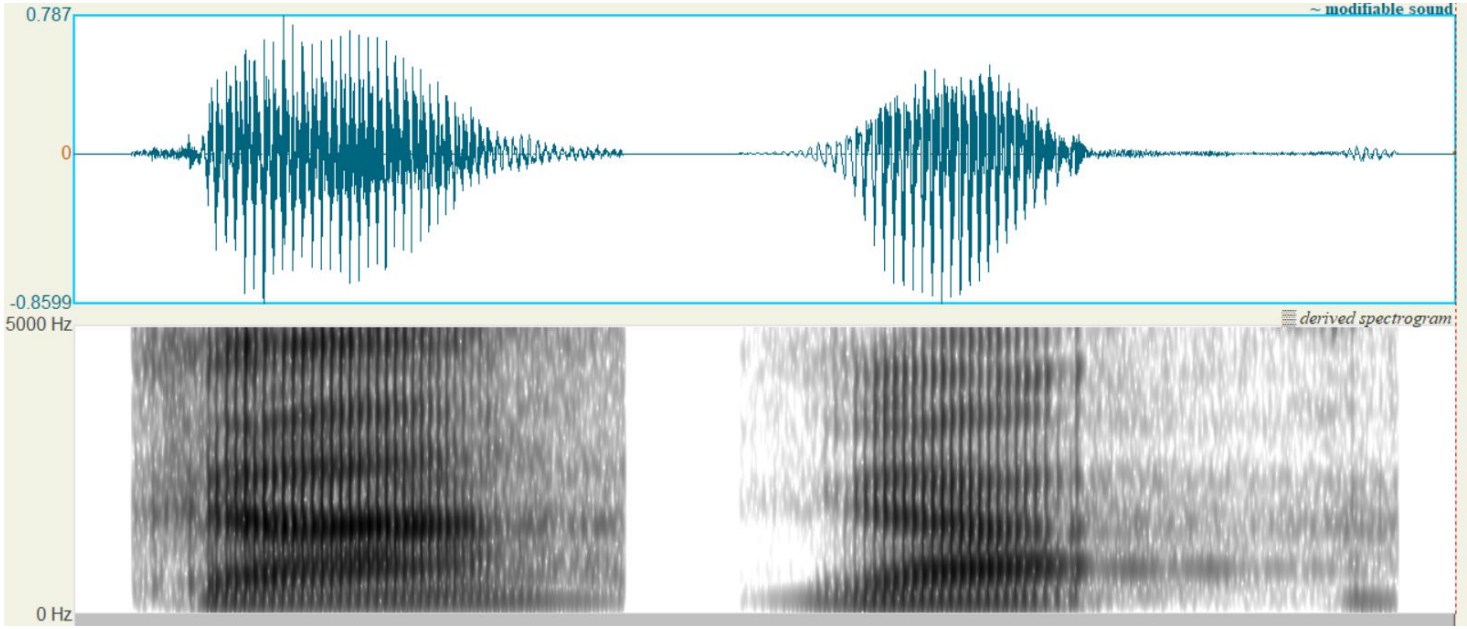
- Yateé Zapotec (zty; San Francisco Yateé) as an example:
  - There is three-way phonation contrast:
    - Modal, Rearticulated (mid-creaky), Checked (end-creaky)
  - The three phonations are fully across with four tones:
    - High, Low, Falling, Rising

Exp 1 – Motivation

- Modal vs. Checked vowel:
  - Duration: Modal > Checked
  - Glottalization: No glottalization vs. Final glottalization

Modal phonation V
gă “nine”

Checked phonation V^{ʔ}
gă^{ʔ} basket”



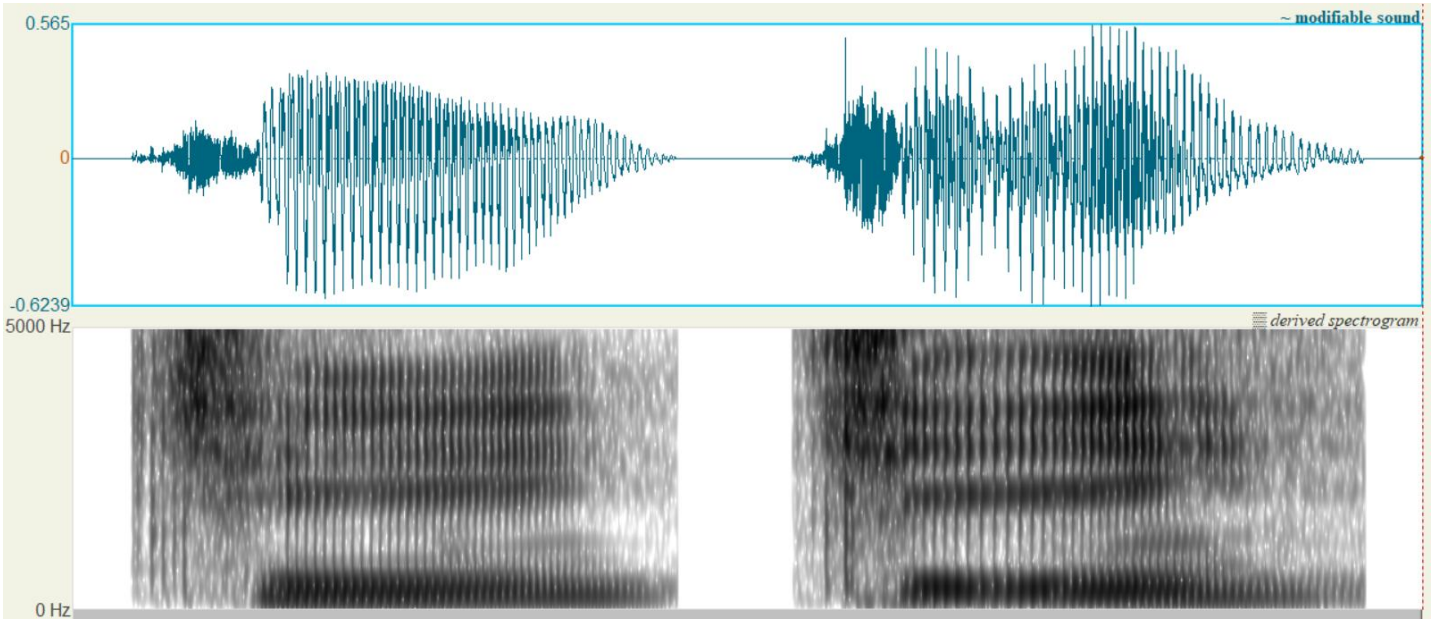
Sounds by Roberto Benitez Pascual

Exp 1 – Motivation

- Modal vs. Rearticulated vowel:
  - Duration: Rearticulated > Modal
  - Glottalization: No glottalization vs. Mid glottalization

Modal phonation V
tʂĭ “ten”

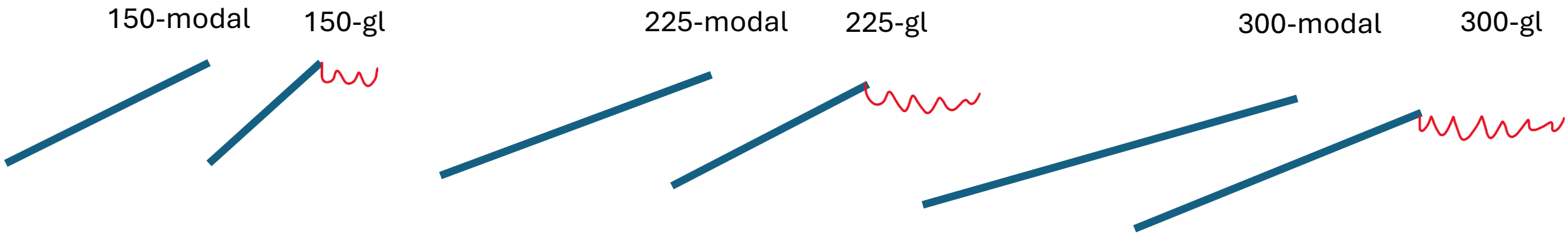
Rearticulated phonation VʔV
tʂìʔí “his/her voice”



Sounds by Roberto Benitez Pascual

Exp 1 – Research question

- For the contrast between modal vs. glottalized phonation, do listeners pay more attention to the **presence/absence of glottalization** or the **duration**?
  - Modal vs. Checked: gă vs. gă?
    - Three durations (150, 225, 300) * Two glottalization conditions (no gl, end 1/5 gl)



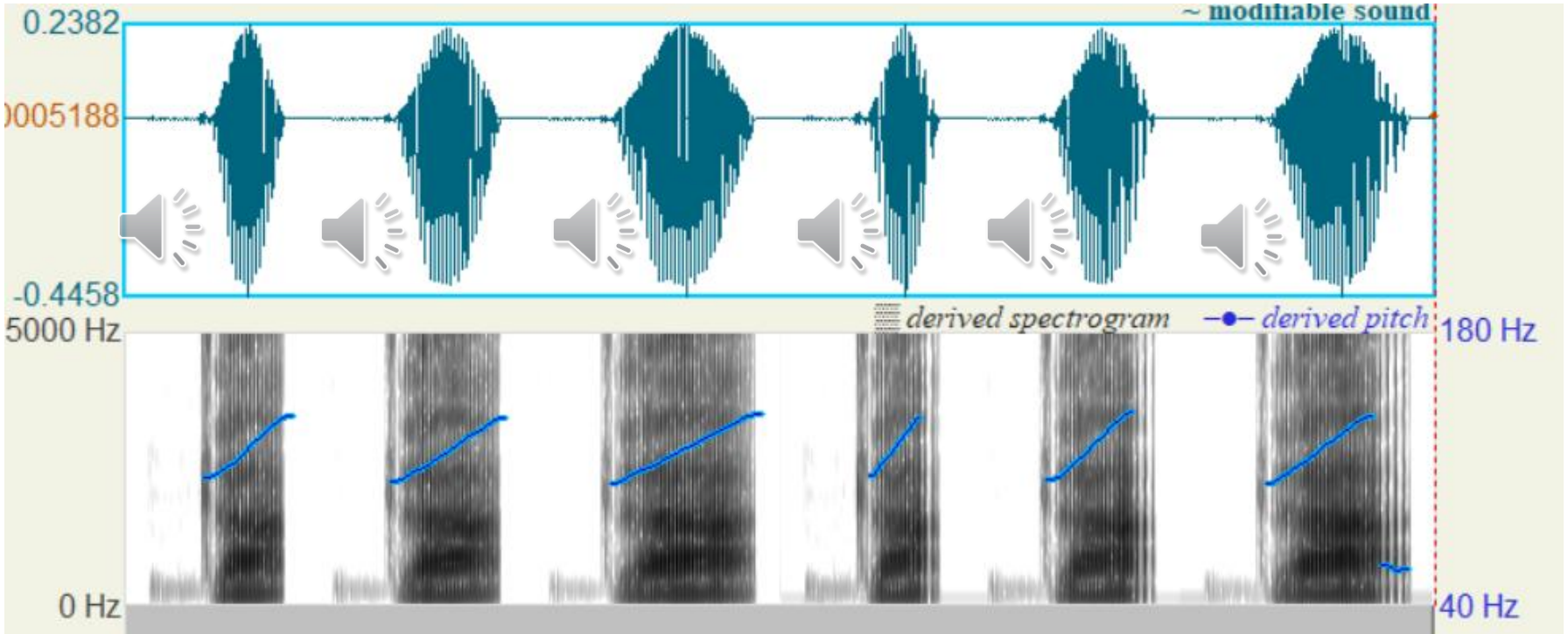
Bi rzenago?

ga'

9

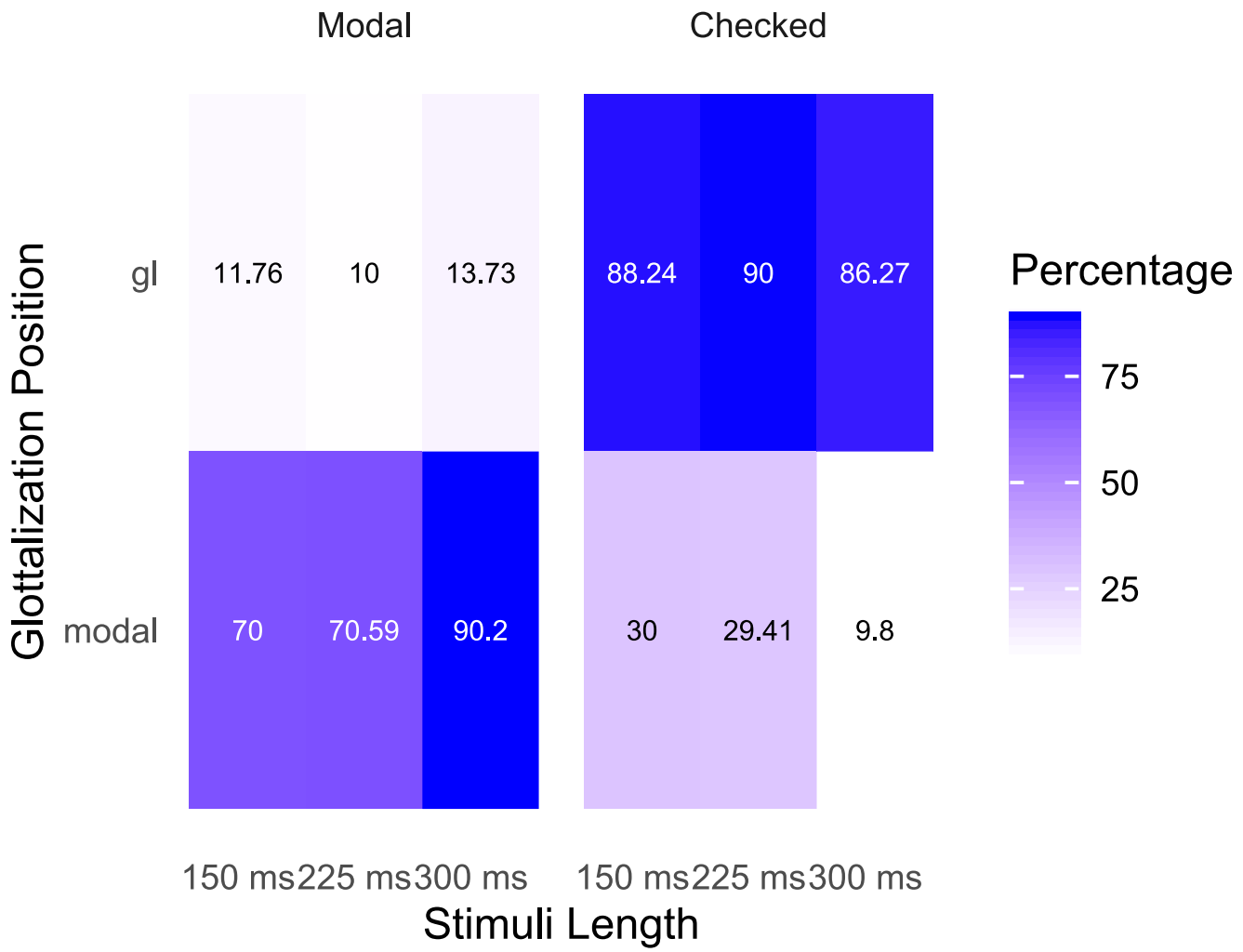
ga

150 modal 225 modal 300 modal 150 gl 225 gl 300 gl



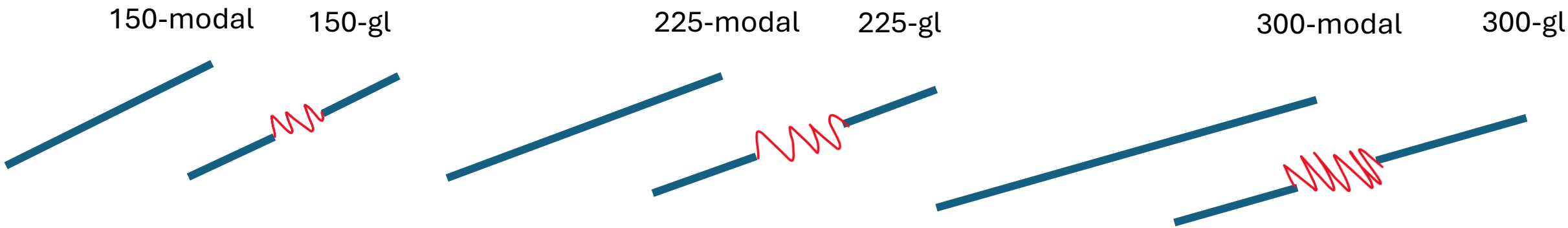
Exp 1 – Results

- Modal vs. Checked:
  - Three durations (150, 225, 300) * Two glottalization conditions (no gl, end 1/5 gl)
- **17** participants; **304** responses
- Having gl significantly increase the probability of perceiving checked phonation;
- Duration does not have a significant effect.



Experiment 1 – Research question 1

- For the contrast between modal vs. glottalized phonation, do listeners pay more attention to the **presence/absence of glottalization** or the **duration**?
  - Modal vs. Rearticulated: tʂǐ vs. tʂì ʔí
    - Three durations (150, 225, 300) * Two glottalization conditions (no gl, mid gl)



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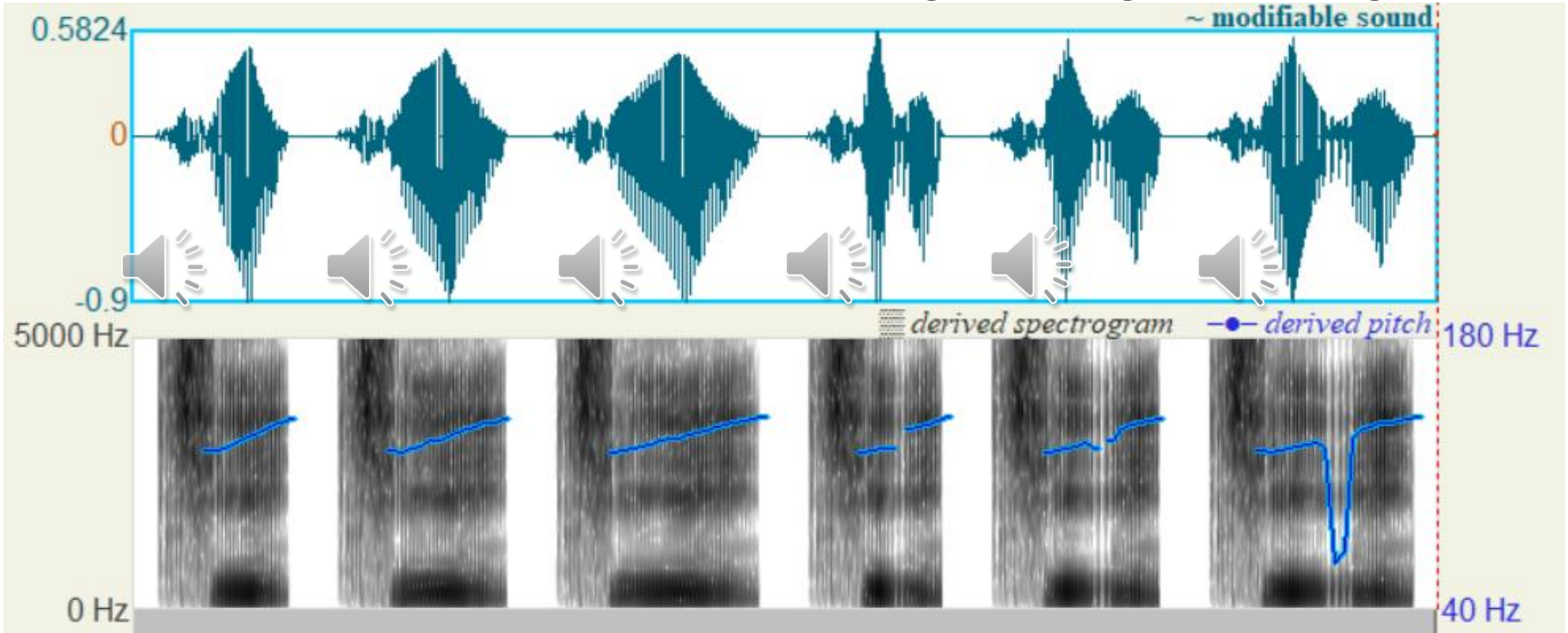
Bi rzenago?

10

chi

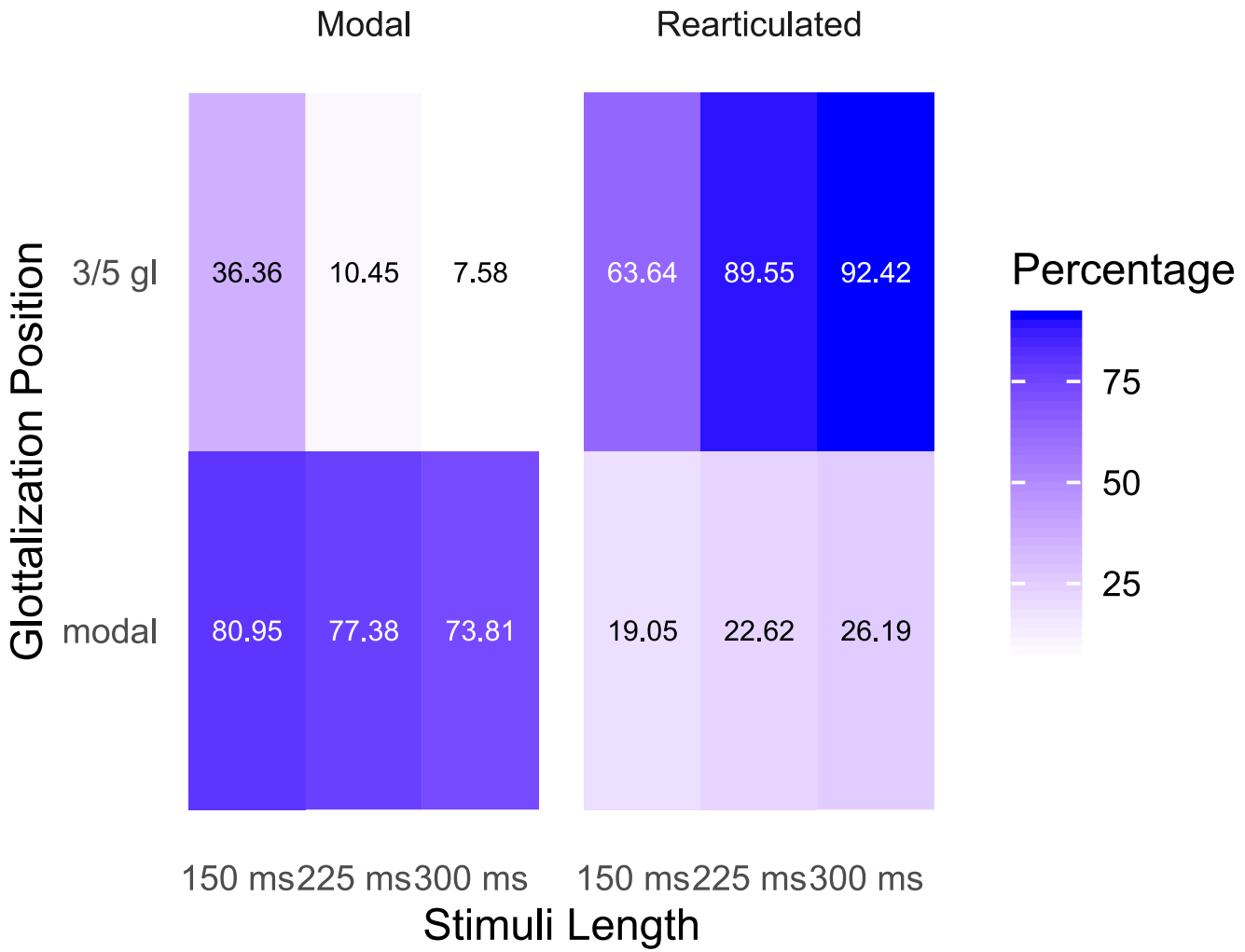
chi'i

150 modal 225 modal 300 modal 150 gl 225 gl 300 gl



Exp 1 – Results

- Modal vs. Rearticulated:
  - Three durations (150, 225, 300) * Two glottalization conditions (no gl, mid gl)
- 24 participants; 451 responses
- Having **mid-glottalization** significantly **increases** the probability of eliciting **rearticulated** phonation.
- When the vowel is **modal**, **duration** does **not** have a **significant** effect;
- When the vowel has **mid-glottalization**, **longer** duration significant elicit **more rearticulated** phonation.

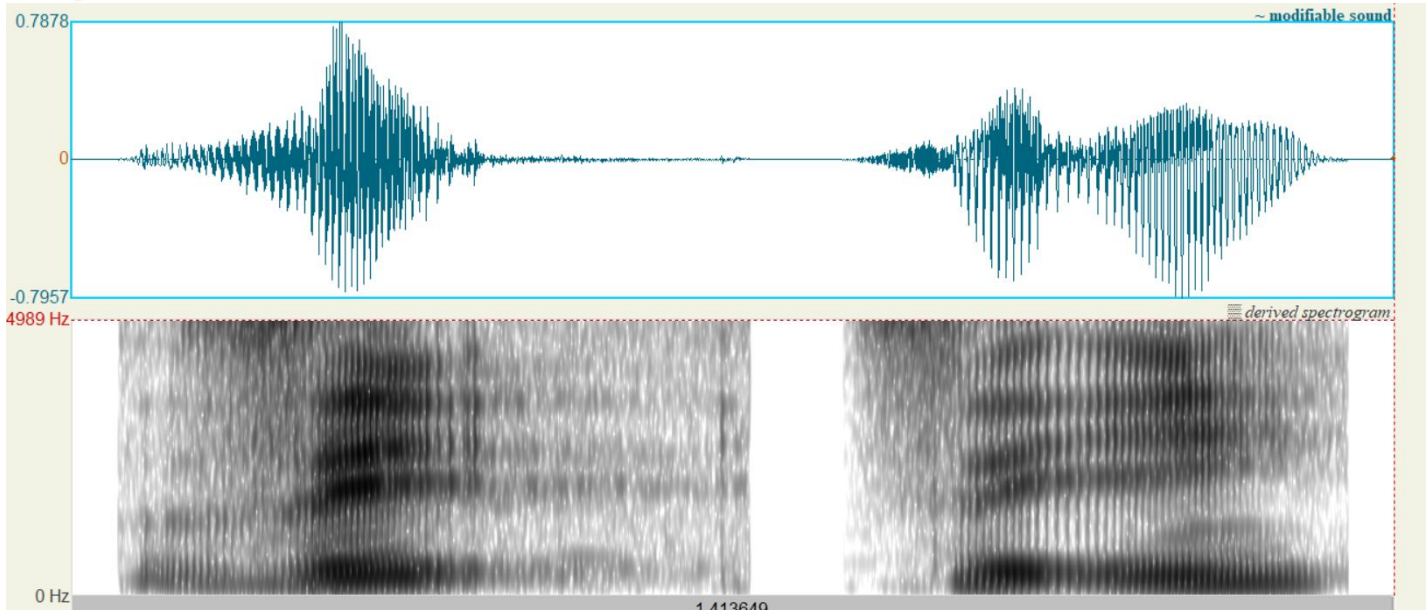


Exp 2 – Motivation

- Checked vs. Rearticulated vowel:
  - Duration: Rearticulated > Checked
  - Glottalization: Mid glottalization vs. Final glottalization

Checked phonation V?
zí? “pain”

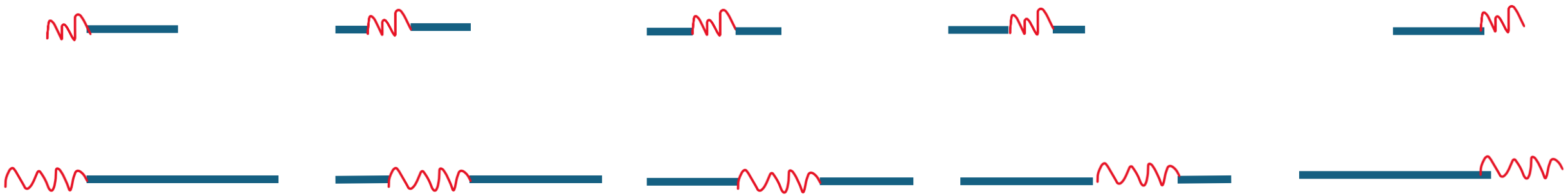
Rearticulated phonation V?V
zí?í “heavy”



Sounds by Roberto Benitez Pascual

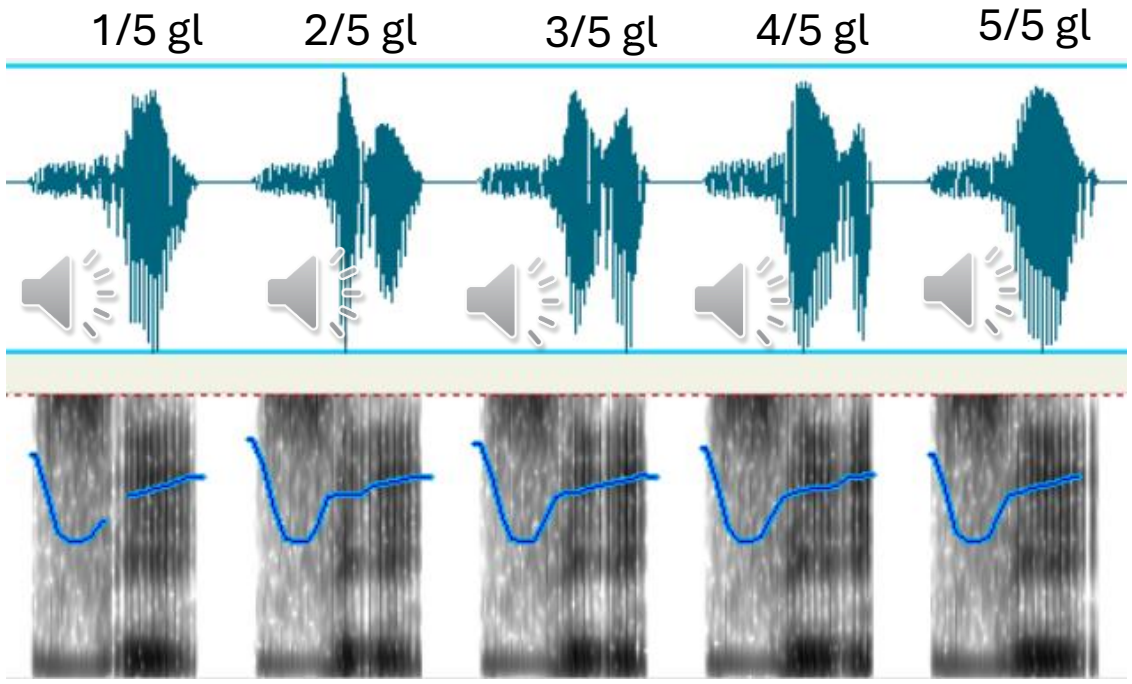
Exp 2 – Research question

- For the contrast between checked vs. rearticulated phonation, do listeners pay more attention to the **position of glottalization** or the **duration**?
  - Checked vs. Rearticulated: zíʔ “pain” vs. zíʔí “heavy”
    - Three durations (150, 225, 300) * Five glottalization conditions (1/5, 2/5, 3/5, 4/5, 5/5)



14

150 ms

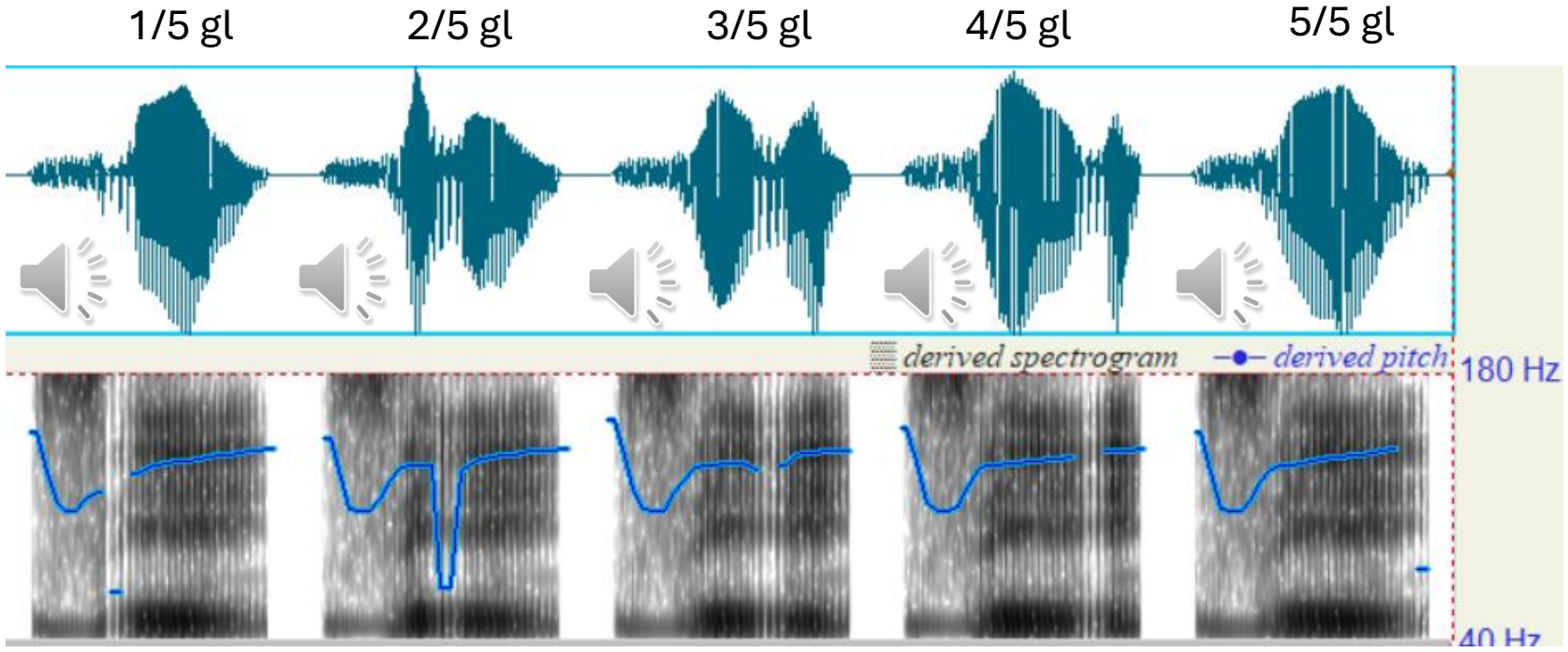


Bi rzenago?

zi'i

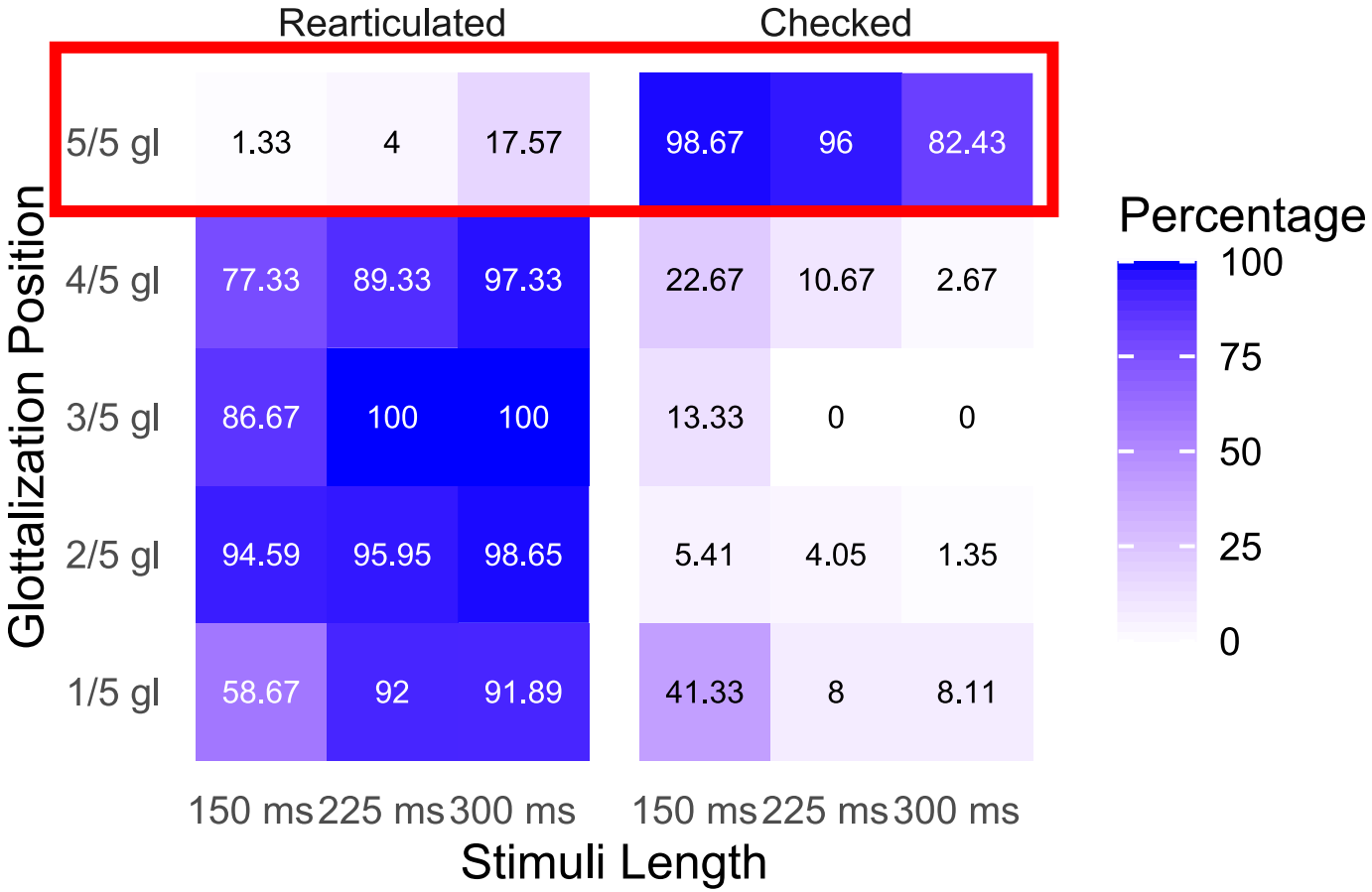
zi'

300 ms



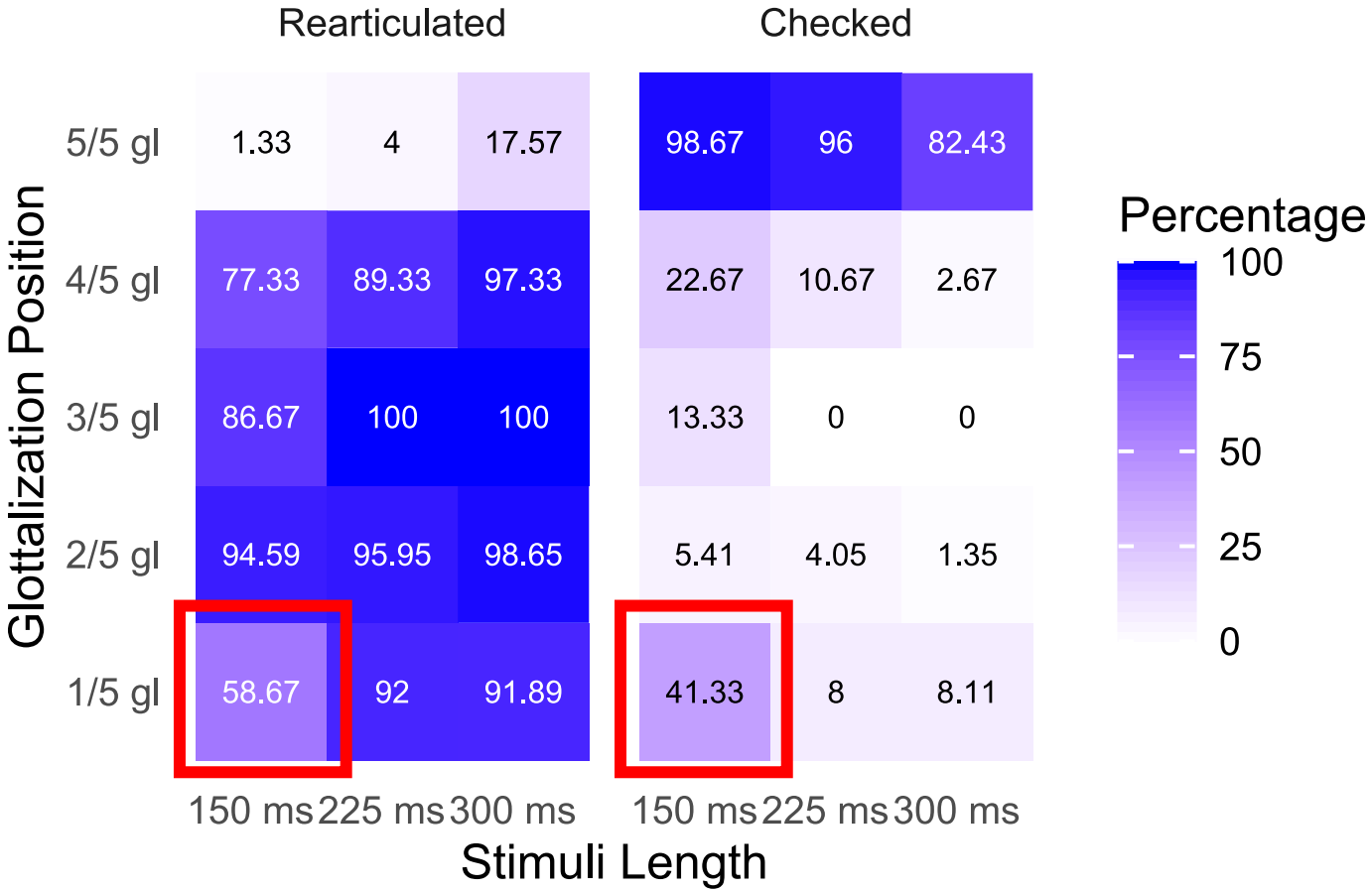
Exp 2 – Results

- Checked vs. Rearticulated:
  - Three durations (150, 225, 300) * Five glottalization conditions (1/5, 2/5, 3/5, 4/5, 5/5)
- **25** participants; **2093** responses
- When glottalization is at non-final position, rearticulated phonation is predominantly elicited.
- When glottalization is at final position, checked phonation is predominantly elicited.
- When glottalization is at first fifth of the vowel, and when the duration is 150 ms, the response is ambiguous.
- Longer duration tends to elicit rearticulated percept; Shorter duration tends to elicit checked percept.



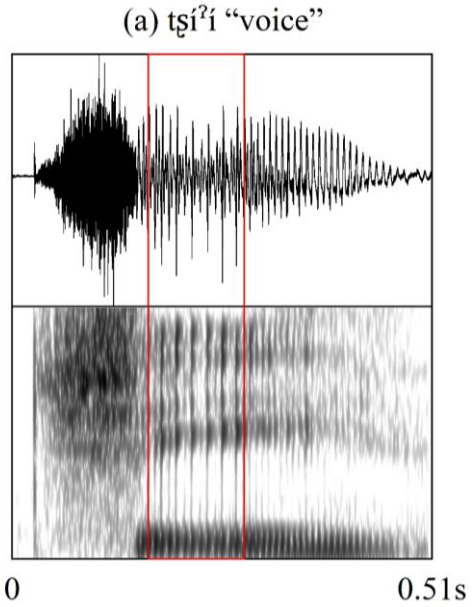
Exp 3 – Motivation

- We saw that when the duration is 150 ms, and when the glottalization is at the first fifth of the vowel, there is ambiguity between rearticulated and checked percept.



Exp 3 – Motivation

- But in natural production, there are rearticulated vowels with the first half being glottalized.



gl at first-half

Exp 3 – Research question

- So could the ambiguity be due to glottalization being too short?
- If we increase the portion of initial glottalization from 1/5 to 1/3 and 1/2, will that lead listeners to a rearticulated percept?

initial 1/5 gl

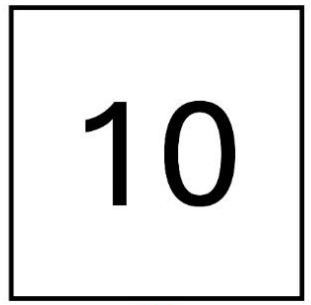
initial 1/3 gl

initial 1/2 gl

Exp 3 – Stimuli – Rearticulated vs. Modal

- Rearticulated vs. Modal
  - tʂìʔí vs. tʂǐ

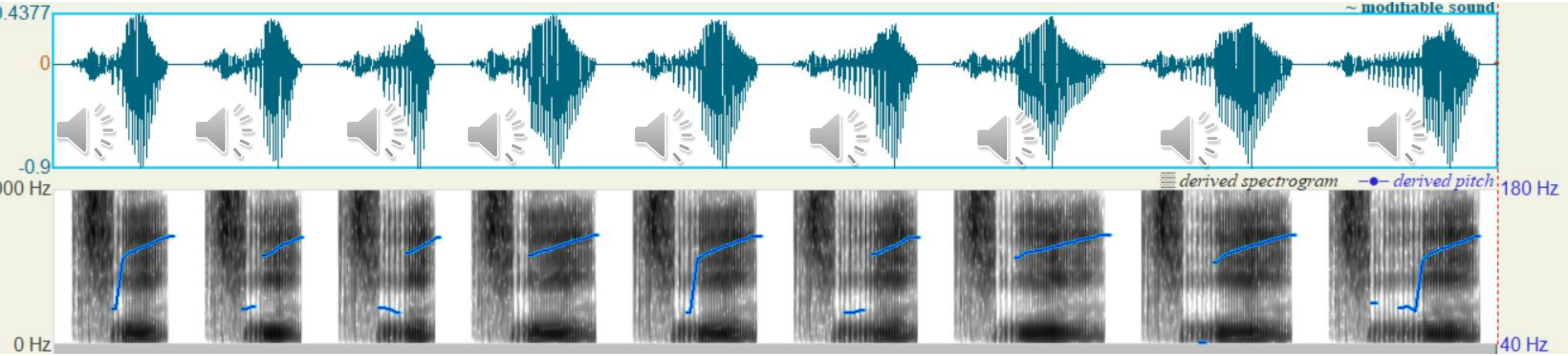
Bi rzenago?



chi

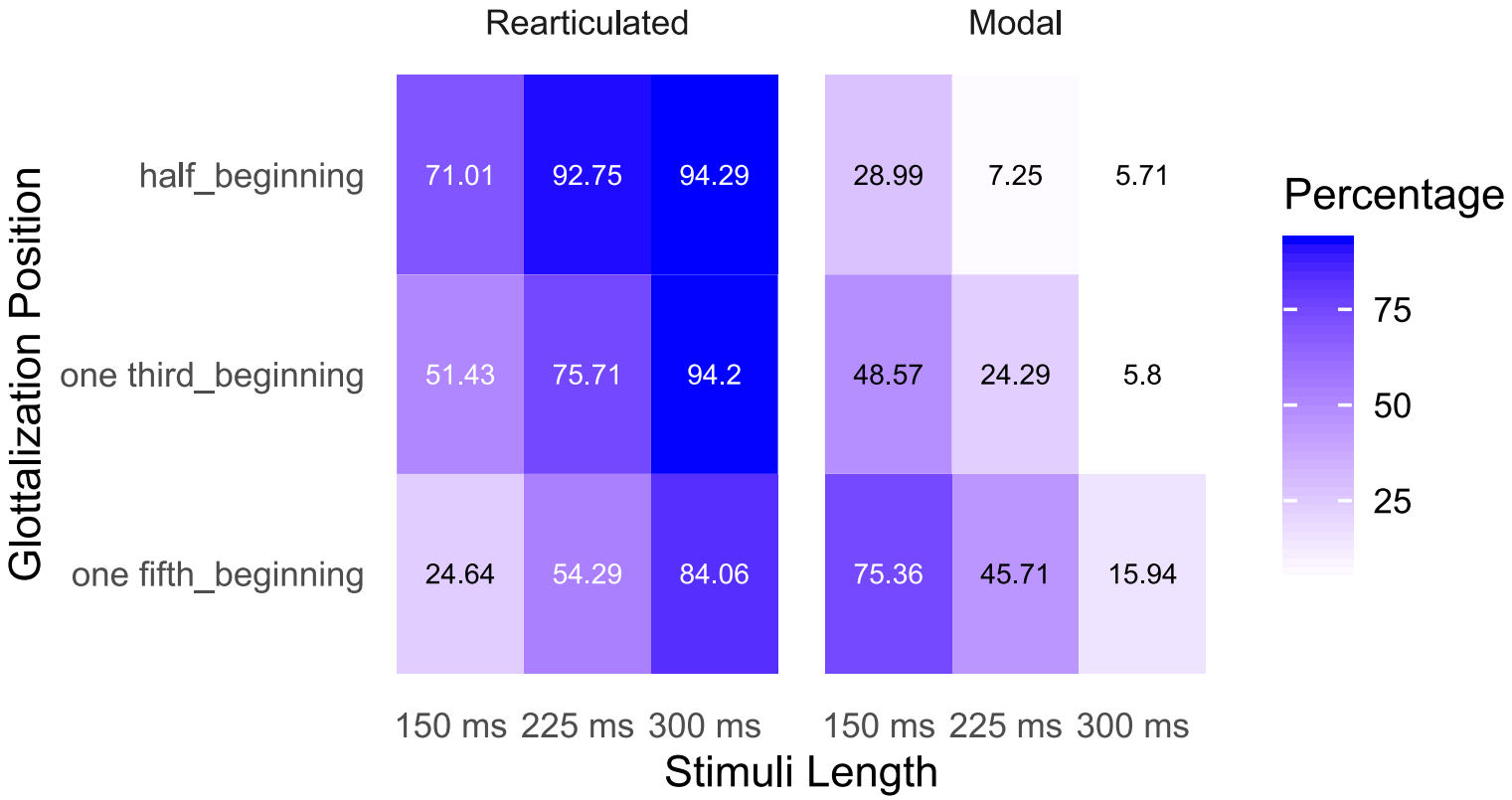
chi'i

150-1/5 gl 150-1/3 gl 150-1/2 gl 225-1/5 gl 225-1/3 gl 225-1/2 gl 300-1/5 gl 300-1/3 gl 300-1/2 gl



Exp 3 – Results – Rearticulated vs. Modal

- 24 participants; 625 responses
- As the proportion of glottalization increases, the probability of getting a rearticulated response increases.



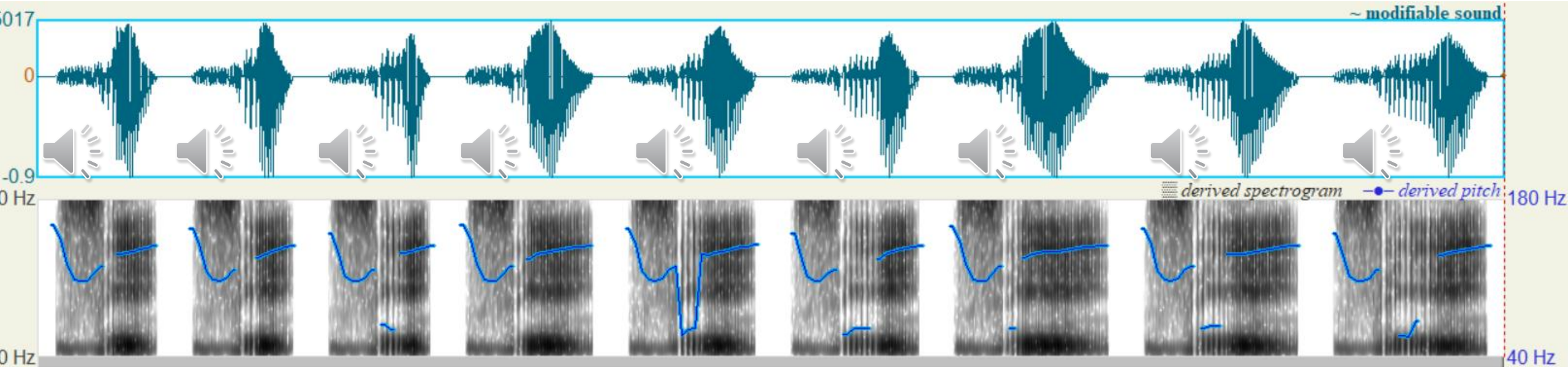
Exp 3 – Stimuli – Rearticulated vs. Checked

- Rearticulated vs. Checked:
  - zíʔí vs. zíʔ

Bi rzenago?

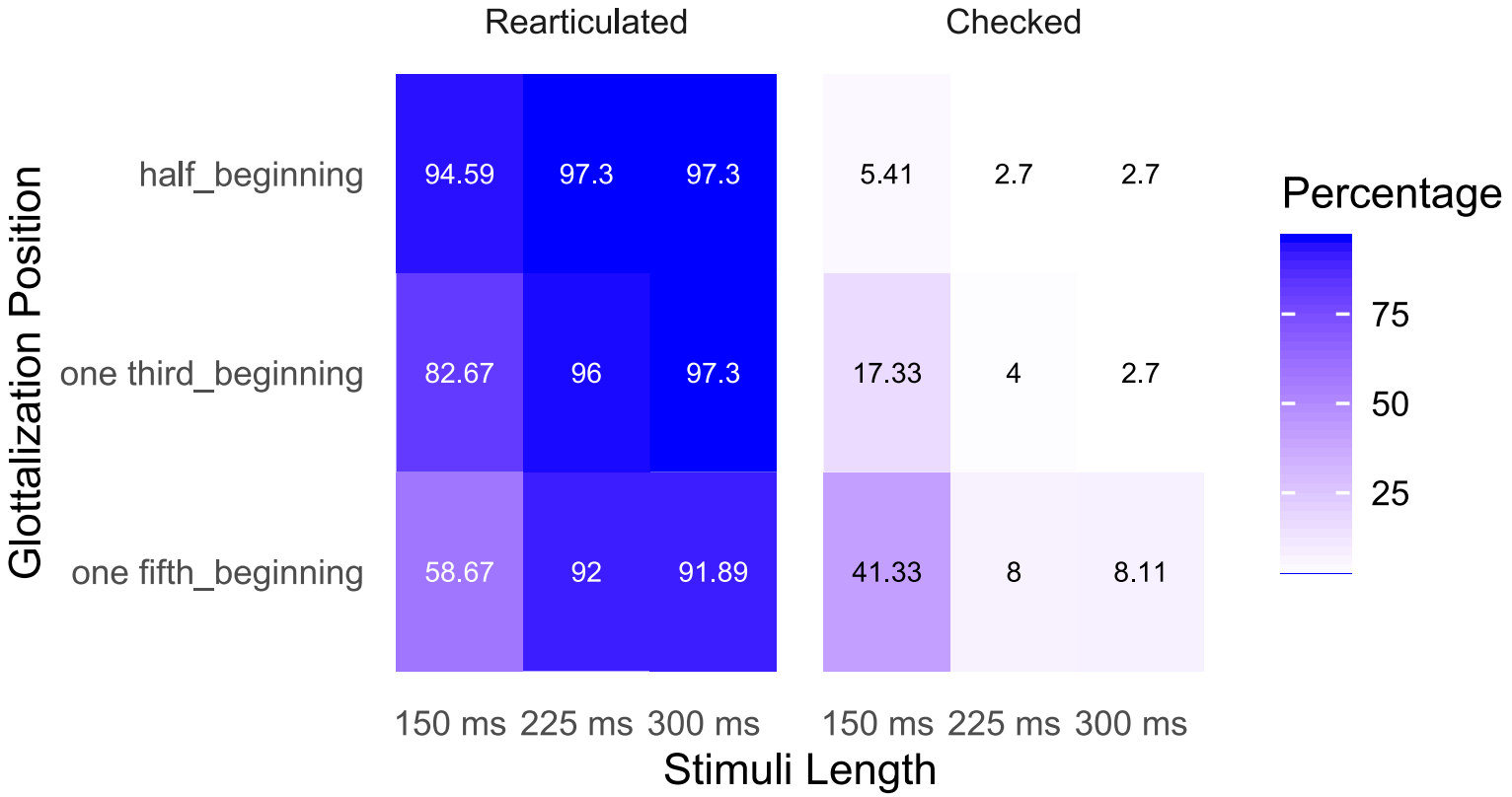
zi'i

zi'



Exp 3 – Results – Rearticulated vs. Checked

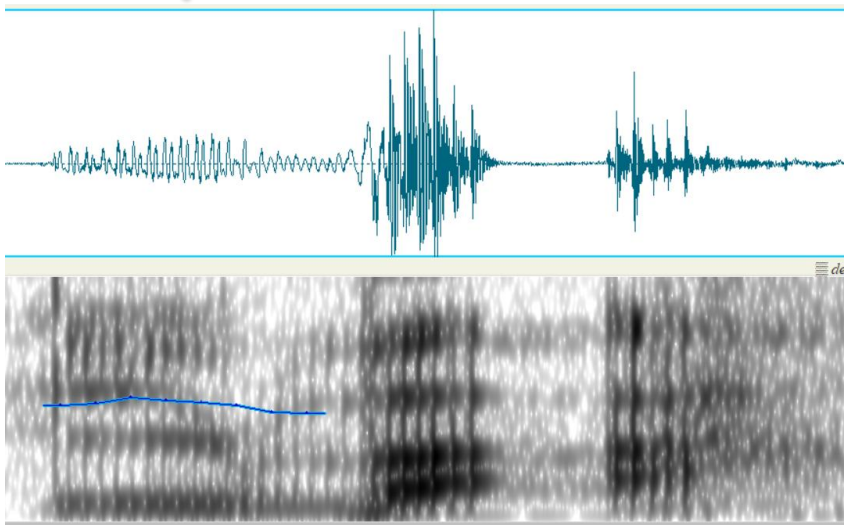
- 24 participants; 670 responses
- As the proportion of glottalization increases, the probability of getting a rearticulated response increases.



Exp 4 – Motivation

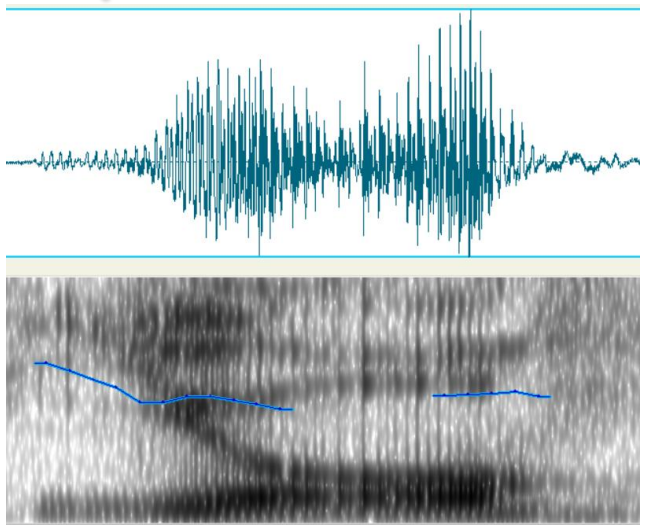
- In natural productions, we see variations of how strong the glottalization is produced.

lbáʔà “my neck”



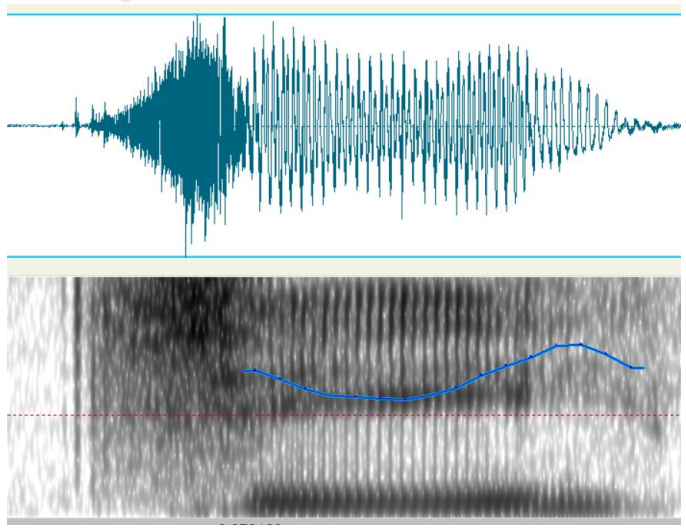
full gl stop

jòʔó “cal lime”



creaky voice

tʂìʔí “his/her voice”

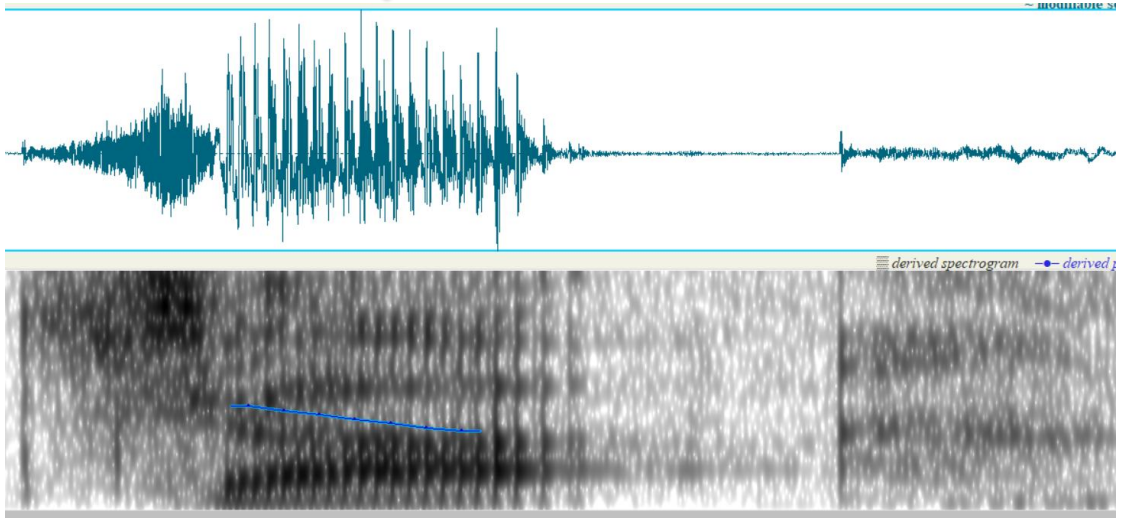


f0 dipping

Exp 4 – Motivation

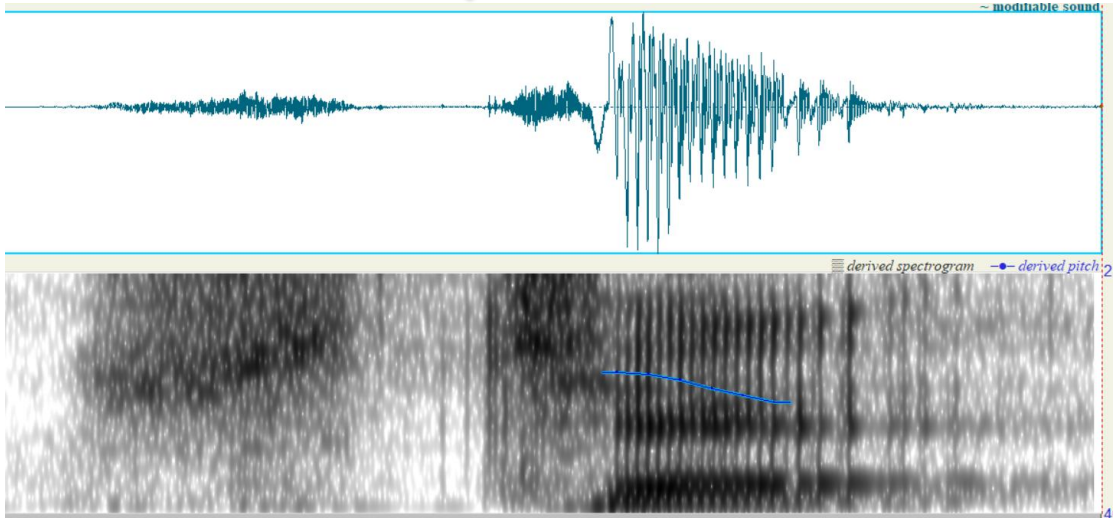
- In natural productions, we see variations of how strong the glottalization is produced.

tʂàʔ “clay pan”



full gl stop

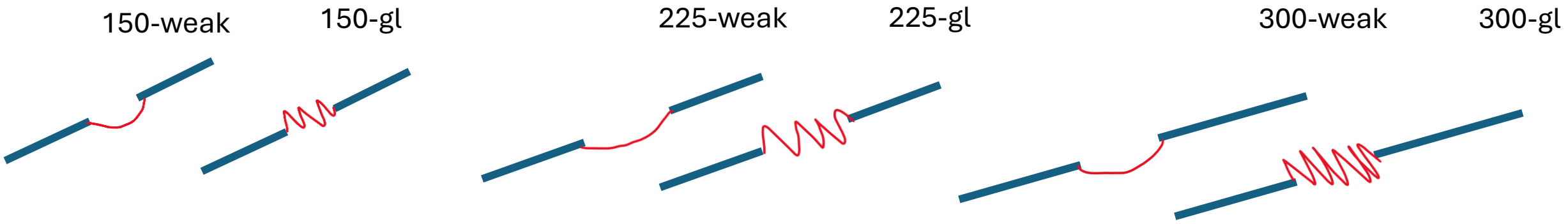
ʂtʂêʔ “dinner”



creaky voice

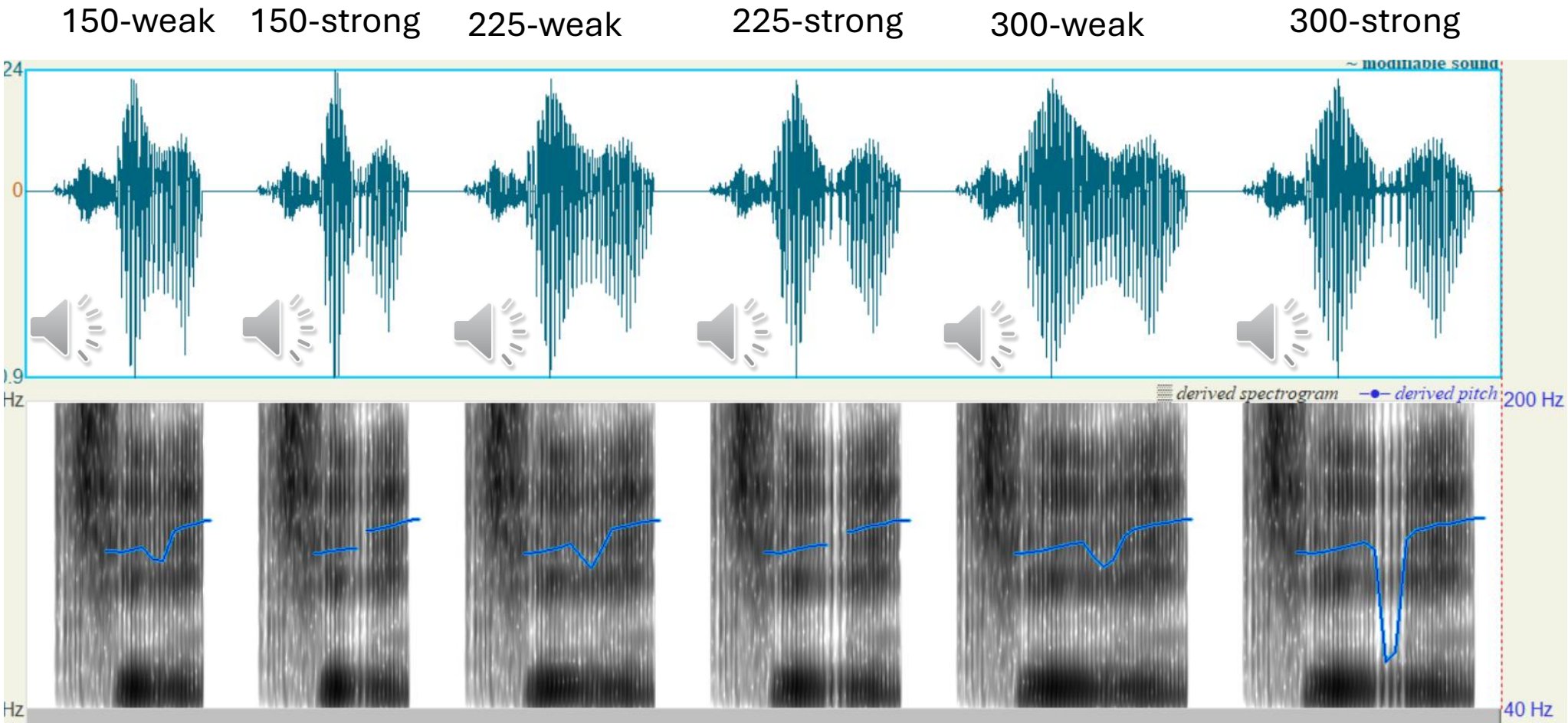
Exp 4 – Research question

- Does the degree of glottalization affect listeners' perception of rearticulated and checked phonations?
  - If we make the mid-gl strong, does the probability of a rearticulated percept increase?
  - If we make the end-gl strong, does the probability of a checked percept increase?



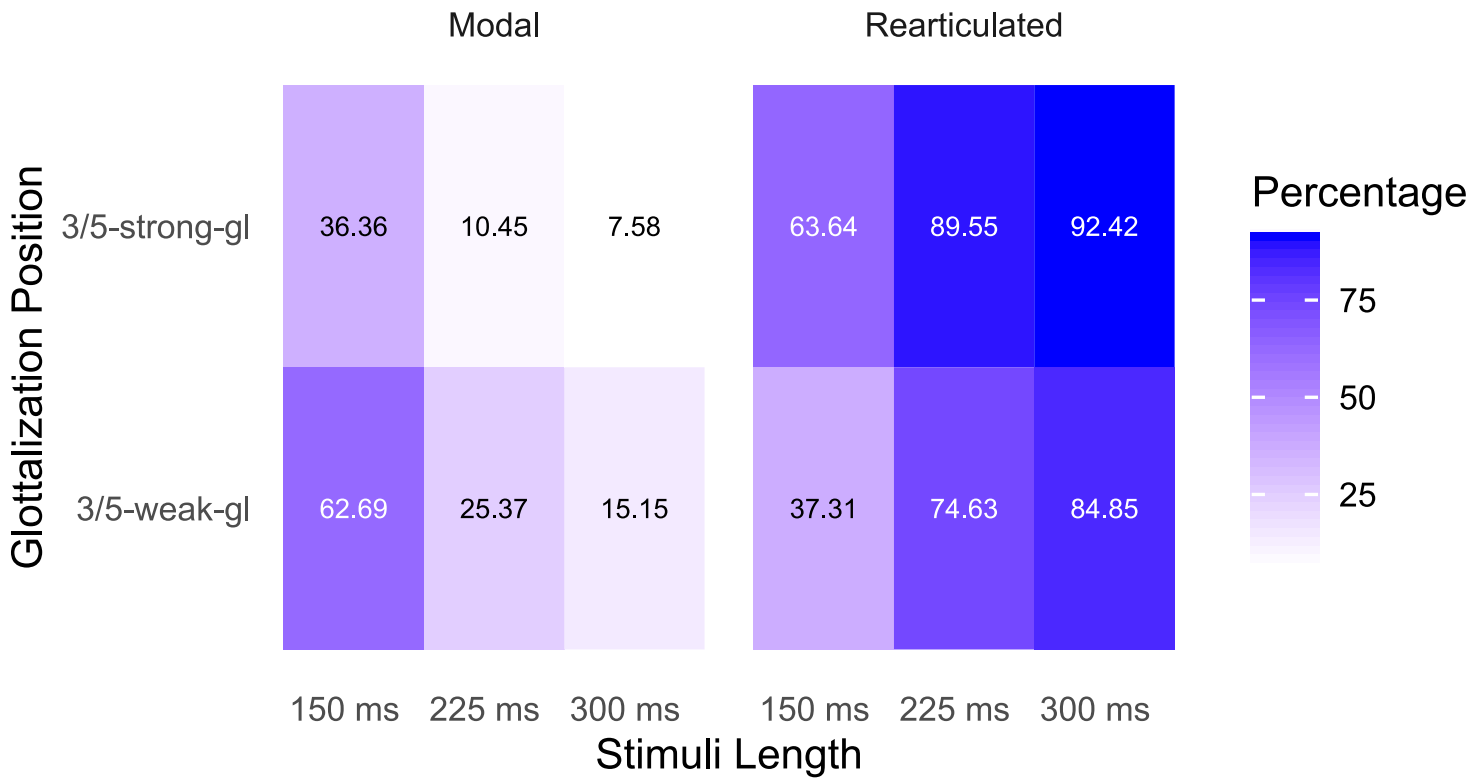
Exp 4 – Stimuli

- First, for rearticulated vowels
  - tʂʏ̌ “ten” vs. tʂìʔí



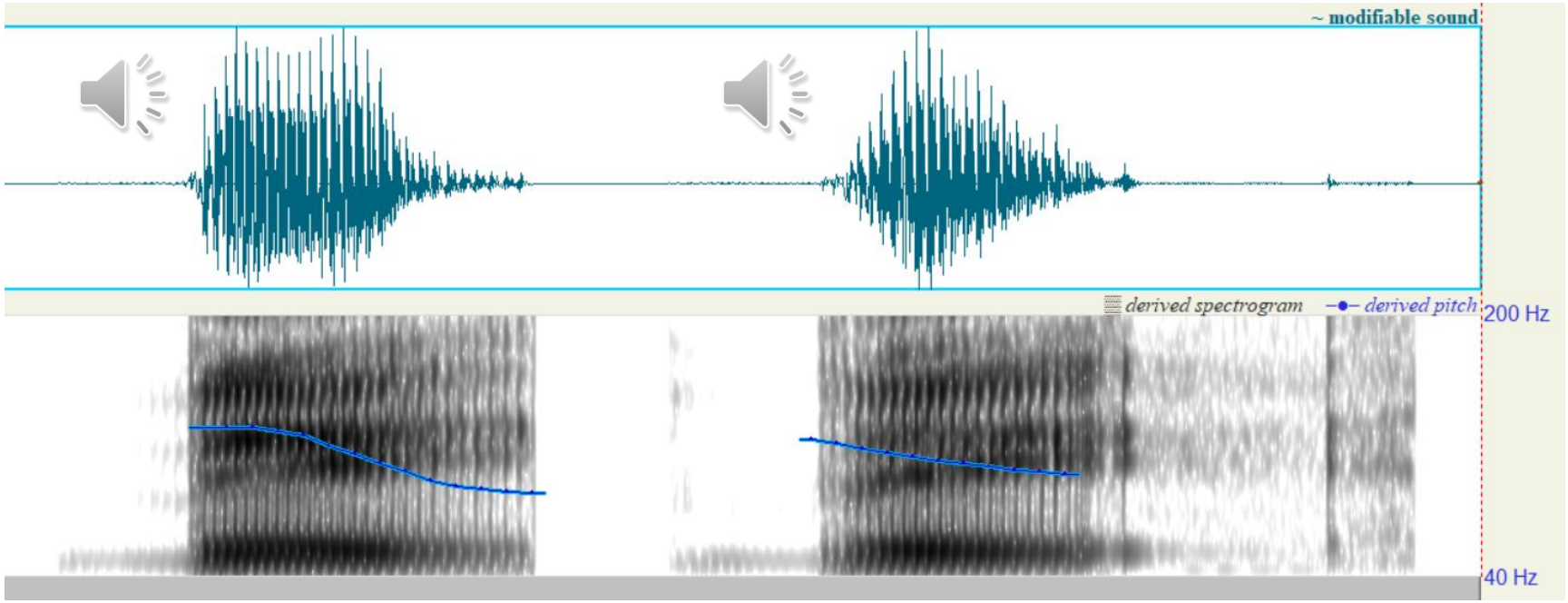
Exp 4 – Results

- 24 participants; 417 responses
- Strong glottalization elicits significantly more rearticulated vowel than f0 dipping.



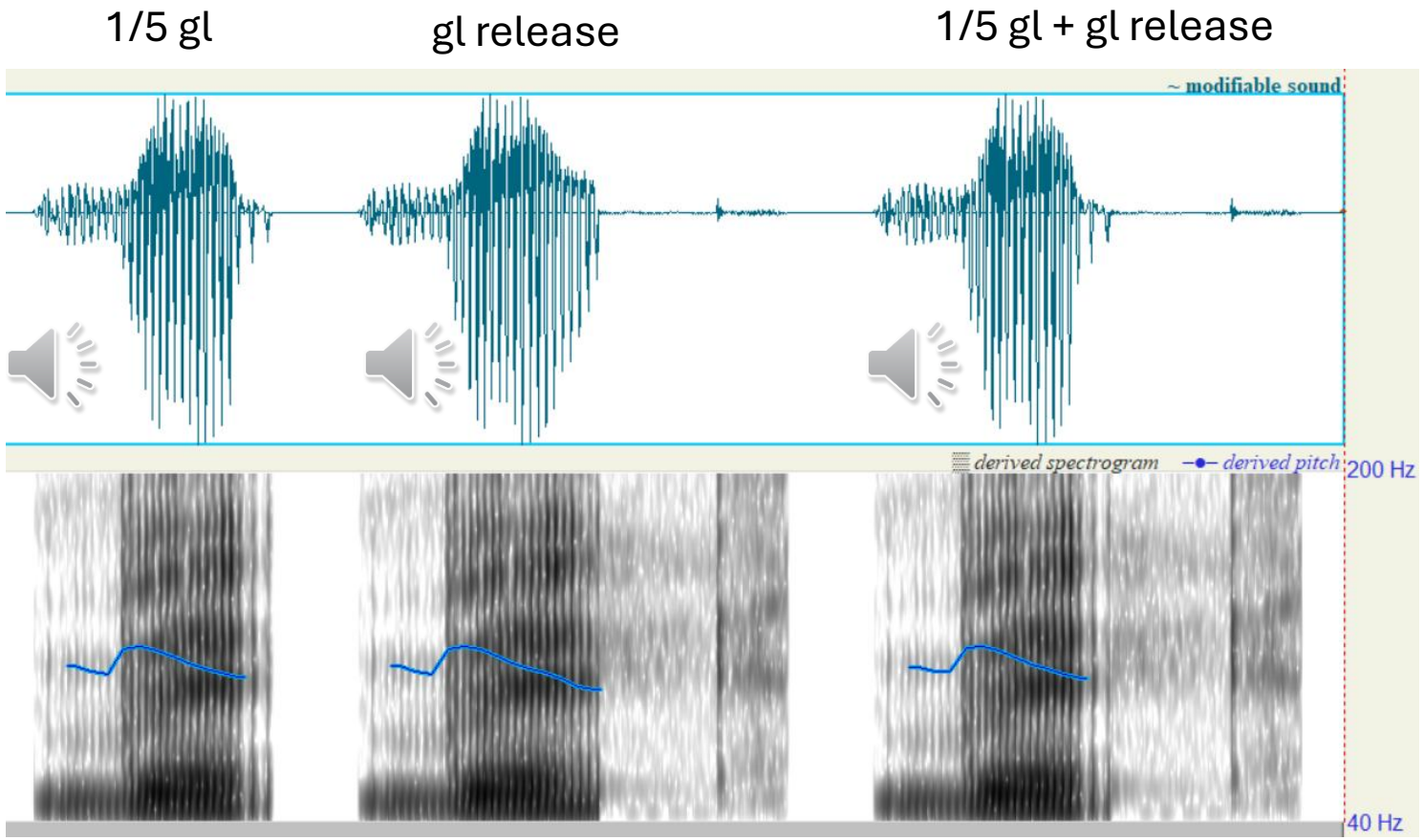
Exp 4 – Research question

- Then, for checked vowels
  - bè “crack” vs. bèʔ “wind”



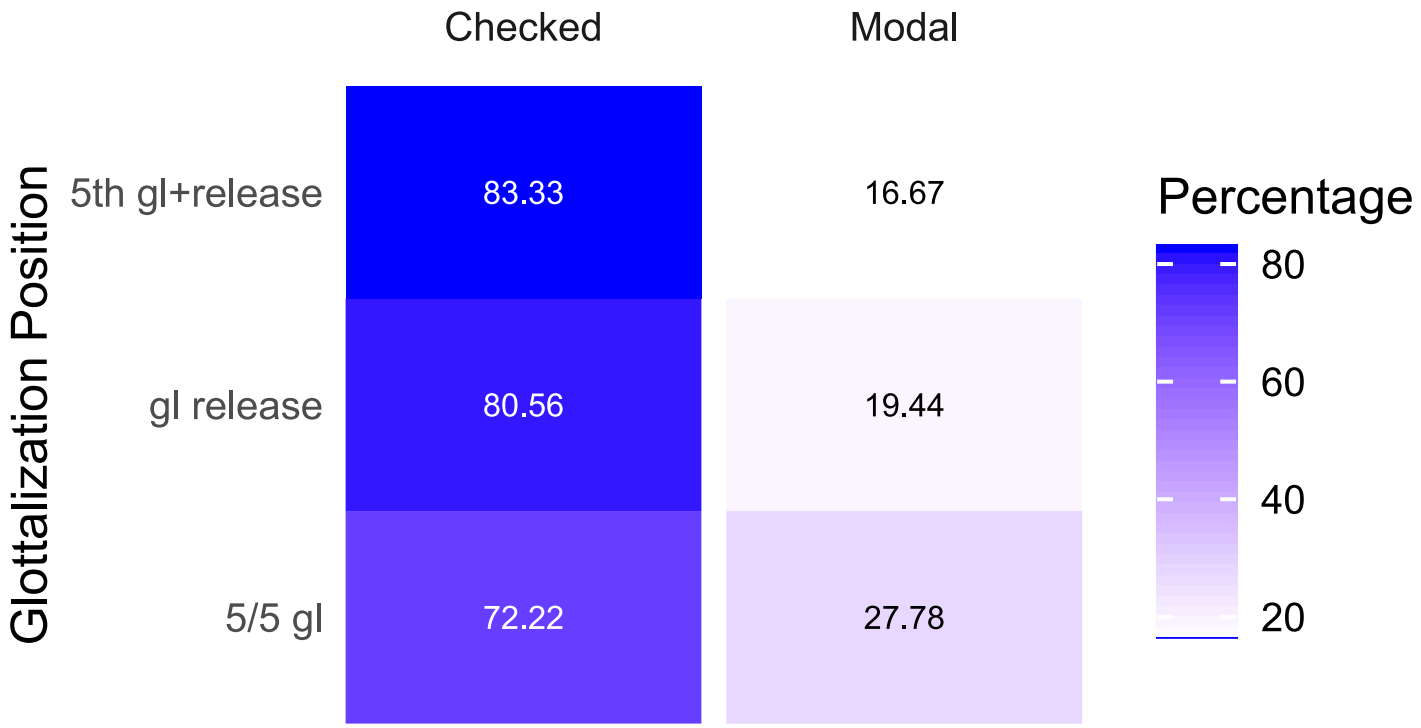
Exp 4 – Stimuli

- Then, for checked vowels
  - bè “crack” vs. bèʔ “wind”



Exp 4 – Results

- 16 participants; 104 responses
- We see a stronger glottalization leads to higher percentage of checked response, but the increase is not significantly significant.



Discussions and conclusions

- Experiment 1:
  - RQ: Is **duration** or **final glottalization** more important for disambiguating between modal and checked phonation?
  - Conclusion: Final glottalization is more important.

  - RQ: Is **duration** or **mid glottalization** more important for disambiguating between checked and rearticulated phonation?
  - Conclusion: Duration does not matter when the vowel is modal; Duration does matter when the vowel has mid glottalization. However, mid glottalization is the principle cue for disambiguating between checked and rearticulated vowels.

Discussions and conclusions

- Experiment 2:
  - RQ: Is **duration** or the **location of glottalization** more important for disambiguating between rearticulated and checked phonation?
  - Conclusion:
    - Location of glottalization is more important.
    - When glottalization is at the initial fifth of the vowel, and when duration is 150 ms, the percept is ambiguous

Discussions and conclusions

- Experiment 3:
  - RQ: Does the **relative proportion** of glottalization at the initial of vowel affect the percept of phonation?
  - Conclusion:
    - Yes, when increasing the proportion of glottalization at the initial of vowel, the percept of rearticulated vowel increases.

Discussions and conclusions

- Experiment 4:
  - RQ: Does the **degree of glottalization** affect the percept of phonation?
  - Conclusion:
    - Yes, mid-glottalization elicits more rearticulated percept than mid-f0-dipping.