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Concerning Schwa:

- Often considered the “neutral” vowel
- The most common vowel in English
- By far, the most common *unstressed* vowel in English



The Meaning of Neutrality:

- What is a “neutral” vowel?

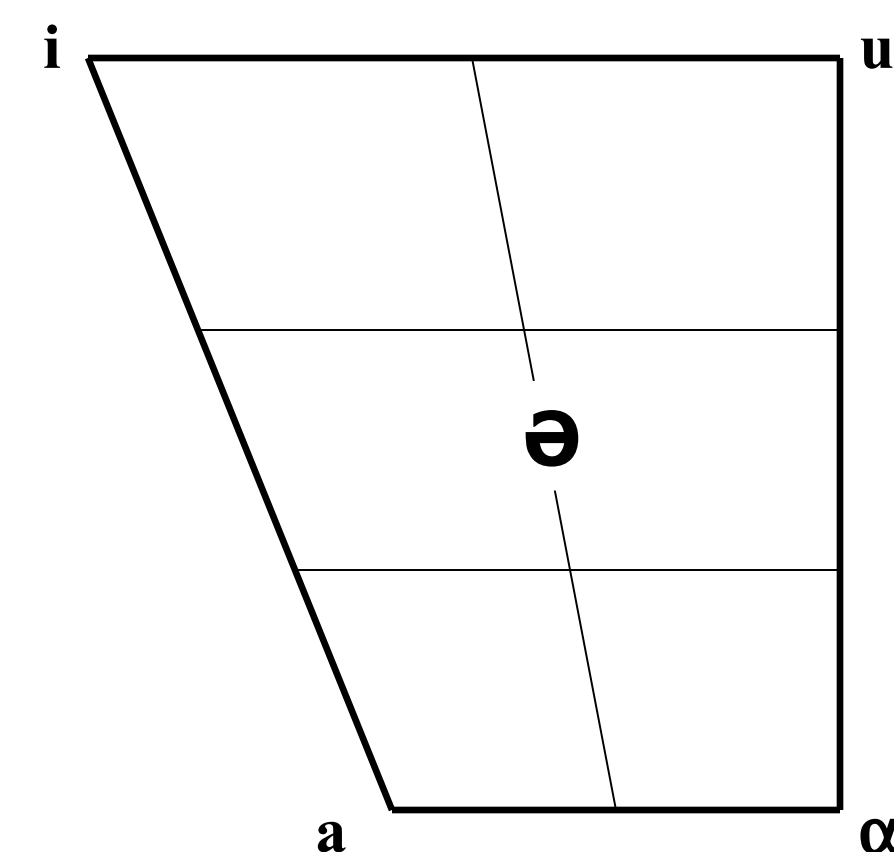
Is the target the mean of language’s vowels?

Does schwa lack a specific constriction target?

- Both cases might be true, depending on the particular situation (ref. 3)

- This implies that there are *TWO TYPES OF SCHWA*

Namely, *targeted* and *untargeted* Schwa



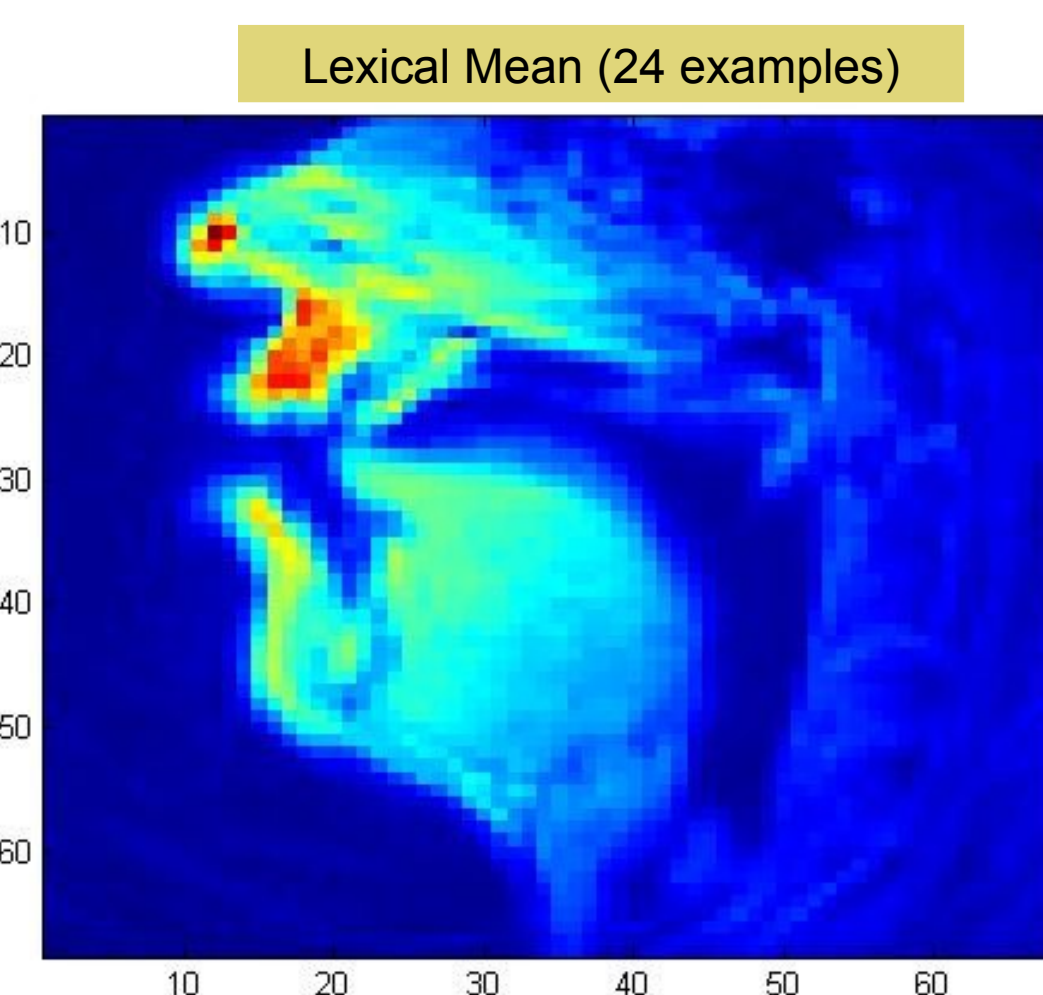
Motivations & Predictions:

- Previous studies used EMA data,
- Real time MRI offers a more complete view of the vocal tract
- We aim to re-establish the two types of schwa (targeted and untargeted)
- We expect that untargeted schwas will show more variability
- We want to show the importance of vowel context in explaining that variability

Shape:

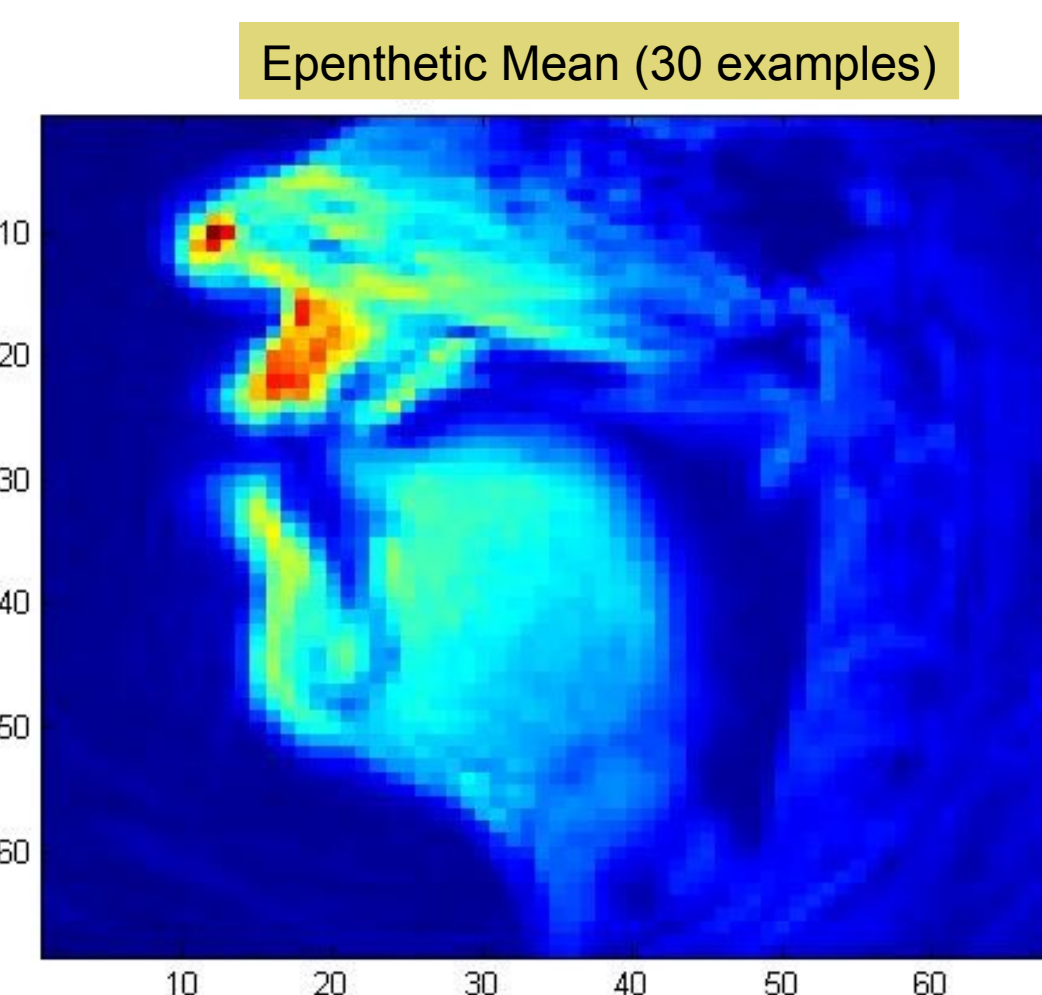
Lexical Schwa

targeted
less variable
e.g., panda, sofa, etc.



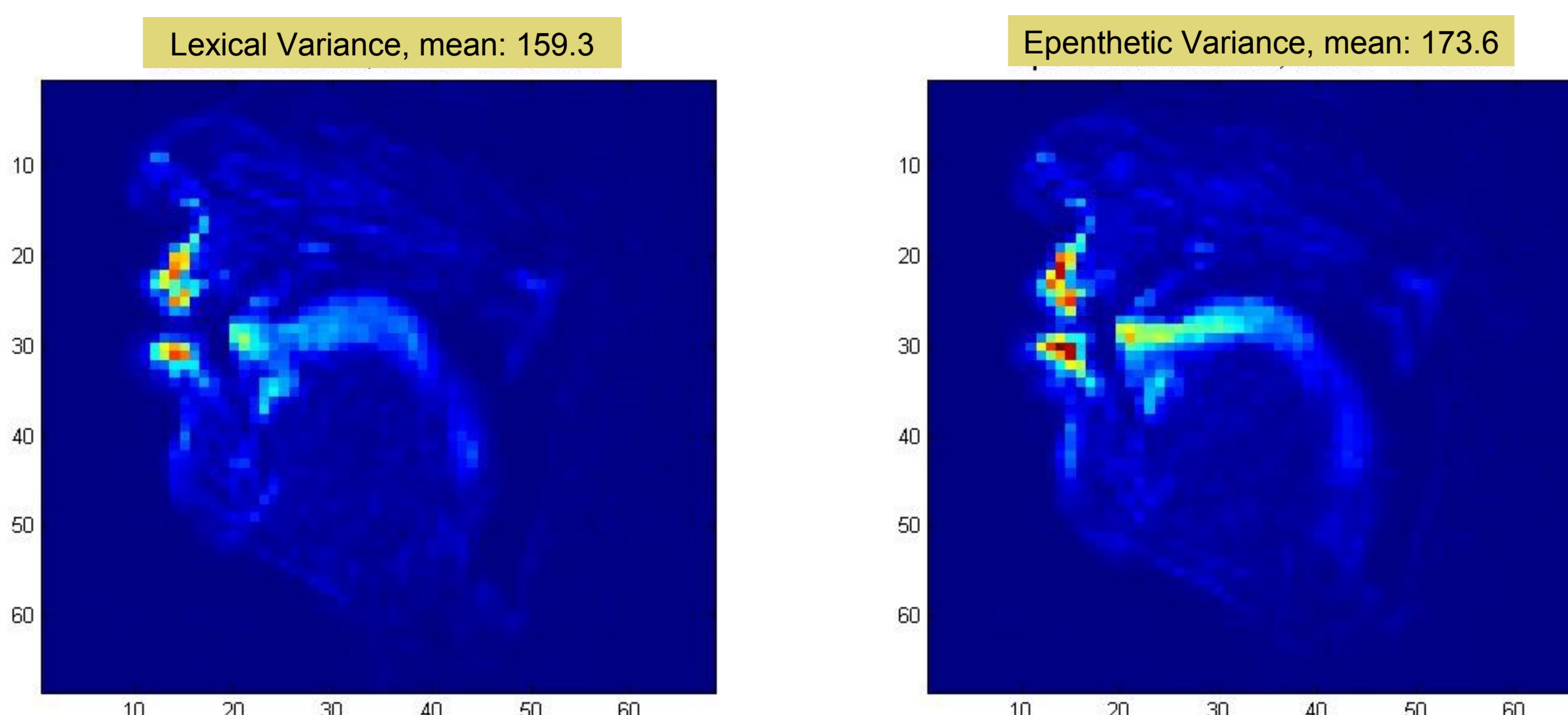
Epenthetic Schwa

untargeted
highly variable
context dependent
e.g., needed, rooted



Variance:

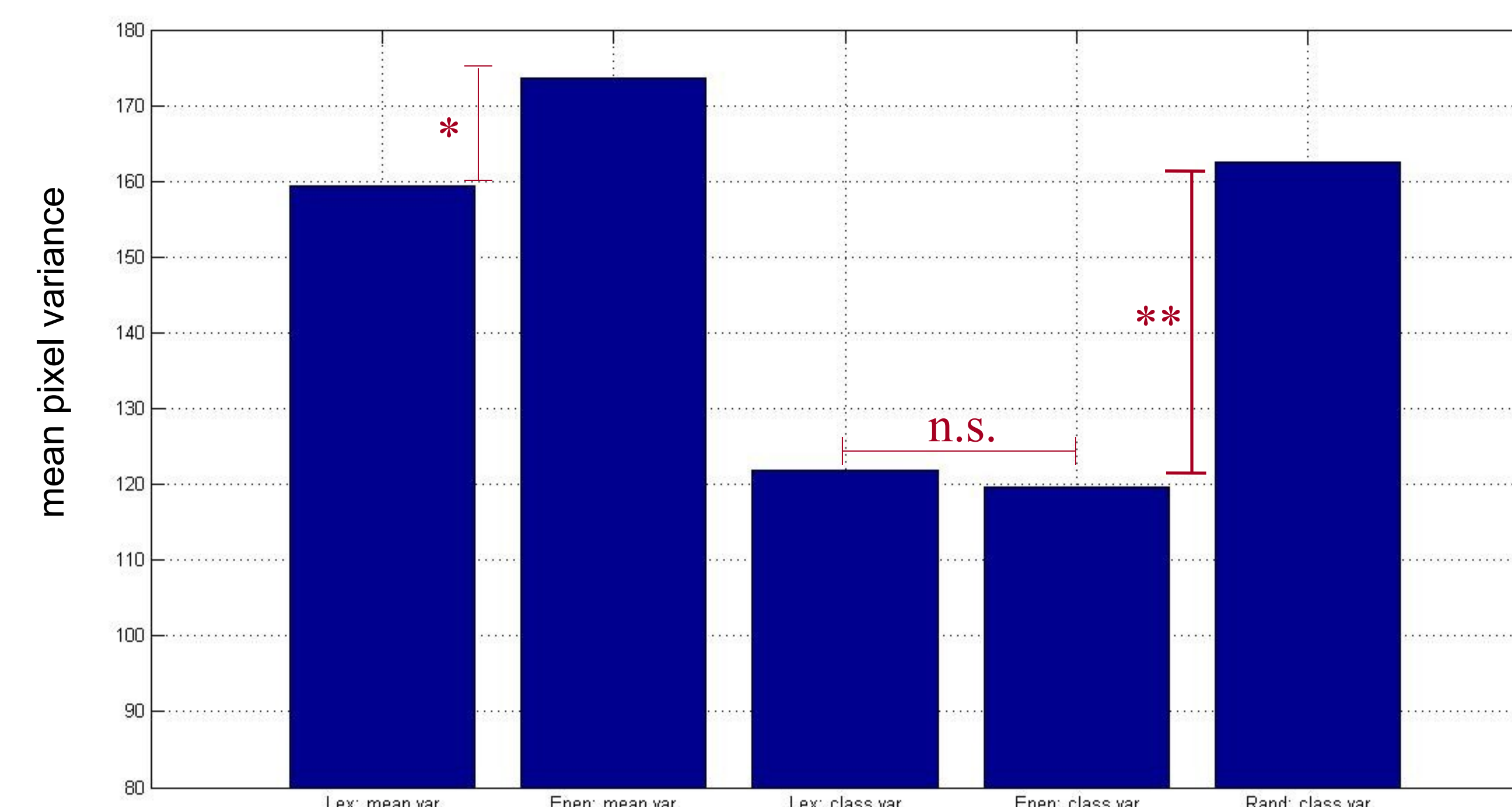
- Is lexical schwa targeted while epenthetic schwa isn't?
- If true, we expect more variability in the configuration of epenthetic schwas
- We can examine this by inspecting the mean pixel variance of the MR images



The distributions in the two groups **DO** differ significantly
(Student t-test, $t = -7.5$, $df = 4623$, $n_1 = 24$, $n_2 = 30$, $p < 0.001$)

Whence Variability?:

- Vowel context might explain the variance of epenthetic schwa configurations
- Each type of schwa was set in one of 8 vowel contexts
- The contexts included: { 'aa' 'ay' 'iy' 'ow' 'uw' 'ae' 'eh' 'ih' }
- When the effect of vowel context is removed, epenthetic schwas should look more like lexical schwas



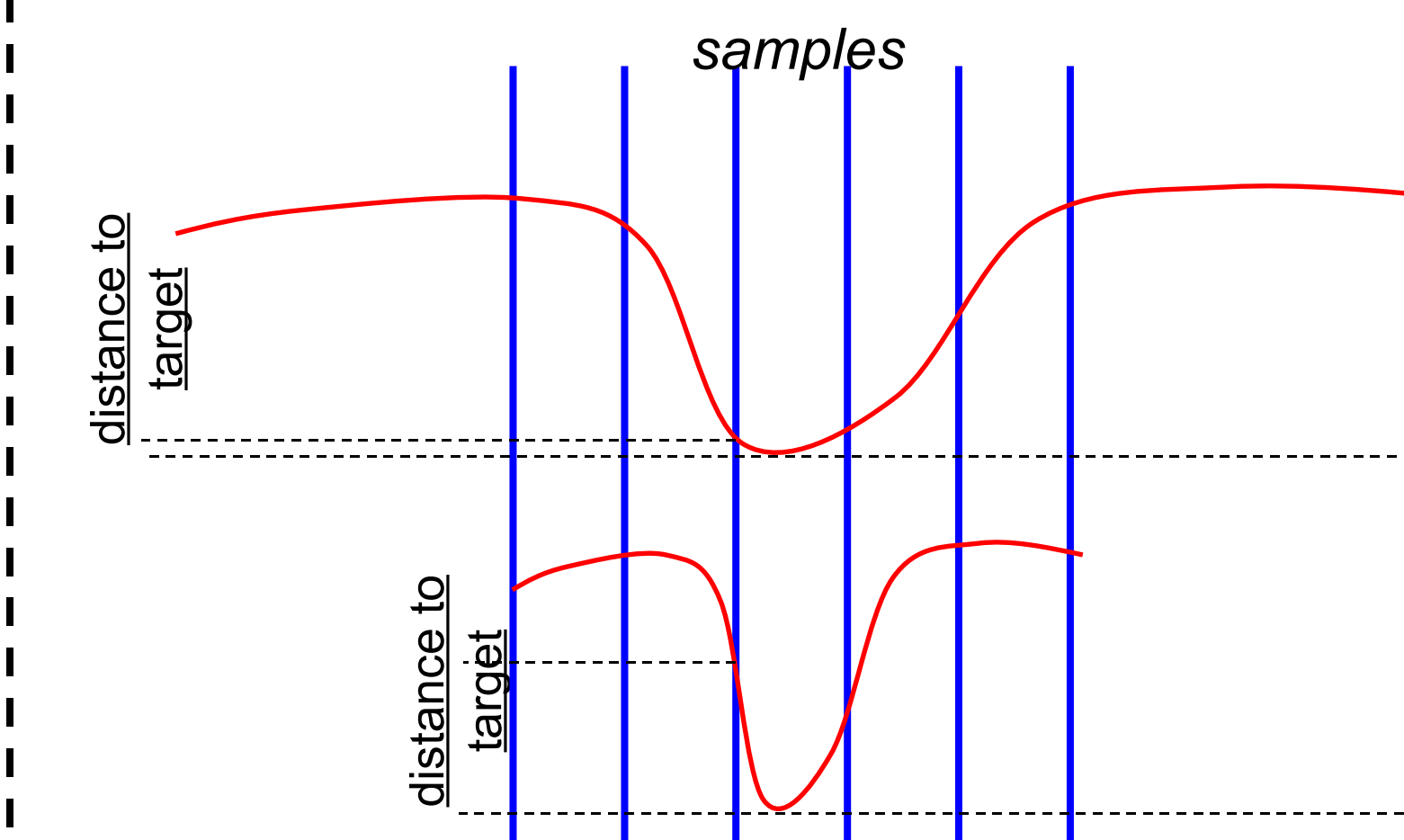
*The epenthetic schwas have significantly higher mean pixel variance (student t-test, $t = -7.5$, $df = 4623$, $n_1 = 24$, $n_2 = 30$, $p < 0.001$)

** This shows the drop in variance observed when the epenthetic schwas were divided into subgroups by vowel-context categories. The taller bar is the expected variance for random subgroups ($p < 0.001$)

n.s. After removing vowel-context effects, the two types of schwas do not differ significantly in terms of mean pixel variance anymore

Timing, A Potential Snag:

- What if lexical schwas are systematically longer than epenthetic schwas?
- The probability of an image falling at the point of maximum constriction would increase
- Thus, we must show that they do not differ in duration



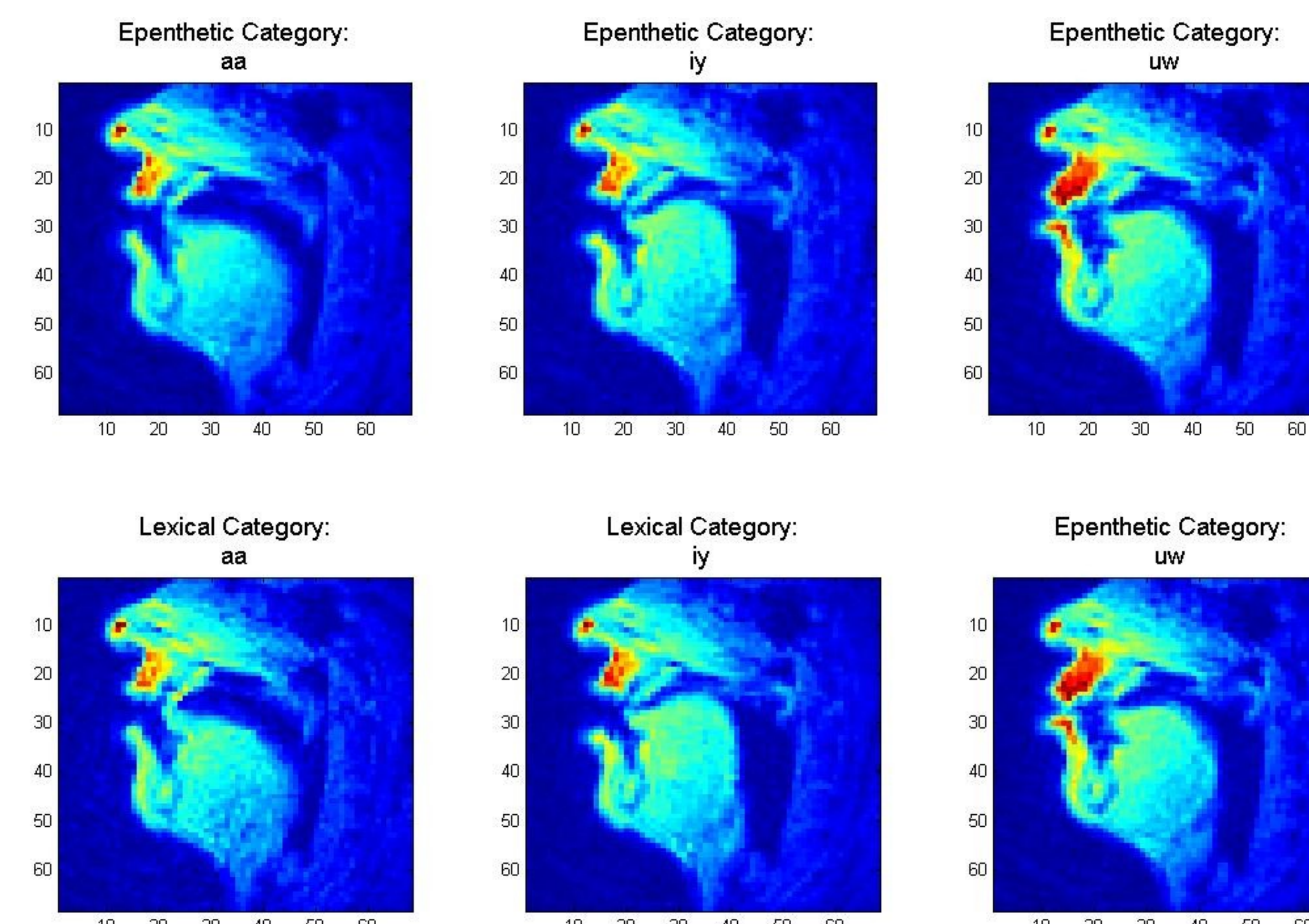
Median # of Samples (Lexical = 2, Epenthetic = 2)

The distributions in the two groups **DON'T** differ significantly

(Mann–Whitney $U = 717$, $n_1 = 24$, $n_2 = 30$, $p = 0.2$)

Visualizing Vowel Context:

- The vowel-context subgroups look like the vowels that define the context
- After accounting for vowel context the two schwa groups are hard to distinguish



Conclusions:

- (1) Lexical schwa is targeted and epenthetic schwa is not
- (2) Variance of epenthetic schwas can be largely explained by local vowel context
- (3) Real-time MRI affords us more confidence with respect to examining articulatory constriction targets, due to a more complete view of the vocal tract

References:

- (1) C. Browman and L. Goldstein. *Targetless Schwa: An Articulatory Analysis*. in Docherty and Ladd (eds.), *Papers in Laboratory Phonology II: Gesture, Segment, Prosody*. 26-56 (1992).
- (2) S. Narayanan, K. Nayak, S. Lee, A. Sethy, D. Byrd. *An approach to real-time magnetic resonance imaging for speech production*. JASA 115, 1771 (2004).
- (3) I. Smorodinsky. *Schwas with and without active gestural control*. JASA 109, 2446 (2001).

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