

## 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:

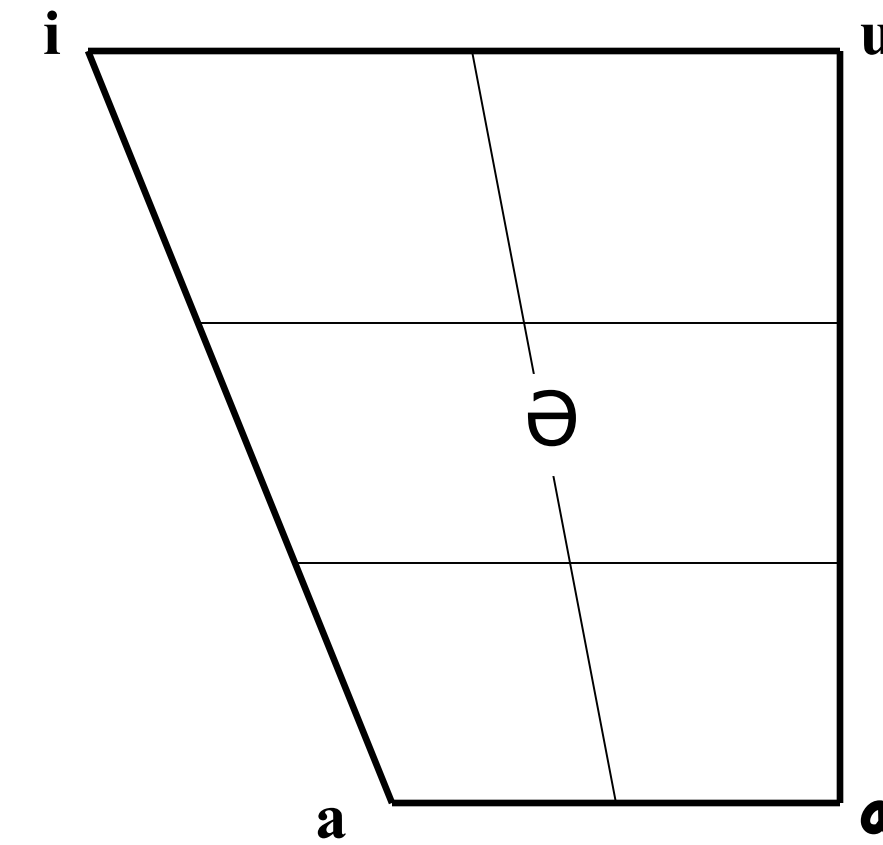
- What is a “neutral” vowel?

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:

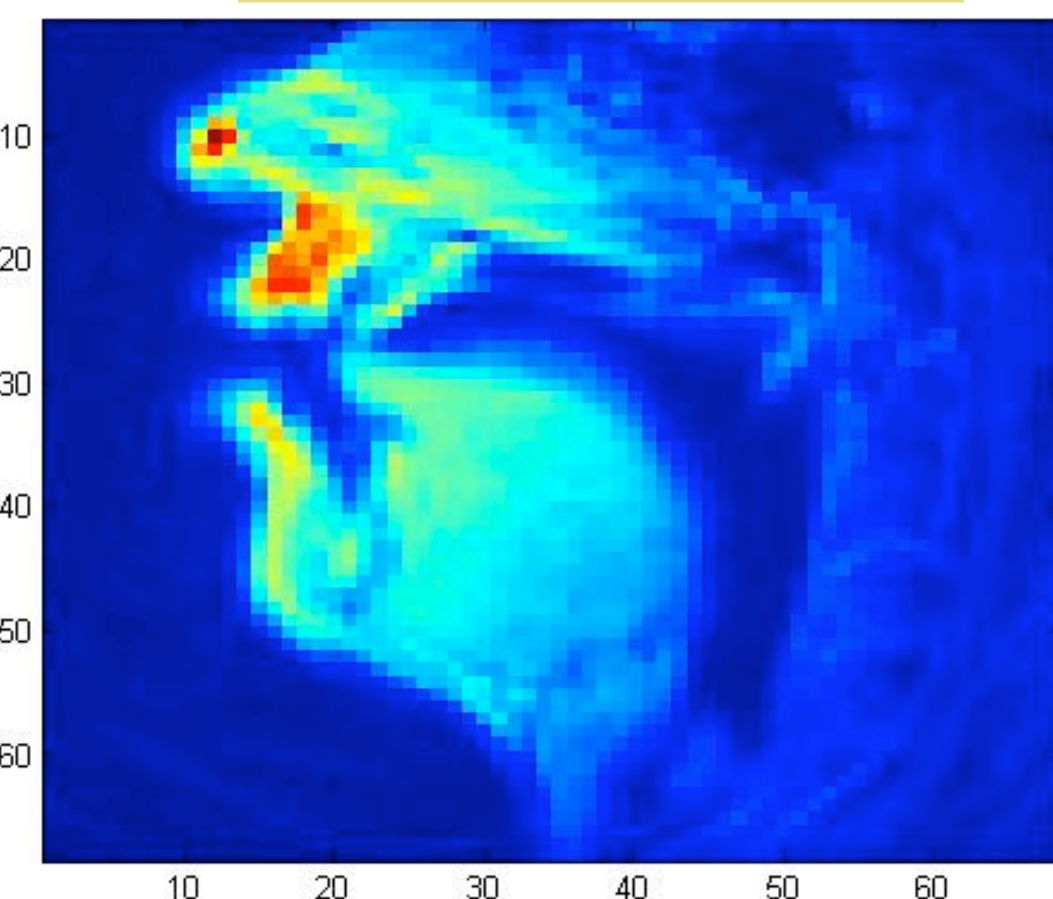
### Lexical Schwa

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

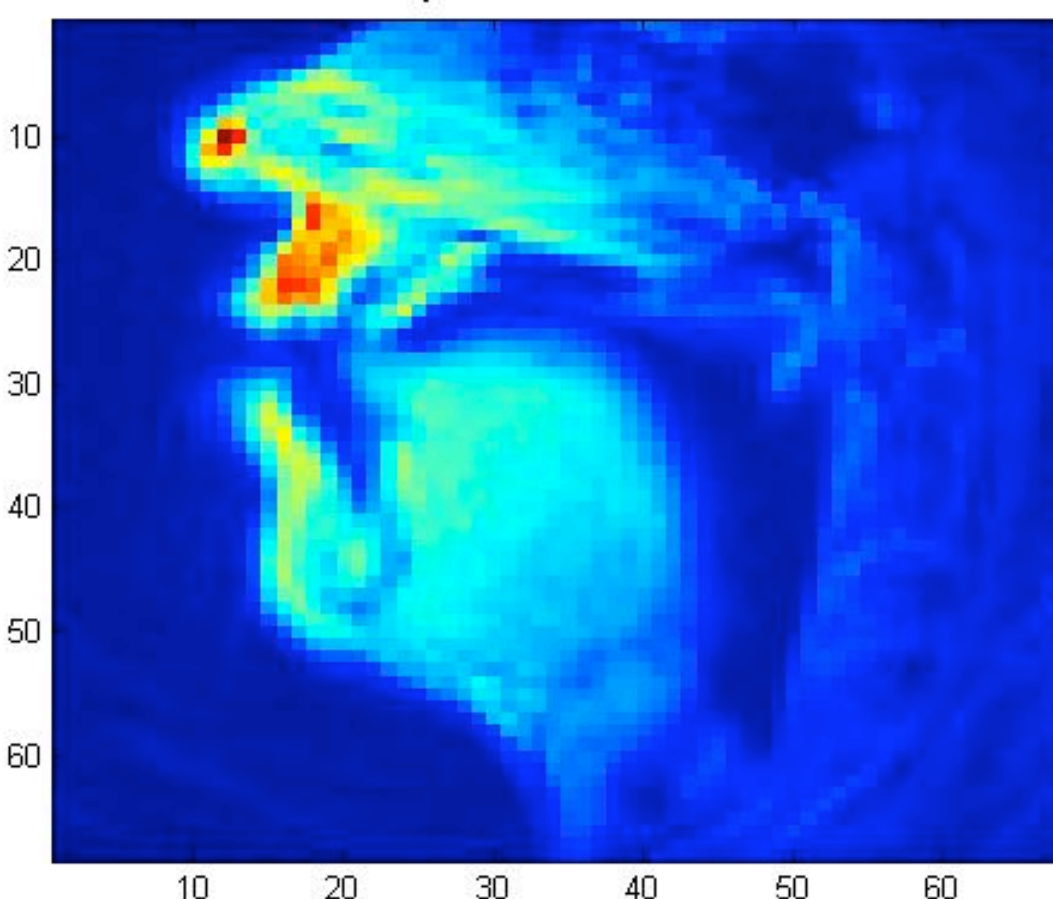
### Epenthetic Schwa

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

Lexical Mean (24 examples)

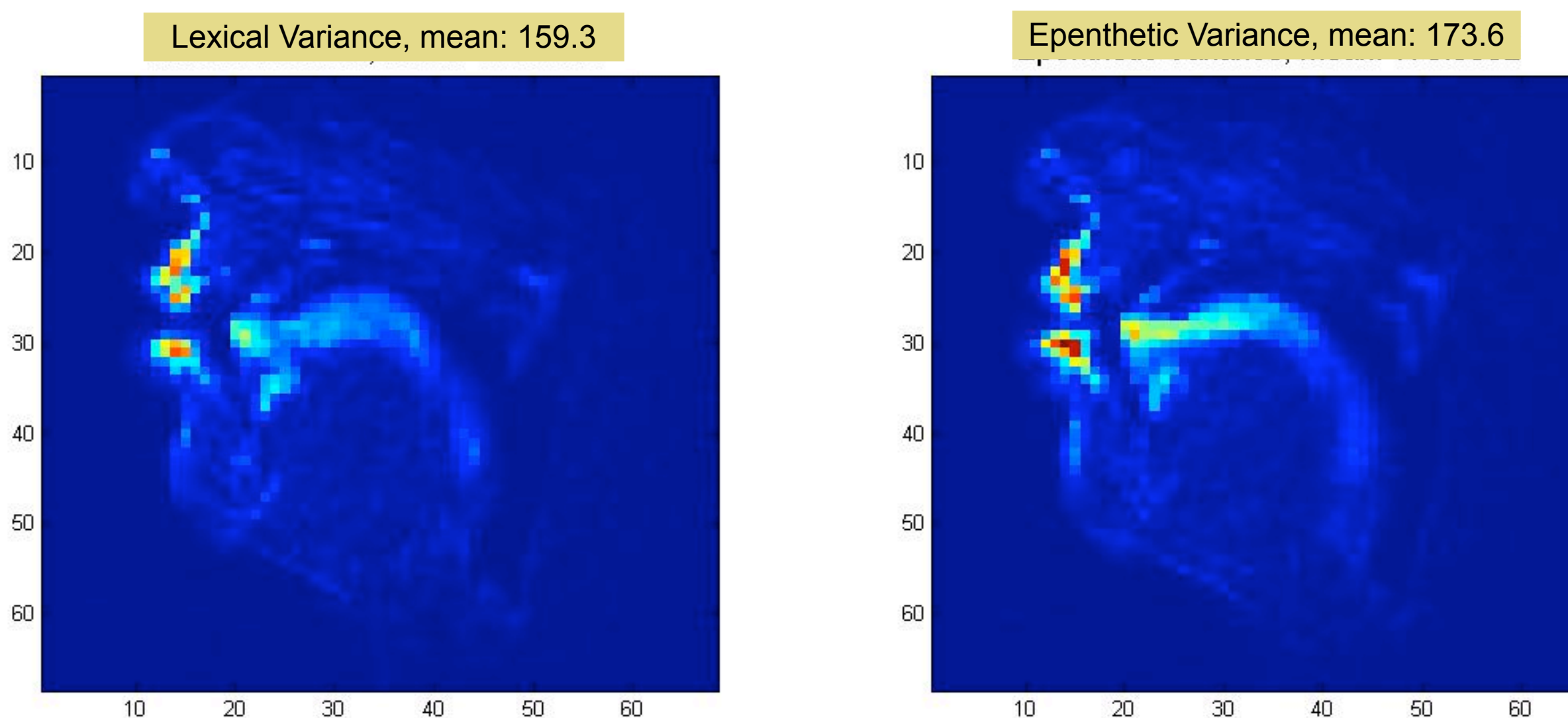


Epenthetic Mean (30 examples)



## Variance:

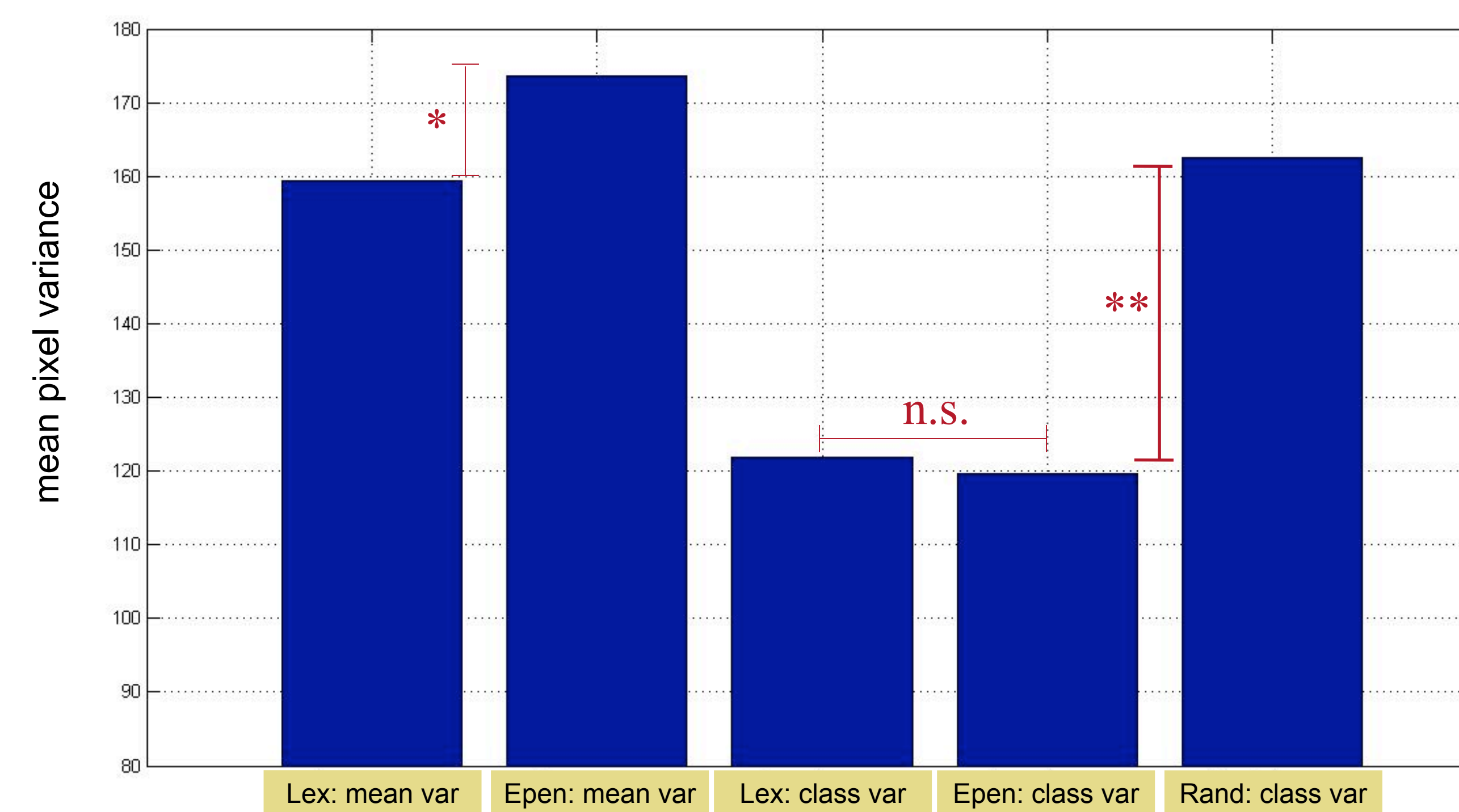
- Is lexical schwa targeted while epenthetic schwa isn't?
- If true, we expect more variability in the configuration of epenthetic schwas
- We can examine this by inspecting the mean pixel variance of the MR images



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



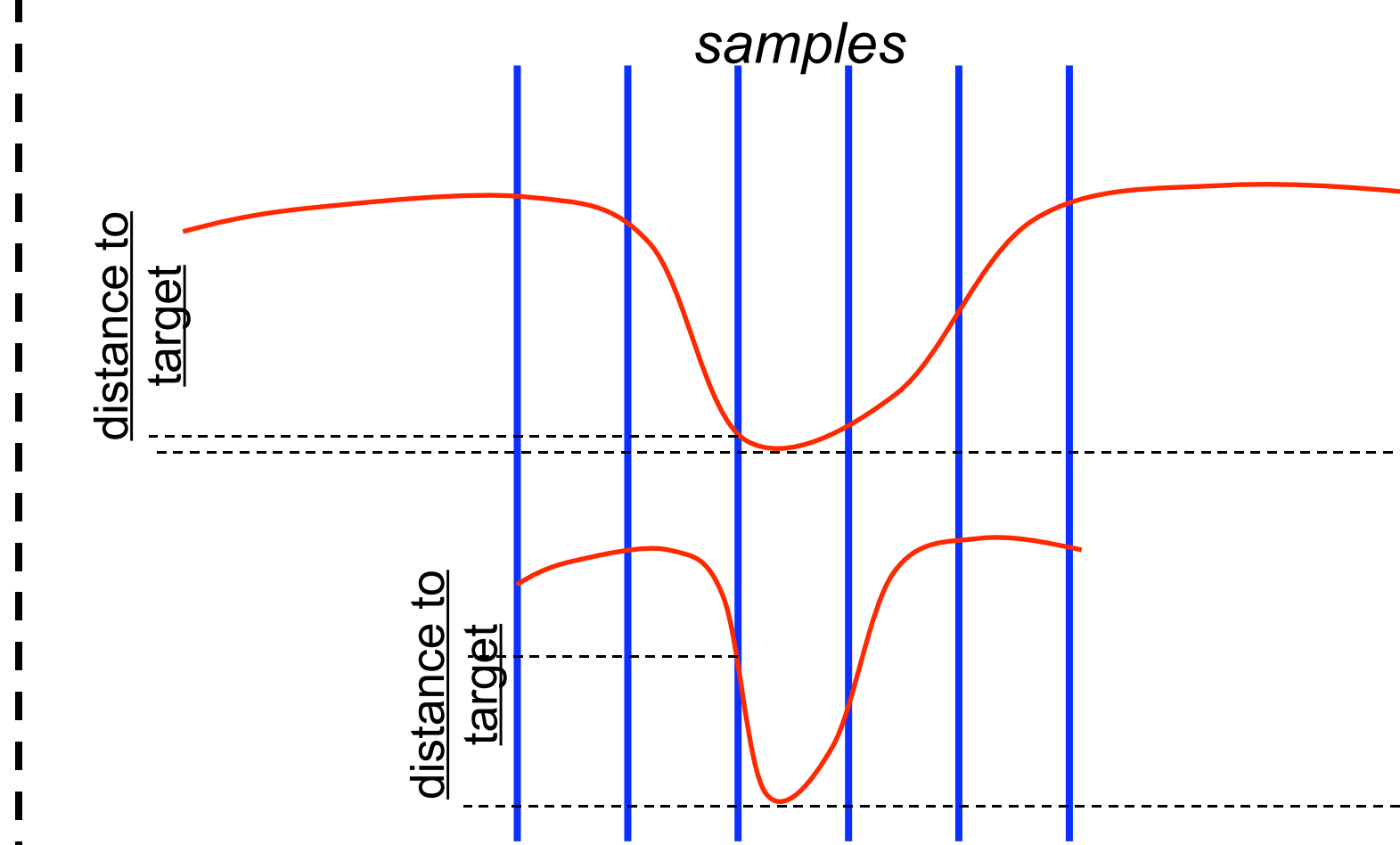
\*The epenthetic schwas have significantly higher mean pixel variance (student t-test,  $t = -7.5$ ,  $df = 4623$ ,  $n_1 = 24$ ,  $n_2 = 30$ ,  $p < 0.001$ )

\*\* 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:

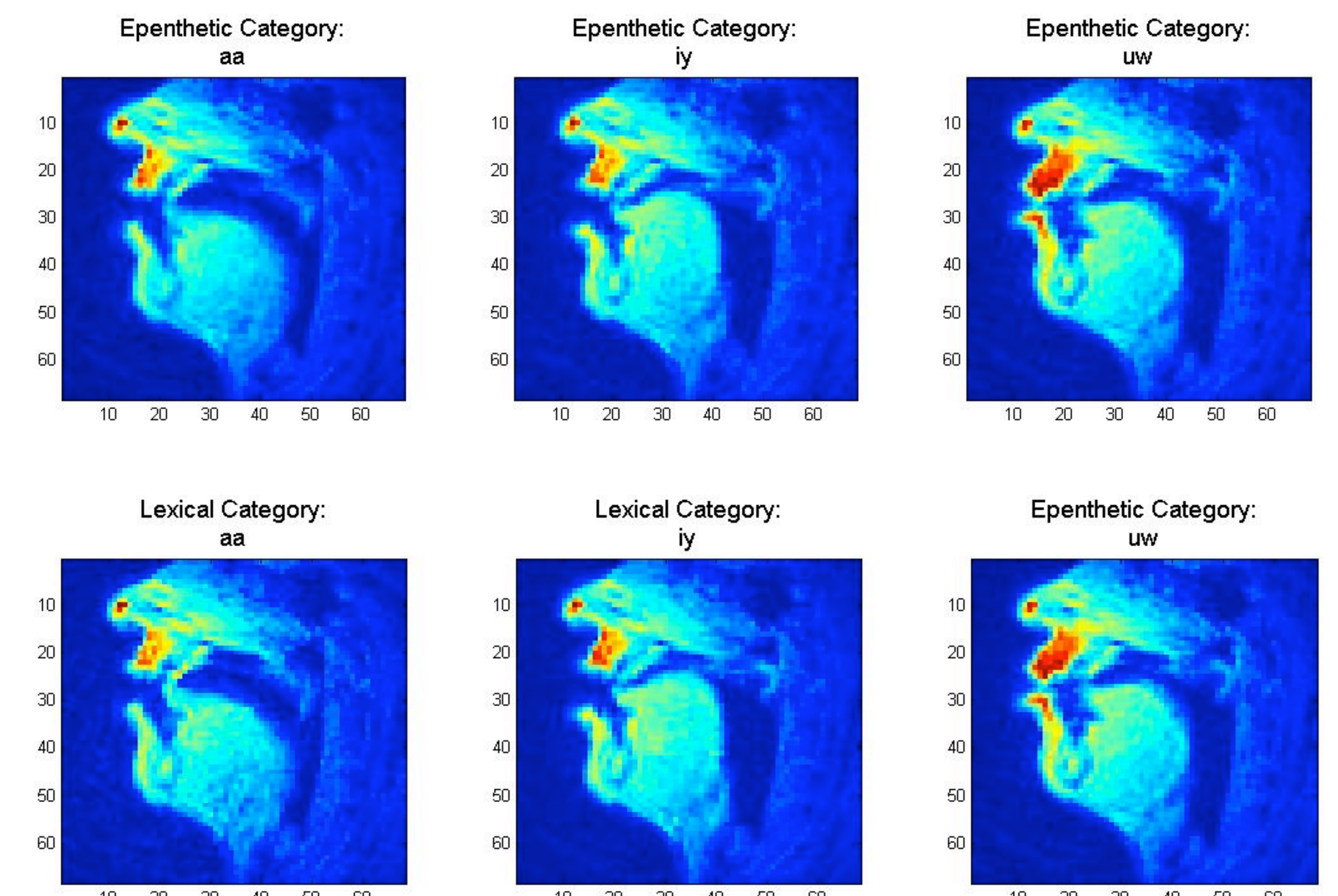
- What if lexical schwas are systematically longer than epenthetic schwas?
- The probability of an image falling at the point of maximum constriction would increase
- Thus, we must show that they do not differ in duration



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 less targeted than epenthetic schwa
- (2) Variance of epenthetic schwas can be largely explained by local vowel context
- (3) Real-time MRI allows us more confidence in examining articulatory constriction targets, due to a more complete view of the vocal tract
- (4) **Epenthetic schwa could be interpreted as a compositional artifact of separating consecutive, similarly located articulatory gestures**

## 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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