

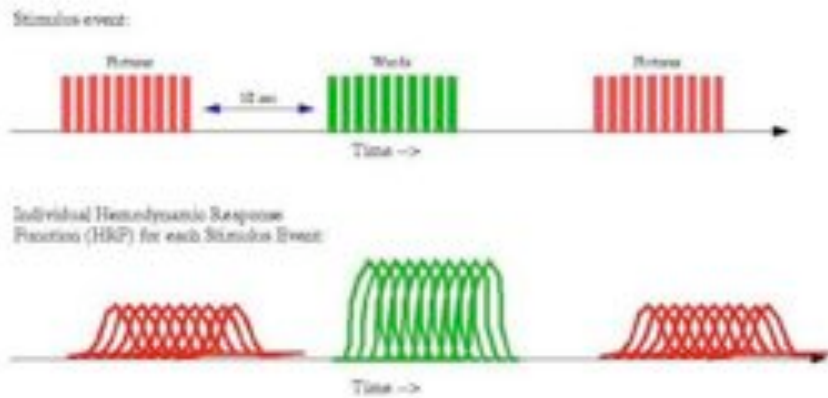
Studying single-word processing with fMRI: A naturalistic reading approach

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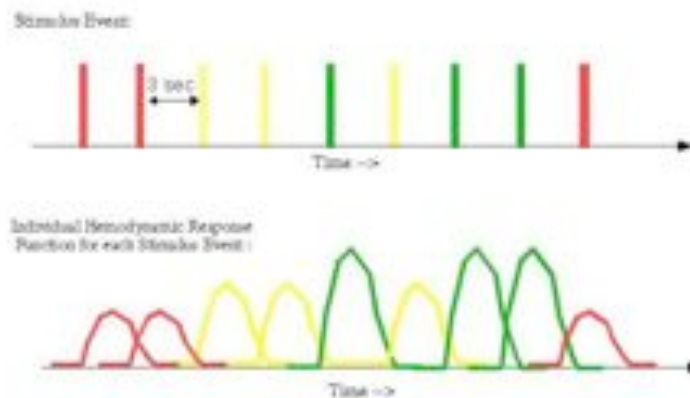
Functional magnetic resonance imaging

- A technique for studying brain activity
- Scanner detects changes in relative oxygenation of blood flowing through brain
- Amount of blood flow to a region roughly reflects the amount of neuronal activity in that region

Block design



Rapid event-related design



fMRI studies of language

- Most studies of language are single word studies
- Use rapid event-related fMRI
- Temporal resolution ~ 2 seconds
- Present single word, require overt response
 - E.g., lexical decision task

Some limitations

- Not a very natural way to read
- Activation patterns could reflect executive/ motor demands
- Factorial designs require careful selection of small set of words
 - Must carefully match words on potentially confounding dimensions

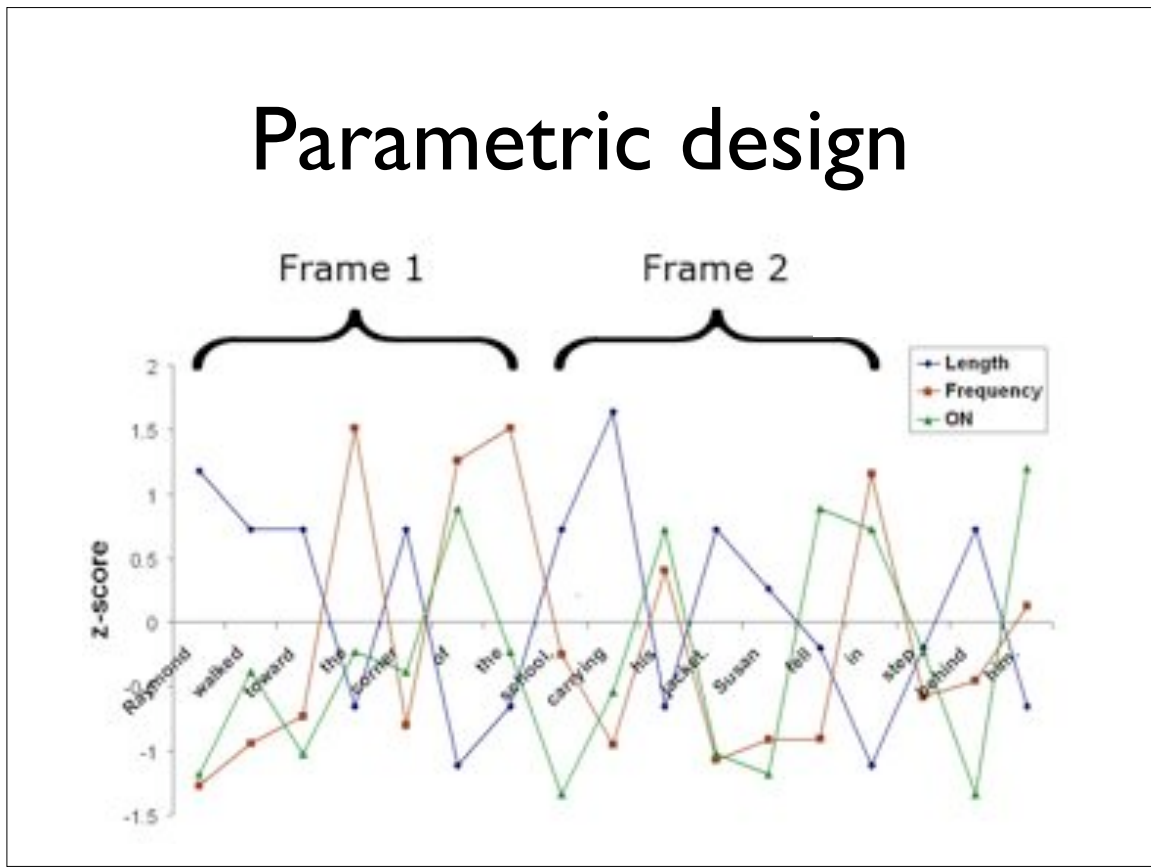
Temporal resolution of fMRI

- Common complaint is that temporal resolution of fMRI is poor (1 - 2 seconds)
- Not completely accurate
 - Early studies showed that activation could be reliably detected for intervals 250 ms or shorter (Burock et al., 1998)
 - Studies that use subliminal stimuli (< 30 ms) find reliable changes in brain activation

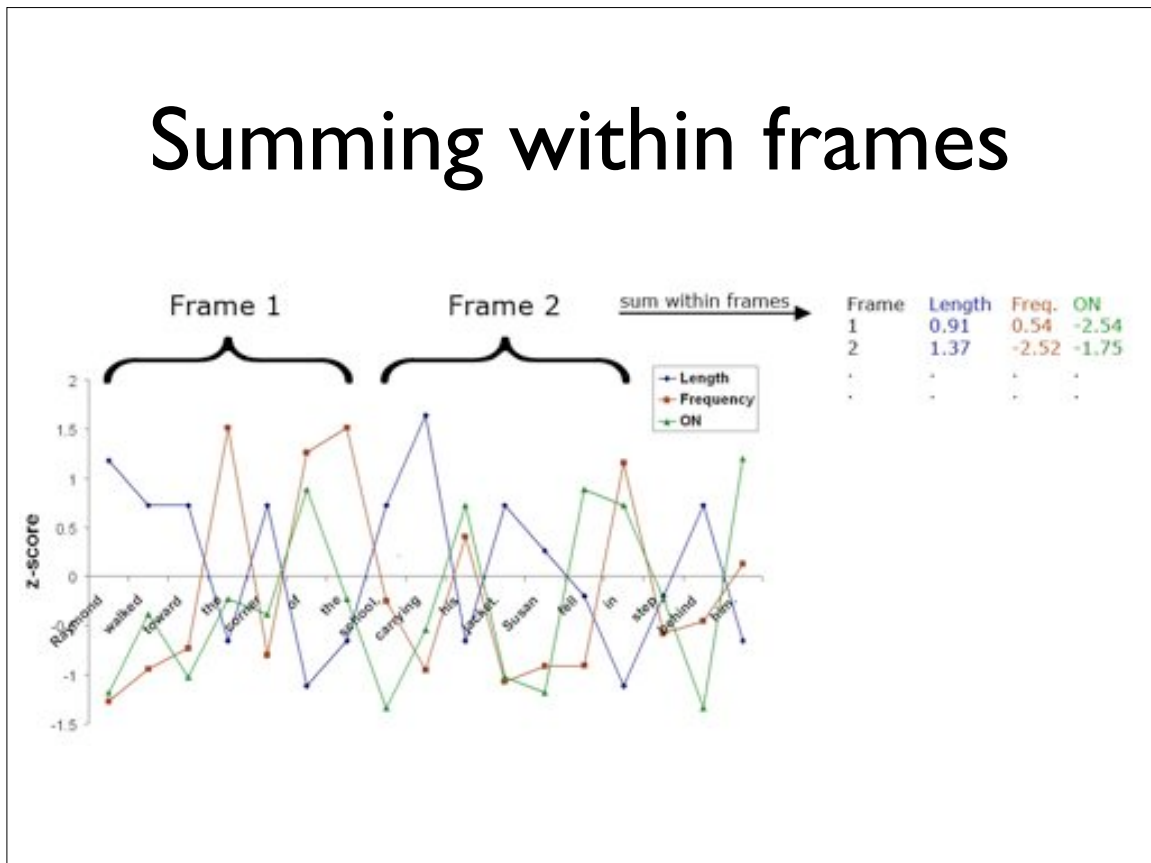
Naturalistic fMRI of language

- Tested ability to detect word-by-word changes in neural activity with fMRI within the context of rapid, coherent reading
- Narrative stimuli contain 5000+ words
 - 1000+ distinct
 - Wide variation in length, frequency, etc.
- Modeled variation in these variables parametrically

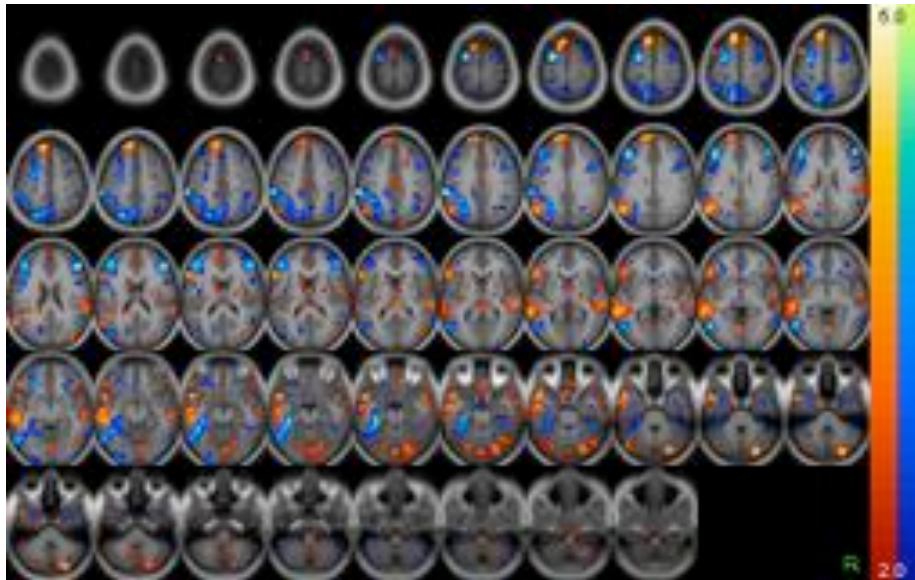
Parametric design



Summing within frames

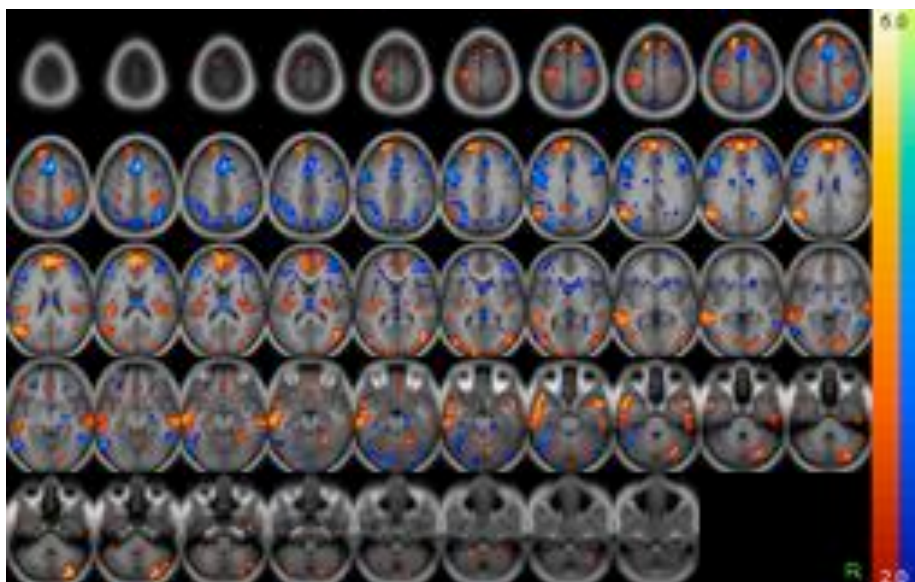


Results (frequency)



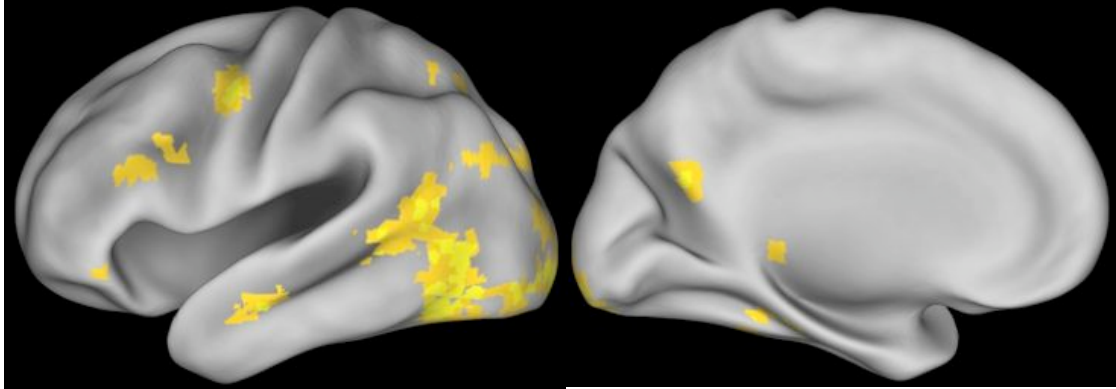
$p < .05$, uncorrected

Replication

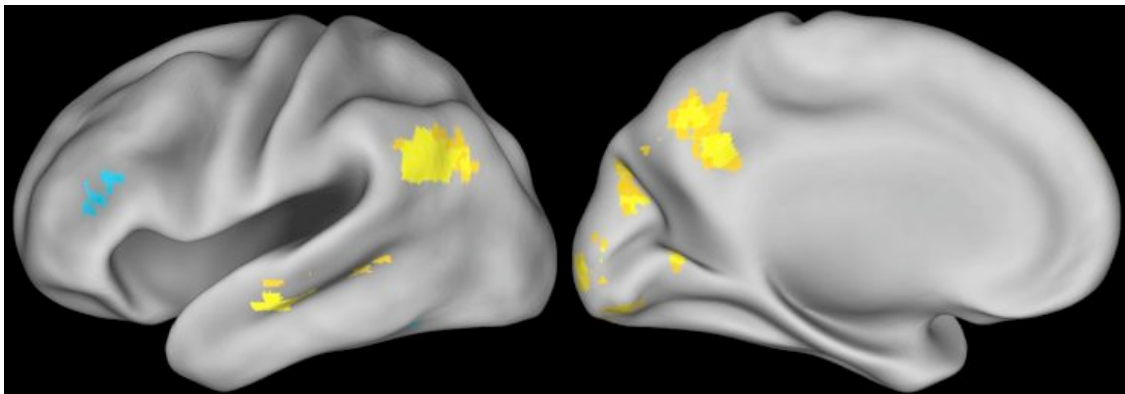


$p < .05$, uncorrected

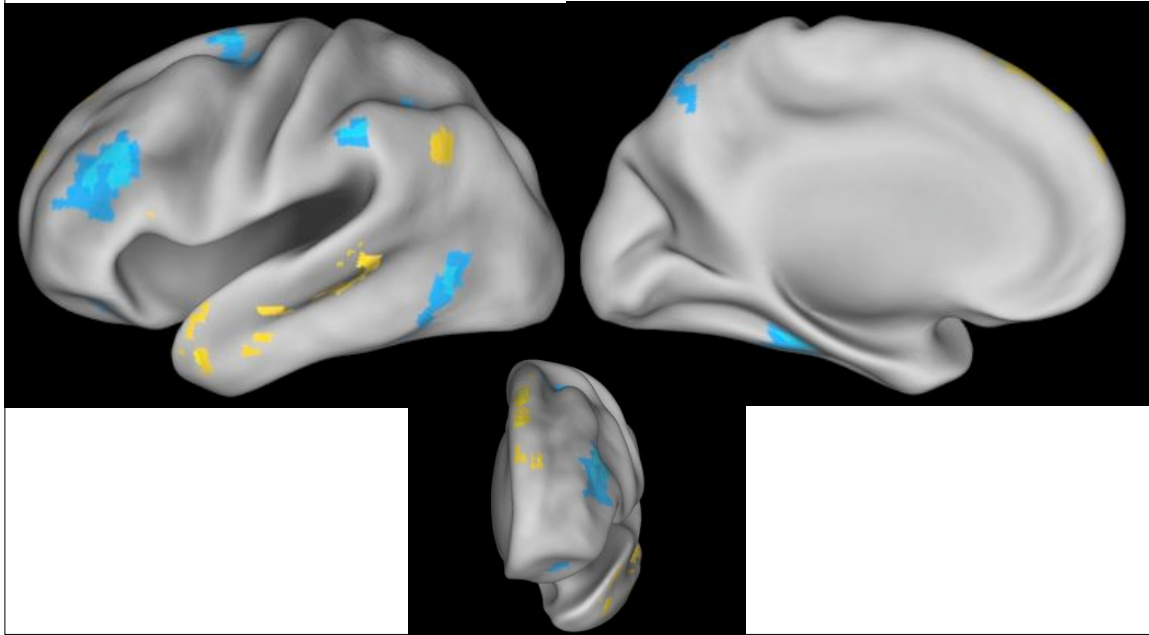
Reading vs. baseline



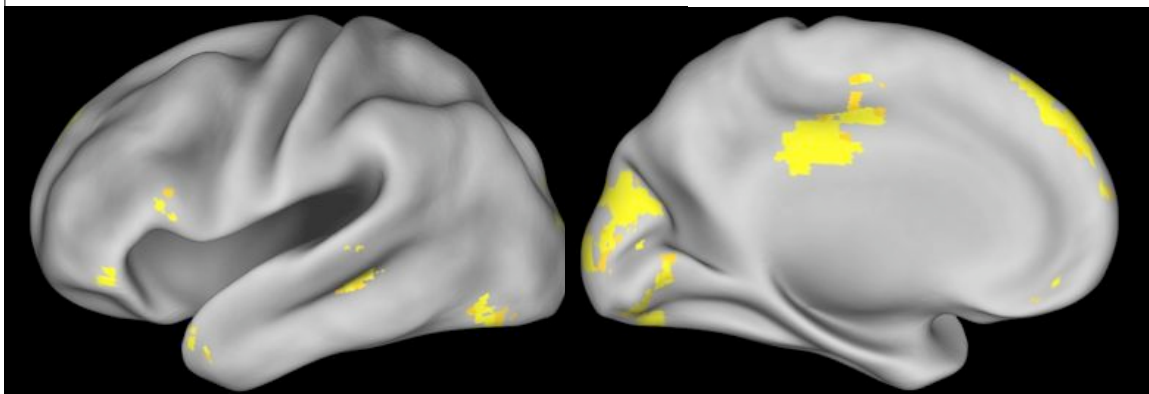
Length



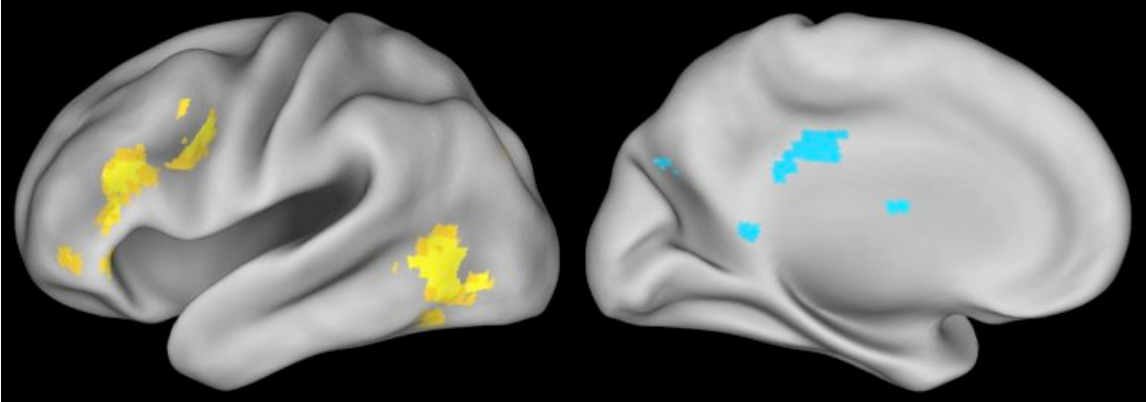
Frequency



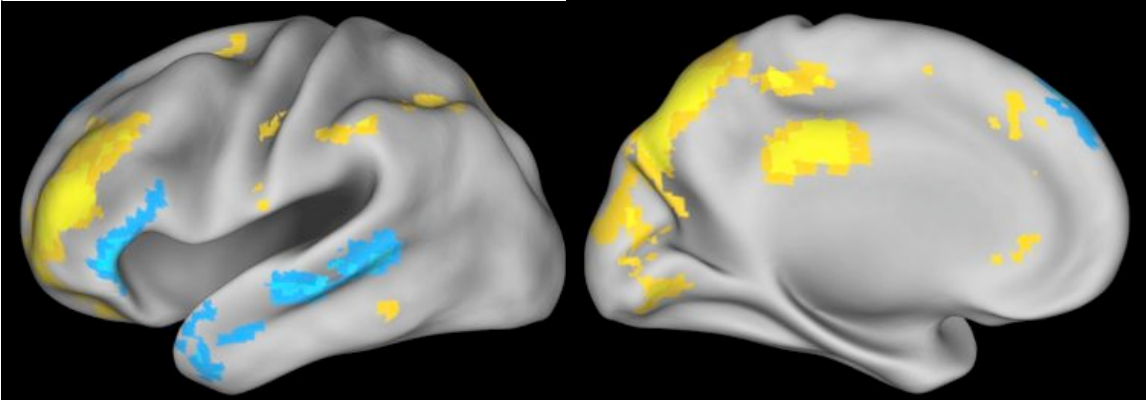
LDT



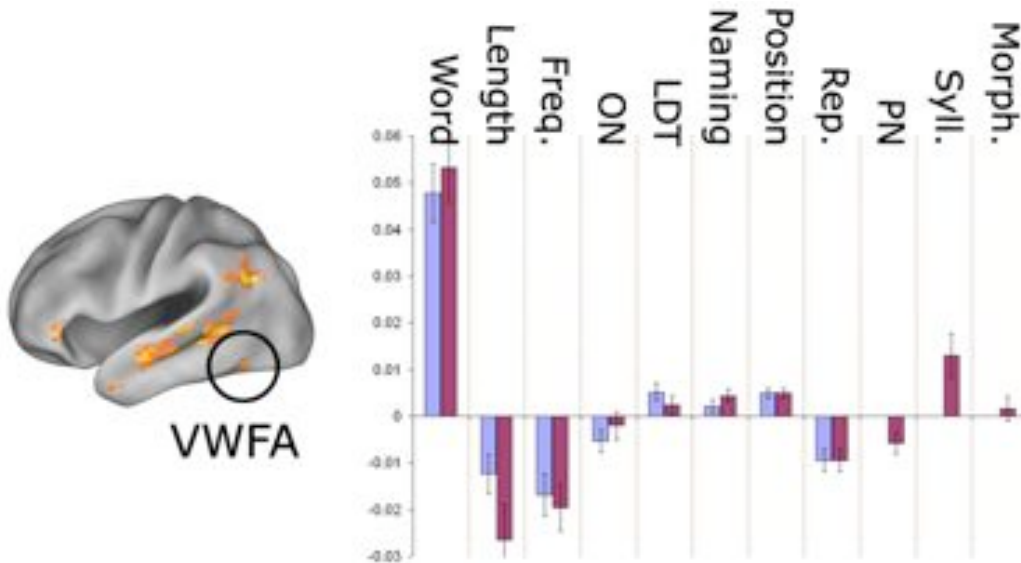
Position



Repetition



VWFA activation



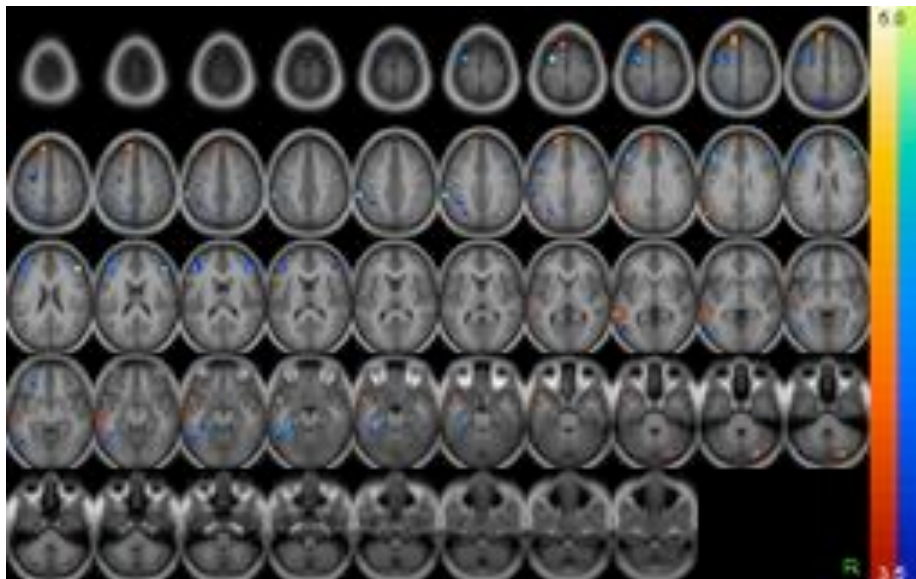
What about omissions?

- Works when exhaustive norms available
- What about smaller sets?
 - E.g., semantic norms may exist for only 4,000 words
- Can parametric model handle omissions?

50% omission model

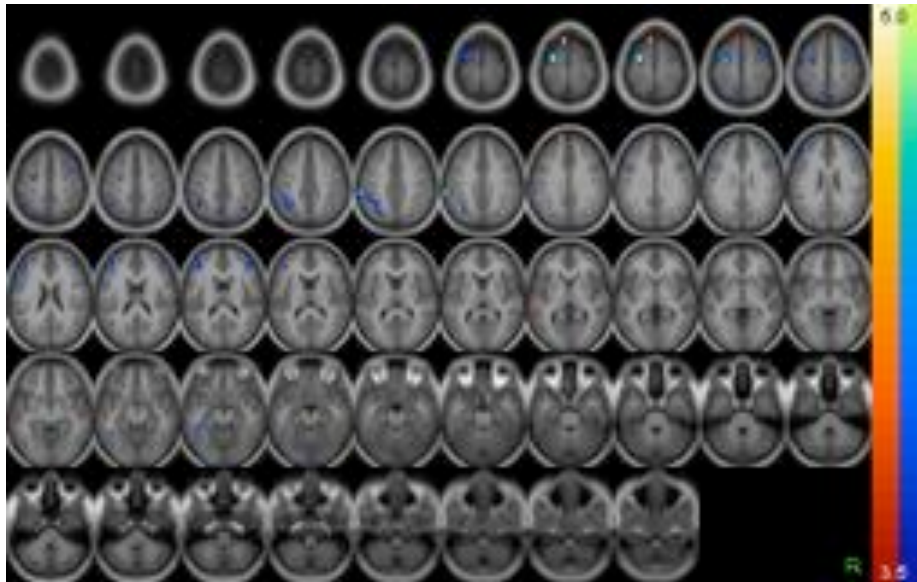
- Can test model's resilience by omitting words
- Each subject had 50% of words omitted
- Results weaker, but same patterns

Frequency: original



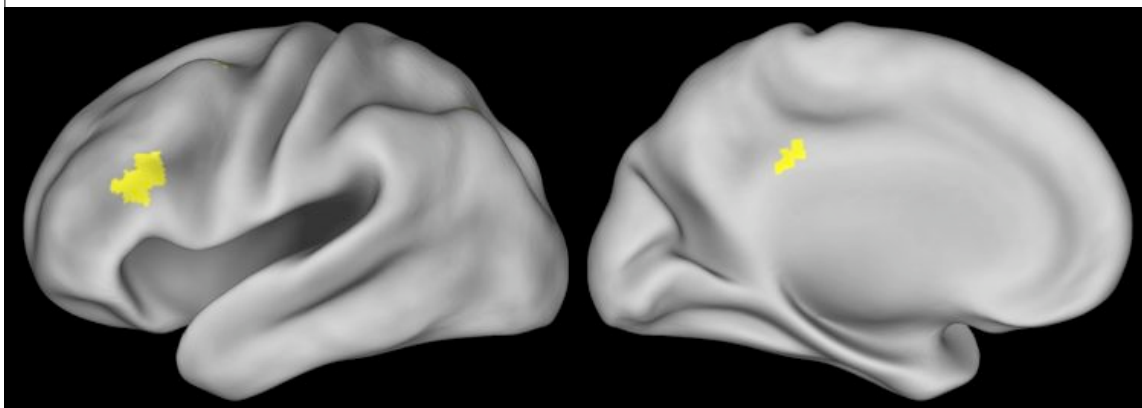
$p < .05$, corrected

Frequency: omit 50%



$p < .05$, corrected

Semantic connectivity



Conclusions

- A novel, flexible way to study reading relatively naturalistically at the single-word level
- Any variable that can be coded on a word-by-word basis can be modeled
- Multiple variables can be modeled together
- Has clear generalization to other domains