

Robust Effects of Working Memory Demand in Language-Selective Cortex

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BACKGROUND

Structure-building in working memory (WM) may drive incremental processing difficulty (Gibson 00, Lewis & Vasishth 05).

But...

- Apparent WM effects may be driven by *surprisal* ($-\log p(\text{word} | \text{context})$; Hale 01, Levy08)

- Naturalistic reading evidence is mixed (Demberg & Keller 08, van Schijndel & Schuler 13)

- Neural substrates of WM for language are unclear (language-specific or domain-general; Just & Carpenter 92, Caplan & Waters 99)?

MAIN QUESTIONS

Do surprisal-independent WM effects register in brain activity?

If so, are neural substrates specialized for language processing?

METHODS

fMRI responses to naturalistic story listening (data from Shain, Blank et al 20)

Participant-specific functional localization of language (LANG; domain-specific) and multiple demand (MD, domain-general) cortical networks (masks shown in **Panel A**)

Strong surprisal controls:

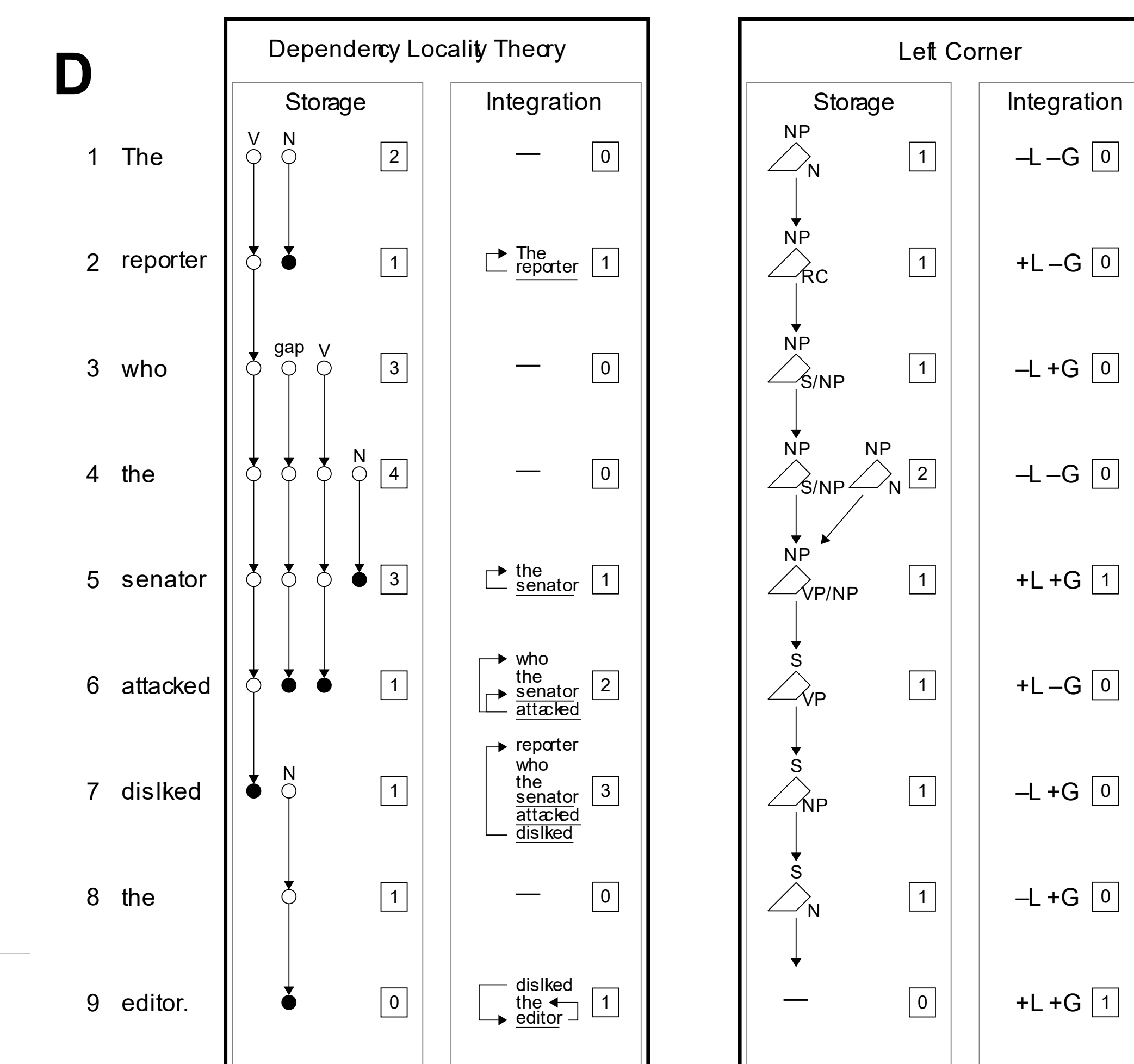
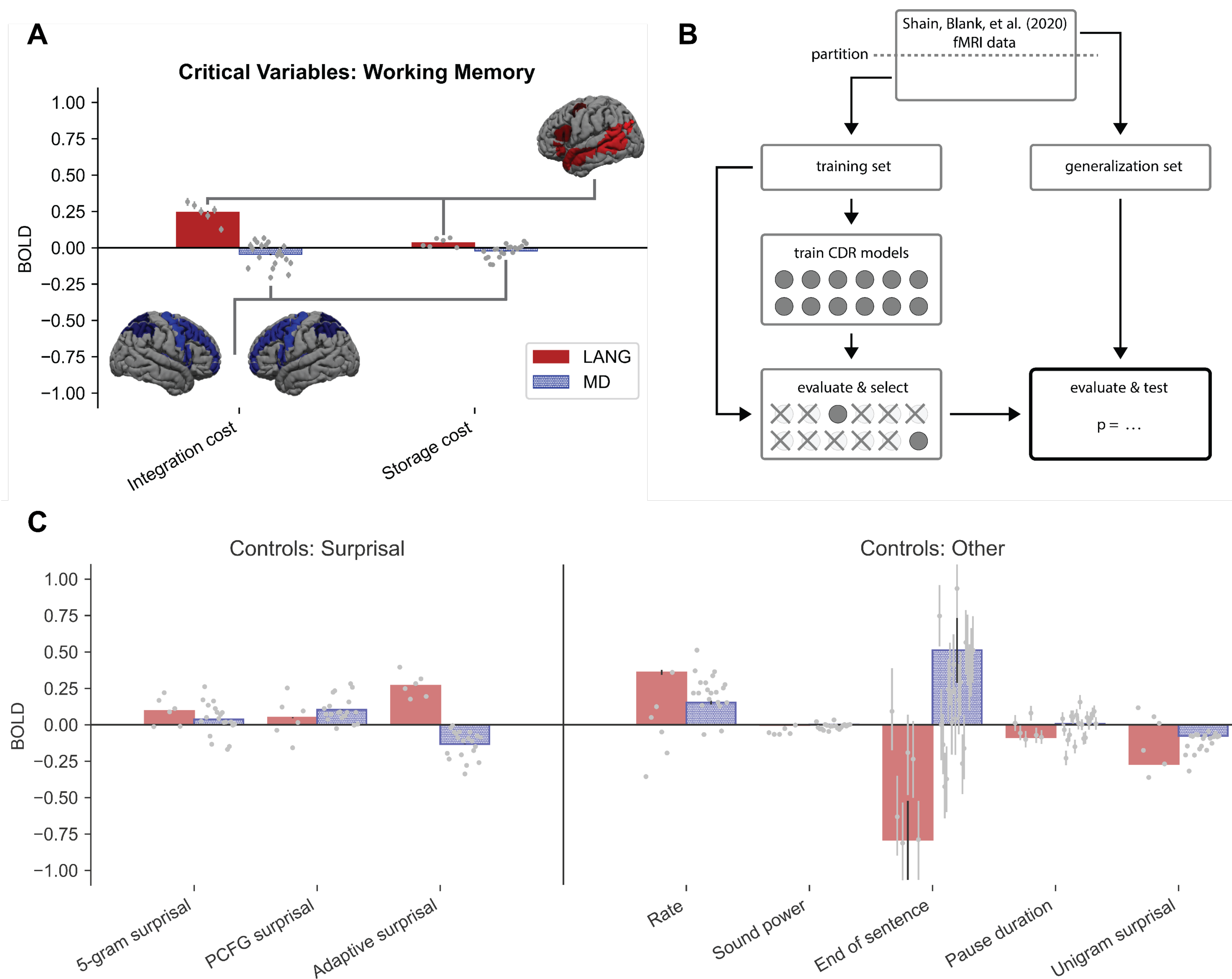
- 5-gram
- Probabilistic context-free grammar (PCFG)
- RNN (“adaptive”; van Schijndel & Linzen 17)
- GPT-2-XL

Broad exploration of WM predictors (22 total, see **Panel D**):

- Dependency Locality Theory (DLT; Gibson 00)
- ACT-R Parsing (Lewis & Vasishth 05)
- Left-Corner Parsing (Rasmussen & Schuler 18)

Hemodynamic response estimation with CDR (Shain & Schuler 19)

Out-of-sample statistical testing



RESULTS

Significant surprisal-independent effect of memory retrieval (DLT integration cost) in **LANG**

No evidence for any WM effects in **MD**

Significantly larger WM effect in **LANG** vs **MD**

CONCLUSION

Evidence of surprisal-independent WM demand during naturalistic story listening

Supports incremental syntactic analysis as a core component of language processing

Neural substrates that implement WM for language are **domain-specific**, with no WM effect in a domain-general brain network (**MD**) that has previously been implicated in WM tasks across domains