# Localizing Structure-building and Memory Retrieval in Naturalistic Language Comprehension

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## Question

Which regions of the brain are involved in structural composition and memory retrieval?

## Introduction

Natural language comprehension relies on at least two cognitive processes:

- Retrieval of memorized elements
- Structural composition

Retrieval is formalized here using "multiword expressions" or MWEs
Structure-building is formalized using a standard bottom-up parsing algorithm (see Hale, 2014)

## Data

*The Little Prince* consists of over 15,000 words.
1,274 MWEs were identified using a CRF tagger, trained on English web treebank and supplemented with external lexicons.
The number of steps that a bottom-up parsing algorithm would take to build the phrase is taken as an index of structure building, as shown in Fig. 1.

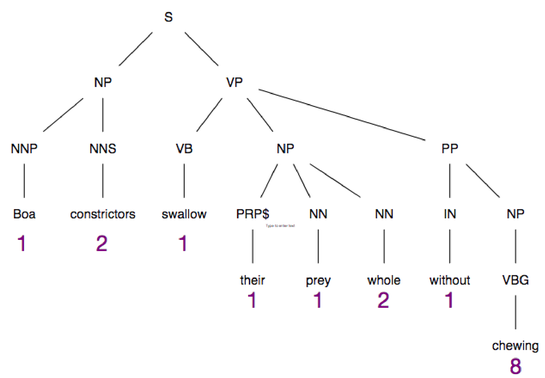


Figure 1: Illustrating bottom-up parser action count on a tree using the Stanford parse (Klein and Manning, 2003)

## Experiment

Participants (n=42) were college-aged, right-handed, native English speakers.
Listened to a spoken recitation of *The Little Prince* for 1 hour and 38 minutes across nine separate sections.
Comprehension was confirmed through multiple-choice questions at the end of each section.

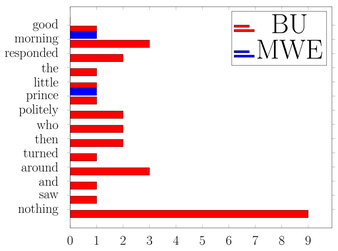


Figure 2: Example sentence: *"**Good morning**", responded the **little prince** politely, who then turned around and saw nothing.*

## Analysis

Preprocessing was carried out with AFNI version 16 and ME-ICA v3.2 (Kundu et al., 2011).

- ME-ICA denoises T2* signal using ICA into BOLD and noise components from physiology, motion, scanner artifacts.

MWE predictor and parser action count, convolved with HRF regressed, against observed BOLD signal during passive story listening.
Also entered four nuisance variables into the GLM analysis using SPM12: word offset, frequency, pitch, intensity.

## Result

The results most strongly implicate Anterior Temporal regions for structure-building and Precuneus Cortex for memory retrieval ($p < 0.05$ FWE), as seen in Fig. 3 and Fig. 4.

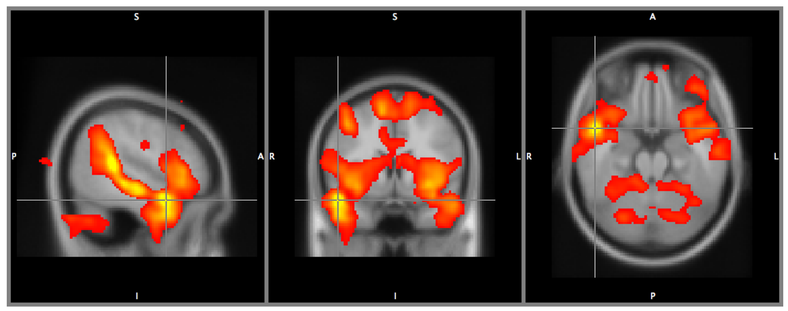


Figure 3: T-score map for the Bottom-up Parser Action count regressor, plotted through FSLView

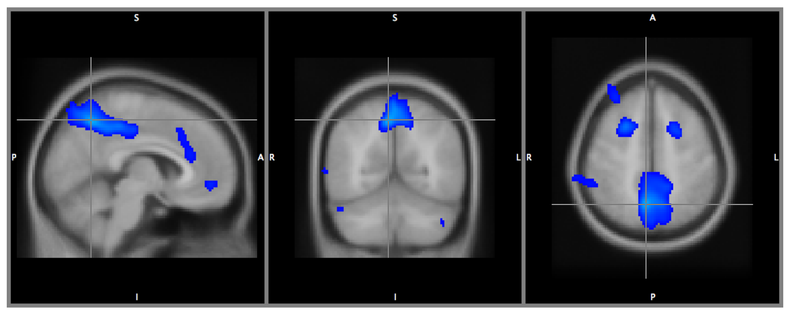


Figure 4: T-score map for the MWE status regressor, plotted through FSLView

## Conclusion

1. Memory retrieval for multi-word expressions evokes a pattern of activation that is spatially-distinct from the pattern evoked by compositional structure-building.
2. Phrase structure composition involves Anterior Temporal region which is consistent with earlier studies (Bemis and Pylkkänen, 2011; Dronkers et al., 2004; Ferstl et al., 2008).
3. While the Precuneus Cortex has not been traditionally viewed as part of the language network, it has been implicated in various memory tasks (Andreasen et al., 1995; Fletcher et al., 1995; Halsband et al., 2002; Mashal et al., 2014; Wallentin et al., 2008).

## Discussion

Do different types of MWEs evoke different patterns of activation?

## Acknowledgements

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## Selected References

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