ERP indices of encoding effects in *wh*-dependency processing

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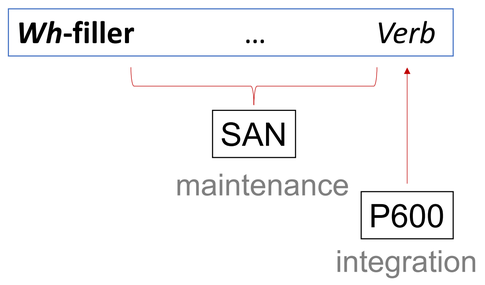
Introduction

- Processing filler-gap dependencies (FGD) involves:
  a. Encoding the filler in memory and maintaining (at least some features of) it; and
  b. Integrating the filler with the verb.
- Semantically and syntactically elaborated fillers lead to slower RTs after the filler and faster RTs at the verb (Hofemister, 2011; Hofmeister & Vasishth, 2014)
- *Hypothesis*: fillers encoding more semantic features are retrieved from memory more easily because they are:
  a. More active in memory.
  b. Less prone to similarity-based interference.



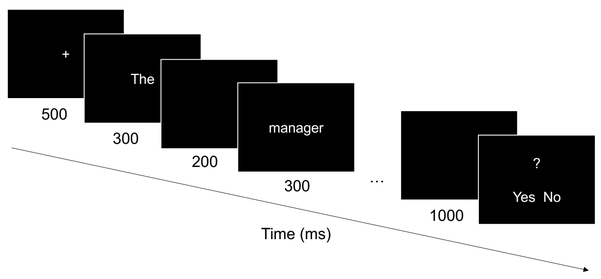
(King & Kutas, 1995; Kaan et al., 2000; Fiebach et al, 2002; Phillips et al., 2005)

The **aim** of this study is to use ERPs, a more precise online method with high temporal resolution, to…

1. Test the hypothesis that encoding complex fillers facilitates integration with the verb.
2. Investigate how encoding complex fillers affects the maintenance stage.
3. Tease apart the contribution of syntactic and semantic complexity of the filler.

Experiment

- 29 electrodes in a 10-20 configuration.
- 42 native speakers of English.
- *Wh*-filler complexity was manipulated:
  - 30 x Control sentences with no FGD (THAT)
  - 30 x Simple filler (WHO)
  - 30 x Syntactically more complex filler (WHICH-PERSON)
  - 30 x Syntactically and semantically more complex filler (**WHICH-N**)



Different epoch lengths:
- Integration: 1200 ms (n=37)
- Maintenance: 5000 ms (n=28)

The manager knew…

that the new owner of the coffee shop would fire the waiter after the scandal.
who the new owner of the coffee shop would fire after the scandal.
which person the new owner of the coffee shop would fire after the scandal.
which waiter the new owner of the coffee shop would fire after the scandal.

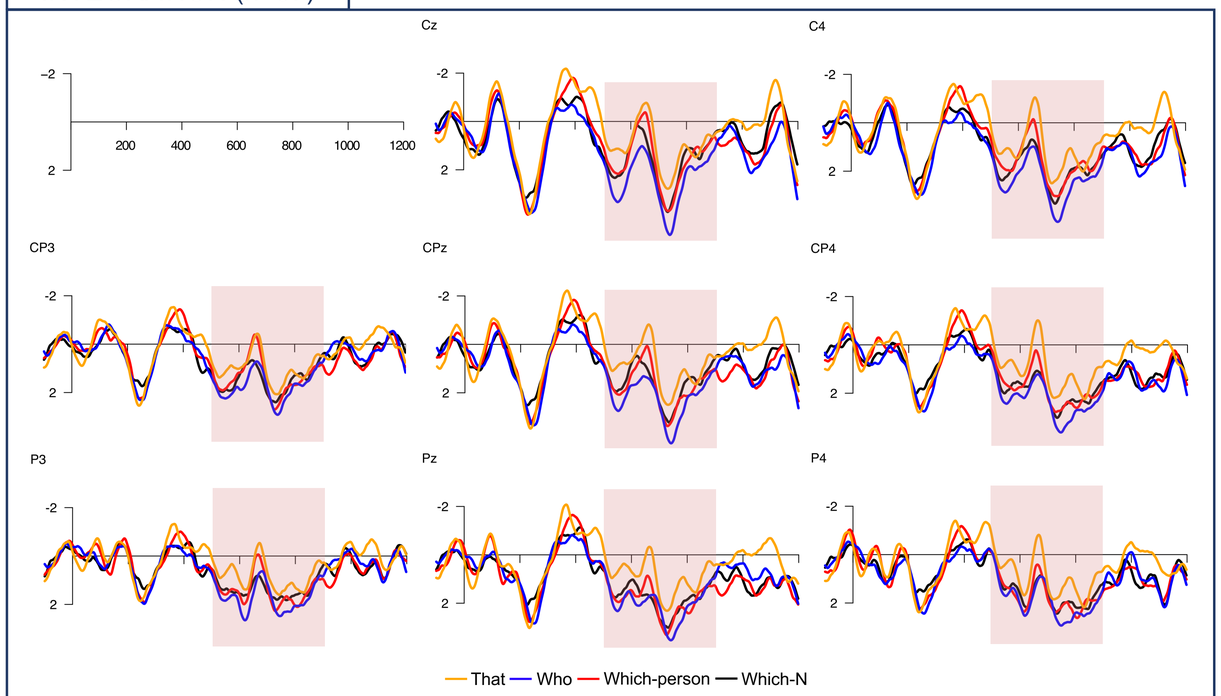
Complex fillers (WHICH-PERSON and WHICH-N) were **predicted** to be…

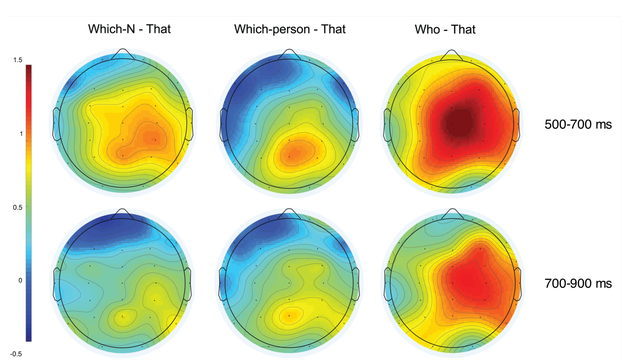
(a) Easier to retrieve from memory at the verb, eliciting a **smaller P600**.
(b) More costly to maintain in memory, eliciting a **larger SAN**.

Differences between WHICH-N and WHICH-PERSON were expected if semantic richness is determining for facilitating filler retrieval.

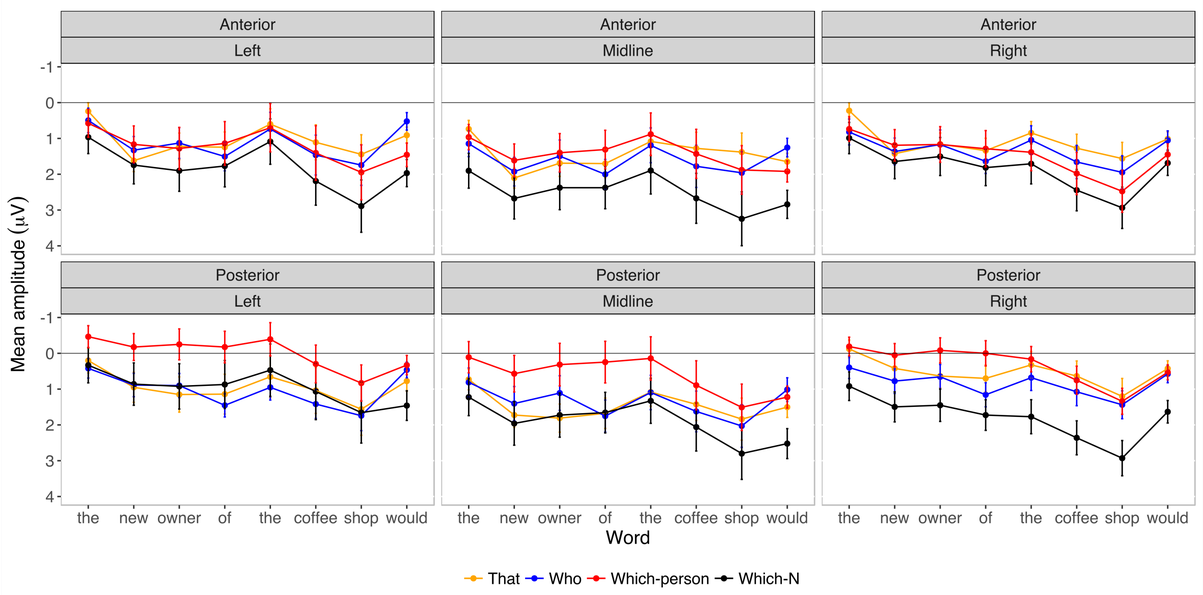
Results

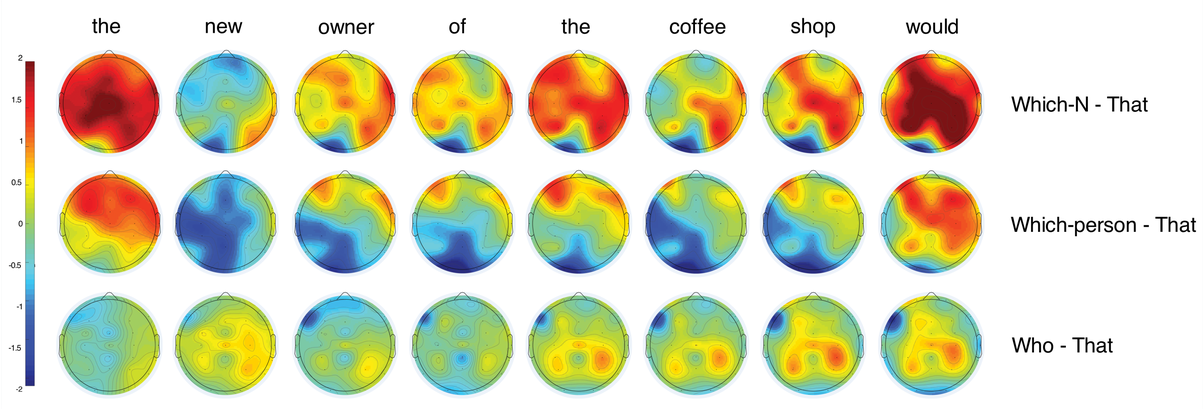
INTEGRATION (n=37)





MAINTENANCE (n=28)





Summary of findings

Integration

- All *wh*-conditions elicited a P600 with respect to the baseline.
- Complex fillers (WHICH-PERSON and WHICH-N) elicited a smaller P600 than the simple filler (WHO).

Maintenance

- *Wh*-conditions did not elicit a SAN with respect to the baseline.

Discussion

Size does matter

- The syntactic complexity of the encoded filler plays a central role when integrating it with the verb.
- Unlike previous behavioral studies, we failed to find a facilitation effect for semantically more distinct fillers.
- Complex fillers are made up of two words, i.e. more time is available to encode the filler in memory.

Why did we fail to find a SAN?

- There is variability across the literature in whether SANs are observed across the dependency.
- Are participants using different parsing strategies: conservative vs. active gap-filling? The task and materials may favor one or the other.
- We observe large individual differences: working memory capacity?

References. **Fiebach, C. J., Schlesewsky, M., & Friederici, A. D. (2002)**. Separating syntactic memory costs and syntactic integration costs during parsing: The processing of German WH-questions. *Journal of Memory and Language*, *47*(2), 250-272. | **Hofmeister, P. (2011)**. Representational complexity and memory retrieval in language comprehension. *Language and Cognitive Processes*, *26*(3), 376-405. | **Hofmeister, P., & Vasishth, S. (2014)**. Distinctiveness and encoding effects in online sentence comprehension. *Frontiers in Psychology*, 5, 1237.| **Kaan, E., Harris, A., Gibson, E., & Holcomb, P. (2000)**. The P600 as an index of syntactic integration difficulty. *Language and Cognitive Processes, 15*(2), 159-201. | **King, J. W., & Kutas, M. (1995)**. Who did what and when? Using word-and clause-level ERPs to monitor working memory usage in reading. *Journal of Cognitive Neuroscience, 7*(3), 376-395. | **Phillips, C., Kazanina, N., & Abada, S. H. (2005)**. ERP effects of the processing of syntactic long-distance dependencies. *Cognitive Brain Research, 22*(3), 407-428.

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