

An event-related potentials measure of the effect of low verbal memory span on gap-filling

Arild Hestvik, Evan Bradley, Catherine Bradley, Megan Kauffman, Tyler Prescott, and Lauren Sparacino

Experimental Psycholinguistics Laboratory, University of Delaware

hestvik-lab.cogsci.udel.edu | arild@udel.edu



Background and questions

- **Question: Does having low working memory resources generally cause “delayed gap-filling”?**
 - Roberts *et al.* (2007): cross-modal picture priming experiment looking for antecedent reactivation at gap in long-distance dependency processing
 - Their finding: Reactivation at gap only observed in high WM subjects, not low WM subjects.
 - Hypothesized that low-span listeners require more time to integrate the filler at the gap and therefore reactivate the filler later during the sentence → “delayed gap-filling”
 - Children with Specific Language Impairment (SLI) typically fail to exhibit antecedent reactivation and typically have low verbal working memory--could also be “delayed gap-filling.”

Current study

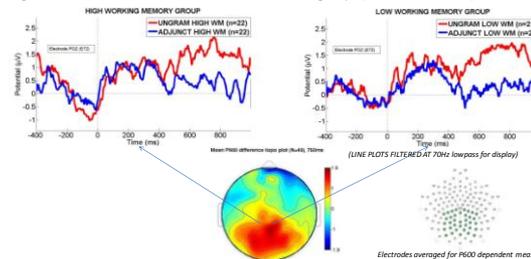
- **Aim: To look for latency differences in gap-filling between low and high WM subjects using continuous measure → ERPs**
- Paradigm: ERP response to ungrammatically filled gaps (Hestvik *et al.*, 2007) (*see Method*)
 - The latency of the response to the filled gap indicates time point when gap-filling attempt occurs
 - If gap-filling is delayed in low WM compared to high WM group, then latency differences in the Early Left Anterior Negativity (ELAN), and the P600 should be observed.

Method

- 43 college-aged subjects were divided into low (N=21) and high (N=22) verbal memory groups based on the Listening Span Test.
- 128-channel EEG was recorded while subjects heard 256 sentences; including 64 ungrammatical tokens and 64 controls, and answered a comprehension question after each trial:
Ungram : *The zebra that the hippo kissed the camel on the nose...
Adjunct: The weekend that the hippo kissed the camel on the nose...
Question: Who did the hippo kiss?
- ERP time-locked to onset of the...

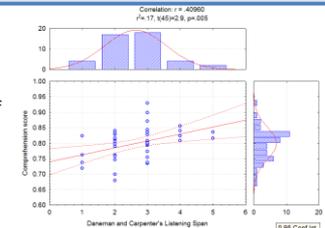
ERP results

- No ELAN (see discussion)
- P600 observed
 - Repeated measures ANOVA with TIME (9 100ms time bins) x CONDITION (ungramm vs. adjunct) x GROUP (low WM vs. high WM); dependent measure: unweighted average voltage of P600-region electrodes
 - Significant effect of CONDITION ($F_{1,41}=7.7, p<.05$) and TIME x CONDITION ($F_{8,328}=11.1, p<.0001$ (G-G adjusted); no interactions with WM group
 - Significant P600 starts between 500-600ms in both groups (Bonferroni t-tests)



Behavioral results

- Significant correlation between listening span and comprehension of stimuli sentences ($r=.41, p=.005$).



Findings and discussion

- Correlation between WM scores and comprehension question scores
 → **behavioral data shows that low WM affects comprehension of long-distance dependencies**
- No ELAN observed, but: ratio of ungrammatical to grammatical in whole experiment (25%) probably too high for ELAN
- P600 observed, but: no interaction between WM group and onset latency of P600 response
 → **ERP shows that both low WM and high WM subjects try to fill gap at the same time**
 - Low WM does not lead to delayed gap-filling
 - Raises doubts that SLI children's lack of immediate gap-filling is due to low WM span alone.

Roberts, L., Marinis, T., Feller, C., & Clahsen, H. (2007). Antecedent Priming at Trace Positions in Children's Sentence Processing. *Journal of Psycholinguistic Research*, 36(2), 175-188.

Van der Lely, A., & Bates, J. (2003). Wh-movements in children with grammatical SLI: A test of the RDR hypothesis. *Language*, 79(1), 153-181.

Hestvik, A., Kaufeldt, N., Schwartz, R. G., & Shuler, V. L. (2007). Brain responses to filled gaps. *Brain and Language*, 100(3), 303-316.

Friederici, A. D. (2002). Towards a neural basis of auditory sentence processing. *Trends in Cognitive Sciences*, 6(2), 78-84.

Daneman, M., & Carpenter, P. (1980). Individual differences in working memory and reading. *Journal of Verbal Learning and Verbal*