Contributions of hippocampal-dependent declarative memory to on-line processing of global syntactic ambiguity

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INTRODUCTION

What is the contribution of the hippocampal dependent declarative memory system to on-line processing of verb-argument structure?

WELL ESTABLISHED are the contributions of hippocampus to the formation of new enduring (long-term) memories (Ranganath, 2010; Squire, 1992), and its contributions to relational binding and representational flexibility (Eichenbaum & Cohen, 2001).

EMERGING RESEARCH shows that hippocampus additionally contributes to on-line processing, even across minimal delays (Hannula & Ranganath, 2008; Öztekin, McElree, Staresina, & Davachi, 2008; Hannula, Tranel, & Cohen, 2006).

THE PRESENT RESEARCH examines contributions of hippocampus to on-line processing of verb argument structure. We focus on syntactic ambiguities such as:

Feel the frog with the cup.

Whether listeners attach the PP (with the flower) to the verb (Feel) or the noun (pig) varies systematically by verb (Snedeker & Trueswell, 2004). Here we ask whether use of verb-specific statistical cues requires the hippocampal-dependent declarative memory system.

METHOD

Participants: 4 participants with bilateral damage to hippocampus and MTL, 4 matched healthy comparison participants, 13 undergrads. Patients were free of aphasia but exhibited profound deficits in long-term memory acquisition (amnesia).

Design: Critical trials contained 2 animals, e.g. a frog holding a small cup and a whale with a small necklace, and two large potential instruments: a large necklace and a large cup. Participants completed 24 critical trials with globally ambiguous instructions plus 24 fillers. Critical sentences contained biased verbs from Snedeker and Trueswell (2004), e.g. Feel the frog with the cup.

- 8 modifier bias verbs (e.g., choose)
- 8 equi-bias verbs (e.g., feel)
- 8 instrument bias verbs (e.g., hit)

ACTION RESULTS

All groups execute more instrument actions for instrument-biased verbs (zs>.30, ps<.0001). Patients not significantly different from comparisons (zs<1.5, ps>.15)

ONLINE RESULTS: Eye movements

(1) During Choose/Feel/Hit the frog with the... marginal interaction between bias and group for fixations to the incorrect animal (t=1.91). Healthy comparison participants look slightly more at animals following modifier-bias verbs. No group differences for target animal (ts<1.0).

(2) During flower, individuals with amnesia look more to the incorrect animal (t = -2.02), particularly for instrument-biased verbs (t = 2.39); fixations to target animal not significantly different between participant groups (ts<1.0).

(3) During flower, action–fixation link differs by participant group for both target animal (t = -4.79) and target instrument fixations (t = 5.74). Healthy comparisons exhibit different fixation patterns consistent with final interpretation (ts>7.5). Individuals with amnesia do not (ts<1.0).

CONCLUSIONS

- Severe declarative memory impairment resulted in subtle changes to the processing of verb-argument structure in on-line processing. While participants with amnesia showed NO DEFICIT in use of verb bias to guide final interpretation, the PROCESS was different.
- Intact off-line processing consistent with classic characterization of amnesia as sparing general language faculties (Milner et al., 1968). On-line processing impairment may reflect:
  - Difficulty integrating verb-bias information with unfolding sentence, leading to late looks to the wrong animal.
  - Difficulty restricting attention to the action-relevant objects during interpretation.

These findings are consistent with claims that hippocampus plays a key role in on-line processing of language (Duff & Brown-Schmidt, 2012), due to its contributions to relational binding and representational flexibility (Eichenbaum & Cohen, 2001).

References