Hippocampal contributions to discourse processing: Findings from Amnesia

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INTRODUCTION

What is the contribution of the hippocampal dependent declarative memory system to on-line processing of reference in discourse?

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. Evidence from hippocampal imaging in healthy participants, and behavioral evidence from patients with bilateral hippocampal damage show:

- Activation of hippocampus in healthy participants for relational learning over short delays (Hannula & Ranganath, 2008), and during retrieval of items from working memory (Öztekin, McElree, Staresina, & Davachi, 2008).
- Degradation of relational representations in patients with bilateral hippocampal lesions over short delays (Hannula, Tranel, & Cohen, 2006) and in the processing of simple stimuli over short delays (Warren, et al. 2010).

THE PRESENT RESEARCH examines contributions of hippocampus to discourse:

- Our initial findings (Kurczek, Brown-Schmidt, & Duff, 2013) revealed profound deficits in ability of hippocampal amnesic participants to recruit discourse information from one sentence to resolve a pronoun in the subsequent sentence:



Mickey is playing the violin for Donald as the sun is shining overhead. He is wearing a yellow bracelet…

- Modeled after previous research with healthy participants (Arnold, et al., 2000), we found that unlike healthy matched comparison participants, patients with hippocampal amnesia did not show a significant preference to interpret the pronoun as referring to the 1st-mentioned referent.
- **Here we ask whether the discourse representation is ENTIRELY LOST in amnesia, or whether it is present, but WEAKENED.**

METHOD

Participants: 3 participants with bilateral damage to hippocampus and MTL, and 7 matched healthy comparison participants. Patients were free of aphasia but exhibited profound deficits in acquisition of new long-term memories (amnesia).

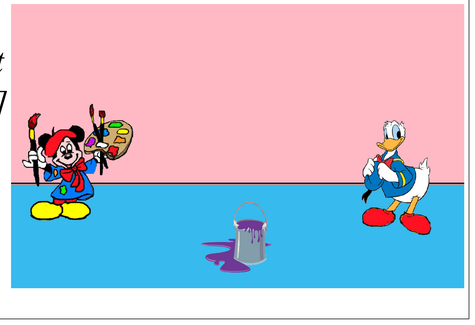
Stimuli: Participants viewed a scene and listened to an associated dialogue modeled after Arnold, et al. (2000) and Song & Fisher (2005). Each dialogue introduced two same-gender referents, and referred back to one with a pronoun. The key manipulations were (a) whether the 1st-mentioned character was made more prominent through re-mention, as in [2]; (b) whether the pronoun referred to the 1st or 2nd-mentioned character. The ambiguity was resolved at, e.g., *yellow shoes.* Interpretation of the critical (underlined) pronoun in [4] is measured using eye gaze to the referents in the associated scene.

[1] *Mickey is painting a portrait of Donald,*

[2] [*Mickey is trying really hard to get the portrait just right, because he wants to be a famous artist someday.]*

[3] *and some paint is spilling on the floor.*

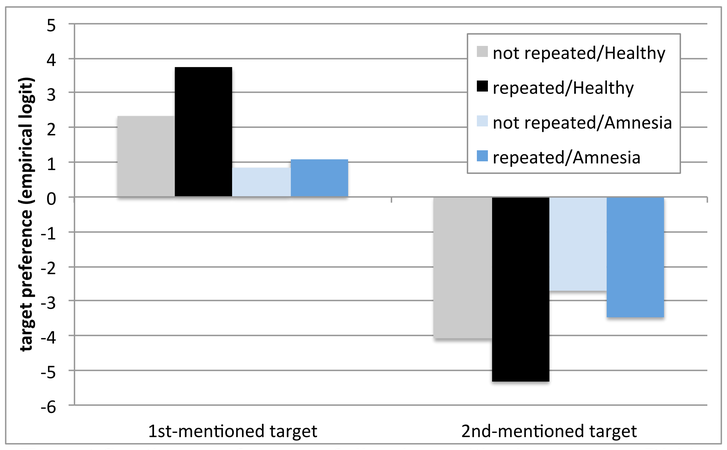
[4] *And what is **he** wearing?*
Look, he's wearing yellow/ red shoes.



RESULTS

Analysis focuses on interpretation of critical pronoun (…***he*** *wearing? Look*…). Eye-gaze following the critical pronoun revealed significant effects of:

- **Mention**: larger preference to fixate the target when pronoun refers to 1st mentioned character (t = -5.27, p<.0001).
- **Mention * Repetition interaction**: Mention effect amplified when 1st mentioned character repeatedly mentioned, showing build-up of discourse representation (t = -5.32, p<.0001).
- **Mention * Repetition * Group interaction**: Healthy comparison participants used the information about discourse structure differently than participants with amnesia (t = -2.22, p<.05).
  - Healthy comparisons showed mention (t = -26.45, p<.0001) and mention*repetition interaction effects (t = -5.14, p<.0001). These findings are consistent with Song & Fisher (2005), and show that repeated mention increases likelihood of co-reference with the pronoun.
  - Participants with amnesia DID use mention (t = -9.73, p<.0001), suggesting some representation of relative discourse salience of the two characters was formed. However, they did not show a mention*repetition interaction (t = -1.74, p=.08), showing less sensitivity to the details of this discourse history.



Target fixation preference following critical pronoun. DV is log odds of a target look in critical region, defined on trial-by-trial basis. Positive values indicate target preference.

CONCLUSIONS

- Severe declarative memory impairment resulted in coarse-grained representations of discourse salience. Participants with amnesia SUCCESSFULLY interpreted the pronoun as referring to the more salient, first-mentioned character. However, they FAILED to make use of repeated-mention information in the discourse.

- These findings build on previous evidence of impaired discourse representations in amnesia (Kurczek, et al. 2013). That these impairments manifest over minimal delays provides key support for the hypothesis that hippocampus contributes to on-line language processing in the moment.

- The contributions may be particularly great when flexible integration of multiple information sources is necessary, even over short time periods.

References

Arnold, et al. (2000). *Cognition 76,* B13-B26. **Kurczek, Brown-Schmidt, & Duff** (2013). *JEP:General 142,* 1346-1354. **Song & Fisher** (2005). *JML 52,* 29-57.

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