Hippocampal damage disrupts referential processing

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INTRODUCTION

- Establishing and maintaining reference is a central component of language processing, as much of what we talk about involves referring to entities
- Referential processing requires maintaining a representation of the unfolding discourse history and potential referents, and integration of information about referential form with rich representations of referential context (Tanenhaus et al., 1995; Brennan & Clark, 1996)
- We have propose that the rapid relational binding and representational flexibility of the hippocampal declarative memory system affords the informational binding and integration necessary for referential processing (Duff & Brown-Schmidt, 2012)
- Partial support for this claim comes from Kurczek and Duff (2012); amnesic patients produced fewer cohesive ties, the adequacy of their ties were more often judged to be incomplete, and ratings of their local coherence were consistently lower than comparison participants, and from Duff et al., 2011; use of definite references disrupted in amnesia
- Combing eyetracking and neuropsychological methods, Current study extends this line of work to examine the role of the hippocampus in on-line referential processing
    - Specifically, does the contribution of the hippocampus extend to brief discourse histories and to items in discourse focus?

METHODS

Participants

4 Individuals with hippocampal amnesia: Inclusion criteria: 1) min 3 months post onset, 2) bilateral, focal, non-progressive hippocampus, adult onset lesion, 3) severe and selective memory deficit

4 Brain Damaged Comparison (BDC) participants: Brain damage outside hippocampus and MTL and no declarative memory deficits

16 Healthy Comparison Participants: matched to patients on age, sex, education, and handedness

Patient Demographic, Anatomical, and Neuropsychological Characteristics

Patient	Sex	Ed	Age	Etiology	HC Volume	WAIS-III FSIQ	WMS-III GMI	Faces	Token	Boston Naming	WCT Cat
Amnesic											
1846	F	14	45	Anoxia	-4.23	84	57	45	41	43	6
1951	M	16	56	HSE	-8.10	106	57	44	44	49	6
2308	M	16	52	HSE	N/A	98	45	50	44	52	N/A
2363	M	16	52	Anoxia	-2.64	98	73	47	44	58	6
Average (StDev)	3 M 1 F	16.0 ± 1.6	51.3 ± 4.6		-5.0 ± 2.8	96.5 ± 9.2	**58.0*** ± 11.5	46.5 ± 2.7	43.4 ± 1.5	50.5 ± 6.2	6.0 ± 0
BDC											
318	M	14	70	Meningioma resection	N/A	143	109	43	44	60	6
2025	F	16	62	ACoA aneurysm	N/A	115	114	43	44	59	6
2352	F	14	61	SaH: ACoA aneurysm	N/A	106	109	43	44	54	6
2391	F	13	64	Meningioma resection	N/A	109	132	49	43	57	6
Average (StDev)	1 M 3 F	14.3 ± 1.3	64.3 ± 4.0			118.3 ± 16.9	116.0 ± 10.9	44.5 ± 3.0	43.8 ± 0.5	57.5 ± 2.7	6.0 ± 0.0

Note: Ed = Years of education; HC Volume = reduction in size of hippocampal tissue, Allen et al., 2006; FSIQ = WAIS-III Full Scale IQ, WMS-3 GMI = Weschler Memory Score- III General Memory Index; Faces = Benton Facial Recognition Test; Token = Token Test; BN = Boston Naming Test; WCT = Wisconsin Card Sorting Task; Cat = Number of categories achieved out of six; * = $p < 0.05$

Figure 1. MR scans of hippocampal patients. Images coronal slices through the midportion of the hippocampus from T1-weighed scans. Volume changes noted in hippocampus bilaterally.

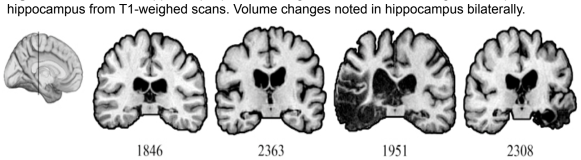
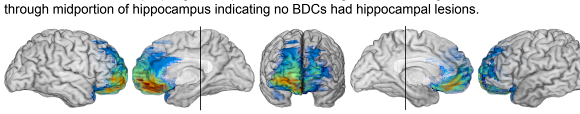
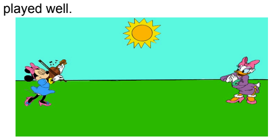
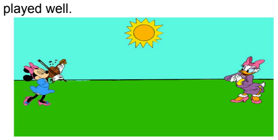
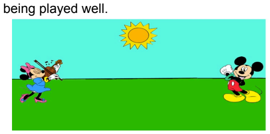
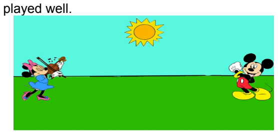


Figure 2. Lesion overlap of brain damaged comparison (BDC) participants. The colorbar indicate number of lesion overlaps (range = 0-4).Vertical line through the left and right mesial views is through midportion of hippocampus indicating no BDCs had hippocampal lesions.



METHODS CONTINUED

Procedure

		Order of mention	
		First	Second
Gender	Same	*S1:* Minnie is playing the violin for Daisy as the sun is shining overhead. *She* is wearing a *yellow* bracelet and it looks like the song is being played well. 	*S2:* Minnie is playing the violin for Daisy as the sun is shining overhead. *She* is wearing a *yellow* bracelet and it looks like the song is being played well. 
	Different	*D1:* Minnie is playing the violin for Mickey as the sun is shining overhead. *She* is wearing a *yellow* bracelet and it looks like the song is being played well. 	*D2:* Minnie is playing the violin for Mickey as the sun is shining overhead. *He* is wearing a *yellow* bracelet and it looks like the song is being played well. 

RESULTS

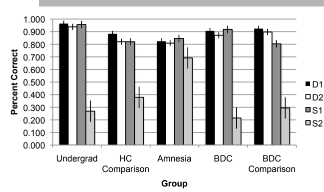


Figure 3. Judgment task accuracy

Participants were accurate in three out of four conditions.
- Undergrads show a gender*OOM effect ($p = 0.03$)
- Comparison of amnesia and HC comparisons reveals no significant effects or interactions
- Comparison of BDCs and their comparisons reveals no significant effects or interactions

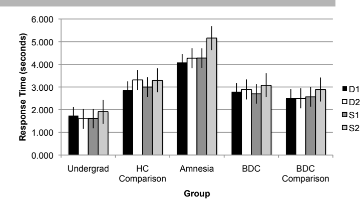
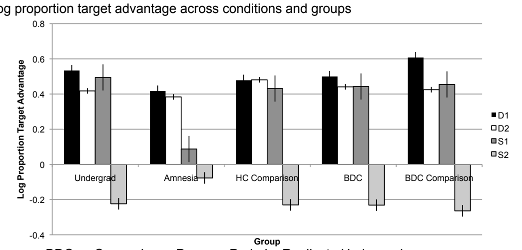


Figure 4. Judgment task response latency

Undergrads show a gender*OOM effect ($t = 3.06$)
- Comparison of amnesia and HC comparisons reveals that amnesia are slower across conditions ($t = 2.51$)
- Comparison of BDCs and their comparisons reveals no significant effects or interactions

Figure 5. Log proportion target advantage across conditions and groups

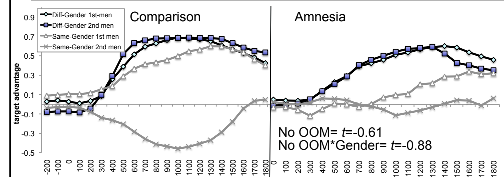
Analysis
- Mixed models
- Maximal random effects
- 3 time regions
- DV: empirical logit of T/C calc. trial-by-trial basis



Replicates Arnold et al., 2000
Undergrads – Pronoun Period
- Larger Target preference for different gendered (t=6.16) and first mentioned character (t=-4.08) with gender*OOM (t=4.43) interaction indicating preference for first mentioned character

BDC vs Comparison– Pronoun Period – Replicate Undergrads
- No group interaction with any variables – indicates normal performance for BDCs
- Larger Target preference for different gendered (t=-6.67) and first mentioned character (t=-3.20) with gender*OOM (t=4.04) interaction indicating preference for first mentioned character

RESULTS CONTINUED



Gender*OOM*Group = t=2.35

Follow-up Analyses

Undergraduates
No effect of gender (t=-1.73), OOM (t=0.47) or gender*OOM (t=0.56) interaction indicating preference for first mentioned character across condition

Amnesia vs Comparison
Significant effect of group (t=4.14) indicating that across conditions comparisons look at target more than amnesic participants

Figure 7. Tracking first character

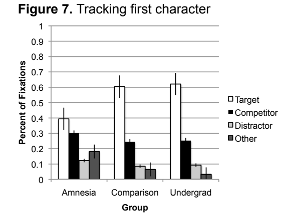
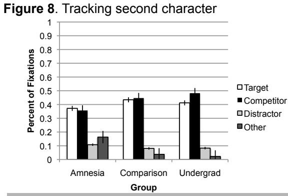


Figure 8. Tracking second character



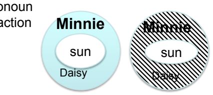
Undergraduates
No effect of gender (t=-1.73), OOM (t=0.47) or gender*OOM (t=0.56) interaction indicating preference for second mentioned character across condition

Amnesia vs Comparison
No significant effects indicating that across conditions comparisons and amnesic participants look at the target

CONCLUSION AND DISCUSSION

- Comparison participants and undergrads use gender and OOM to interpret pronoun
    - Amnesia patients show gender effect following pronoun
    - Amnesia patients do not show gender*OOM interaction

Minnie is playing the violin for Daisy as the sun is shining overhead. *She*



- Consistent with unitary views of working & long-term memory in which access to all but the single item in the focus of attention depends on hippocampal-mediated memory systems (Oztekin et al., 2010; also McElree,2006; Lewis & Vasishth, 2005)
- Consistent with direct-access views of referential processing (Foraker & McElree, 2007)
    - 1st-mentioned character more distinct (available) in hippocampal-mediated memory
    - "She" co-refers with [Minnie] because we can look up the relevant information in memory, not because she's in the focus of attention
- Findings point to a role for hippocampus in language use. The rapid relational binding and representational flexibility afforded by the hippocampal declarative memory system is important for informational binding and integration necessary referential processing (Duff & Brown-Schmidt, 2012)
    - Relevant Functions:
        - Use of all but the most recent discourse information
        - Integrating Information across discourse
    - Deficits in amnesia
        - Integration across discourse segments necessary
        - Temporal order is involved
        - Competition exists between activated candidates

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