Hippocampal amnesia disrupts episodic memory and narrative construction

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INTRODUCTION

• Hallmark processing features of the hippocampus include its relational binding and representational flexibility (Eichenbaum & Cohen, 2001). Recent findings demonstrate that these same processes are engaged on-line in service of supporting behavior in the moment (Hannula & Ranganath, 2008 Barense et al., 2007; Warren et al., 2011).

• This functionality of the hippocampus has been linked to cognitive abilities beyond its traditional role in long-term declarative (relational) memory including language. Duff and Brown-Schmidt (2012) have proposed that the functionality of the hippocampus positions it as a key contributor to language use and processing. Indeed, patients with hippocampal damage have a variety of deficits in the flexible and creative use of language and in the on-line processing of language (Duff & Brown-Schmidt, 2012).

•An on-going debate is the whether deficits in the production of narrative elements, across either personal stories or picture descriptions/narratives, represent solely an impairment in memory (Race et al., 2011; 2013) or a more basic impairment in cognitive functioning outside of memory (Gasser et al., 2011; Zeman et al., 2012).

• Here, we examine narrative in patients with hippocampal amnesia and analyze their narrative productions using methods from both the memory and language literatures. Based on our proposal about the role of hippocampus in language use, including narratives, we predict that hippocampal damage and relational memory impairment will disrupt narrative production across a variety of memory and language measures.

METHODS

Participants

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

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

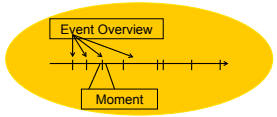
Patient Demographic and Neuropsychological Characteristics

Patient	Sex	Ed	Age	Etiology	HC Volume	FSIQ	WMS-III GMI	Token	Boston Naming	CF Copy	WCST PE	WCST Cat
1606	M	12	61	Anoxia	-3.99	91	66	44	32	34	27	6
1846	F	14	45	Anoxia	-4.23	84	57	41	43	28	6	6
1951	M	16	56	HSE	-8.10	106	57	44	49	32	16	6
2308	M	16	52	HSE	N/A	98	45	44	52	26	N/A	N/A
2363	M	16	52	Anoxia	-2.64	98	73	44	58	26	12	6
2563	M	16	53	Anoxia	N/A	94	63	44	52	36	6	6
Average		15	53.2		-4.74	95.2	60.2	43.5	47.7	30.3	13.4	6.0
(StDev)		(1.7)	(5.3)		(2.3)	(7.4)	(9.6)	(1.2)	(9.1)	(4.3)	(8.7)	0

Note: 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; Token = Token Test; CF Copy = Complex Figure copy; WCST = Wisconsin Card Sorting Task; PE = Perseverative errors; Cat = # of Categories achieved out of 6.

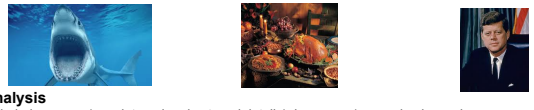
Procedure

1. ***Cue word elicitation***: Adapted from Levine et al. (2002) participants produced a narrative in response to a neutral cue word (e.g., tree) for four time conditions for a total of 12 descriptions (3 per condition)



2. ***Picture Narrative Generation***: Participants generated narratives in response to three pictures, *The Runaway, Breaking Home Ties*, and *The Cookie Theft* picture

3. ***Conversationally Elicited Personal Narrative*** (Hengst & Duff, 2007): participants produced narratives on the following themes: Frightening story, Family story, Historically significant story



Analysis

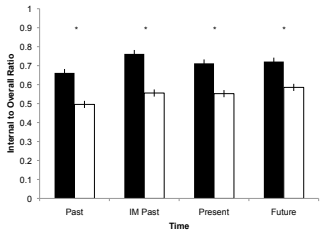
Included memory (e.g., internal and external details), language (e.g., cohesion, coherence, reported speech) and subjective measures (e.g., reports of re-experiencing, narrative "goodness").

RESULTS

Comparison
Amnesia

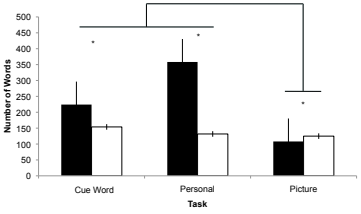
Memory Analysis

Time, AMI, Cue Word Elicitation



Patients produced a smaller ratio of internal to overall details, indicating less "episodiciness" in their narratives, $F_{(1,40)} = 32.714$, $p < 0.001$, further, there was neither a main effect of time, $F_{(3,40)} = 1.569$, $p = 0.21$, or any group by time interaction, $F_{(3,40)} = 0.249$, $p = 0.86$, indicating that amnesic participants produced less episodic details across all time periods. Further results were collapsed across time.

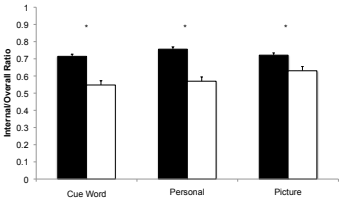
Word Count



There were significant effects of both group, $F_{(1,30)} = 16.20$, $p < 0.001$, with comparison participants producing more words than amnesics and narrative elicitation type, $F_{(2,30)} = 10.29$, $p < 0.001$, with picture elicitations producing fewer words than both personal past narratives ($p < 0.001$) and event constructions ($p < 0.05$). Additionally, a significant interaction, $F_{(2,30)} = 9.40$; $p = 0.001$, indicated that previous effects were due to the much longer personal narratives produced by comparison participants ($p < 0.001$)

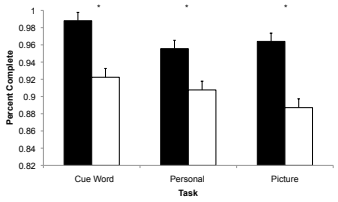
Language Analysis

AMI Memory



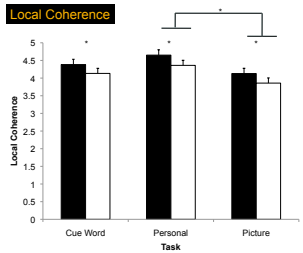
There was a main effect of group on the internal/overall ratio, $F_{(1,30)} = 31.80$, $p < 0.001$, with no effect of narrative elicitation, $F_{(2,30)} = 1.03$, $p = 0.50$, nor any group by elicitation interaction, $F_{(2,30)} = 1.22$, $p = 0.46$, indicating that amnesic participants produced narratives of less "episodic re-experiencing" across narrative types

Cohesion % Complete



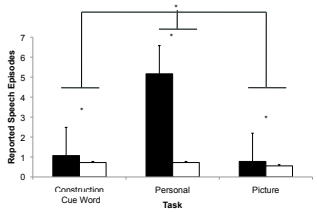
There was a main effect of group, $F(_{1,30}) = 5.7880$, $p < 0.05$, where amnesic patients produced less complete ties across tasks compared to comparison participants.

Local Coherence



There was a main effect of group on ratings of local coherence, $F(_{1,30}) = 9.0505$, $p < 0.05$, where comparison participants were rated higher across tasks. Additionally a main effect of task, $F(_{2,30}) = 10.8369$, $p < 0.01$, and post-hoc test revealed that personal narratives were rated higher on local coherence than picture narratives ($p < 0.001$)

Reported Speech

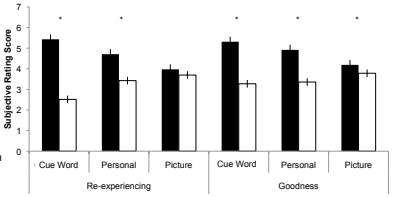


Analysis of the reported speech episodes revealed an effect of group, $F_{(1,30)} = 11.10$, $p < 0.01$, and narrative elicitation, $F_{(2,30)} = 8.34$, $p < 0.01$. Additionally, a significant interaction, $F_{(2,30)} = 7.65$, $p < 0.01$, indicated that previous effects were due to the much higher use of reported speech in the personal past narratives of comparison participants

RESULTS CONTINUED

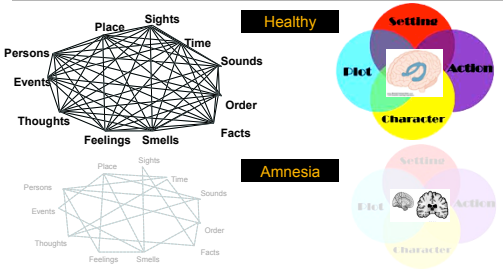
Subjective Analysis

There was no main effect of group, $F_{(1,30)} = 1.58$, $p = 0.22$, but both an effect of narrative elicitation, $F_{(2,30)} = 7.78$, $p < 0.01$, and a group by elicitation interaction, $F_{(2,30)} = 15.62$, $p < 0.001$, where amnesic participants where rated significantly lower than comparison participants on both the cue word elicitations ($p < 0.001$) and personal narratives ($p < 0.05$) but not picture narratives ($p = 0.99$)



Analyses of the others' ratings for narrative goodness revealed a main effect of group, $F_{(1,30)} = 26.20$, $p < 0.001$, (Figure 4) and no effect of narrative elicitation, $F_{(2,30)} = 0.46$, $p = 0.73$, nor any group by elicitation interaction, $F_{(2,30)} = 3.45$, $p = 0.07$

THE HIPPOCAMPUS AND NARRATIVE



CONCLUSION AND DISCUSSION

•**Narrative is at the interface of memory and language**

- ***Narrative as memory*** focuses on the way individuals (re)construct mental representations to form past and future episodes (e.g., Hassabis et a., 2007)
- ***Narrative as language*** focuses on the flexible and creative ways individuals use reconstruct, reenact, and retell events of our lives in conversation (e.g., Tannen, 1989; Ochs & Capps, 2001)
- ***Richly detailed and contextualized elements*** and the ***relational binding*** of these details across people, time, and space is at the heart of narrative as memory and as language

• **Hippocampal damage disrupts narrative construction**

- Deficits found in narrative construction on both language and memory measures
- Consistent with proposal that, in addition to memory, hippocampal functionality (e.g., rapid relational binding, representational flexibility) also supports a range of language abilities (Duff & Brown-Schmidt, 2012)

• **Narrative as Language-and-Memory-in-Use**

- Growing body of work linking the hippocampus to a diverse set of cognitive abilities beyond its role in memory blurring the lines between cognitive domains.
- Indeed, memory exerts its effects in other domains when the memory processing demands are large enough; language use involves more than just basic linguistic mechanisms including memory
- Shifting our investigations to how these systems work together, distinctions between memory and language become less clear, and we would argue, less important

FUTURE DIRECTIONS

We are continuing to examine narrative construction in patients with hippocampal damage by extending our work to:

- the flexible telling of known stories and personal episodic memories
- audience design – unique crafting of narratives to different stimuli and partners

ACKNOWLEDGEMENTS

Thanks to Neal Cohen, Dan Tranel and NIDCD RO1 DC011755