Neuropsychologia 81 (2016) 180–185

Contents lists available at ScienceDirect

Neuropsychologia

journal homepage: www.elsevier.com/locate/neuropsychologia

Experience-near but not experience-far autobiographical facts depend on the medial temporal lobe for retrieval: Evidence from amnesia

Matthew D. Grilli, Mieke Verfaellie*

Memory Disorders Research Center, VA Boston Healthcare System, Boston University School of Medicine, Boston, MA, United States

ARTICLE INFO

Article history:
Received 13 October 2015
Received in revised form
14 December 2015
Accepted 22 December 2015
Available online 22 December 2015

Keywords:
Personal semantics
Autobiographical memory
Self
Semantic memory
Episodic memory

ABSTRACT

This paper addresses the idea that there may be two types of autobiographical facts with distinct cognitive and neural mechanisms: "Experience-near" autobiographical facts, which contain spatiotemporal content derived from personal experience and thus depend on the medial temporal lobe (MTL) for retrieval, and "experience-far" autobiographical facts, which are abstract memories and thus rely on neocortical brain regions involved in retrieval of general semantic memory. To investigate this conceptual model of autobiographical fact knowledge, we analyzed the nature of autobiographical facts that were generated by 8 individuals with MTL amnesia and 12 control participants in a recent study of identity and memory [Grilli, M.D., & Verfaellie, M. (2015). Supporting the self-concept with memory: insight from amnesia. Social Cognitive and Affective Neuroscience, 10, 1684–1692]. Results revealed that MTL amnesic participants generated fewer experience-near autobiographical facts than controls. Experience-far autobiographical fact generation was not impaired in amnesic participants with damage restricted to the MTL, but there was preliminary evidence to suggest that it may be impaired in amnesic participants with damage to the MTL and anterior lateral temporal lobe. These results support a cognitive and neural distinction between experience-near and experience-far autobiographical facts and have implications for understanding the contribution of autobiographical fact knowledge to self-related cognition.

Published by Elsevier Ltd.

1. Introduction

Autobiographical facts represent personal knowledge about an individual's life. According to models of self and memory (Conway, 2005; Haslam et al., 2011; Prebble et al., 2013), autobiographical fact knowledge supports a variety of self-related cognitive functions, including constructing a personal identity, maintaining continuity with one's past, and thinking about one's future. All autobiographical facts are similar in that they have been extracted from life experiences and therefore do not incorporate the degree of detail characteristic of episodic memory: memories that involve re-experiencing singular events. However, it is not known whether autobiographical fact knowledge relies on a unitary set of cognitive and neural mechanisms, or alternatively, whether there are different types of autobiographical facts supported by distinct mechanisms. To understand how autobiographical fact knowledge contributes to self-related cognition and is affected by neurological disorders and psychiatric conditions, it is important to close this gap in knowledge.

We (Grilli and Verfaellie, 2014) recently proposed that autobiographical facts vary in the extent to which they contain spatiotemporal content that has been derived from personal experience (for a similar perspective, also see Renoult et al. (in press)). According to this viewpoint, "experience-near" autobiographical facts, although lacking the detail of episodic memory, are not completely devoid of spatiotemporal information. Rather, they incorporate content that was derived from unique event experiences (e.g. my first child was born during a blizzard), repeated event experiences (e.g. I went to happy hours with friends every Friday as an intern), or lifetime period experiences (e.g. I was involved in sports during college). In contrast, "experience-far" autobiographical facts have undergone a more complete abstraction process and thus do not include spatiotemporal content that is linked to unique, repeated, or broader lifetime period experiences (e.g. I have four siblings; I live an active lifestyle). Based on this theoretical framework, experience-near autobiographical facts may share mechanisms with episodic memory and thus depend on the medial temporal lobe (MTL) for retrieval, whereas experience-far facts, once consolidated, may rely on neocortical brain regions involved in retrieval of general semantic memory (Greenberg and Verfaellie, 2010). Consistent with this idea, findings from neuropsychology (Grilli and Verfaellie, 2014; Philippi et al., 2015) and functional neuroimaging (Martinelli et al., 2013)

* Correspondence to: VA Boston Healthcare System, 150 South Huntington Avenue (151A), Boston, MA 02130, United States.
E-mail address: verf@bu.edu (M. Verfaellie).

http://dx.doi.org/10.1016/j.neuropsychologia.2015.12.023
0028-3932/Published by Elsevier Ltd.

Table 1
Demographic information and neuropsychological data.

Patients	Etiology	Age	Edu	WAIS III		WMS III			Volume loss (%)	
				VIQ	WMI	GM	VD	AD	Hippocampal	Subhippocampal
MTL-Only										
P01	Anoxia/Ischemia	63	12	83	84	52	56	55	N/A	N/A
P02	Cardiac arrest	61	17	134	126	86	78	86	N/A	N/A
P03	Cardiac arrest	64	16	110	92	86	78	83	N/A	N/A
P04	Anoxia/Ischemia	45	12	103	95	59	68	55	46%	–
P05	Anoxia	55	14	90	99	45	53	52	70%	–
P06	CO poisoning	57	14	111	117	59	72	52	22%	–
Controls										
mean		59	14	107	111					
MTL+										
P07	Anoxia+Left Temporal Lobectomy	50	16	86	84	49	53	52	63%	60%[a]
P08	Encephalitis	85	18	133	133	45	53	58	N/A	N/A
Controls										
mean		67	16	113	112					

Note: Age, age in years; Edu, education in years; WAIS-III, Wechsler Adult Intelligence Scale-III; WMS-III, Wechsler Memory Scale-III; VIQ, verbal IQ; WMI, working memory index; GM, general memory; VD, visual delayed; AD, auditory delayed; CO, carbon monoxide; Hippocampal, bilateral hippocampal volume loss; Subhippocampal, bilateral parahippocampal gyrus volume loss.

[a] Volume loss in left anterior parahippocampal gyrus (i.e., entorhinal cortex, medial portion of the temporal pole, and the medial portion of perirhinal cortex; (see Kan et al. (2007) for methodology).

converge on the notion that the MTL is involved in retrieval of autobiographical facts, albeit less so than in episodic memory (Grilli and Verfaellie, 2014). Moreover, Renoult et al. (in press) recently demonstrated that the neural bases of autobiographical fact retrieval are distinct from but overlap with episodic memory and general semantic memory. Renoult et al. (in press) did not contrast experience-near and experience-far facts, and as such, their results leave open the possibility that the similarity with episodic memory is due to the inclusion of facts that contain spatiotemporal content derived from personal experience.

To shed further light on the mechanisms underlying autobiographical fact retrieval, in the present study, we compared the status of experience-near and experience-far autobiographical facts in individuals with MTL amnesia relative to healthy adults. To do this, we used a novel scoring protocol to analyze a subset of data gathered through a recent study on identity and memory (Grilli and Verfaellie, 2015). In that study, individuals with MTL amnesia and healthy adults generated I Am statements (e.g. I am optimistic), and then in an open-ended task described why their four highest ranked I Am statements were self-defining. Participants' responses were scored for different types of memory. Importantly, the use of a narrative response format in that study enabled us to reliably determine whether a participant was referencing a singular event in a factual manner without more elaborative retrieval (i.e. generating a unique event derived autobiographical fact) or whether the unfolding of the details of a singular event were being recalled (i.e. retrieving an episodic memory). Because both groups primarily generated autobiographical facts in these narratives, this study provided a valuable corpus of data to investigate the nature of autobiographical fact retrieval in amnesia.

We hypothesized that if the role of the MTL is limited to retrieval of experience-near autobiographical facts, then amnesic participants' I Am statement narratives should contain fewer experience-near facts than those of controls but an equivalent number of experience-far facts. Alternatively, if the contribution of the MTL to autobiographical fact retrieval does not depend on the relationship of such facts to personal experience, amnesic participants with damage restricted to the MTL should be equally impaired at generating experience-near and experience-far facts.

2. Methods

2.1. Participants

Eight individuals with MTL amnesia and 12 healthy adults who participated in Grilli and Verfaellie (2015) were included in this study. Neuropsychological testing revealed significant impairments isolated to memory in the amnesic participants (three females). Etiology of amnesia included ischemia and anoxia ($n=6$), encephalitis ($n=1$), and status epilepticus followed by temporal lobectomy ($n=1$). MRI/CT scans confirmed MTL pathology for six patients and volumetric data was available for four patients. MTL pathology was inferred based on neuropsychological profile and etiology of memory impairment for two patients (P02, P03) who had suffered cardiac arrest and could not be scanned due to medical contraindications[1]. Two participants (P07, P08) had lesions that extended into anterior lateral temporal lobe, as revealed by brain imaging. As such, amnesic participants were divided into an MTL-only ($n=6$) and MTL+ ($n=2$) subgroup. Eight of the healthy adults were matched to the MTL-only amnesic participants on age, education, and verbal intelligence (Wechsler Adult Intelligence Scale Third Edition), whereas the other four healthy adults were matched to the MTL+ amnesic participants on these same variables. Clinical and demographic information is provided in Table 1. All participants provided informed consent in accordance with the Institutional Review Board of the VA Boston Healthcare System.

2.2. Materials/Procedures

In Grilli and Verfaellie (2015) the open-response task narratives were segmented into distinct memories and scored for number and type of distinct memories. The scoring protocol assessed for several types of memory but only autobiographical facts are relevant to this paper. In particular, whereas Grilli and Verfaellie 2015) also scored the narratives for thoughts and beliefs, these were not included, as thoughts and beliefs do not reference the

[1] Including these two amnesic participants did not alter the pattern of results.

Table 2
Examples of experience-far and experience-near autobiographical facts.

Experience-far autobiographical facts
Amnesic: "I have a child, a son."
Control: "I know how to work out problems."
Lifetime period derived facts
Amnesic: "I took courses in religion *in college* and I learned 'don't be so proud. Thank God.'"
Control: "I did learn programming in college, both in *undergraduate and graduate school*, and I took more adult education in Brookline many years ago."
Repeated event derived facts
Amnesic: "I'm *at church every Sunday*."
Control: "I like to go *to the gym* and exercise."
Unique event derived facts[a]
Control: "I was in *New York City for 9/11*, and I saw the tower go down."

[a] No amnesic participant generated a unique event derived fact.

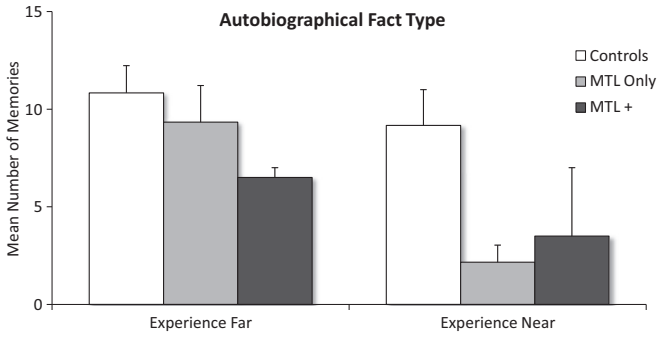

Fig. 1. Mean number of experience-far and experience-near autobiographical facts generated by amnesic participants and controls. Means depicted in these figures are based on the untransformed data. Error bars depict the standard error of the mean.

self to the same degree (e.g. I think politics are divisive) as autobiographical facts. Moreover, whereas autobiographical facts have a truth value (i.e., they are true or false), thoughts and beliefs do not. Inter-rater reliability was high for autobiographical fact memories (Cronbach's α=.96). The total number of autobiographical facts for each participant ranged from 4 to 19 in the amnesic group (mean=11.1) and 11–31 in the control group (mean=20).

2.3. Scoring

Autobiographical facts were scored as experience-near if some of the content of the fact was related to a spatial location or time period that was derived from personal experience, and facts were scored as experience-far in the absence of such information. The experience-near category was further subdivided into three subtypes: lifetime period derived facts, repeated event derived facts, and unique event derived facts. Whether experience-near autobiographical facts were categorized as lifetime, repeated, or unique event derived facts depended on the degree of event and time specificity of the content of each autobiographical fact. Table 2 provides examples of each autobiographical fact category with the spatiotemporal content of experience-near autobiographical facts italicized to demonstrate the scoring procedure. Inter-rater reliability was calculated based on a random selection of 25 percent of autobiographical fact memories provided by amnesic participants and an equal number of memories provided by controls. The secondary rater, but not the primary rater, was blind to subject status, in accordance with established scoring procedures from previous research (Levine et al., 2002; Verfaellie et al., 2014). Inter-rater reliability was high for experience-far autobiographical facts and each of the experience-near subcategories (all Cronbach's α's $\geq$ .92).

3. Results

3.1. Experience-near vs. experience-far autobiographical facts

The performance of the MTL-only amnesic participants was examined separately from that of the MTL+ amnesic participants, so as not to confound the contributions of these two brain regions to autobiographical fact retrieval. Because there were no differences in the performance of the control participants matched to these two subgroups of patients, controls were combined into a single group. The single control group did not significantly differ from either amnesic sub-group on age, education, or verbal IQ. Fig. 1 shows the frequency with which amnesic participants and controls generated experience-near and experience-far autobiographical facts.

Due to small sample sizes in the amnesic participant groups, a 3 (group: MTL-only, vs. MTL+ vs. controls) by 2 (autobiographical fact type: experience-near vs. experience-far) mixed analysis of variance (ANOVA) was run in a nonparametric fashion, similar to prior neuropsychological research (Berryhill et al., 2007; Konkel et al., 2008; Olson et al., 2006). In the first stage of analysis, the *F* statistic was calculated in the standard way on the square root transformed data. Group and memory type were then randomly rotated across scores, and a new ANOVA was run with new *F* values. This was repeated 100,000 times to generate a nonparametric distribution of *F* values for main effects and the interaction. An effect in the original data was considered significant if the obtained *F* value fell in the top 5 percent of that effect's distribution. Similar to prior research (Berryhill et al., 2009; Konkel et al., 2008), we also used a permutation test analogous to a one-tailed *t*-test to further analyze group differences. The *t*-test was first calculated on the observed values. Then two groups were randomly defined and a *t*-test was performed again. This was repeated 100,000 times. The reported *p*-values refer to the proportion of scores above the observed original value. Notably, with this approach there is no *t*-statistic.

The mixed ANOVA revealed significant effects of group, F (2, 17)=4.52, p=.04; memory type, F (1, 17)=13.64, p=.001; and a significant interaction, F (2, 17)=3.61, p=.03. MTL-only amnesic participants generated fewer experience-near autobiographical facts than controls, p=.001, but not fewer experience-far autobiographical facts than controls, p=.24. MTL+ amnesic participants generated fewer experience-near autobiographical facts than controls, p=.04; generation of experience-far autobiographical facts in MTL+ participants was lower than controls, albeit not significantly, p=.09. MTL-only and MTL+ participants did not significantly differ for experience-near facts, p=.26, or experience-far facts, p=.24.

3.2. Subtypes of experience-near autobiographical facts

Fig. 2 shows the frequency with which amnesic and control participants generated the three subtypes of experience-near autobiographical facts in their I Am statement narratives. To compare the amnesic participants to the controls, we collapsed across MTL-only and MTL+ participants given that both were similarly impaired at generating experience-near autobiographical fact memories.

A 2 (group: amnesics vs. controls) by 3 (experience-near subtype: lifetime period vs. repeated event vs. unique event) mixed nonparametric ANOVA on the square root transformed data revealed significant effects of group, F (1, 18)=13.72, p=.003, and

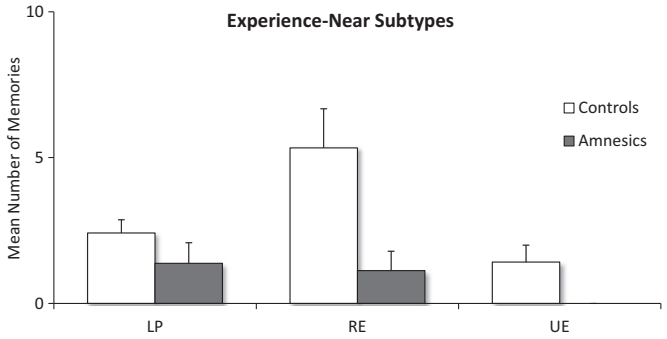

Fig. 2. Mean number of lifetime period (LP), repeated event (RE), and unique event (UE) derived autobiographical facts generated by amnesic participants and controls. Means depicted in these figures are based on the untransformed data. Error bars depict the standard error of the mean.

memory type, F (2, 36)=7.42, p=.03, without a significant interaction, F (2, 36)=1.69, p=.33. As seen in Fig. 2, amnesic participants generated fewer lifetime period, repeated event, and unique event derived facts in comparison to control participants. In regards to the main effect of experience-near memory type, repeated event derived facts and lifetime period derived facts were generated more than unique event derived facts, t's > 3.08, p's ≤ .006. Generation of repeated event derived facts was not significantly different from generation of lifetime period derived facts, t (19)=1.07, p=.30. Fig. 2 shows that the amnesic participants rarely generated any of the subtypes of experience-near facts, and thus the control participants were driving the main effect of experience-near fact subtype. When further analyzed, we found that the control participants generated repeated event derived facts more than unique event derived facts, t (11)=3.59, p=.004; and marginally more than lifetime period derived facts, t (11)=2.09, p=.06.

4. Discussion

We investigated the nature of autobiographical fact memories generated by individuals with amnesia and healthy adults in the context of a narrative task. There were two main findings: (1) in comparison to control participants, amnesic participants with MTL damage were less able to generate experience-near autobiographical facts; and (2) whereas amnesic participants with damage restricted to the MTL did not differ from controls in generation of experience-far autobiographical facts, we found preliminary evidence to suggest that amnesic participants with damage to the MTL and anterior lateral temporal lobe may have more difficulty generating experience-far facts relative to controls.

Findings were consistent with the hypothesis that the contribution of the MTL to autobiographical fact retrieval varies depending on the inclusion of spatiotemporal content derived from personal experience. Amnesic participants were less able than controls to generate autobiographical facts related to lifetime periods, repeated events, and unique events. However, amnesic participants with damage restricted to the MTL were as capable as controls at generating experience-far autobiographical facts. Therefore, these results demonstrate that autobiographical fact knowledge does not rely on a unitary set of cognitive and neural mechanisms: experience-near autobiographical facts, similar to episodic memories, depend on the MTL for retrieval, whereas experience-far autobiographical facts do not.

These findings support the idea that facts that have not been fully abstracted from the spatiotemporal context from which they were derived rely on the MTL for retrieval. Prior research has shown that the MTL supports retrieval of multisensory perceptual details (St-Laurent et al., 2014). Therefore, experience-near autobiographical facts, while not as perceptually rich as episodic memory, may not be completely devoid of the multisensory details of past experiences. Consistent with this idea, recent functional neuroimaging research has shown that the MTL is associated with retrieval of general semantic memories that have spatial qualities (Hoscheidt et al., 2010; Ryan et al., 2010). As such, retrieval of spatial information drawn from past experience may be one mechanism by which autobiographical facts remain experience-near. However, future research must determine which perceptual details are incorporated in autobiographical facts. It will also be important to determine the extent to which unique event derived facts and episodic memories rely on shared relative to distinct neural mechanisms.

Our results further suggest that experience-far autobiographical fact knowledge may depend on the anterior lateral temporal lobe for retrieval, as generation of this type of autobiographical knowledge was notably lower numerically, albeit not statistically, in two amnesic participants with damage extending into this brain region. This implies that, although experience-far autobiographical facts reflect knowledge that is specific to each individual, after consolidation this type of memory may rely on neural regions involved in retrieval of general semantic memory. However, given the preliminary nature of our findings, future research will need to corroborate this idea, perhaps by investigating autobiographical facts in individuals with isolated or disproportionate damage to the anterior lateral temporal lobe.

Consistent with the notion that autobiographical fact knowledge relies on semantic memory mechanisms, in our review of neuropsychological research on personal semantic memory (Grilli and Verfaellie, 2014), we found that autobiographical fact knowledge was less severely impaired than episodic memory in most patients with MTL lesions. Although this finding corroborated early anecdotal reports of individuals with profound amnesia (Cermak and O'Connor, 1983; Damasio et al., 1985; Tulving, 1985), why autobiographical fact knowledge was better preserved than episodic memory in individuals with amnesia remained underspecified. The results of this study suggest that autobiographical fact knowledge may be better preserved primarily because experience-far autobiographical fact knowledge is spared in individuals with MTL lesions. Indeed, the MTL lesion patients in this study were near the floor for experience-near autobiographical fact generation, suggesting that the severity of impairment for this type of autobiographical fact knowledge may be akin to that for episodic memory.

The results of this paper build on current conceptual models that view personal memory as a form of memory that incorporates both episodic and semantic information (Conway, 2005; Haslam et al., 2011; Martinelli et al., 2013; Renoult et al., in press). However, much remains unknown about the neural and cognitive bases of personal memory. In their meta-analysis of functional neuroimaging research on personal memory, Martinelli et al. (2013) revealed that autobiographical fact retrieval in healthy adults was associated with a widely distributed neural network that includes anterior and posterior cortical midline structures, frontal and temporal gyri, thalamus, fusiform gyrus, and the MTL. We have demonstrated that one region in this network, namely the MTL, is needed for retrieval of only a subset of autobiographical facts. A challenge for future cognitive neuroscience research, therefore, will be to determine which of the other brain regions within this network support experience-near autobiographical facts, experience-far autobiographical facts, or both. In addition to clarifying the neural bases of autobiographical facts, such research could elucidate whether autobiographical facts are unique in spanning both episodic and semantic components in the

organizational framework of personal memory (Renoult et al., 2012).

These results also add to recent research focused on understanding whether memories of repeated life experiences should be considered a form of semantic memory or a form of episodic memory (Grilli and Verfaellie, 2015; Renoult et al., 2012; Rubin and Umanath, 2015). Based on the findings of this study and our prior work (Grilli and Verfaellie, 2015), we propose that repeated life experiences may be stored both as episodic-like personal memories and as personal knowledge in the form of autobiographical facts. When repeated event memories are episodic-like, they capture the unfolding of details from a frequently experienced event and are relived when retrieved. In contrast, when stored as autobiographical facts, repeated event memories are not relived, despite containing details derived from a frequent experience. From this viewpoint, the neural bases of repeated event memories may depend on whether repeated life experiences are retrieved in factual form or in the context of their reliving and episodic-like qualities.

In this study, autobiographical facts were taken from participants' responses to an open-ended narrative task which involved reflecting on one's identity. Notably, participants were not prompted for specific details after their spontaneous account. Thus, it remains an open question whether the deficit in experience-near autobiographical fact retrieval demonstrated by individuals with amnesia could be attenuated with more specific probing, similar to the type of probing used in the Autobiographical Interview (Levine et al., 2002). It will be important for future research to investigate whether additional prompting can result in an experience-far autobiographical fact becoming experience-near, and to determine which sort of probes (e.g. space or time period) are most effective. Such knowledge would speak to the possibility that the experience-near deficit in individuals with amnesia reflects the habitual use of abstract retrieval strategies (see also Rudoy et al. (2009)).

The finding that retrieval of experience-near autobiographical facts is selectively impaired in individuals with MTL amnesia may have important implications for understanding how individuals with MTL dysfunction use memory to support a sense of self. Notably, whereas we recently found that amnesic participants primarily use autobiographical facts to support personal identity (Grilli and Verfaellie, 2015), the present results indicate that, relative to controls, they are using autobiographical facts that are more abstract. It is intriguing to consider the possibility that an inability to retrieve autobiographical facts that include information from past experiences may lead an individual to construct a sense of self that is less experience-specific and thus more absolute (e.g. “I am always …”). In addition, if experience-near semantic memories are needed to maintain certain aspects of personal identity, failure to access such memories also might result in a more limited sense of self. Moreover, given the role of memory in future thinking (Race et al., 2011; 2013; Schacter and Addis, 2007), an impaired ability to retrieve experience-near autobiographical facts may lead to a more abstract sense of what one will be like in the future. This may result in the imagining of less specific personal goals and expectations (Stawarczyk and D’Argembeau, 2015). Addressing such questions about the importance of experience-near autobiographical facts to the self could have broad implications for understanding how personal identity is affected by neurological disorders (e.g. Alzheimer's disease) and psychological conditions (e.g. schizophrenia; depression) that are associated with dysfunction of the MTL.

In regards to the contribution of autobiographical facts to the self-concept in normal cognition, the control participants primarily relied on facts derived from repeated events rather than facts derived from unique events or lifetime periods to support their roles and traits. These results suggest that contributions to the self-concept that remain grounded in personal experience may predominantly reflect facts derived from experiences that have been engaged in frequently. However, future research will need to replicate this finding in a larger healthy sample and determine whether the effect holds across the lifespan.

In conclusion, this paper demonstrates that autobiographical fact knowledge involves a complex set of cognitive and neural mechanisms and adds to a growing body of research to indicate that distinctions between semantic and episodic memory are not always clear cut (Greenberg et al., 2009; Hoscheidt et al., 2010; Renoult et al., in press; Westmacott et al., 2004). Here we have shown that autobiographical knowledge consists of experience-near and experience-far facts, with the MTL necessary for retrieval of the former but not the latter. We therefore have provided a model of autobiographical fact knowledge that can be applied to investigate the self-supporting functions of personal memory and to guide clinical psychological investigations into the impact of neurological disorders and psychological conditions on sense of self.

Funding

This work was supported by: Clinical Science Research and Development Service, Department of Veterans Affairs Grant IO1CX000925.

Acknowledgments

We thank Keely Burke for help with scoring. The contents do not represent the views of the U.S. Department of Veterans Affairs or the United States Government.

References

Berryhill, M.E., Drowos, D.B., Olson, I.R., 2009. Bilateral parietal cortex damage does not impair associative memory for paired stimuli. Cogn. Neuropsychol. 26 (7), 606–619.
Berryhill, M.E., Phuong, L., Picasso, L., Cabeza, R., Olson, I.R., 2007. Parietal lobe and episodic memory: bilateral damage causes impaired free recall of autobiographical memory. J. Neurosci. 27 (52), 14415–14423.
Cermak, L.S., O'Connor, M., 1983. The anterograde and retrograde retrieval ability of a patient with amnesia due to encephalitis. Neuropsychologia 21 (3), 213–234.
Conway, M.A., 2005. Memory and the self. J. Mem. Lang. 53 (4), 594–628.
Damasio, A.R., Eslinger, P.J., Damasio, H., VanHoesen, G.W., Cornell, S., 1985. Multimodal amnesic syndrome following bilateral temporal and basal forebrain damage. Arch. Neurol. 42, 252–259.
Greenberg, D.L., Verfaellie, M., 2010. Interdependence of episodic and semantic memory: evidence from neuropsychology. J. Int. Neuropsychol. Soc. 16 (5), 748–753.
Greenberg, D.L., Keane, M.M., Ryan, L., Verfaellie, M., 2009. Impaired category fluency in medial temporal lobe amnesia: the role of episodic memory. J. Neurosci. 29 (35), 10900–10908.
Grilli, M.D., Verfaellie, M., 2014. Personal semantic memory: insights from neuropsychological research on amnesia. Neuropsychologia 61, 56–64.
Grilli, M.D., Verfaellie, M., 2015. Supporting the self-concept with memory: insight from amnesia. Soc. Cogn. Affect. Neurosci. 10, 1684–1692.
Haslam, C., Jetten, J., Haslam, S.A., Pugliese, C., Tonks, J., 2011. I remember therefore I am, and I am therefore I remember': exploring the contributions of episodic and semantic self knowledge to strength of identity. Br. J. Psychol. 102, 184–203.
Hoscheidt, S.M., Nadel, L., Payne, J., Ryan, L., 2010. Hippocampal activation during retrieval of spatial context from episodic and semantic memory. Behav. Brain Res. 212 (2), 121–132.
Kan, I.P., Giovanello, K.S., Schnyer, D.M., Makris, N., Verfaellie, M., 2007. Role of the medial temporal lobes in relational memory: neuropsychological evidence from a cued recognition paradigm. Neuropsychologia 45 (11), 2589–2597.
Konkel, A., Warren, D.E., Duff, M.C., Tranel, D.N., Cohen, N.J., 2008. Hippocampal amnesia impairs all manner of relational memory. Front. Hum. Neurosci. 2, 15.
Levine, B., Svoboda, E., Hay, J.F., Winocur, G., Moscovitch, M., 2002. Aging and autobiographical memory: dissociating episodic from semantic retrieval. Psychol.

Aging 17 (4), 677–689.
Martinelli, P., Sperduti, M., Piolino, P., 2013. Neural substrates of the self-memory system: new insights from a meta-analysis. Hum. Brain Mapp. 34 (7), 1515–1529.
Olson, I.R., Moore, K.S., Stark, M., Chatterjee, A., 2006. Visual working memory is impaired when the medial temporal lobe is damaged. J. Cogn. Neurosci. 18 (7), 1087–1097.
Philippi, C.L., Tranel, D., Duff, M., Rudrauf, D., 2015. Damage to the default mode network disrupts autobiographical memory retrieval. Soc. Cogn. Affect. Neurosci. 10, 318–326.
Prebble, S.C., Addis, D.R., Tippett, L.J., 2013. Autobiographical memory and sense of self. Psychol. Bull. 139 (4), 815–840.
Race, E., Keane, M.M., Verfaellie, M., 2011. Medial temporal lobe damage causes deficits in episodic memory and episodic future thinking not attributable to deficits in narrative construction. J. Neurosci. 31 (28), 10262–10269.
Race, E., Keane, M.M., Verfaellie, M., 2013. Losing sight of the future: impaired semantic prospection following medial temporal lobe lesions. Hippocampus 23 (4), 268–277.
Renoult, L., Davidson, P.S.R., Palombo, D.J., Moscovitch, M., Levine, B., 2012. Personal semantics: at the crossroads of semantic and episodic memory. Trends Cogn. Sci. 16 (11), 550–558.
Renoult, L., Tanguay, A., Beaudry, M., Tavakoli, P., Rabipour, S., Campbell, K., Moscovitch, M., Levine, B., Davidson, P.S.R., 2015. Personal semantics: is it distinct from episodic and semantic memory? An electrophysiological study of memory for autobiographical facts and repeated events in honour of Shlomo Bentin. Neuropsychologia . http://dx.doi.org/10.1016/j.neuropsychologia.2015.08.013 (in press).
Rubin, D.C., Umanath, S., 2015. Event memory: a theory of memory for laboratory, autobiographical, and fictional events. Psychol. Rev. 122 (1), 1–23.
Rudoy, J.D., Weintraub, S., Paller, K.A., 2009. Recall of remote episodic memories can appear deficient because of a gist-based retrieval orientation. Neuropsychologia 47 (3), 938–941.
Ryan, L., Lin, C.Y., Ketcham, K., Nadel, L., 2010. The role of medial temporal lobe in retrieving spatial and nonspatial relations from episodic and semantic memory. Hippocampus 20, 11–18.
Schacter, D.L., Addis, D.R., 2007. The cognitive neuroscience of constructive memory: remembering the past and imagining the future. Philos. Trans. R. Soc. B – Biol. Sci. 362 (1481), 773–786.
Stawarczyk, D., D'Argembeau, A., 2015. Neural correlates of personal goal processing during episodic future thinking and mind-wandering: an ALE meta-analysis. Hum. Brain Mapp. 36 (8), 2928–2947.
St-Laurent, M., Moscovitch, M., Jadd, R., McAndrews, M.P., 2014. The perceptual richness of complex memory episodes is compromised by medial temporal lobe damage. Hippocampus 24, 560–576.
Tulving, E., 1985. Memory and consciousness. Can. J. Psychol. 26, 1–12.
Verfaellie, M., Bousquet, K., Keane, M.M., 2014. Medial temporal and neocortical contributions to remote memory for semantic narratives: evidence from amnesia. Neuropsychologia 61, 105–112.
Westmacott, R., Black, S., Freedman, M., Moscovitch, M., 2004. The contribution of autobiographical significance to semantic memory: evidence from Alzheimer's disease, semantic dementia, and amnesia. Neuropsychologia 42 (1), 25–48.