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Supporting the self-concept with memory: insight from amnesia

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Abstract

We investigated the extent to which personal semantic memory supports the self-concept in individuals with medial temporal lobe amnesia and healthy adults. Participants completed eight 'I Am' self-statements. For each of the four highest ranked self-statements, participants completed an open-ended narrative task, during which they provided supporting information indicating why the I Am statement was considered self-descriptive. Participants then completed an episodic probe task, during which they attempted to retrieve six episodic memories for each of these self-statements. Supporting information was scored as episodic, personal semantic or general semantic. In the narrative task, personal semantic memory predominated as self-supporting information in both groups. The amnesic participants generated fewer personal semantic memories than controls to support their self-statements, a deficit that was more pronounced for trait relative to role self-statements. In the episodic probe task, the controls primarily generated unique event memories, but the amnesic participants did not. These findings demonstrate that personal semantic memory, in particular autobiographical fact knowledge, plays a critical role in supporting the self-concept, regardless of the accessibility of episodic memories, and they highlight potential differences in the way traits and roles are supported by personal memory.

Key words: self; personal semantics; episodic memory; amnesia

Introduction

Recent research has shown that memory can be utilized to serve a wide range of psychological abilities, including prospection (Schacter and Addis, 2007; Race *et al.*, 2011, 2013), decision making (Gupta *et al.*, 2009; Palombo *et al.*, 2015), communication (Duff *et al.*, 2011), problem-solving (Sheldon, *et al.*, 2011; Vandermorris *et al.*, 2013) and empathy (Beadle *et al.*, 2013; Bluck, *et al.*, 2013; Gaesser and Schacter, 2014). In addition, theoretical models propose that another function of memory may be to support the self-concept, the conception of oneself that enables each individual to construct a personal identity (Conway, 2005; Haslam *et al.*, 2011; Prebble *et al.*, 2013). According to these models, the self-concept consists of traits (e.g. I am optimistic) and roles (e.g. I am a psychologist); memory is used to support these traits and roles, and in the process helps to create continuity and coherence in one's personal identity.

Supporting the self-concept with memory may have broad implications for emotional functioning, life satisfaction and one's self-appraisal (Wilson and Ross, 2003; McAdams, 2013). On the one hand, the use of memory to support the self-concept may be constructive, with positive outcomes such as enhanced wellbeing (Waters, 2014). On the other hand, the use of memory to support the self-concept may be maladaptive if doing so perpetuates a negative identity (Abdollahi *et al.*, 2012). However, despite the potential importance of memory to personal identity, how memory can be used to support one's self-concept remains underspecified. Thus, to advance understanding of the relation of self and memory, this study focuses on uncovering the types of memory that function to support the self-concept.

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The majority of research investigating how people use memory to support the self-concept has focused on episodic memory: memory for personally experienced events (e.g. remembering the birth of one's first child; Tulving, 1983, 1985). For example, research has shown that when instructed to recall specific events related to the self, healthy adults frequently retrieve memories that are re-experienced from a personal vantage point and that include phenomenological details (Rathbone *et al.*, 2011; Bennouna-Greene *et al.*, 2012; Martinelli *et al.*, 2013). Similarly, prior research has shown that when asked to reflect on single events from one's life, healthy adults tend to retrieve memories that are thought of as self-defining (Waters *et al.*, 2014). These findings suggest that episodic memory can support one's self-concept. However, whether the self-concept is supported exclusively by episodic memory is unknown.

For instance, it is possible that personal semantic memory, information in one's repository of knowledge that is specific and unique to each individual, may also be used to support self-defining traits and roles. Personal semantic memory can be separated into personal thoughts and beliefs (e.g. I think running is enjoyable) and autobiographical facts (e.g. I live in Boston; Martinelli *et al.*, 2013). Personal semantic memory is thought to rely on cognitive and neural mechanisms that are partly distinct from those mediating episodic memory and general semantic memory, which is shared world knowledge (Renoult *et al.*, 2012). Although current models propose that the self retains a connection with personal semantic memory (Conway, 2005; Klein and Lax, 2010; Haslam *et al.*, 2011; Prebble *et al.*, 2013), prior research has not uncovered the extent to which this type of memory can be used to support one's self-concept.

Individuals with amnesia have profound episodic memory deficits, and thus provide a unique opportunity to uncover what types of semantic memory can be utilized to support one's self-concept. Previous neuropsychological case studies have demonstrated that amnesic patients can reliably and accurately judge their demeanor (Tulving, 1993; Klein *et al.*, 1996, 2002), and generate self-defining traits and roles (Rathbone *et al.*, 2009). However, how—or even if—individuals with amnesia use memory to support the self-concept has not been thoroughly investigated, although qualitative findings from a case study suggest that they may turn to forms of memory other than unique episodic memories (Rathbone *et al.*, 2009).

To deal with this gap in knowledge, we investigated the types of memory used to support the self-concept in individuals with medial temporal lobe (MTL) amnesia and we compared their performance to that of healthy controls. We developed a paradigm that combines an established procedure for investigating the self-concept, the I Am Task (Rathbone *et al.*, 2008), with an open-ended narrative response task to give participants the opportunity to draw on different types of memory to support the self-concept. Furthermore, we developed a scoring protocol that enabled us to conduct a fine-grained analysis of the various types of memories that were generated during the narrative task. We also included an episodic probe task to directly investigate the degree to which individuals with amnesia can retrieve self-supporting episodic memories.

Based on the findings of previous research investigating healthy adult populations, we predicted that control participants would primarily rely on episodic memory to support the self-concept during the narrative task. We also predicted that, if semantic memory can support the self-concept, amnesic participants should be able to provide statements that support the self-concept during the narrative task, albeit using a different type of memory than controls.

Methods

Participants

Eight amnesic participants (three females) with MTL lesions participated in the study (Table 1). Amnesic participants underwent extensive neuropsychological testing and their neurocognitive profiles revealed significant impairments isolated to memory. Etiology of amnesia included ischemia or anoxia (six patients), encephalitis (one patient) and status epilepticus followed by temporal lobectomy (one patient). MRI/CT scans confirmed MTL pathology for six patients. Two of these patients (P07, P08) had lesions that extended beyond the MTL into anterolateral temporal neocortex. Two patients (P02, P03), who had suffered cardiac arrest, could not be scanned due to medical contraindications, and therefore MTL pathology for these patients was inferred based on etiology and neuropsychological profile.

Twelve healthy adults matched to the amnesic group on the basis of age, education and verbal intellect as measured by the Wechsler Adult Intelligence Scale Third Edition (WAIS-III) also participated in the study (Table 1). All participants provided informed consent in accordance with the Declaration of Helsinki and the Institutional Review Board of the VA Boston Healthcare System.

Materials and procedures

The experiment consisted of three parts: an I Am task, a narrative task and an episodic probe task. To begin the experiment participants were instructed to reflect on the most defining features of their identity by completing a written eight-item version of the I Am Task (e.g. I am ____) and then to rank their top 4 completions. For each of these four statements, they were asked to report aloud 'what makes you say "I am ____?"' Participants were given four minutes to provide an oral response for each statement and their narratives were recorded. They were prompted once (i.e. 'can you tell me more about what makes you say "I am ____?"') if they stopped prior to the time limit. Following this narrative task, the episodic probe task was administered. Participants were told that they were to describe orally six 'specific events from your life that exemplify why this self-statement defines you'. It was explained that these specific events should be unique moments that lasted <24 h. They also were instructed to provide as much detail as possible, so that

Table 1. Demographic information and neuropsychological data

Participants	Etiology	Age	Education	WAIS III		WMS III		
				VIQ	WMI	GM	VD	AD
P01	Anoxia/ischemia	63	12	83	84	52	56	55
P02	Cardiac arrest	61	17	134	126	86	78	86
P03	Cardiac arrest	64	16	110	92	86	78	83
P04	Anoxia/ischemia	45	12	103	95	59	68	55
P05	Anoxia	55	14	90	99	45	53	52
P06	CO poisoning	57	14	111	117	59	72	52
P07	Anoxia + Left TL	50	16	86	84	49	53	52
P08	Encephalitis	85	18	133	133	45	53	58
Controls mean		61	15	110	111			

WAIS III, Wechsler Adult Intelligence Scale Third Revision; WMS III, Wechsler Memory Scale Third Revision; VIQ, Verbal IQ; WMI, Working Memory Index; GM, General Memory; VD, Visual Delayed; AD, Auditory Delayed; TL, Temporal Lobectomy.

the experimenter might be able to 'mentally picture the event being described'. Responses were recorded. This procedure was repeated for the top 4 self-statements. If the participant's response was not clearly describing a unique episodic memory, the experimenter prompted the participant to describe a specific event.

Scoring

I Am statements were scored for type (trait or role) and total number completed. I Am statements that described personality characteristics were scored as traits (e.g. I am energetic; I am a kind person), whereas I Am statements that described social and occupational identities were scored as roles (e.g. I am a father; I am a psychologist). A random selection of 25% of the top 4 self-statements from the amnesic patients and an equal number from controls revealed perfect agreement between two raters in scoring self-statements as traits or roles.

I Am narratives were scored two ways. In the first scoring method, narratives were segmented into distinct memories and scored for number and type of distinct memories. A segment of the narrative was considered a single memory if all information within that portion of the narrative related in the same way to the I Am statement that was being described. All distinct memories were weighted equally, although some contained more details than others. The three main categories of memories were personal episodic memory, personal semantic memory and general semantic memory. The personal episodic memory category consisted of three subtypes of memories: unique events (i.e. a single event that lasted <24 h and contained episodic details from the original experience), hypothetical events (i.e. a single event that would last <24 h if it were to occur) and repeated events (i.e. a described event that captures the details of a repeated episode). The hypothetical event subtype was included to account for the possibility that participants may construct novel events based on details from episodic memory. The repeated event subtype was included in this category because findings from cognitive neuroscience indicate that the cognitive and neural bases of this type of memory partly overlap with those of unique event memories (Renoult *et al.*, 2012). The personal semantic memory category also consisted of three subtypes of memories: autobiographical facts, thoughts/beliefs and statements about traits/roles other than the trait/role that was designated as the I Am statement. These personal semantic memory categories were selected as research on individuals with MTL amnesia indicates that they may involve distinct cognitive and neural mechanism (Grilli and Verfaellie, 2014). Examples of each of these memory subtypes are provided in the Supplementary Table S1. Inter-rater reliability was calculated based on a random selection of 25% of narratives provided by amnesic participants and an equal number of narratives 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 total number of memories, personal episodic memories and personal semantic memories (Cronbach's α's ≥ 0.96). None of the narratives used to calculate inter-rater reliability included general semantic memories, which reflects how infrequently such memories were used as supporting information for the self-statements. Inter-rater reliability also was high for two of the personal semantic memory subtypes (autobiographical facts and thoughts/beliefs Cronbach's α's ≥ 0.91; none of these narratives included statements about other traits/roles), and for the personal episodic memory subtypes (Cronbach's $\alpha \geq 0.92$).

To examine the richness and complexity of individual memories, for the second scoring method, the number and type of details contained within distinct memories were tallied. Details were scored using an adapted version of the autobiographical interview procedure (Levine *et al.*, 2002) such that the narratives were segmented into individual details and then assigned to a detail category based on its content. Segments were categorized as personal episodic details if they described the quality of a specific episode, such as an event (e.g. 'I walked to him'), a place (e.g. 'we were at Boston Common'), time (e.g. 'it was the afternoon'), perceptual feature (e.g. 'it was darker than usual') or experienced thought/emotion (e.g. 'I remember thinking that I was very fortunate'). In comparison, segments were categorized as personal semantic details if they described information that was not specific to an event and instead reflected an autobiographical fact, broad personal thought/belief or personality trait/role statement. Finally, segments were scored as general semantic details if they described non-personal knowledge (e.g. 'everyone dies'). Inter-rater reliability was high for total number of details, personal episodic details, personal semantic details, general semantic details (Cronbach's α's ≥ 0.80) and for two of the personal semantic detail subtypes (autobiographical facts and thoughts/beliefs Cronbach's α's ≥ 0.93). Inter-rater reliability for the traits/roles and the episodic detail subtypes varied because of small sample sizes in the narratives (Cronbach's α ranged from 0 to 1.0). We therefore calculated inter-rater reliability for these detail categories on the basis of 16 randomly selected memories from the episodic probing task (eight from amnesic participants and eight from controls), and all detail categories received acceptable inter-rater reliability (Cronbach's α's > 0.80).

In the episodic probe task, we scored the number of unique event memories and the number of repeated event memories. Given the paucity of episodic memories in the amnesic group, we did not further analyse the number and type of details that comprise episodic memories.

Results

I Am task

In the group of amnesic participants, P03 generated seven self-statements, P04 generated six self-statements and P08 generated five self-statements, whereas the other amnesic participants generated eight self-statements. All control participants generated eight self-statements.

In regards to the most self-defining statements (i.e. the self-statements ranked in the top 4), amnesic participants generated relatively fewer trait relative to role self-statements in comparison to controls, $\chi^2 = 6.18$, $P = 0.01$ (amnesic participants: 16 traits/16 roles; controls: 38 traits/10 roles). Not all participants ranked both traits and roles in their top 4 I Am statements. Seven amnesic and 12 control participants ranked at least one trait, and seven amnesic and seven control participants ranked at least one role. The ratio of traits to roles in the top 4 self-statements of P03 and P04 was 2:2 and thus consistent with the top 4 trait to role ratio of the amnesic participants who generated eight self-statements. P08 ranked only traits in the top 4.

Narrative task: nature of supporting memories

The Supplementary Table S1 provides an example of an I Am narrative response from an amnesic participant and a control

participant that has been scored for number and type of distinct memories. Figure 1 presents the frequency with which amnesic participants and controls generated different types of memories in support of their I Am statements. The trait and role self-statement narrative data were analysed separately as the groups differed in their prioritization of trait *vs* role self-defining statements. The number of distinct memories was square root transformed prior to analysis because of unequal variance across groups.

For trait-supporting information, a 2 (group) by 3 (memory type: personal episodic *vs* personal semantic *vs* general semantic) mixed analysis of variance (ANOVA) revealed significant effects of group, F (1, 17) = 10.40, $P = 0.005$, $\eta^2 = 0.38$; memory type, F (2, 34) = 157.61, $P < 0.001$, $\eta^2 = 0.86$; and a significant interaction, F (2, 34) = 7.74, $P = 0.002$, $\eta^2 = 0.04$. Amnesic participants used fewer personal semantic memories than controls to support their trait self-statements, t (17) = 4.00, $P = 0.001$. Amnesic participants and controls did not differ in their use of personal episodic memory and general semantic memory as trait-supporting information, t's (17) ≤ 1.45, P's ≥ 0.17, but as shown in Figure 1, floor effects limit the ability to detect group differences. Given that P08 has damage extending into anterolateral temporal neocortex, a region that may be important for personal semantic memory storage and retrieval (Grilli and Verfaellie, 2014), we re-ran the mixed ANOVA without the data from this patient. The outcomes were the same. P07 also has damage extending into the anterolateral temporal cortex, but this patient did not rank a trait statement among his top 4.

For role-supporting information, a 2 (group) by 3 (memory type) mixed ANOVA revealed a significant effect of memory type only, F (2, 24) = 86.92, $P < 0.001$, $\eta^2 = 0.86$. Although the main effect of group and the interaction of group and memory type were not significant, we performed follow-up comparisons to ensure that the failure to find group differences for any type of memory was not due to floor effects. Neither controls nor amnesic participants were on the floor for the personal semantic memory category, and yet, in contrast to the results from the trait self-statement narratives, amnesic participants did not significantly differ from controls in their ability to use personal semantic memories to support their role self-statements, t (12) = 1.63, $P = 0.13$. However, as can be seen in Figure 1, the use of personal semantic memory to support roles was not completely normal in the amnesic participants, as controls on average generated approximately two personal semantic memories more than amnesic participants to support role self-statements. Sample size may have limited our ability to detect a group difference. There also were no significant group differences in the use of personal episodic memory and general semantic memory as role-supporting information, t's (12) ≤ 1.55, P's ≥ 0.17, but similar to the trait self-statement narratives, for these memory types there are floor effects.

The finding that the amnesic participants significantly differed from controls in their use of personal semantic memory to support trait self-statements but not role self-statements suggests that amnesic participants' deficit in the use of personal semantic memory as self-supporting information may be more pronounced for traits. To investigate this possibility further, we performed a 2 (group) by 2 (self-statement type) mixed ANOVA on the personal semantic memory data from participants who selected both statement types (six amnesic participants and seven controls). The results revealed a significant interaction, F (1, 11) = 5.80, $P = 0.04$, $\eta^2 = 0.33$, confirming that, relative to control participants, amnesic participants were more impaired at using personal semantic memory to support trait relative to role self-statements.

Figure 2 presents the personal semantic memory data as a function of memory subtype (autobiographical fact, thought/belief and other trait/role). The other trait/role category was not included in the subsequent analyses, as it was rarely used by either group.

For trait-supporting information, A 2 (group) by 2 (personal semantic memory subtype) mixed ANOVA revealed significant effects of group, F (1, 17) = 26.23, $P < .001$, $\eta^2 = 0.33$; and memory type, F (1, 17) = 40.86, $P < .001$, $\eta^2 = 0.68$; without a significant interaction. As shown in Figure 2, amnesic participants generated fewer autobiographical facts and thoughts/beliefs than controls, and both groups used autobiographical facts more than thoughts/beliefs as trait-supporting information. Removing P08 from this analysis did not change these effects.

For role-supporting information, A 2 (group) by 2 (personal semantic memory subtype) mixed ANOVA revealed a significant effect of memory type only, F (1, 12) = 97.93, $P < 0.001$, $\eta^2 = 0.89$. Amnesic participants and controls did not significantly differ in their use of autobiographical facts or thoughts/beliefs to support role self-statements, although numerically amnesic participants generated fewer of both types of personal semantic memory; and as shown in Figure 2, both groups used autobiographical facts more than thoughts/beliefs.

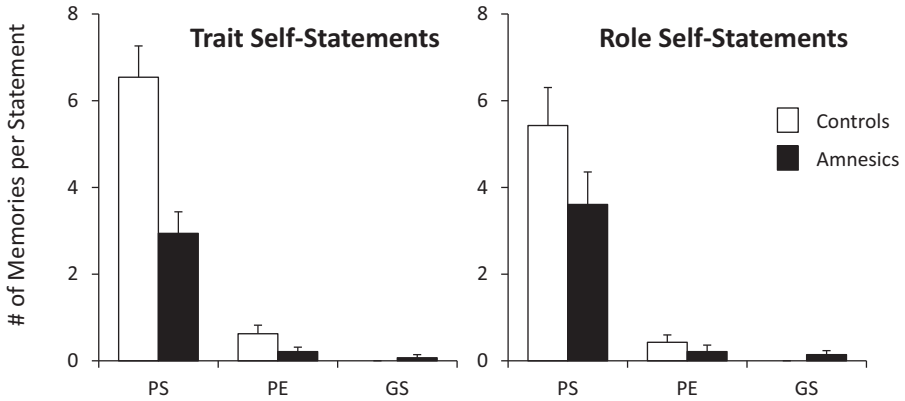

Fig. 1. Mean number of personal semantic (PS), personal episodic (PE) and general semantic (GS) memories generated per self-statement during the narrative task by amnesic participants and controls, separated by trait and role self-statements. Error bars depict the standard error of the mean.

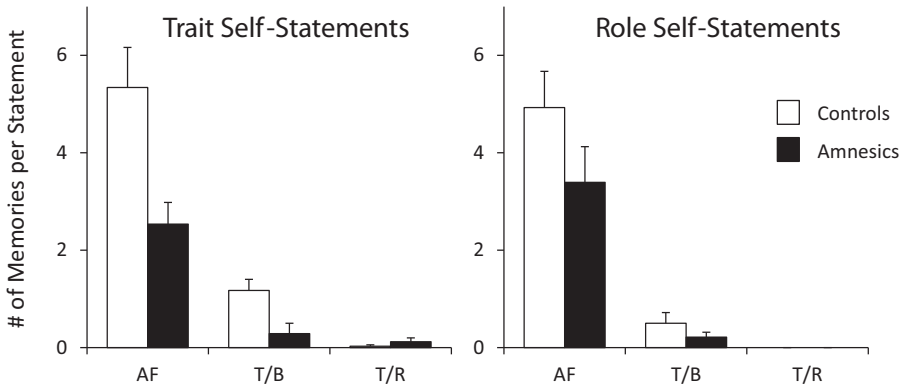

Fig. 2. Mean number of autobiographical fact (AF), thought/belief (T/B) and trait/role (T/R) memories generated per self-statement during the narrative task by amnesic participants and controls, separated by trait and role self-statements. Error bars depict the standard error of the mean.

Narrative task: use of details per supporting memory

This analysis was limited to details included in personal semantic memories, as episodic and general semantic memories were used infrequently. Figure 3 shows the number of personal and general semantic details generated per personal semantic memory.

For trait-supporting personal semantic memories, a 2 (group) by 2 (detail type: personal semantic *vs* general semantic) mixed ANOVA revealed main effects of group, F (1, 17) = 10.81, $P < 0.01$, $\eta^2 = .39$; detail type, F (1, 17) = 200.32, $P < 0.001$, $\eta^2 = 0.88$ and a significant interaction, F (1, 17) = 8.77, $P < 0.01$, $\eta^2 = 0.04$. Controls generated more personal semantic details per memory than amnesic participants, t (17) = 3.14, $P < 0.01$. The groups did not differ in their use of general semantic details, t (17) = 1.7, $P = 0.11$.

For role-supporting personal semantic memories, a 2 (group) by 2 (detail type) mixed ANOVA revealed a main effect of group, F (1, 12) = 16.36, $P < 0.01$, $\eta^2 = 0.58$; detail type, F (1, 12) = 122.90, $P < 0.001$, $\eta^2 = 0.85$ and a significant interaction, F (1, 12) = 10.42, $P < 0.01$, $\eta^2 = 0.07$. In comparison to controls, amnesic participants generated fewer personal semantic details per memory, t (12) = 3.67, $P < 0.01$, but not fewer general semantic details, t (12) < 1.

Episodic probe task: self-defining unique and repeated event memories

Figure 4 shows the number of unique and repeated event memories generated by participants for each I Am statement in the episodic probe task. Similar to the narrative data, trait and role self-statements were analysed separately. The episodic probe data were square root transformed prior to analysis because of unequal variance across groups.

For trait self-statements, there were significant effects of group, F (1, 17) = 120.05, $P < 0.001$, $\eta^2 = 0.86$; memory type, F (1, 17) = 14.37, $P = 0.001$, $\eta^2 = 0.34$; and a significant interaction, F (1, 17) = 10.06, $P < 0.01$, $\eta^2 = 0.25$. Amnesic participants generated fewer trait-defining unique events, t (17) = 8.59, $P < 0.001$, and fewer trait-defining repeated events, t (17) = 2.80, $P = 0.01$, than controls, but the difference between groups for unique events was more pronounced than that for repeated events.

For role self-statements, there was a significant effect of group, F (1, 12) = 9.91, $P < 0.01$, $\eta^2 = 0.37$; and a significant interaction of group and memory type, F (1, 12) = 5.98, $P < 0.05$, $\eta^2 = 0.30$; without a main effect of memory type. Amnesic participants generated fewer role-defining unique events than controls, t (12) = 3.74, $P < 0.01$. Amnesic participants and controls did not differ in their retrieval of role-defining repeated events, t (12) = 1.23, $P = 0.24$.

Discussion

In this study, we investigated how individuals with amnesia and healthy adults support their most defining self-statements in the context of an open-ended narrative task and an episodic probe task. There were three main findings: (i) amnesic and control participants primarily relied on the retrieval of personal semantic memories, in particular autobiographical facts, to support their self-statements in the narrative task; (ii) amnesic participants generated fewer personal semantic memories than control participants, a deficit that was more pronounced for trait self-statements and (iii) when probed for episodic memories, control participants retrieved unique events to corroborate their self-statements, but amnesic participants were less able to do so.

Results from the narrative task were only partially consistent with our hypothesis regarding the types of memory that would be used to support the self-concept. As predicted, amnesic patients relied almost exclusively on personal semantic memory to support their self-statements. However, contrary to our prediction, a similar predominance of personal semantic memory was seen in the control participants. At first sight, this result appears contradictory to prior research in healthy adults, which has shown a more robust role for episodic memory in supporting the self-concept (Rathbone *et al.*, 2011; Bennouna-Greene *et al.*, 2012; Martinelli *et al.*, 2013; Waters *et al.*, 2014). However, a major difference between our study and previous ones lies in the fact that in our narrative task participants were not explicitly instructed to retrieve specific memories. When instructions are more open-ended, it appears that healthy adults may turn to personal semantic memory to describe their defining features. These findings suggest that personal semantic memory holds a prominent role in supporting the self-concept, regardless of the status of episodic memory, and provide support for conceptual models of the self that propose that personal semantic memory includes information that is self-defining (Conway, 2005; Haslam *et al.*, 2011; Prebble *et al.*, 2013).

Comparing the narrative task performance of the amnesia group directly to that of the control group, we found that patients generated fewer personal semantic memories than controls, in particular when supporting trait self-statements. This impairment in self-supporting memories is not surprising, as

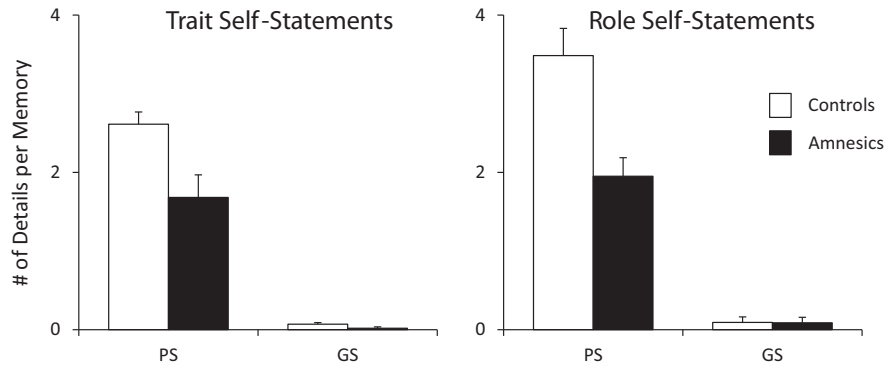

Fig. 3. Mean number of personal semantic (PS) and general semantic (GS) details incorporated into each personal semantic memory during the narrative task by amnesic participants and controls, separated by trait and role self-statements. Error bars depict the standard error of the mean.

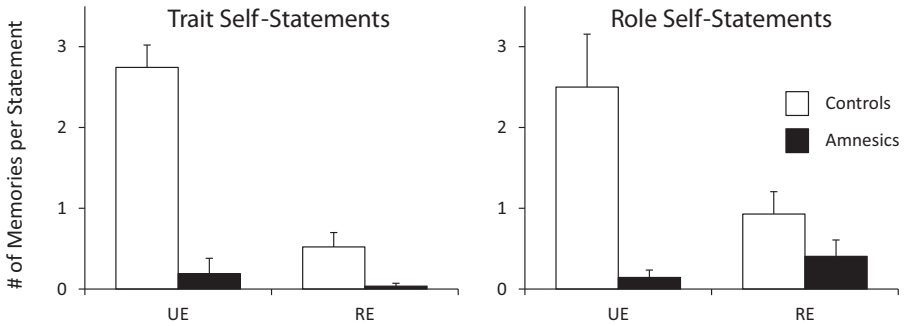

Fig. 4. Mean number of unique events (UE) and repeated events (RE) generated per self-statement during the episodic probe task by amnesic participants and controls, separated by trait and role self-statements. Error bars depict the standard error of the mean.

personal semantic memory is frequently compromised in individuals with amnesia, albeit not to the same extent as episodic memory (Grilli and Verfaellie, 2014). This is especially the case for autobiographical fact knowledge, which is the type of personal semantic memory both amnesic and control participants relied on most prominently. Moreover, neuropsychological research has shown that episodic memory can facilitate semantic memory retrieval (Greenberg and Verfaellie, 2010). Although the control participants used personal episodic memory sparingly in their narratives, episodic memories nevertheless may have promoted additional semantic memory retrieval, thus further exacerbating the impairment of the amnesic participants. It seems unlikely that the deficit in trait supporting personal semantic memory retrieval was simply due to impairment in the ability to construct a narrative response, since prior research has shown that individuals with MTL amnesia have no difficulty constructing narratives when information is perceptually available (Race *et al.*, 2011).

How then should we understand the fact that amnesic participants were better able to retrieve personal semantic memory to support role self-statements than trait self-statements? Prior research has shown that the life story is organized on the basis of 'chapters'—semantic memories that capture common themes of experiences that occur over extended periods of one's life (e.g. growing up in California; Thomsen, 2009). Chapters are thought to provide one avenue through which personal memory can be accessed. Because life-chapters center on broad themes such as work, education, life transitions and relationships (Conway and Pleydell-Pearce, 2000; Conway, 2005), they may have a stronger thematic link to roles than to traits. To the extent that patients use life-chapters as a cue for the retrieval of personal semantic memories, this would favor the retrieval of role-supporting memories over trait-supporting memories. Furthermore, given that chapters are highly conceptual, this may also explain why the role-supporting memories of amnesic participants were less detailed than those of control participants. However, this idea is speculative, as it is predicated on the assumption that amnesic patients can retrieve information pertaining to life chapters, which to our knowledge has not been directly studied.

Even without a privileged link to life chapters, there are two possible reasons why role-supporting memories may be accessed more easily than trait supporting memories. First, roles are considered to be more concrete (Rathbone *et al.*, 2008). Thus, role self-statements may directly cue the retrieval of more specific forms of memory, whereas traits may not (Klein and Lax, 2010). As such, roles may pose fewer demands on generative retrieval strategies, which are often involved in the search for personal memory (Conway, 2005), and are compromised in amnesic patients (Moscovitch and Melo, 1997; Verfaellie *et al.*, 2014). By this view, roles may provide amnesic patients more direct access to autobiographical facts than do traits. Further, the ability of the amnesic participants to retrieve some repeated event memories in support of their roles in the episodic probe task might similarly reflect the fact that roles provide a more concrete retrieval cue. Second, it has been suggested that the life script, which is general knowledge of the ordering and timing of experiences in a typical life, may guide retrieval of personal memories during construction of one's own life story (Berntsen and Rubin, 2002, 2004). Interestingly, research with healthy adults has shown that the life script is organized on the basis of common educational, social, intimate and occupational

transitions (e.g. college, marriage, first job, death of a loved one; Berntsen and Rubin, 2004). Thus based on the idea that the life script guides personal memory retrieval, individuals with amnesia may be able to use the life script to cue retrieval of personal semantic memories that are related to roles more easily than personal semantic memories that are related to traits.

It is noteworthy that the amnesic participants, despite being impaired in their ability to access autobiographical facts to support their self-statements, did not utilize other types of personal semantic memory that remain relatively preserved following MTL lesion, such as personal thoughts and beliefs (Grilli and Verfaellie, 2014). We recently suggested that autobiographical fact knowledge may represent an experience-near form of personal semantic memory that is distinct from, but shares mechanisms with, episodic memory (Grilli and Verfaellie, 2014). It is possible that the self-concept can be supported by semantic memories that remain closely associated with the personally significant experiences from which they were extracted, but not by more abstract semantic memories. Given that the controls also primarily relied on autobiographical facts, this implies that although healthy adults may not typically retrieve episodic memories to support the self-concept, they may rely on a type of self-defining semantic knowledge that can readily cue the retrieval of unique personal event memories if necessary, as Conway's (2005) generative retrieval model of autobiographical memory would suggest.

Consistent with the notion that individuals with intact memory can access self-supporting memories at different levels of specificity, control participants recalled primarily self-defining unique events when probed to do so in the episodic task. In contrast, the amnesic participants were not able to do so, with seven of the eight amnesic participants retrieving a total of one or fewer unique events. There is considerable evidence to show that amnesia results in episodic memory impairment (Cermak and O'Connor, 1983; Tulving, 1985; Corkin, 2002), but to our knowledge this study is the first to directly investigate the ability of individuals with MTL amnesia to access self-defining episodic memories. The results support prior qualitative reports from neuropsychological case studies to show that the connection between the self-concept and episodic memory appears to be severed in individuals with MTL amnesia.

With a primary focus on understanding how individuals with amnesia support their self-concept, this study leaves open several questions regarding how memory functions to allow people to construct a sense of self. For instance, this study did not aim to directly assess the veracity or centrality of the participants' self-statements. Nevertheless, we found that the amnesic participants were less likely to include traits in their top 4 self-statements in the 'I Am' task. Whether this finding is related to their difficulty generating trait-supporting semantic memories is unknown, but it is intriguing to speculate that amnesic participants did not prioritize self-defining traits precisely because their ability to retrieve trait-supporting semantic memories is particularly compromised. Future studies will need to examine this possibility. Another challenge for future research will be to elucidate the roles of different forms of memory in updating the self-concept. The self is a dynamic entity that changes with experience (McAdams, 2013), but the extent to which individuals with amnesia are capable of updating their core self-concept remains underspecified. Such knowledge may provide insight into the types of memory that contribute to the development of a self-concept, as well as to adaptive and maladaptive changes to the self. Moreover, this study only included 12 healthy adults and therefore the extent to which the self-concept is normally supported primarily by personal semantic memory remains to be further examined. Applying our open-ended narrative response task to a larger healthy sample will be particularly important for understanding the self-supporting function of episodic memory, as the results of this study raise the possibility that healthy individuals may use this type of memory only when directed to do so. In addition, our study did not include a condition where participants had to draw on memory to support their knowledge of other people's identities, and therefore whether the role of memory in supporting the self differs from its role in supporting knowledge of other people is uncertain. It also will be important for future research to investigate the clinical implications of these findings. For instance, given our finding that individuals with amnesia can ground the self in personal semantic memory, perhaps this type of knowledge can be capitalized on to boost wellbeing or self-continuity in amnesic patients as well as in individuals with other episodic memory disorders, such as Alzheimer's dementia (Rathbone *et al.*, 2015).

A limitation of this study is that we did not gather information regarding the time at which traits and roles or their supporting memories were formed. Investigating the temporal nature of self-defining traits and roles could elucidate the extent to which certain time periods from the personal life story are central to constructing the self-concept. Future research also could investigate whether self-defining traits and roles are grounded in personal semantic memories that coincide with the time when each trait and role emerged (Rathbone *et al.*, 2008).

In conclusion, although prior research has focused on investigating the contribution of episodic memory to the self, here we show that personal semantic memory plays an important role in supporting the self-concept as well. In particular, our findings suggest that personal semantic memory may be sufficient to maintain aspects of the self-concept (Tulving, 1993; Rathbone *et al.*, 2009; Klein and Lax, 2010; Haslam *et al.*, 2011), as the amnesic participants, despite a severe inability to ground the self-concept in episodic memory, were able to support their core identity via semantic memories. This study therefore lays the groundwork for future research focused on elucidating how semantic memory influences other self-related functions in healthy adults as well as in individuals with neurological disorders and mental health conditions. Although much remains unknown, this paper highlights that investigating the contributions of personal semantic memory and episodic memory to the self-concept may provide valuable insight for clinical, cognitive and social psychological research focused on understanding the relation of memory to the self.

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Supplementary data

Supplementary data are available at *SCAN* online.

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