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Episodic Memory and Imagination In Highly Superior Autobiographical Memory Individuals

For centuries the study of memory has been preoccupied with past recollection while ignoring its crucial role in planning the future. This is evolutionarily short-sited as it is logical that the systems of memory evolved because they conferred an advantage on an organisms' ability to survive and reproduce by anticipating favorable future situations (Klein 2013). Recently, it was discovered that patients with amnesia (resulting from hippocampal damage) who cannot recall episodic memories from their past similarly cannot construct future possible episodic memories (Tulving 1985). This striking result supports the theory that the hippocampus (which is a crucial structure in the recall of episodic memories) is not merely a mediator for the consolidation and recall of memory but rather a cognitive map in which events (recalled or internally generated) can be played out and observed (Maguire et al. 2013). Imagination is therefore a complementary system to episodic memory, which holds interesting prospects for future research. Individuals who experience strong imagination would presumably also experience vivid recollections of episodic memory and vice versa. There is a phenomenon of isolated enhanced episodic memory in people with Highly Superior Autobiographical Memory (HSAM) and this study aims to utilize their condition to illuminate possible relationships between memory systems and imagination.

Imagination is often viewed as a propensity for fantasy but it functionally plays an integral role in our day-to-day lives as evidenced by Endel Tulving in 1985 with his case study on K.C. (a patient with complete retrograde and anterograde amnesia resulting from a traffic accident). While exhibiting intact semantic memory, K.C. was not able to remember personal events before or after his accident and described the same kind of "blankness" when asked about his future plans. He seemed unable to imagine a timeline of his life and Tulving suggested that episodic memory was therefore crucial in what he referred to as "autonoetic consciousness" or the subjective experience of one's self in time. Interestingly, K.C. was perfectly capable at describing the concept of chronological time and he also exhibited some intact autiobiographical memory (e.g. what year his family moved and the names of schools he attended) although he recalled it with the same impersonal nature as other semantic facts. This finding supported the distinction Tulving made in 1972 between episodic and semantic memory by suggesting it is preserved in future-orientated processes.

The extension of neuropsychological dissociations between episodic and semantic memory from past to future were further supported in 2002 by Klein et al. in their case study of D.B. who exhibited amnesia for personally experienced past and future events but not non-personal events. D.B. was not able to consciously bring to mind any events before or after his accident (cardiac arrest with presumed anoxic encephalopathy) nor was he able to imagine future events in his life demonstrating significant deficits in his episodic memory. However, not only was D.B. able to recall facts about public figures and events he was also able to make non-personal predictions about events and issues in the public domain (e.g. environmental issues). Klein et al. proposed two distinct perceptions of time: the known past/future (an objective

chronology of the world) and the lived past/future (a subjective timeline of one's life), which correspond to semantic and episodic memory respectively. Amnesic patients who are no longer able to perceive lived time are still able to perceive known time and access their semantic memory to make predictions about the future which further distinguishes episodic and semantic memory.

The engagement of episodic memory involves an additional discrete neural system from semantic memory (including personal semantic memory of episodes of our lives e.g. name of your hometown), which is clearly evidenced in more recent studies of patients with impaired hippocampi who show intact semantic memory and impaired episodic memory. The hippocampus has had a historical role in the study of memory but this role has shifted in recent years from simple consolidation and retrieval to a complex cognitive map in which organisms can re-experience past events or simulate new ones to determine possible outcomes (Maguire et al. 2013). This provides the theoretical basis for the connection between episodic memory and imagination, as they both entail an internal simulation, which presumably utilizes the same neurological systems as a function of the conservative nature of evolution.

The neurological system underlying both past and future episodic memory undoubtedly involves the hippocampus because patients with amnesia resulting from hippocampal damage are unable to perform both tasks (Hassabis et al. 2007a). Furthermore, in healthy controls the neural circuitry engaged in episodic memory is also similarly engaged when subjects are asked to imagine new experiences (Hassabis et al. 2007). This connection, which is not present for tasks of semantic memory or prospection, requires extensive further research in both amnesic patients and healthy controls to be fully understood.

Impaired episodic memory is common in patients with amnesia but superior episodic memory is a rare phenomenon, which has recently been discovered in individuals with HSAM. These individuals are able to vividly recall a staggering number of episodes from each and every day of their lives (LePort et al. 2012). Interestingly, these individuals were significantly more likely than matched controls to remember false memories when induced in the lab, which researchers possibly attributed to their increased proneness for fantasy (Pathis et al. 2013). Although HSAM individuals have shown increased proneness for fantasy, the implications along with their enhanced episodic memory for the connection between episodic memory and imagination have not been explicitly studied.

This study aims to further illuminate the connection between episodic memory and imagination by using individuals with HSAM. The recent discovery of HSAM requires further investigation into the nuances of the abnormality and those investigations can be highly illuminating on the underlying processes of human memory. HSAM individuals present a rare opportunity to study memory through anomaly resulting in enhancement rather than impairment (in the case of neural damage or pathology) in order to present a contrast and possible double dissociation in the performance episodic memory and imagination to demonstrate their connection.

Methods

HSAM participants will be identified based on two objective measures of autobiographical memory, the Public Events Quiz (PEQ) in which subjects are given instances of public importance and respond with the date it occurred and the reverse 10 Dates Quiz (10DQ)

in which subjects are given dates and asked for the corresponding public events. On these measures controls may be accurately able to recollect a few dates but only HSAM individuals will be able to complete both measures with close to 100% accuracy. (LePort et al. 2012). Controls will be matched on age, education and IQ (determined by the Wechsler Adult Intelligence Scale).

Baseline imagination will be assessed first by fantasy proneness using the Creative Experiences Questionnaire, which is a series of yes/no questions that generates a score of 0-25 (Merckelbach et al. 2001). To assess episodic imagination participants will be asked to construct novel imagined experiences in response to short verbal cues that outline a range of simple commonplace scenarios and describe them in as much detail as possible. Their answers will be scored according to content (spatial reference, entity presence, sensory description, or thought/emotion/action), participant ratings of sense of presence and perceived salience as well as their own spatial coherence of the scene they created. The combined scores will be the experiential index used to compare the overall richness of HSAM participants with matched controls. (Hassabis et al. 2007a)

Results/Discussion

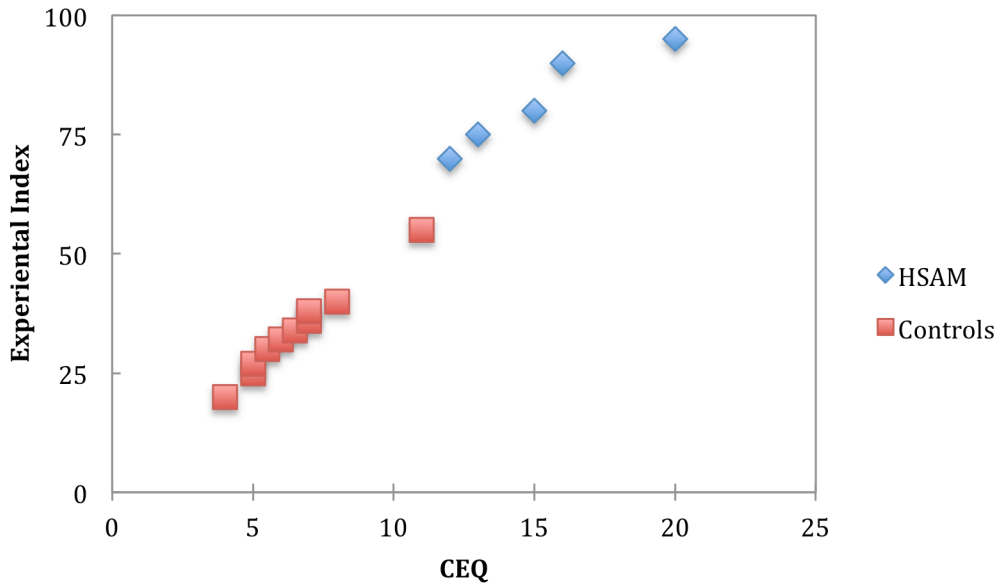

Figure 1. Participants' scores on the Experiential Index (generated from mean scores of imagined scenarios) and the Creative Experiences Questionnaire (to assess baseline imaginative proclivity).

The results showed a clear correlation between subjects' baseline imagination and their ability to simulate and describe commonplace imaginative scenarios involving themselves. Furthermore, HSAM participants scored significantly higher on the Experiential Index in correlation with their baseline imagination assessment (through the Creative Experiences

Questionnaire) as shown in Figure 1. This confirms the results of Pathis et al. (2013) who found that HSAM individuals score significantly higher than controls on the CEQ, which they used to attribute their increased false memories in the lab. These results suggest that HSAM participants are not only extremely capable of recalling past episodes with coherent and accurate spatial richness they are also better equipped to simulate future scenarios with a similar level of richness. This trend extended into the controls with those scoring highly on the CEQ similarly scoring highly on the Experiential Index, a correlation that has been previously undocumented. These results provide significant evidence for the underlying connection between imagination and episodic memory.

The previous paradigm of episodic memory as merely reliving discrete episodes in our past has been expanded to include the imagination of episodes in our future. This began with the significant discovery that amnesic patients who cannot remember past episodes similarly cannot simulate future possible in recent years scenarios involving themselves. In these patients, semantic memory (both past and future appears to be intact) suggesting that episodic memory engages an additional system that builds upon semantic understandings of chronological time in order to simulate episodes (both recalled and imaged). While episodic memory impairment has been tied to impairment in imaginative ability there has been no research into enhanced episodic memory and the effect on imagination. Individuals with HSAM provided the ideal participants to measure this phenomenon.

HSAM has been noted to include vivid recollections of personal past episodes and furthermore, a proneness to fantasy which already provide a basis for the connection between episodic memory and imagination. This study's results build on that connection by providing a concrete quantifiable relationship between the two systems in HSAM individuals and matched controls. The significant relationship between episodic memory and imagination is conserved across participant groups with HSAM patients scoring proportionally higher than controls on the Experiential Index based on their initial CEQ. This shows that regardless of neurological status (e.g. amnesia, HSAM) episodic memory inherently includes episodic imagination or the ability to imagine ourselves in future scenarios.

Previous research into human memory has often utilized individuals with memory disorders, most often amnesia, and HSAM provides an interesting opportunity to test episodic memory enhancement versus impairment. Possible research beyond this study should include neurological measures of HSAM individuals engaging in future episodic memory such as fMRI in order to compare hippocampal activity with contrasting amnesic patients. The current leading research into HSAM included such measures but failed to address future-oriented episodic memory and personal imagination beyond fantasy proneness. As more information about this disorder emerges it should be contextualized by the connection between superior episodic memory and superior imagination.

The systems of human memory and human imagination and their inherent connection bear significant evolutionary implications that are supported by current evidence. Future-oriented episodic memory or the ability to imagine ourselves in novel situations is a clear evolutionary advantage that can aid in intelligent decision making however it is too often obscured in the modern study of human memory. An integrative approach to memory research is needed that considers the correlation between episodic memory and imagination either by modifying pre-established methods with measures on imagination and future memory (such as the Experiential Index and CEQ) or by creating new methods that specifically test the relationship. Studies such as this one aim to bring memory research into a new age beyond retrospection and recollection

into a complementary relationship with prospection and imagination that should be considered in future research.

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