



Commentary

Future-oriented simulations: The role of episodic memory

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Over the past several years, there has been considerable interest in the functions of memory beyond simply remembering the past, with a focus on the ability to imagine the future. With various lines of evidence suggesting significant parallels between memory and imagination, an emerging view is that imagining the future is a key adaptive function of memory (Boyer, 2008; Schacter, 2012; Schacter & Addis, 2007; Suddendorf & Corballis, 1997, 2007; Tulving, 2005). Klein's Target Paper (2013) crystallizes this view on the function of memory and its temporal orientation: that although memory represents the past, it is used primarily in ways that are oriented towards the future. Imagining episodic simulations of events in one's personal future is but one instantiation of this function.

Klein's main argument regarding the prospective function of memory is very much in line with our own views concerning what we termed the "prospective brain" (e.g., Schacter, Addis, & Buckner, 2007). Consistent with this view, people frequently engage in future simulations in everyday life (D'Argembeau, Renaud, & Van Der Linden, 2011), and memory-based simulations of future events serve a number of important functions, including facilitating various kinds of goal directed behaviors (e.g., D'Argembeau & Mathy, 2011; Sheldon, McAndrews, & Moscovitch, 2011; Taylor, Pham, Rivkin, & Armor, 1998), supporting farsighted decision making (e.g., Benoit, Gilbert, & Burgess, 2011; Boyer, 2008; Peters & Büchel, 2010), and contributing to psychological well being (Brown, MacLeod, Tata, & Goddard, 2002; Crisp & Turner, 2009; for detailed

review and discussion, see Schacter, 2012). However, one point of divergence concerns the relative contributions of episodic and semantic memory to the simulation of the future. Klein asserts that "there is no principled (or empirical) reason to suppose that semantic memory cannot and does not make available the same memory content (who, what, where and when) as does episodic memory" (p.26). We think a qualification to this claim is necessary; specifically, the degree to which episodic memory is essential depends on the type of future-oriented thought. In many situations, a schematic representation of the future will suffice, and semantic memory alone should provide adequate memory content. However, if dynamic future simulations are needed to mentally 'play out' upcoming events, then episodic memory would be crucial to provide the vivid, experiential detail characteristic of this type of future-oriented thought. Moreover, we have argued that the flexibility afforded by the episodic memory system facilitates the integration of disparate details into *episodic* simulations that can be used to explore the consequences of future behaviours and situations (Schacter & Addis, 2007). And indeed, the neural network supporting episodic memory – including structures mediating associative processes, such as the hippocampus – appears to be critical in supporting the construction of vivid simulations (Addis & Schacter, 2012; Buckner & Carroll, 2007; Schacter et al., 2007).

This is not to say that semantic memory is unimportant in the construction of episodic simulations. Indeed, semantic memory appears to be involved in related processes, such as autobiographical memory, which typically comprises elements from both episodic and semantic memory (Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002) and engages the semantic memory network during retrieval (Binder, Desai, Graves, & Conant, 2009).

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Similar interplay between semantic and episodic systems is apparent during the construction of future simulations. A ubiquitous finding from neuroimaging studies is that the construction of future simulations recruits lateral temporal regions thought to underpin semantic memory (for review, see Schacter et al., 2012). These lateral temporal regions can be up-regulated in populations experiencing declines in episodic memory, such as older adults (Addis, Roberts, & Schacter, 2011), possibly reflecting a tendency to ‘flesh out’ future-oriented thoughts with increasing amounts of semantic information as episodic memory becomes more sparse (Addis, Wong, & Schacter, 2008). Work with neuropsychological patients has also provided support for the interplay between episodic and semantic memory. In a recent study, Irish and colleagues found that although semantic dementia patients showed no significant impairments of episodic memory, their ability to generate detailed future simulations was significantly compromised (Irish, Addis, Hodges, & Piguet, 2012). Importantly, this deficit in episodic future detail was specifically associated with impaired semantic memory as well as atrophy in anterior lateral temporal cortex. Thus, even when episodic memory is available, it is not alone sufficient to facilitate the generation of detailed episodic simulations of the future. This observation highlights the important role of semantic memory, which likely provides the framework necessary for imagining such detailed simulations.

Can we experimentally isolate the contributions of episodic memory to the construction of future simulations? Recent evidence suggests that the contributions from episodic memory to future simulation may be dissociable from contributions made by other processes, including semantic memory. Madore et al. (2013) used an episodic specificity induction to investigate whether it is possible to selectively enhance the episodic processes that, according to the constructive episodic simulation hypothesis (Schacter & Addis, 2007), contribute to the simulation of future events. Participants watched a video consisting of everyday actions, and were then given either the episodic specificity induction, which was comprised of items from the Cognitive Interview (Fisher & Geiselman, 1992) that required participants to retrieve specific episodic details from the video, or a control induction that required participants to provide general thoughts and impressions concerning the video. After each induction, participants were presented with a series of pictures, and for each one either remembered a related past personal experience, imagined a related possible future experience, or described the picture. Relative to the control induction, the episodic specificity induction resulted in an increase in the number of episodic details comprising memories and future simulations, but the induction had no effect on non-episodic details. Moreover, performance on the picture description task was not influenced by the induction, confirming that this induction was selective to tasks with a reliance on episodic memory.

A theme throughout Klein’s paper is that memory is *of* the past but *about* the future, the implication being that memory is primarily oriented towards the future. However, the temporal orientation of memory may not be that clear-cut, especially given evidence of differences between the remembered past and the imagined future (for reviews, see Schacter et al., 2012; Szpunar, 2010). A number of studies report distinct patterns of neural activity for simulations and memories, including increased hippocampal activity during future relative to past events (Addis & Schacter, 2012). Moreover, others have reported differential deficits for future relative to past tasks in older adults (Rendell et al., 2012) and patients with Parkinson’s disease (de Vito et al., 2012). This evidence suggests, as Tulving is quoted in the *Target Paper* (Klein, 2013) as saying, that episodic recollection can be distinct from future-oriented thought.

This point brings into sharp relief a significant caveat to Klein’s main thesis: that episodic memory can be *of* the past and *about* the future or *about* the past. What, then, are the other functions

of episodic recollection, if not solely to enable future-oriented thought? One possibility is that memory facilitates the construction and maintenance of identity. In a novel framework mapping autobiographical memory to distinct facets of the self, Prebble, Addis, & Tippett (2013) argue that episodic recollection is particularly important for the sense of the self as temporally extended over time (see also, Klein, 2010; Klein, Loftus, & Kihlstrom, 2002, for a similar view). Episodic memory links the present moment with the past experience in a way that provides unequivocal evidence that “my past” was experienced by “me”. When coupled with episodic simulation, this “phenomenological continuity” of the self can also be extended to the future. Our sense of the past, as conveyed by episodic memory, may be as important to our humanness as our ability to use memory to comprehend the future.

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