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# What differentiates episodic future thinking from complex scene imagery?

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ABSTRACT

We investigated the contributions of familiarity of setting, self-relevance and self-projection in time to episodic future thinking. The role of familiarity of setting was assessed, in Experiment 1, by comparing episodic future thoughts to autobiographical future events supposed to occur in unfamiliar settings. The role of self-relevance was assessed, in Experiment 2, by comparing episodic future thoughts to future events involving familiar others. The role of self-projection in time was assessed, in both Experiments, by comparing episodic future thoughts to autobiographical events that were not temporal in nature. Results indicated that episodic future thoughts were more clearly represented than autobiographical future events occurring in unfamiliar setting and future events involving familiar others. Our results also revealed that episodic future thoughts were indistinguishable from autobiographical atemporal events with respect to both subjective and objective detail ratings. These results suggest that future and atemporal events are mentally represented in a similar way.



## 1. Introduction

Episodic Future Thinking (EFT) refers to our ability to pre-experience the future by simulating it in our minds (Atance & O'Neill, 2001). Until recently, most of the research on EFT focused on better characterizing the similarities and the differences between EFT and memory. Converging evidence from cognitive, neuropsychological, and neuroimaging studies indicates that these two processes rely indeed on common psychological and neural processes (for reviews, see Buckner & Carroll, 2007; Hassabis & Maguire, 2007; Schacter, Addis, & Buckner, 2007, 2008; Szpunar, 2011). Yet, there has been little consideration of what makes EFT a distinct process that differentiates it from the related concept of complex scene imagery. Both tasks involve, indeed, the process of "scene construction", which refers to the generation, maintenance and visualization of a complex spatial setting in which an event (real or imaginary) can be mentally experienced (Hassabis & Maguire, 2007). Note that this kind of complex "scene" imagery differs markedly from "object" imagery (e.g., for faces or single objects), in that it requires the binding of disparate (possibly multimodal) elements of a scene into a coherent whole (Hassabis, Kumaran, & Maguire, 2007). Hassabis and Maguire (2007) hypothesized that scene construction is a core process that underlies a host of cognitive functions that crucially rely on constructing, maintaining and visualizing complex scenes such as, for example, autobiographical memory, EFT, imagination, spatial navigation, and that this can account for a large proportion of the overlapping network found in neuroimaging studies of these functions.

Given that EFT and autobiographical memory are tightly intertwined, our quest for the key aspects differentiating EFT from complex scene imagery should start from considering what differentiates a retrieved autobiographical event (i.e., remembering my last summer barbecue on a Greek beach) from an imagined complex scene (i.e., imagining to walk in a

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tropical jungle). Most of us would agree that is it the subjective sense of time, the connection to the self, the feelings of familiarity and a special kind of consciousness, termed autonoetic consciousness that enable one to be aware of the self in subjective time (Tulving, 2002). These elements may be present in imagined fictitious experiences either to a much lesser extent or not at all (Hassabis, Kumaran, Maguire, 2007). Similarities and differences between complex scene imagery and autobiographical memory are well documented in a neuroimaging study of Hassabis, Kumaran, Maguire (2007). These authors showed that a distributed brain network involving the hippocampus, parahippocampal gyrus, retrosplenial cortices, posterior parietal cortices, and ventromedial prefrontal cortex was recruited during both autobiographical memory recall and recall of previously constructed fictitious experiences that were well-matched for difficulty, age, detail and vividness. These specific conditions were investigated because the comparison between them allowed us to partial out the effects of scene construction, and to ask which brain regions underlie the special properties of autobiographical memory. Activation of specific brain areas, i.e., the posterior cingulated cortex, the anterior medial prefrontal cortex, and precuneus, was indeed observed only during episodic memory recall, suggesting that these regions may support functions reflecting self-projection in time, self-relevance and sense of familiarity that are specific to autobiographical memory over and above scene construction (Tulving, 2002).

As noted by Hassabis, Kumaran, Maguire (2007), the pattern of activation specific to autobiographical memory resembles the network found to support EFT (e.g., Addis, Wong, & Schacter, 2007). One may, therefore, argue that recalling past experiences and thinking about plausible, autobiographical future events share the same key, defining processes. Indeed, when individuals remember past or simulate future events, they imaginatively place themselves into specific settings that are temporal in nature (settings that pertain to their past and to their future). Furthermore, when envisioning events that will occur in the future, especially in the near future, individuals imagine themselves in the context of familiar settings (e.g., Gamboz, Brandimonte, & De Vito, 2010). This is not to say that familiarity of setting is a defining feature of EFT, as it is for autobiographical memory. We can indeed pre-experience an event expected to occur somewhere we have never been before and, still, scene construction is surely not restricted to events represented in unfamiliar settings. However, empirical evidence indicates that familiarity of setting is indeed an important modulator of the characteristics of EFT (e.g., Szpunar & McDermott, 2008).

The specific contribution of self-projection in time and self-relevance over and above the role of scene construction in EFT is currently rather speculative. For instance, does mentally projecting an imaginary event into the future make it any different from imagining an event not temporal in nature (e.g., ''Imagine walking in a sunny garden next year'' vs. ''Imagine walking in a sunny garden'')? Similarly, is there any difference between imagining oneself doing an activity and imagining familiar others doing the same activity (e.g., ''Imagine walking on the beach next year'' vs. ''Imagine Silvio Berlusconi walking on the beach next year'')? So far, only a few studies have provided initial insights into this issue. With respect to the role of the temporality of imagined events in EFT, Hassabis, Kumaran, Vann, and Maguire (2007) reported that five memory-impaired patients with a bilateral hippocampus damage had difficulty in constructing novel events. Their imagined experiences were deficient in spatial coherence, relative to controls, resulting in their constructions being fragmented and lacking in richness. Hassabis, Kumaran, Vann, Maguire (2007) tested patients and controls on both episodic future thinking scenarios (e.g., imagining a possible Christmas event) and atemporal imagined scenarios (e.g., ''Imagine you are standing in the middle of a bustling street market''). No difference in descriptions was found. This result suggests that atemporal and future imagined events may be represented in a very similar way. The suggestion of Hassabis and Maguire (2007, 2009) is that the timestamp of an event, imagined or remembered, should not be elevated to the status of a key property of recollection and prospection, as some suggested (e.g., Buckner & Carroll, 2007; Tulving, 2002), but rather it should be considered as a piece of semantic knowledge that might or might not be included or logically deduced at the point an event is remembered or imagined. This view is surely quite radical but, nevertheless, it draws attention to the need to clarify the status of the temporal nature of mental representations of events.

Concerning the contribution of self-relevance to EFT, in a neuroimaging study (Szpunar, Watson, & McDermott, 2007) the core brain network common to past and future thinking was found to show greater activation when participants envisioned their personal future (or recollected their past) as compared with a control task requiring participants to imagine a familiar individual participating in life-like events with no explicit temporal reference (Bill Clinton at his birthday). This result thus highlights a neural differentiation between envisioning a personal future experience and imagining the experience of someone else. However, given that the two types of mental representations included in Szpunar et al.'s (2007) study differed also with respect to the temporality of the imagined events, the unique and specific contribution of selfness to EFT still remains to be defined.

As for the role played by the familiarity of setting in EFT, it is clear that humans can mentally simulate virtually infinite future possibilities, up to the extreme situation of imagining or even daydreaming about unlikely events. However, as noted by Szpunar (2010), episodic future thoughts generally revolve around the short-term concerns of participants (D'Argembeau et al., 2009; Spreng & Levine, 2006). Accordingly, the contents of episodic future thoughts are typically characterized by familiar contextual information (e.g., Gamboz et al., 2010). When participants are prompted by the experimenter to imagine autobiographical future events occurring in unfamiliar settings (e.g., Jungle, North Pole, Great Wall of China), their representations are rated as containing less sensorial details, as occurring in a less clear context, and as having a weaker subjective experience as compared to when they engage in episodic future thoughts occurring in familiar contexts (e.g., home, friend's apartment, pub; Szpunar & McDermott, 2008). It has also been shown that the regions within the posteromedial parietal cortex and the medial temporal lobes, typically engaged when individuals imagine themselves in familiar contexts (or retrieve