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Cognitive approaches to the study of episodic future thinking

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The concept of episodic future thinking—the ability to simulate events that may take place in the personal future—has given rise to an exponentially growing field of research that spans a variety of sub-disciplines within psychology and neuroscience. In this introduction to the special issue, we provide a brief historical overview of factors that have shaped research on the topic and highlight the need for additional behavioural work to uncover cognitive mechanisms that support episodic future thinking and differentiate it from other related modes of future-oriented cognition. We conclude by discussing the manner in which the various contributions to the special issue fill the gaps in our knowledge and make some of our own suggestions for future work.

Keywords: Episodic future thinking; Episodic memory; Prospection; Future-oriented cognition.

Memory does not primarily exist to think about the past. It primarily exists to help us know what to do in the present and to plan for the future. On a daily basis, people spend considerable time turning their attention away from the immediate environment and focusing instead on events that have yet to transpire, such as upcoming meetings, trips, or chores. Indeed, a recent study estimated that healthy human adults think about the future an average of about 60 times per day with many of those instances of future thinking focusing on specific events (D'Argembeau, Renaud, & Van der Linden, 2010). Social and clinical psychologists have long been interested in this ubiquitous feature of human cognition and in particular in the manner in which the ability to evaluate the future often fails. For instance, social psychologists have identified various biases in mental simulation that limit our ability to predict how future events will make us feel (e.g., Gilbert & Wilson, 2007). At the same time, clinical psychologists have focused on how thinking about the future may change in the context of mood and anxiety disorders (e.g., Miloyan, Bulley, & Suddendorf, in press). Despite all this, it was not until relatively recently that cognitive psychologists and neuroscientists began to pay attention to the future and how the human brain/mind supports our ability to think about it. Here we provide a brief exposition of what episodic future thinking is, how it has been studied, and what we know about it to date. This provides a basis for understanding and integrating the various topics covered by articles in this special issue of the *Quarterly Journal of Experimental Psychology*, which has been created to introduce and attract research to this emerging topic in the field.

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Background and motivation

Interest in thinking about the future from a cognitive perspective has its roots in the seminal observations of Tulving (1985), who wrote about an amnesic individual with no episodic memory who was unable to remember events from his personal past or imagine events that might take place in his personal future. About a decade later, Suddendorf and Corballis (1997) suggested that the capacity to engage in mental time travel into the personal past and future may be a uniquely human ability, an idea that continues to be hotly debated in the literature (Corballis, 2013; Suddendorf, 2013). A few years later, Atance and O'Neill (2001) formally dubbed the ability to simulate personal future events as *episodic future thinking*. More recently, additional findings from neuroscience and cognitive psychology have continued to support the claim that episodic memory and episodic future thinking may represent two sides of a single overarching capacity. For instance, Klein, Loftus, and Kihlstrom (2002) described a case of amnesia in which an individual lost the ability to remember the personal past and imagine the personal future, but retained the ability to think about the past and future in non-personal ways. Okuda et al. (2003) used positron emission tomography (PET) imaging to show that thinking about the past and future evoke similar patterns of neural activity. Finally, D'Argembeau and Van der Linden (2004) demonstrated that events imagined as occurring in the near past or future (e.g., past or next day or month) are mentally represented in more detail than events imagined as occurring in the distant past or future (e.g., past or next year), while Spreng and Levine (2006) found that people generally tend to spend more time thinking about past and future events that are temporally near than about those that are temporally distant.

Despite the growing evidence connecting the personal past and future, interest in the cognitive and neural mechanisms that give rise to the ability to simulate future events did not galvanize until early 2007. At that time, three articles were published that provided unique insights into the close connection between the personal past and future at a neural level. Whereas Tulving (1985) and Klein et al. (2002) both reported deficits of episodic memory and episodic future thinking in amnesia, their patients were respectively characterized by brain damage that was distributed across the entire brain or indeterminate. Because of this, it was difficult to know for certain which part(s) of the brain were responsible for the coinciding deficits of episodic memory and future thinking. Hassabis, Kumaran, Vann, and Maguire (2007) provided clarity on this issue by demonstrating similar patterns of deficits in memory and future thinking in patients whose brain damage was largely limited to the hippocampus. Although the role of hippocampus in future thinking continues to be refined (for a detailed review, see Addis & Schacter, 2012), the results of Hassabis et al. (2007) shed light on which neural structure is vital to the relation between episodic memory and future thinking.

At about the same time as Hassabis et al. (2007), two separate neuroimaging studies were published that showed that a close neural relation between memory and future thinking could be attributed to thoughts about specific past and future events. While prior work by Okuda et al. (2003) had found similar patterns of activity associated with thinking about the past and future, that study used a blocked design during which participants were told to generate many thoughts about the past or future. Moreover, there was little assurance that the past and future events that were generated were specific as opposed to general or semantic. Addis, Wong, and Schacter (2007) and Szpunar, Watson, and McDermott (2007) expanded on the Okuda et al. (2003) work and made use of event-related experimental designs that ensured that participants thought about specific past and future events. Importantly, these latter studies reported results supporting the idea that specific or episodic memories and future thoughts engage a common core network of brain regions (for a recent review, see Benoit & Schacter, 2015).

Taken together, the neuropsychological and neuroimaging results relating the past and future led to the suggestion that one adaptive function of human memory, and of episodic memory in

particular, may be to provide the building blocks for constructing mental representations of the future (Schacter & Addis, 2007), along with other memory-based modes of cognition (Buckner & Carroll, 2007). This hypothesis has served as the driving force for much of the research that followed. For instance, studies of individuals with underdeveloped and impoverished episodic memory, such as young children and older adults, have reported deficits in episodic future thinking (e.g., Addis, Wong, & Schacter, 2008; Atance, 2008). Similarly, studies of individuals with varying degrees of episodic memory impairment, such as Alzheimer's disease (Addis, Sacchetti, Ally, Budson, & Schacter, 2009), mild cognitive impairment (Gamboz et al., 2010), schizophrenia (D'Argembeau, Raffard, & Van der Linden, 2008), and posttraumatic stress disorder (Brown et al., 2013), have likewise demonstrated deficits of episodic future thinking. In general, limitations in the ability to extract details of past experiences from episodic memory are associated with an inability to generate detailed simulations of future events, supporting the hypothesis that episodic memory serves as the basis for episodic future thinking.

In terms of functional brain imaging, dozens of studies have now replicated the finding that a common core set of brain regions support both episodic memory and episodic future thinking (Benoit & Schacter, 2015). Presently, cognitive neuroscientists are working diligently to identify how various regions within this network support various aspects of simulated events (e.g., people, places, objects, scenarios; Hassabis et al., 2014; Szpunar, St. Jacques, Robbins, Wig, & Schacter, 2014), the extent to which various regions may serve multiple functions in the context of simulating future events (e.g., encoding, detail recombination, retrieval; e.g., Addis & Schacter, 2012), the manner in which this common core network may interact with other networks in the brain to achieve goal-directed cognition (Spreng, Stevens, Chamberlain, Gilmore, & Schacter, 2010), and how structural and functional abnormalities associated with this network may be associated with limitations in the ability to simulate the future (Hach, Tippett, & Addis, 2014).

An important point to take away from the last decade of research on episodic future thinking is the strong contribution from the cognitive neurosciences. This is not too surprising given that the close neural overlap associated with thinking about specific past and future events seems to have driven interest in the area. Regardless, many such studies have also made important advances in terms of the cognitive paradigms that have been developed to study episodic future thinking. For instance, initial studies of episodic future thinking largely used cueing techniques that employed pre-existing stimuli, such as common nouns, to evoke memories and simulations of the future, much like studies of autobiographical memory (Crovitz & Schiffman, 1974). More recently, researchers have become interested in ensuring that participants are generating truly novel future events. The experimental recombination procedure, which involves randomly rearranging participant-generated lists of familiar people, places, and objects into unique simulation cues, was developed specifically for this purpose (Addis, Pan, Vu, Laiser, & Schacter, 2009; for variations on this technique, see Szpunar, Addis, & Schacter, 2012).

In addition to developing novel research paradigms, researchers have also amassed a number of techniques for assessing the quality of simulated events. For instance, Hassabis et al. (2007) developed a measure for assessing the spatial coherence associated with imagined events, an approach that has since been applied to the study of episodic future thinking in other populations (e.g., D'Argembeau et al., 2008). Other lines of research have borrowed methods from the autobiographical memory literature, such as the autobiographical interview (Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002), which assesses the extent to which participant descriptions of past and future events are characterized by specific or extraneous details (e.g., Addis et al., 2008).

Nonetheless, primarily cognitive studies of episodic future thinking are somewhat lagging behind the quantity of research emerging from the neurosciences. This difference may often be recognized in the number of presentations on the topic at

national conferences devoted to the neurosciences and cognitive psychology. The purpose of this special issue is to spur further interest in the development of cognitive studies of episodic future thinking. In this context we highlight recent approaches to the study of episodic future thinking from a largely cognitive standpoint, such as studies of the frequency with which people think about the future (D'Argembeau et al., 2010), techniques for enhancing the specificity with which people are able to simulate the future (e.g., Madore, Gaesser, & Schacter, 2014), and considerations of how episodic future thinking may interact with other modes of future-oriented cognition (e.g., Brewer & Marsh, 2009). Next, we provide additional details of specific contributions.

Contents of this issue

As we alluded to earlier, prior work has demonstrated that people spend considerable portions of their days thinking about the future (D'Argembeau et al., 2010). Among the many interesting findings to emerge from this survey is that most thinking about the future has a strong emotional component. The special issue begins with an extension of this survey approach for identifying characteristics of future thinking in everyday life. In particular, Barsics, Van der Linden, and D'Argembeau (2016) present results from a diary/laboratory study that further serves to outline the frequency and characteristics of emotional future event simulations in daily life.

Next, van Mulukolm, Schacter, Corballis, and Addis (2016) focus on the role of constructive processes in episodic future thinking via the experimental recombination procedure (Addis, Pan et al., 2009). Specifically, the authors demonstrate a novel use of the paradigm whereby personal information from different social spheres may be variably re-organized to manipulate the ease with which participants are able to generate novel simulations of future events. This unique twist on the experimental recombination procedure may hold promise for further developing our understanding of factors involved in making judgments about the future as the approach provides an easy way to manipulate the perceived plausibility of simulated events.

Keeping with the theme of constructive processes involved in episodic future thinking, McDermott, Wooldridge, Rice, Berg, and Szpunar (2016) set out to assess whether a similar or different constructive process may underlie the construction of memories and future events. In particular, the authors assess the visual perspective(s) that people adopt as they remember the past and imagine the future in the third person: perspectives that could have never occurred or could never occur and so must be constructed (for further reading, see Rice & Rubin, 2011). Interestingly, the distribution of third-person perspectives in the context of remembering and episodic future thinking turns out to be highly similar, suggesting that a common constructive mechanism underlies mental time travel into the past and future.

It is important to keep in mind that not all thoughts about the future require effortful processing, and that direct or spontaneous processes also play a role in this context. Jeunehomme and D'Argembeau (2016) demonstrate that the commonly used word-cueing paradigm can elicit thoughts about memories and future events that come to mind in a direct manner. Notably, Jeunehomme and D'Argembeau highlight that future thoughts that come to mind with little effort are likely to have been previously thought about before (Ingvar, 1985; Szpunar, Addis, McLelland, & Schacter, 2013) and are emotionally laden. Cole and Berntsen (2016) focus on the related concept of involuntary instances of memory and future thinking, whereby future events come to mind not only with little to no effort but also in times when the individual is not necessarily attempting to think about the future. Interestingly, Cole and Berntsen demonstrate that involuntary thoughts about the future may nonetheless be goal directed, a finding that resonates well with recent findings in the cognitive neuroscience literature that instances of mind wandering, often characterized by thoughts about the future (Stawarczyk, Cassol, & D'Argembeau, 2013), evoke activity in both core regions involved in representing simulated events (Benoit & Schacter,

2015) and frontoparietal control regions involved in goal-directed cognition (Fox, Spreng, Ellamil, Andrews-Hanna, & Christoff, 2015; see also Spreng et al., 2010).

As mentioned earlier, recent advances in the behavioural study of episodic future thinking include attempts to enhance the extent to which people are able to simulate the future in a specific manner. Madore et al. (2014) showed that a brief cognitive interview about a recent experience can be used to induce people to generate more detailed simulations of the future and that such an induction can selectively increase specific details associated with the event as opposed to extraneous details that may be irrelevant to the event (cf. Levine et al., 2002). Madore and Schacter (2016) replicate and extend their earlier findings using a novel set of stimuli and control conditions, thereby demonstrating the generality of their results. The authors discuss the potential implications of their induction procedure for improving performance on daily future-oriented tasks, such as planning.

Indeed, the extent to which detailed simulations of the future may enhance planning and other future-oriented tasks represents a topic of growing interest in the field (Szpunar, Spreng, & Schacter, 2014). This movement to broaden our understanding of episodic future thinking and its relation to future-oriented cognition is well represented by several contributions to the special issue. For instance, Renoult, Kopp, Davidson, Taler, and Atance (2016) focus on the biases that typically pervade predictions about the future, which many have argued are based on incomplete simulations of the future (e.g., Gilbert & Wilson, 2007). Terrett et al. (2016) assess the role of episodic future thinking in improving prospective memory performance. This latter study replicates considerable prior work showing that episodic simulation can in fact enhance the extent to which people remember to perform specific actions in the future (e.g., Brewer & Marsh, 2009). Importantly, Terrett et al. provide the first evidence that the relations between these modes of future thinking can differ as a function of age.

Whereas most researchers have focused on the manner in which memory facilitates the ability to think about the future, a number of contributions to this special issue address the manner in which memory may actually limit future thinking or the manner in which future thinking may limit memory for related events. Cordonnier, Barnier, and Sutton (2016) show that memory, albeit in the form of scripted knowledge, may constrain simulations generated in the context of a future planning task (for other recent discussions of the role of scripted or semantic knowledge to future thinking, see Irish & Piguet, 2013; Klein, 2013; Szpunar, 2010). Ditta and Storm (2016) test the assumption that memory and future thinking are closely related to one another by assessing the extent to which the generation of future events may actually reduce the accessibility of related autobiographical experiences in memory. Giebl, Storm, Buchli, Bjork, and Bjork (2016) extend this viewpoint by assessing correlations between an index of retrieval induced forgetting and the propensity for individuals to generate positive as opposed to negative future events. While the results of this latter study raise interesting insights into the positivity biases that commonly characterize memory (Walker & Skowronski, 2009) and future thinking (Szpunar et al., 2012), the reported data also call for more work to establish causal links between measures of retrieval-induced forgetting and positivity in event cognition.

Although the special issue does not focus much attention on developmental perspectives in episodic future thinking (Atance, 2008), Davis, Suddendorf, and Cullen (2016) introduce a unique approach to the study of episodic future thinking in young children. In particular, the authors assess the role of practice in improving performance in future tasks. As with most demonstrations of episodic future thinking in young children, practice must be demonstrated in an objective manner as the ability to discuss future-oriented behaviour is still developing at an early age. Overt practice of task performance may turn out to represent an important advance for gaining insights into the prospective abilities of young children.

The special issue concludes with a contribution from Klein (2016) that asks readers to consider the central role of autonoetic consciousness—the

capacity to be aware of subjective time—in episodic future thinking. Specifically, Klein argues, as Tulving (1985) had done so previously, that the ability to sense subjective time is central in enabling the capacity to mentally travel into the personal past or future. Although research on the concept of autonoetic consciousness is lacking in the literature (but see, Nyberg, Kim, Habib, Levine, & Tulving, 2010; Piolino et al., 2003), it is our hope that this thoughtful piece from Klein will help to inspire researchers to develop novel techniques that may be used to advance the study of this ubiquitous mental phenomenon.

Moving forward

The study of episodic future thinking represents a unique opportunity for psychologists and neuroscientists from various disciplines to come together in the study of a psychological concept that has far-reaching implications for adaptive behaviour. A deeply rooted understanding of the cognitive mechanisms that support episodic future thinking will serve to advance our understanding of how the brain supports this important capacity, limitations associated with using this capacity to predict the future, its developmental trajectory, and the manner in which this capacity may break down in various neuropsychological, mood, and anxiety disorders. The contents of this special issue are intended to highlight novel developments in the study of episodic future thinking from a cognitive perspective and also to hopefully serve as an impetus for additional work.

It is also hoped that a greater awareness of this topic will be helpful to researchers who study other areas of cognition that may be aided by the insights from work on episodic future thinking. For example, this area of research could be helpful to studies of event cognition (cf. Radvansky & Zacks, 2014). As one example of this, research on narrative creation, the production of fictional alternative worlds, is likely to involve processes that are similar to the imagining of future events. Also, when using event models to help solve problems, one would need to imagine future states to help determine whether they could be helpful or harmful to the process of problem solving. Finally, the ability or inability people have in imagining possible future events surely plays a role in how people come to make decisions and to reason about the world (but see, Rosenbaum et al., in press). Even this sampling shows the potential value of work on episodic future thinking to a wide variety of aspects of cognition in general.

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