CHAPTER TWO

The Role of Context in Understanding Similarities and Differences in Remembering and Episodic Future Thinking

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Abstract

Remembering events from one's lifetime (autobiographical remembering) and envisioning events one might experience in the future (episodic future thought) call upon many similar cognitive processes, yet humans can routinely distinguish between the two. How can we understand their similarities and differences (in phenomenological and processing terms)? This chapter suggests that the greater accessibility of contextual associations for remembered events than imagined events plays a key role in understanding this puzzle, and we present behavioral and neuroimaging evidence that converges on this conclusion.

1. INTRODUCTION

Estimates suggest that people spend up to half of their awake time each day thinking about the past or the future (Killingsworth & Gilbert, 2010). Many such thoughts are episodic: they involve imagining oneself in a specific place, participating in an activity. Episodic thoughts about the future are likely functionally important in that they facilitate goal achievement (Pham & Taylor, 1999, Taylor, 2011). This chapter is concerned with how we go about this ordinary, yet important, set of processes.

Specifically, this chapter reviews the emerging evidence that this type of future-oriented thinking involves cognitive processes very similar to—yet distinct from—those engaged during autobiographical memory retrieval. The primary contribution is a consideration of how the similarities and differences in episodic future thought and remembering can be conceptualized in terms of underlying cognitive processes.

The chapter is organized as follows: Section 2 describes the concept of episodic future thought and its origins. Section 3 considers memory-impaired populations and describes how complementary deficits in episodic future thought have been observed in people with profound and subtle memory impairments. In Section 4, we review conceptual issues (e.g., what episodic future thought is *not* and some initial hypotheses about the source of the strong similarities between episodic future thought and remembering). We then discuss individual differences in episodic future thought within healthy young adults (Section 5). We discuss what direct contrasts of the phenomenological reports accompanying episodic future thought and remembering can reveal about their relation (Section 6), and then consider how functional neuroimaging studies have informed our understanding of the relation between the two sets of processes

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(Section 7). We then discuss the construct of contextual associations and our view of the important role context plays in understanding the similarities between episodic future thought and remembering. Specifically, we review studies that show how a manipulation of the familiarity of context (via manipulating familiarity of the spatial setting) can alter the similarity of episodic future thought and remembering in predictable ways (Section 8). Further, we review an emerging literature that demonstrates that contextual setting can also be used to understand some of the differences that can be seen between remembering and episodic future thought (Section 9). We conclude with a section summarizing the key points made in this review.

2. EPISODIC FUTURE THOUGHT: THE CONCEPT

In 1985, Endel Tulving published a seminal paper in which he proposed that humans can differentiate between "remembering" and "knowing" events that happened in their personal past (Tulving, 1985). Specifically, Tulving's idea was that remembering carries rich episodic detail, whereas knowing relies on less personal, fact-like experiences (e.g., one could know they saw a picture previously in much the same way that one knows one's mailing address).

Although this "remember/know" distinction is the paper's legacy, the bulk of the article focused on the broader issue of the importance of (and up to that point, the relative neglect of) consciousness in memory. Specifically, the article proposed that "autonoetic" (self-knowing) consciousness enables the "special phenomenal flavor" of remembering (p. 3). In criticizing the field's avoidance of dealing directly with the slippery concept of consciousness, Tulving further noted that "One might think that memory should have something to do with remembering, and remembering *is* a conscious experience" (p. 1, italics in original). Hence, Tulving posited that this special form of consciousness—autonoetic consciousness—is a capacity that enables the rich recollective experience that accompanies remembering.

Autonoetic consciousness was further proposed to enable a second type of conscious experience: the ability to envision events that might take place in one's personal future. This capacity has since been labeled *episodic future thought* (Atance & O'Neill, 2001), and also referred to as *episodic simulation* (Schacter, Addis, & Buckner, 2007), *prospection* (Buckner & Carroll, 2007;

Gilbert & Wilson, 2007), and *pre-experiencing* (Botzung, Denkova, & Manning, 2008). Following the logic of McDermott, Szpunar, and Arnold (2011), we use *episodic future thought*, in part due to its similarity to the concept and term *episodic memory* (Szpunar & McDermott, 2008b; Tulving, 1983, 2002).

The evidence for this capacity of human consciousness was primarily a case study of an amnesic patient, currently known as K.C. (but referred to as N.N. in Tulving, 1985). K.C. had profound neurological damage throughout his brain as a result of a motorcycle accident. Despite the diffuse damage, he had average intelligence, could carry on a conversation, perform basic algebra, and had normal semantic and short-term memory. His long-term memory, however, was quite impaired. That is, K.C. had profound global amnesia: K.C. could not remember a single event from his lifetime (Rosenbaum et al., 2005; Rosenbaum, McKinnon, Levine, & Moscovitch, 2004), regardless of whether the event happened 10 minutes, 10 months, or 10 years earlier (or more). He simply could not remember. The primary novel observation that sets the Tulving (1985) article apart from other articles about amnesic patients, however, was the observation that K.C. could not do "mental time travel" of any sort. That is, not only could he not recollect the past, but also he could not envision the future in any kind of specific way. He could not imagine what he might do tomorrow, although he did understand the question and the concept of the future (Craver, Kwan, Steindam, & Rosenbaum, 2014), and could describe quite poignantly what it felt like when he tried to imagine the future—that it felt "blank" (Tulving, 1985).

This pair of deficits—inability to recollect events from the past *and* to envision events in the future—led Tulving to propose that a single common capacity must underlie both abilities. Specifically, he suggested that amnesia be considered a "derangement of consciousness and not just a derangement of memory for past events" (Tulving, 1985, p. 5). As mentioned previously, Tulving named this specific type of consciousness *autonoetic consciousness* (with autonoetic derived from the Greek terms auto and noesis to mean self-knowing).

This proposal is reminiscent of a suggestion made by Lidz (1942), who noted that episodes are not experienced in isolation; rather, in order for an episode to be fully appreciated in the moment, the experience must be integrated into the broader experiences of one's lifetime (see also Ingvar, 1985). In the absence of that ability to integrate the present with the past and future (as in amnesia), Lidz proposed, current experiences are not fully lived. To fully experience an episode, "it must be woven into the experiences of one's life, as well as be hitched to what precedes and follows" (Lidz, 1942, p. 595). Because people with amnesia lack this integrative ability, Lidz argued, "the past cannot be fully utilized … the future must remain even hazier, more vague, and more confused. [The amnesic patient] is almost marooned in the moment" (p. 596). The ability to place episodes in a larger spatiotemporal context and the importance of that context for understanding memory are the primary focus of this chapter.

3. SIMILARITIES IN MEMORY-IMPAIRED POPULATIONS

3.1 Amnesia

The initial impetus for investigating episodic future thought and its relation to memory came from the literature on amnesia, as reviewed above. As such, we review here more recent studies of amnesic patients following on the observations by Tulving. One such amnesic patient, D.B., has been investigated by Klein and colleagues (Klein, Loftus, & Kihlstrom, 2002; Klein, Rozendal, & Cosmides, 2002), who established that D.B. had deficits not only in remembering but also in envisioning himself in future episodes. Importantly, D.B. understood the concept of time and could even talk about general problems that society faces in the future (e.g., global warming). He could not, however, envision personal episodes set in the future.

We return now to K.C., who was more recently a participant in more focused study regarding his deficits in memory and imagining. K.C. was impaired at generating fictional events (Rosenbaum, Gilboa, Levine, Winocur, & Moscovitch, 2009). For example, when asked to invent a detailed story about an event that he did not personally experience but that was plausible, he was unable to do so. Afterward, the interviewer cued him with a general idea (e.g., first pet) and a possible introductory sentence to the story. Only when given these prompts could K.C. begin to do the task. But even with this large amount of assistance, K.C.'s stories were "without the richness in detail typical of the fictional incidents created by control participants" (Rosenbaum et al., 2009, p. 2184). K.C. also demonstrated difficulties when asked to produce familiar fairy tales (e.g., Jack and the Beanstalk) or bible stories (e.g., Noah and the Ark) (Rosenbaum et al., 2009). When given the details and asked to recognize them, K.C. could do it, but he could not generate those details on his own.

Much like D.B., K.C. understood time and his place in it (Craver et al., 2014). He understood that there was a future, could define it, and could reason about the passage of time. Further, he showed typical patterns of temporal discounting (Kwan et al., 2012; Kwan, Craver, Myerson, & Rosenbaum, 2013). In short, his deficit did not appear to arise from any misunderstanding about times other than the present but rather in constructing mental experiences related to episodes—whether they be at times other than the present or atemporal (e.g., fairy tales).

In 2007, a paper entitled "Patients with hippocampal amnesia cannot imagine new experiences" (Hassabis, Kumaran, Vann, & Maguire, 2007) drew attention to this issue more broadly. Five patients with amnesia were studied; in all cases, the amnesia was attributed to bilateral hippocampal damage resulting from encephalitis. In line with the behaviors of K.C. and D.B. (and as can be seen in Figure 1), the patients could not envision potential future scenarios.[1] An additional, important observation is that even when the "future" component was removed from the task, the patients could not perform it. For example, when asked to "Imagine you are lying on a white sandy beach in a beautiful tropical bay," the patients could not do so. This observation suggests that complex, scene-constructing imagery in general might be impaired in amnesia and that the deficit need not involve "mental time travel." The authors concluded that "The patients' imagined experiences were strikingly deficient in spatial coherence, resulting in their constructions being fragmented and lacking in richness. The hippocampus, therefore, may make a critical contribution to the creation of new experience by providing the spatial context or environmental setting into which details are bound" (p. 1729).

Whether it is the hippocampus per se leading to these imagery deficits is another matter and has been the topic of considerable recent debate (Kim et al., 2013; Maguire & Hassabis, 2011; Squire, McDuff, & Frascino, 2011; Squire et al., 2010). For the purposes of this review, we put the role of the hippocampus in mental imagery aside and focus on a different view of the emerging literature—that the memory-related processes impaired in amnesia seem also to cause profound deficits in complex

[1] One of the five patients did perform the task normally, which was an issue discussed but not resolved by the authors. One suggestion the authors make is that this patient has some residual hippocampal function, which enables him to perform the task. A follow-up fMRI investigation comparing this patient to control subjects suggests that the patient relied on many of the same regions as control subjects to perform scene construction including right hippocampus.

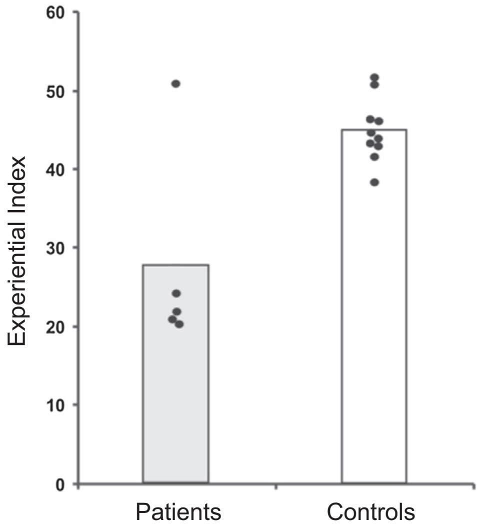

Figure 1 Patients cannot vividly imagine novel experiences, as shown by their scores on the experiential index, which measures the richness of their reports. *Data from Hassabis, D., Kumaran, D., Vann, S. D., & Maguire, E. A. (2007). Patients with hippocampal amnesia cannot imagine new experiences.* Proceedings of the National Academy of Sciences of the United States of America, 104*(5), 1726–1731. Copyright (2007) National Academy of Sciences, U.S.A; vertical bars represent sample means and dots indicate means for individual participants.*

imagery involving a scene (whether that scene is in the future or not, and possibly whether one places the self in the scene). We note, however, that an extensive literature has developed surrounding the role of the hippocampus in spatial navigation (Burgess, Maguire, & O'Keefe, 2002; O'Keefe & Nadel, 1978) and that this literature, although beyond the scope of the current review, is highly relevant to the conceptualization forwarded here.

One outstanding question is whether K.C. would have been able to perform scene-constructing imagery when asked very directly to do so (e.g., in the absence of storytelling demands). It is noteworthy that although K.C. was reported to have intact imagery abilities (Rosenbaum et al., 2004), he did not appear to have been tested on *scene* imagery, which may have been impaired. Further, although the amnesic patients with hippocampal damage have been reported by Squire and colleagues to be able to perform spatial imagery tasks (Squire et al., 2010), one open question may be whether they can perform scene-related imagery. Perhaps, the spatial/scene difference can account for the different conclusions.

In summary, patients with medial temporal lobe amnesia exhibit parallel deficits in episodic remembering and episodic future thought. The specific processes that give rise to these striking observations are still under investigation, although some evidence suggests that the ability to imagine scenes might be a key contributor to the parallel deficits. We turn now to consider whether these deficits co-occur in other patient populations with memory deficits.

3.2 Other Memory-Impaired Populations

Parallels between memory and episodic future thought can be seen in populations with memory impairments less extreme than those exhibited in people with medial temporal lobe amnesia. People who recently overdosed on drugs in suicide attempts show deficits in both processes (Williams et al., 1996). Moreover, people with schizophrenia (D'Argembeau, Raffard, & Van der Linden, 2008), healthy aging adults (Addis, Wong, & Schacter, 2008) and those with mild Alzheimer's disease (Addis, Sacchetti, Ally, & Budson, 2009) all show this pattern. Studies of children have shown that the capacities to remember and imagine both emerge at about the same age—about 4 or 5 years old (Busby & Suddendorf, 2005). In short, people with memory impairments that are less extreme than those seen in amnesia also exhibit parallel deficits in episodic future thought.

In addition to adult-acquired amnesia as reviewed in the previous section, two patients with developmental amnesia have now been studied in depth with respect to their abilities to envision the future (Kwan, Carson, Addis, & Rosenbaum, 2010; Maguire, Vargha-Khadem, & Hassabis, 2010). Further, a sample of 21 children with similar developmental deficits has also been researched, as reviewed in the following paragraphs.

The conclusions reached from this literature are not entirely consistent. Kwan et al. (2010) employed the Autobiographical Interview (Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002) and a modified Galton–Crovitz cueing task (Crovitz & Schiffman, 1974), whereby the patient (H.C., a 20-year old woman with bilateral hippocampal damage—about 50% reduction—attributed to premature birth) was given cue words and asked to use each cue to either remember an event or an envision a specific future event. She was to perform each imagery or memory trial for 5 min, and when she stopped producing information, she was prompted with general prompts to continue (e.g., "Is there anything more?"). H.C. produced fewer internal, central details and external, peripheral details than did control subjects for both temporal directions (past and future). Her ratings of the qualities of her memories and imaginings were also lower than those of controls, and this pattern held for both past and future conditions.

This conclusion is in contrast to that reached by Maguire et al. (2010), who reported on the patient Jon, a 28-year old man with bilateral hippocampal damage. Like H.C., his damage has been attributed to premature birth and has been described as about 50% volume loss of the hippocampus. The task given to Jon was not the Autobiographical Interview but the task used in Hassabis, Kumaran, Vann, et al. (2007) study, described above. That is, he was asked to envision scenarios (some in the future, some atemporal), such as lying on a white sandy beach in a beautiful tropical bay. Jon could perform this task as well as control subjects (unlike most of the amnesic subjects studied previously). Further complicating the story is that when H.C. was tested with the methods used with Jon (and by the research group who had tested Jon), she was found to have intact abilities to envision both hypothetical and future-oriented scenarios (Hurley, Maguire, & Vargha-Khadem, 2011).

In addition, Cooper, Vargha-Khadem, Gadian, and Maguire (2011) examined a group of 21 adults who had suffered neonatal hypoxia/ischemia with bilateral hippocampal damage. These patients, too, were able to describe imagined events in a detailed way (using a paradigm somewhat like the scene construction paradigm of Hassabis, Kumaran, Vann, et al. 2007). Thus far, it appears that findings involving the scene construction task lead to the conclusion that these patients can imagine scenes. Conversely, the Autobiographical Interview shows mixed results (once reflecting a deficit and once not in the same person, H.C.). Resolution of this situation awaits further work, wherein the processing differences between the Autobiographical Interview and the scene construction task can be more clearly delineated. Nonetheless, it does appear that at least by some measures, patients with developmental amnesia can imagine scenes and envision future scenarios as well as control subjects.

4. CONCEPTUAL ISSUES

Here we pause to consider a few important distinctions between episodic future thought and other related capacities, and review some of the theoretical frameworks that began to emerge as the literature on future thought in amnesia (and other work, to be described below) garnered interest in the late 2000s.

First, a distinction should be made between episodic future thought and prospective memory. Prospective memory is memory to do something in the future (e.g., to pick up the dry cleaning). Although it is true that using episodic future thought to imagine oneself engaging in the to-be-remembered activity can enhance the likelihood of remembering to perform the intended action (termed "implementation intention" in the prospective memory literature, Gollwitzer, 1999), it is important to distinguish the two concepts. There are many other types of future-oriented thinking that are similar to—yet distinct from—episodic future thought, but space precludes a thorough treatment here. The interested reader is referred to Szpunar (2010) and Szpunar, Spreng, and Schacter (2014).

Second, the original conceptualization of autonoetic consciousness stressed the importance of both the self and time. That is, "mental time travel" was a key component, and that process required a traveler—the self. Hence, one interpretation of the literature showing the parallel deficits in episodic future thought and memory is that autonoetic consciousness is impaired, and this ability underlies both capacities (Tulving, 1983, 1985). A related suggestion (the Self Projection hypothesis) is that the key similarity between episodic future thought and remembering is the capability of withdrawing oneself mentally from the immediate environment, and shifting one's perspective to another time and/or place (Buckner & Carroll, 2007). The key piece of evidence here is that theory of mind and navigation share some overlapping neural substrates and processes with episodic future thought and remembering (see also Spreng, Mar, & Kim, 2009), although reports that amnesic patients have intact theory of mind (Rosenbaum, Stuss, Levine, & Tulving, 2007) do not align well with this suggestion.

Other ideas began to emerge and, as will be seen, we view these hypotheses as more promising in describing the emerging body of work when viewed as a whole. Schacter, Addis, and colleagues put forward the Constructive Episodic Simulation hypothesis (Schacter & Addis, 2007), which is built on the assumption that constructing fictitious episodes in the future is dependent upon memory; without fragments of remembered events to bind together in novel ways, one could not build a mental image of a future-oriented event. Another key component to this idea is that memory is inherently constructive (Bartlett, 1932; Roediger & McDermott, 1995). Rememberers do not so much replay past events as actively construct them during the retrieval process. The critical component of this perspective is that remembering needs to be constructive in order to allow this complementary process—episodic future thought—to exist. Hence, people with amnesia cannot envision the future because future scenarios are constructed on the basis of memories that they cannot access.

The remaining two prominent hypotheses are built on the idea that both remembering and episodic future thought call upon a third component or process that is not directly linked to time (or the self in time). Maguire, Hassabis, and colleagues have suggested the Scene Construction hypothesis—that is, scene construction is the fundamental element linking together episodic future thought and remembering. The amnesic patients in their 2007 study (Hassabis, Kumaran, Vann, et al., 2007) could not envision future episodes or remember past episodes. The key addition, however, is that they also could not envision atemporal scenes; when they tried, their output was fragmented and lacked cohesion. Hence, the authors argued, the core of the deficit does not involve mental time travel but rather the inability to imagine scenes.

A very similar hypothesis has been forwarded by McDermott, Szpunar, and colleagues; this suggestion emerged from some functional MRI (fMRI) studies, which will be reviewed in a later section. The hypothesis here centers on the finding that contextual associations not only guide our perception of the local environment and allow us to make predictions about what is likely to occur in the immediate future, but also enable us to create complex scenarios centered on hypothetical events (that may be placed in the future or elsewhere).

It is important to define what we do, and do not, mean by our use of *context* and *contextual associations*. Here, we use the term *context* to refer to a highly associated collection of objects, locations, and concepts, which frequently co-occur, and whose co-occurrence enables us to organize and understand the world around us (we borrow this definition from Aminoff, Kveraga, & Bar, 2013; see also Bar & Aminoff, 2003). To provide a concrete example, a "kitchen" is an example of a particular context. Based upon our accumulated experiences, we know that a kitchen likely includes a refrigerator, linoleum or tile floor, a sink, a microwave oven, a drawer with knives and forks, and a stove (among other items). All of these are *associated* within a specific context, which we understand to be a kitchen.

It is also important to discuss the related concept of a *context frame*, which is a mental model that contains the associations of all the different concepts held within a context (Bar, 2004, 2009). Context frames are thought to operate in such a manner that the observation of a single component of a given context can activate the rest of its contextual associates (Bar & Aminoff, 2003). In other words, observing a single toaster will activate other objects and concepts associated with the broader kitchen context, and observing a kitchen would activate the associated concept of a toaster (even if one is not physically present). Establishing a context frame may be a precursor to scene construction; a context frame places the emphasis on statistically associated things (people, places, objects, or ideas) and may enable rapid scene construction.

5. INDIVIDUAL DIFFERENCES WITHIN HEALTHY YOUNG ADULTS

5.1 Tendencies

People differ in their personal relationship with time. Anecdotally, we can all likely conjure up examples of friends or relatives who have tendencies to live in the past, live for the future, or lose themselves in the moment. These tendencies have been formalized in the Zimbardo Time Perspective Inventory (Zimbardo & Boyd, 1999). This scale classifies people on five dimensions with respect to their personal orientation toward time. Those who are future-oriented tend to spend a lot of time planning, goal setting, are achievement-oriented, and are accomplished at delay of gratification. Those who are high on the Present-Hedonistic dimension have a tendency for risk-taking and pleasure-seeking. The Past-Negative subscale measures the degree to which one holds a negative view of the past and is associated with conservatism. The Past-Positive subscale measures one's sentimentality toward the past and is often associated with strong family orientation. Lastly, the Present-Fatalistic subscale is indicative of a hopeless view of one's future and general helplessness.

A reasonable prediction might be that people who are future-oriented engage in more (or more vivid) episodic future thought. This has indeed been observed. Specifically, participants were administered a variant of the Memory Characteristics Questionnaire (Johnson, Foley, Suengas, & Raye, 1988), in which they are asked to rate on a 7-point scale various characteristics of their memories (or future thoughts).

Greater scores on the future subscale were associated with enhanced feelings of pre-experiencing the future (Arnold, McDermott, & Szpunar, 2011). Further, scores on the future subscale were positively correlated with the degree to which people reported that they felt like they were traveling in time ("mental time travel") (Arnold et al., 2011). The same correlations were also shown during remembering. That is, people higher in future orientation reported greater re-experiencing when remembering and greater feelings of mental time travel. Additionally, those higher in future orientation have been reported to provide more sensory descriptions during episodic future thought (D'Argembeau, Ortoleva, Jumentier, & Van der Linden, 2010).

What is not clear is whether people are future oriented because they have these strong abilities in pre- and re-experiencing and mental time travel or whether perhaps being future oriented and performing those thoughts regularly lead one to be able to do it well/vividly.

Complicating the picture slightly is that the same patterns of correlations found by Arnold et al. (2011) for the future subscale were also found for the Present-Hedonistic subscale. People higher in hedonism also reported higher levels of re- and pre-experiencing the past and future, and greater feelings of traveling through time when remembering the past and imagining the future. This situation is complex because Present-Hedonistic measure is negatively correlated with the future subscale. People who are future oriented tend to be low on hedonism, for example. In short, these two variables act as suppressor variables in this situation.

Other tendencies toward certain mental orientations have shown relationships with the qualities of future thought. For example, people who tend to suppress their emotions report less vivid episodic future thought. Specifically, on the Emotion Regulation Questionnaire (Gross & John, 2003), people who score higher on the Expressive Suppression measure report fewer sensory, contextual, and emotional details during episodic future thought (D'Argembeau & Van der Linden, 2006).

People who tend to focus on their inner experiences (feelings, thoughts, physical sensations) report a greater number of sensory descriptions and greater feelings of pre-experiencing episodic future thoughts. This work adds to prior work showing that openness to feelings predicts the phenomenological experience of remembering (Rubin & Siegler, 2004).

Other work has attempted to identify personality and temperament dimensions that might predict the two capacities, but thus far the work done has been on small sample sizes, and therefore the conclusions are somewhat limited (Quoidbach, Hansenne, & Mottet, 2008).

5.2 Cognitive Abilities

The literature on cognitive abilities is less developed, but includes several relevant studies. An obvious prediction is that people who report being good at imagery in general might report vivid episodic future thought. That does appear to be the case. Specifically, the Vividness of Visual Imagery

Questionnaire (VVIQ, Marks, 1973) predicts phenomenological experiences such that people with more vivid visual imagery (as measured by that scale) remembered and imagined events with more visual and other sensory details. Further, the scale predicts the clarity of spatial context, the degree of emotional feelings, and personal importance of the imagined future events (D'Argembeau & Van der Linden, 2006). Other measures of visualspatial processing have shown patterns similar to those of the VVIQ (D'Argembeau et al., 2010).

It is worth noting that the VVIQ questions are similar to those used by Hassabis, Kumaran, Vann, et al. (2007) in their study of amnesic patients. For example, some of the questions are as follows: "Think of a county scene which involves trees, mountains and a lake. Consider the picture that comes before your mind's eye. Then rate the following items: the contours of the landscape; the color and shape of the trees; the color and shape of the lake." These aspects are all rated on a scale ranging from "perfectly clear and as vivid as normal vision" to "no image at all (only 'knowing' that you are thinking of the object)." Thus, this questionnaire asks the participant to rate the qualities of the mental image instead of to produce descriptions of them, as done by Hassabis and colleagues. Nonetheless, the essential task—whereby people are given a short description of a scene and asked to imagine the scene as vividly as possible—is similar.

Another set of cognitive measures classified as having to do with executive function (largely semantic fluency and phonemic fluency) have also been shown to predict the amount of episodic detail and number of sensory descriptions for imagining future events and have similar predictive power for remembering (D'Argembeau et al., 2010).

6. DIRECT CONTRASTS OF THE PHENOMENOLOGY OF REMEMBERING AND FUTURE IMAGINING WITHIN HEALTHY YOUNG ADULTS

6.1 Vividness

The Memory Characteristics Questionnaire (MCQ, Johnson et al., 1988) has been adapted to contrast the phenomenological experiences of people during remembering and episodic future thought. Most such investigations have followed the lead of D'Argembeau and Van der Linden (2004), who selected a subset of MCQ questions and revised them for future thought, as follows. Subjects were asked the degree to which their memories or future thought contained: "visual details (1 = none, 7 = a lot); sounds

(1 = none, 7 = a lot); smell/taste (1 = none, 7 = a lot); clarity of location (1 = not at all clear, 7 = very clear); clarity of the spatial arrangement of objects (1 = vague, 7 = clear and distinct); clarity of the spatial arrangement of people (1 = vague, 7 = clear and distinct); clarity of the time of day (1 = not at all clear, 7 = very clear); valence of the emotions involved in the event (1 = negative, 7 = positive); intensity of the emotions involved in the event (1 = not intense, 7 = very intense); feelings of re-experiencing (or pre-experiencing) the event when remembering (or imagining) it (1 = not at all, 7 = a lot); importance of the event for the self-image (1 = not at all important, 7 = very important)."

Figure 2 displays a set of findings representative of the general patterns seen. Specifically, people rate their phenomenological experience of remembering as being more vivid than episodic future thought in the following dimensions: degree of re-experiencing (or pre-experiencing) the episode; clarity of location; clarity of objects; clarity of people; degree to which it forms a coherent story; time of day; degree to which it feels as though you are traveling in time; clarity of visual details. Remembered events are also

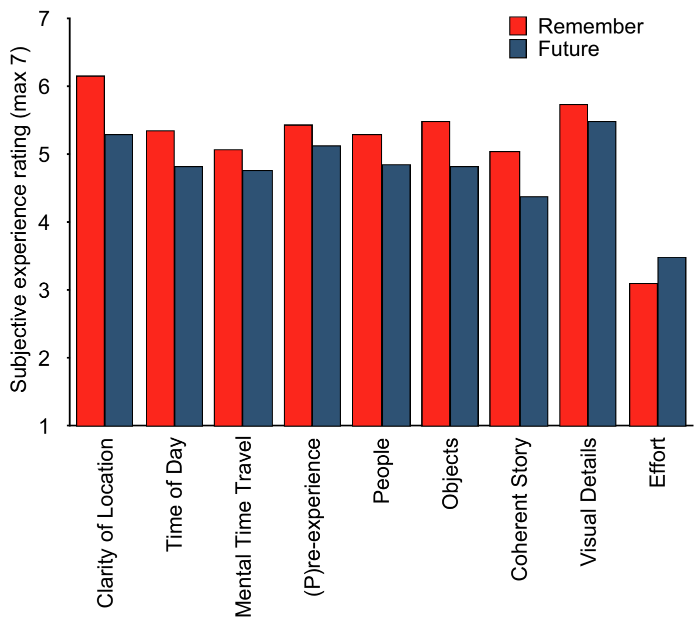

Figure 2 Subjective ratings of phenomenological experiences during remembering and episodic future thought. *Data from Springer, Memory & Cognition, Vol. 39, 2011, Imagining the near and far future: The role of location familiarity, Arnold, K.M, McDermott, K.B., Szpunar K.K., Table 1, with kind permission from Springer Science and Business Media.*

reported more generally to be experienced more vividly at a global level, and occur in locations that are more familiar to participants, than are imagined future events. Other dimensions show no reliable differences: degree of emotion (or degree of negative or positive emotion); clarity of sounds; clarity of movements; clarity of smells/tastes. Finally, episodic future thought is consistently rated as being slightly more effortful than remembering, although neither is rated as particularly effortful (average reported scores of 2.89 and 3.36, for remembering and episodic future thought, respectively, of a maximum of 7, Arnold et al., 2011). In short, remembering is more vivid overall (Arnold et al., 2011; D'Argembeau et al., 2010; D'Argembeau & Van der Linden, 2004; Szpunar & McDermott, 2008a), and this overall vividness difference can be isolated into separate components via the MCQ.

It is worth noting that although this is the first mention of explicit contrasts showing differences between remembering and episodic future thought, there are some hints of it in the literature previously reviewed. For example, although most individual difference measures similarly predict remembering and episodic future thought, some are predictive of one but not the other. Whether these differences are real or simply a matter of statistical thresholds is not known.

6.2 Visual Perspective

Autobiographical memories can be recalled from first-person (i.e., field) perspectives or from third-person (observer) perspectives (Nigro & Neisser, 1983). Rice and Rubin (2011) have recently demonstrated that not all third-person perspectives are the same. Rather, sometimes when remembering oneself in an episode from the observer perspective, we "see" ourselves from the back, and other times from the front. Sometimes, we remember the event from eye level, and other times from above or below eye level.

McDermott, Wooldridge, Rice, Berg, and Szpunar (2015) have explored these phenomenological characteristics, comparing them in remembering and episodic future thought. Specifically, McDermott and colleagues examined the frequency with which participants remembered past or imagined future events from third-person perspectives and the distribution of spatial viewpoints associated with events that were either remembered or imagined from a third-person perspective. Although future events were somewhat more likely to be imagined from a third-person perspective than were remembered events, the spatial viewpoint distribution of third-person perspectives that characterized remembered and imagined events were highly similar. These results speak again to the phenomenological similarity of the two (for similar results, see also D'Argembeau & Van der Linden, 2004).

Further, the results suggest that when people remember events from a perspective that could not have been experienced in the past (i.e., when they remember in the third-person perspectives), they may draw upon similar constructive processes as when they imagine events from a perspective that could not be experienced in the future (imagine in the third-person perspectives).

7. NEURAL CORRELATES OF REMEMBERING AND EPISODIC FUTURE THOUGHT

Functional neuroimaging studies, particularly those employing fMRI, have become a critical source of knowledge concerning the similarities and differences between remembering and episodic future thought. In this section, we review the short history of how theory has been advanced by examinations of the neural underpinnings of these two important processes.

7.1 Positron Emission Tomography

Although it was not embraced by many psychologists at the time of publication, an early study using positron emission tomography (PET) bears strongly on the relationship between remembering and imagining (Andreasen et al., 1995). In this work, the authors compared to a semantic memory task several different episodic memory retrieval conditions, one of which involved participants lying quietly at rest without any explicit task. Post-scan interviews suggested that participants thought about "a variety of things, especially events of the past few days or future activity of the current or next several days" (p. 1582) in this otherwise task-free condition. In other words, the "task-free" condition was associated with very active autobiographical memory retrieval or episodic future thinking. A related contribution of this work, at least with respect to the topics covered in this review, is the linking of both remembering and episodic future thought with activity in what has become known as the *default mode network* (Shulman et al., 1997; see also Buckner et al., 2008).

We pause here to describe briefly the default mode network and its relevance to this discussion. Shulman et al. (1997) noted that in situations in which people are asked to attend to their external environment, they tend to deactivate a common set of brain regions. The specific task did not matter much; the finding was very reliable across tasks. The set of regions was subsequently labeled the default network (Gusnard & Raichle, 2001; Raichle et al., 2001), which was chosen to suggest that this network is active during the "default" state of cognitive functioning (i.e., when we are not otherwise engaged in a specific task), while attention-demanding tasks involving external stimuli require transient suppression of this set of regions. Subsequent research has confirmed that the term "network" is appropriate in that the regions are correlated during task states as well as during resting states (Power et al., 2011; Yeo et al., 2011). Despite the overwhelming amount of attention paid to the default mode network over the past decade, its exact contribution to cognitive processing is still under debate. Of relevance here, one highly consistent finding among researchers is that activity within the default mode network is linked to processing both remembered past and imagined future events. Returning to the discussion of Andreasen et al. (1995), which was published before the introduction of the default mode network to the literature, the anecdotal report linking this set of regions to both episodic retrieval and episodic future thought represented a promising, but very preliminary, description of neural activity commonly supporting these two processes.

A more direct comparison between remembering and future-oriented thinking was conducted by Okuda et al. (2003). This study also used PET, and asked participants to "freely and fluently talk about their ideas" in response to cues orienting them to the recent or distant past or future. Although we caution that these vocalizations did not purely represent episodic content (e.g., see their Table 1, which suggests fewer than 20% were episodic in nature), we note that these authors found common activity in several default regions as well, including the hippocampus, parahippocampal cortex (PHC) bilaterally, as well as bilateral superior frontal regions.

In sum, these studies each implicated regions within the default mode network as being critical for both remembering and episodic future thought, but at the same time, offer only preliminary glimpses into the processes of remembering and episodic future thought. Three fMRI experiments, all published in 2007, would better clarify the relationship between remembering and episodic future thought. These studies would mark a renewed period of interest in the similarities and differences between the processes of remembering and episodic future thought, and would highlight appreciable differences, as well as commonalities, between the two tasks.

7.2 Early fMRI Studies

Twelve years after the report by Andreasen et al. (1995), and 22 years after Tulving (1985) hypothesized a common capacity underlying different types of mental time travel, the first fMRI studies were published in which remembering and episodic future thought were directly compared. These studies, and many of those published since, used variants of the Galton–Crovitz cuing paradigm (Crovitz & Schiffman, 1974), wherein participants are asked to remember past or imagine future events related to cues consisting of single words or short phrases.

The first two of these studies, published by Szpunar, Watson, and McDermott (2007) and Addis, Wong, and Schacter (2007), converged upon two common findings. One, consistent with prior PET results, was that the processes of remembering and imagining commonly engage a number of regions that fall within the default mode network (as noted by Szpunar et al., 2007). The other was that in cases where differential activity between remembering and imagining was found, greater activity was always observed for episodic future thought. That is, no regions showed significantly greater activity during the retrieval of past events, relative to the envisioning of future events.

The lack of regions showing greater activity for remembered past events was unexpected, and several hypotheses were offered to explain this asymmetry. One, forwarded by both Szpunar et al. (2007) and Addis et al. (2007), was that future events have not yet occurred, and so novel representations must be constructed during the task (for related discussion see McDermott et al., 2011). This explanation is described more completely by the Constructive Episodic Simulation hypothesis (Schacter & Addis, 2008), identified previously. This hypothesis explains why greater activity can be observed in some regions during episodic future thought, but it struggles to explain why other regions should *not* also show an opposite pattern, of greater activity during remembering (see also Szpunar & McDermott, 2009).

Later experiments would continue to emphasize the (generally) common neural basis of both remembering and imagining (Addis, Pan, Vu, Laiser, & Schacter, 2009; Hassabis, Kumaran, & Maguire, 2007; Szpunar, Chan, & McDermott, 2009; Weiler, Suchan, & Daum, 2010). These studies also continued to find only regions exhibiting greater activity during episodic future thought than during remembering (typically in the angular gyrus, superior frontal cortex, posterior cingulate cortex, medial prefrontal cortex, and right hippocampus). However, Addis, Pan, et al. (2009) and Weiler et al. (2010) reported several regions, particularly in visual cortex, that showed a pattern of greater activity for remembered events. The regions were inconsistent across the two studies and, in the case of Addis, Pan, et al. (2009), were observed under multivariate, but not a univariate, analysis. As such, no consistent evidence of regions showing greater activity when remembering existed in the literature, although these experiments did suggest that such effects might be observable in future experiments.

7.3 fMRI Studies Focusing on Scenes

A separate fMRI study, published by Hassabis, Kumaran, and Maguire (2007), also compared activity during remembering and episodic future thought, but did so from the perspective of trying to disentangle "scene construction" processes (needed to mentally build a particular environment) from those that might be related to "mental time travel" per se. For the present purposes, we can summarize the findings of this report to also support a generally common collection of regions supporting both remembering and episodic future thought. However (and importantly), Hassabis and colleagues associated activity the hippocampus, PHC, the retrosplenial complex (RSC), and ventral parietal cortex with the construction of scenes, rather than mental time travel. In other words, many of the regions reportedly involved in remembering or imagining by other reports were, instead, likely serving a broader (albeit related) function.

We note here also that many "scene construction" regions, particularly the PHC and RSC, have also been linked to the processing of contextual associations (e.g., Bar & Aminoff, 2003). Although there is still some debate as to the specific nature of what information PHC and RSC regions are processing, it has become clear that scene construction and contextual processing appear to be highly related (see e.g., Aminoff et al., 2013; but for a different view Auger, Mullally, & Maguire, 2012). This similarity was noted by both Addis et al. (2007) and Szpunar and McDermott (2008b).

Emerging work continues to suggest that contextual associations between parts of a remembered or imagined scene are critical in understanding aspects of the similarities observed between remembering and episodic future thought, and critically, can also serve as a key means of understanding differences between these processes. We consider how contextual information and contextual associations may play both roles in the following sections.

8. THE IMPORTANT ROLE OF LOCATION FAMILIARITY IN EXPLAINING *SIMILARITIES* BETWEEN REMEMBERING AND EPISODIC FUTURE THOUGHT

We argue here that contextual associations can, at least in part, explain the similarities commonly observed between remembering and episodic future thought. Stated briefly, it appears that the more contextually rich imagined future events are, the more similarly they are experienced to remembered past events. Behaviorally, this can be observed from phenomenological reports, and neurally, this appears to be true when examining fMRI data.

We note that while each of the to-be-considered experiments manipulated the context of imagined future events, the principle way by which this was accomplished was to manipulate the degree of subjects' familiarity with event locations. As will be discussed, location familiarity is likely not sufficient to describe the effects of context on episodic future thought in their totality, but it has allowed a good deal of progress as a convenient surrogate for the larger construct.

In one follow-up to their 2007 fMRI study comparing remembering and imagining, Szpunar and McDermott (2008a) directed participants to imagine events in either highly familiar settings (e.g., their homes) or highly unfamiliar settings (e.g., the jungle). In a separate experiment, they asked participants to imagine events in either a setting with which they were recently familiar (their current university campus) or a temporally remote, yet still personally familiar setting (their high school campus). Across the two experiments, events in conditions that were more immediately familiar to participants were rated as having more sensory detail clarity in their context, and were more strongly subjectively experienced (see Figure 3). This was taken as

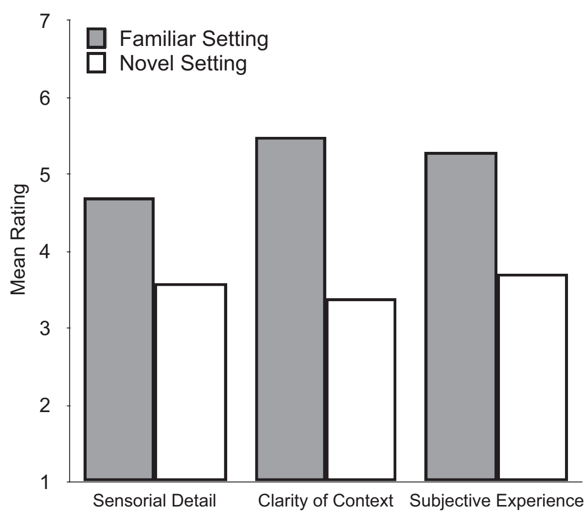

Figure 3 When episodic future thoughts are placed in familiar settings (e.g., home), they are rated as more vivid than those placed in novel settings (e.g., jungle). *Data from Table 1 in Szpunar and McDermott (2008a, Experiment 1).*

evidence that better memory representations allow for more robustly imagined events, and for our purposes here, suggests that greater contextual information may make imagined events more "memory-like."

A similar study was conducted by Arnold et al. (2011), which both replicated and extended the findings of Szpunar and McDermott (2008a). Across three experiments, these authors found that the familiarity of an imagined event's location appeared to drive the amount of detail in which it was experienced. In one experiment, as events were imagined in more and more distant future periods, both the clarity of the imagined location and the overall vividness of the event decreased. In another, events imagined in the near future (which generally have more similar phenomenologies to remembered events than do imagined events set in the far future) tended to be set in very familiar locations. Given that imagined events tend to be placed in close temporal proximity to the present (Spreng & Levine, 2006), this was an important observation as it suggests that imagined events also naturally occur in fairly familiar settings. Finally, Arnold et al. found that directing participants to imagine events in familiar locations increased the reported clarity of an imagined scene. In sum, the work of Arnold et al. (2011) suggests that events imagined in familiar settings (regardless of the specific reason for the use of the setting) appear to be more phenomenologically similar to remembered past events, which by necessity also involve very familiar locations. Furthermore, imagined events tend to be set in familiar locations, and this familiarity may be largely responsible for the high degree of overlap we see in the neural correlates of both remembering and imagining.

An fMRI study published by Szpunar and colleagues offers direct empirical support for location familiarity influencing the degree to which remembering and episodic future thought elicit similar neural responses. In this study, participants were asked to remember events, or to imagine future events in either familiar or unfamiliar settings (similar to the design of Szpunar & McDermott, 2008a). Events set in unfamiliar locations, compared to those set in familiar locations, elicited less activity across PHC, posterior cingulate cortex, and the RSC, whereas very few differences were observed between events remembered or imagined in familiar locations (and the differences that were observed showed the typical pattern of greater activity during episodic future thought, in regions that had previously shown such effects).

To summarize the results of these studies, it seems that the familiarity of an imagined event's location can affect the amount (or strength) of available contextual information. As the amount or strength of available contextual information increases, it appears that both phenomenologically and neurally, episodic future thought becomes more similar to remembering. Thus, one possible explanation for the similarities observed between remembering and episodic future thought is that, all things being equal, we tend to place imagined events in familiar locations. A question remains, however, as to how broadly manipulations of location familiarity can alter the broader construct of contextual information as a whole. As we noted earlier (and highlighted in Figure 2), we see consistent differences between remembered past and imagined future events across a number of different features, *including* the clarity of an event's location. Presumably, these reflect differences in the total amount of contextual information available. In the following section, we discuss emerging evidence that suggests how these contextual differences can also serve as a means of differentiating remembered and imagined events.

9. THE IMPORTANT ROLE OF CONTEXT IN EXPLAINING *DIFFERENCES* BETWEEN REMEMBERING AND EPISODIC FUTURE THOUGHT

In the previous section, we hypothesized that the generally stronger phenomenological ratings for remembered than imagined future events likely suggest greater available contextual information during remembering. If greater contextual information is available for remembered events, then one would expect to see this pattern in brain regions known to be sensitive to the strength of contextual associations (i.e., within RSC and PHC). However, among all the fMRI studies we have reviewed thus far, only a single experiment suggested that PHC might show greater activity during remembering than during episodic future thought, and it only showed an effect in one specific analysis (Addis, Pan, et al., 2009). Other experiments (e.g., Addis et al., 2007; Szpunar et al. 2009, 2007) found approximately equal levels of activity for remembering and episodic future thought in PHC and RSC. However, these analyses were all based on whole-brain analyses, and did not use a priori methods of identifying regions sensitive to contextual associative strength. As such, the broader view offered by these whole-brain analyses may have missed differential activity in specific regions.

This possibility was directly interrogated by Gilmore, Nelson, & McDermott (2014). In this experiment, participants completed both a task in which they remembered past or imagined future events, and critically, a task meant to localize the contextual association network (Bar & Aminoff, 2003). Using the localizer task to define, within the subject sample, regions sensitive to contextual associative strength, Gilmore et al. found significantly greater activity in PHC and RSC regions bilaterally. Furthermore, when these same regions were queried in several previous fMRI datasets (Szpunar et al., 2009, 2007), Gilmore and colleagues again observed greater activity for remembered than imagined events in regions within PHC and RSC (as can be seen in Figure 4, Panel B). We note that in the case of the Szpunar et al. (2009) dataset, this difference appears particularly important, as the remembering condition was compared to a condition in which events were only imagined in highly familiar locations, suggesting that location familiarity alone does not eliminate observable differences within certain regions.

These results, across three distinct studies, suggest that regions within both the PHC and RSC are sensitive to the status of an event as being either remembered or imagined. Why, then, did other studies fail to find these differences? One logical explanation would be that this was entirely driven by the use of a priori regions of interest on the part of Gilmore et al. (2014). While this undoubtedly explains some of the results, a follow-up voxelwise analysis also found significantly greater activity in a region of left PHC and right RSC; hence, a targeted approach is not necessary for observing the differences. Further evidence comes from an additional experiment (Gilmore et al., 2014), in which a whole-brain contrast also demonstrated greater activity for remembering than episodic future thought in PHC cortex and RSC. A more likely explanation, then, is the commission of Type 1 errors in previous studies. We also note that this would also help explain why Addis et al. (2009) found an effect of remembered > imagined events only in their multivariate, but not univariate, analysis.

Given that regions sensitive to contextual associative strength remain sensitive to the remembered, as compared to the imagined, status of an event, what can this tell us about how remembering and episodic future thought differ? And how can we relate this to our previous discussion on context as a source of similarity between remembering and episodic future thought? We term this explanation as the *Contextual Association hypothesis*, and describe it as follows:

1. *Consistent with the Scene Construction hypothesis, much of the similarity in processes observed between remembering and episodic future thought is a result of the need to construct a mental scene, in which the scenario will occur.*
2. *Within this scene, details will be extracted from episodic memory (consistent with the Constructive Episodic Simulation hypothesis), but mainly from our semantic*

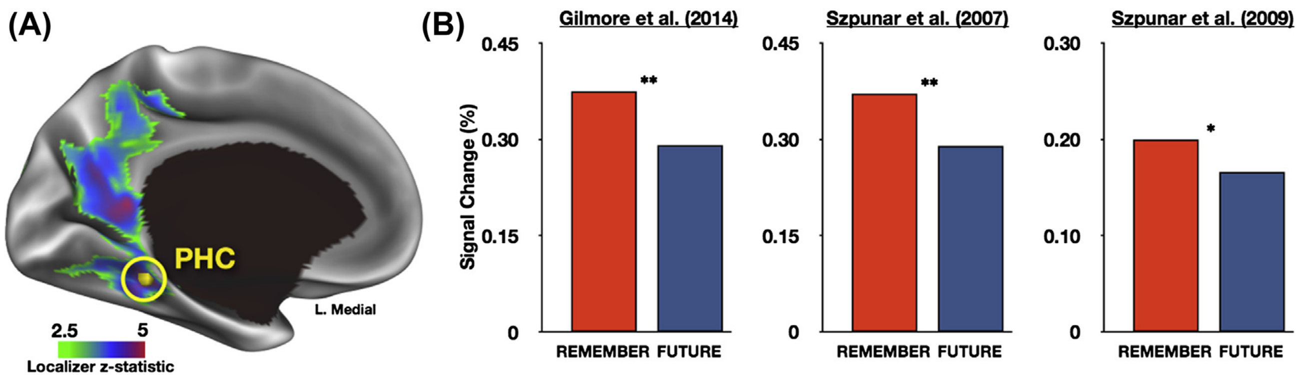

Figure 4 Regions emerging from the context localizer task also show REMEMBER > FUTURE effects. (Adapted from Gilmore et al., 2014). Panel (A): The context localizer task (borrowed from Bar & Aminoff, 2003) revealed greater activity for items with strong contextual associations (e.g. a roulette wheel) than those with weak contextual associations (e.g., a cherry), as seen in the heat map. Regions demonstrating this pattern appear in PHC, RSC, and others, not shown. The yellow (White in Print versions) node represents a region-of-interest in left PHC that was queried with respect to its activation during remembering and episodic future thought. Figure adapted with permission from Gilmore et al. (2014). Panel (B): fMRI signal (% change) in three separate studies within the left PHC region. In all cases, the remember condition produced more activity than episodic future thinking. Error bars denote SEM. *$p < 0.05$; **$p < 0.01$. *Data from Gilmore et al. (2014), Szpunar et al. (2007, 2009).*

understanding of the world, in the form of context frames and the associations between items contained therein.

3. *In the case of remembered events, only a single spatiotemporal context (encompassing a single event) is needed as a source of details, whereas for imagined future events, multiple contexts must be accessed to construct the scene, due to the disparate details within each.*
4. *The commonality of the source for remembered events results in greater activity within contextual association regions than when associations are made across multiple contexts, and as more (or more distinct) context frames must be activated, this difference will become increasingly large.*
5. *As associative strength is reduced, phenomenology will be affected such that the "background" (i.e., various types of details) will be less organized, and therefore the whole experience will be less vivid.*

This hypothesis does not attempt to describe why certain regions are more active during episodic future thought than during remembering. This is intentional, as the Constructive Episodic Simulation hypothesis, which attributes this specific pattern to the increased difficulty in assembling a novel, coherent narrative involved in episodic future thought, very adequately explains this pattern of results. However, for other aspects of how remembering and episodic future thought are related, the Contextual Association hypothesis explains how context can serve both as a source of similarity and differences—as one imagines events in more familiar spatial contexts, one requires fewer context frames to be activated as a source of event details, and therefore the imagined future events will appear more "memory like." On the other hand, events involving largely disparate people, places, or objects, from many different contexts, will be very distinct from a remembered episode, both neurally and phenomenologically.

10. CONCLUSIONS

This chapter reviews the literature on the relation between episodic future thought and episodic remembering, with an emphasis on the role that contextual associations play in understanding their relation. We began with a review of the initial observations that led memory researchers to consider the relation between these two important capacities. Specifically, we considered observations Endel Tulving made of amnesic patient K.C., who demonstrated pronounced deficits in episodic future thought (as well as remembering). We considered how other memory-impaired people

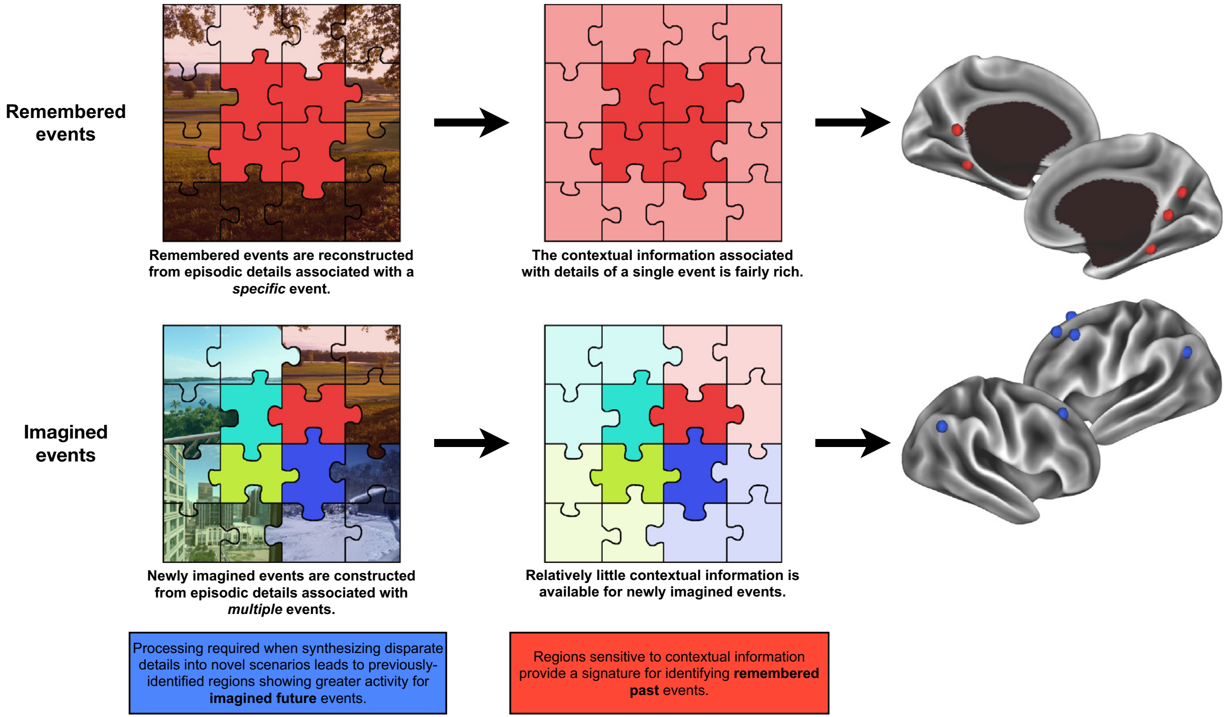

Figure 5 Framework for conceptualizing how remembered and imagined events are processed differently. Left: Remembered events draw upon details that arise from a single experience or event; imagined events are generated from a combination of experiences. Middle: The common source of the remembered event details provides strong contextual associations with other event components; in contrast, the multiple sources comprising the imagined events result in reduced overall associative strength. Right: This difference in contextual associative strength results in increased activity for remembered events in PHC and RSC. *Adapted with permission from Gilmore et al. (2014).*

(amnesic patients and less-impaired populations) have shown parallel deficits in episodic future thinking. We discussed how these parallel deficits might be conceptualized and then considered how phenomenological comparisons and fMRI studies inform this issue. An emphasis was placed on how remembering elicits greater activation than future thought in regions important for contextual associations, a finding which enabled us to advance a framework for better understanding the relationship between remembering and episodic future thought. This framework (depicted in Figure 5) highlights the importance of contextual associations in building the scenes in which we place both remembered and imagined events, and posits that the amount of available information is a key separator of remembered past and imagined future events.

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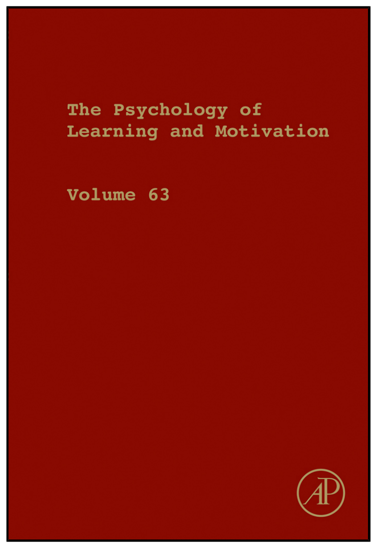

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