

The Role of Subjective Temporality in Future-Oriented Mental Time Travel

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Future-oriented mental time travel (FMTT) consists in a set of neurocognitive functions that enable one to break free of the grasp of the perpetual “now” and consider how things might be in the “next.” The adaptive functionality of such a mental competence is immense: to be capable of anticipating, imagining, and responding to contingencies that cannot be known with certainty—but whose consequences have fundamental significance for survival—provides an enormous selective advantage. While organisms vary greatly in the complexity and temporal reach of their ability to consider the future (e.g., Cheke & Clayton, 2010; Klein, 2013a; Suddendorf & Corballis, 1997), all living things possessed of motility and reasonably sophisticated neural function must, of adaptive necessity, be able to orient toward and react to personally relevant possibilities (Klein, 2013a). Indeed, several investigators have proposed that an organism’s ability to anticipate and plan for the future is a major driving force of cortical evolution (e.g., Bar, 2011; Klein, Cosmides, Tooby, & Chance, 2002; Pezzulo, 2008; Tulving, 2005).

Psychologists have long held an interest in various aspects of anticipatory behavior. It was not until the first stirrings of the “cognitive revolution” in the 1950s, however, that serious and sustained attention to FMTT became a regular feature of research agendas. This now has developed into a thriving industry, with several hundred papers devoted to FMTT appearing in just the past 15 years.

While tremendous progress in our understanding of FMTT has been attained, these gains primarily have been in the explication of the behavioral characteristics, neuroanatomical correlates, and phylogenetic precursors of the human ability to orient toward the future. Considerably less attention has been devoted to the processes that enable a person to mentally navigate a nonexistent world of possibility. What, specifically, is future-oriented subjective temporality?

Although subjective temporality has long been a focus of philosophical and psychological investigation (for reviews, see Arstila & Lloyd, 2014; Roepckelein, 2000), it seldom has been addressed in the context of FMTT (there are, of course, exceptions; e.g., Dalla Barba, 2002; Klein, Loftus, & Kihlstrom, 2002; Tulving, 2005). We conjecture that this lack of attention is, in part, a consequence of the assumption that FMTT is an act of memory and imagination—and, since psychologists have trained their investigative skills on these faculties for much of the discipline’s history, wherein lies the motivation to reinvent the “wheels” of memory and imagination?

1. GOALS OF THE CHAPTER

In this chapter we focus on the human ability to subjectively orient toward the future. First, however, a few words are required about the role of imagination in mental time travel (memory’s role will be treated in section 3). FMTT experience typically entails some form of imagination (e.g., counterfactual, scenario construction, simulation, etc.). But to experience FMTT, imagination must be acted on by processes that enable temporal awareness—and it is those processes, not the imaginative act per se, that allow us to mentally project occurrent imagination from the “now” to the “next” (e.g., one can imagine a camping trip without situating those imaginings in *any* temporal context; Klein, Robertson, & Delton, 2010). In short, our capacity to move the mind through landscapes yet to be actualized is not, and cannot, be achieved solely via an act of imagination: absent additional processes, no imaginative movement through time is possible. These processes—which we refer to as subjective temporality—are the focus of this chapter.

For much of its existence as a topic of investigative effort, FMTT has been accorded the status of a reasonably well-circumscribed set of neurocognitive abilities. Despite surface variation due to the task employed, the mechanisms underlying FMTT are assumed to share a strong family resemblance (based largely on their supposed grounding in episodic memory; see section 2 and Klein, in press). However, when examined through an analytic lens, it becomes clear that the totality of phenomena labeled FMTT is more akin to a complex fractal set than a well-formed taxonomy. This, in turn, suggests that if we are going to understand FMTT we must be cognizant that it comes in different forms or types: one size does not fit all (for a recent review, see Klein, 2013a).

To anticipate our conclusions, we argue that although there is a marked tendency to treat FMTT as a unitary mental faculty that, despite task-driven outward variation, ultimately reduces to a common phenomenological state (underwritten primarily by episodic memory), FMTT is neither unitary nor is it necessarily beholden to episodic memory (on this latter point, see also Abraham & Bubic, 2015; Irish, Chapter 19 of this volume; Irish & Piguet, 2013; and Klein, 2013a). Rather, FMTT is diverse both in its experiential realizations and causal dependencies.¹ It is our contention that the phenomenological diversity found with FMTT is dependent not on the type of memory in play (e.g., episodic versus semantic), but on the type of subjective temporality associated with a particular memorial state (Klein, in press).

2. A BRIEF REVIEW OF THOUGHT ABOUT SUBJECTIVE TEMPORALITY AND MEMORY

Western interest in subjective temporality begins with ancient Greek philosophy.² Hesiod, in his *Theogony* (circa 700 B.C.), observes that a function of memory is to enable its possessor to subjectively transcend the stasis of the present. While he was not entirely clear whether temporal navigation was directionally biased (i.e., toward past or future), Aristotle (384 BC—322 B.C. was adamant: “The object of memory is the past” (cited in Sorabji, 1972, 13). The future, in contrast, is known not by memory but by acts of anticipation.

Aristotle’s position dominated discourse on the relation between time and memory for almost two thousand years. Thus, Augustine (354–430 A.D.) contends, “The time of present things past is memory, the time of present things present is direct experience and the time of present things future is expectation” (*Confessions*, Book 11, chapter 20, heading 26). Although the concept of memory underwent a number of (often minor) changes (mostly in the hands of Scholastic authorities; e.g., Danziger, 2008; Yates, 1966), its relation to the past served as the stable ground for virtually all discourse.

It was not until the late nineteenth century that the idea that the subjective temporality enabled by memory is restricted to navigating one’s past met serious challenge. Dissatisfaction with the Aristotelian view was stimulated by Darwin’s work on natural selection. For example, Bradley (1887), adopting a functional perspective, argued that memory *must*, of adaptive necessity, be oriented toward the future. “Why,” he asked,

is our memory directed towards our incoming sensations and towards the [temporal] side from which change comes? . . . The answer, in a word, is practical necessity. . . . Life being a process of decay and of continual repair and struggle throughout against dangers, our thoughts, if we care to live, must mainly go the way of anticipation. We are concerned practically with what meets us and what we go to meet, and this practical concern has formed the main habit of our thought.” (Bradley, 1887, 581–582; word in brackets added for textual clarification).

For much of the next century, treatment of the relation between memory and future-oriented temporal perspective remained largely in the hands of philosophers, while academic psychology continued to devote attention to the intuitively more appealing notion that memory is concerned with things past (thereby committing the logical error of assuming that since memory is *from* the past it must be *about* the past; e.g., Klein, 2013b, 2015).

2.1. The Emergence of FMTT and Its Relation to Memory

Psychology’s interest in subjective temporality has been on display from the time the discipline first achieved academic independence (around the middle of the nineteenth century; for a review, see Fraisse, 1963). However, little of this work was devoted to explication of the role of memory in future orientation: to the

extent that memory was partnered with subjective temporality, the questions asked were largely psychometric—for example, the role of memory in retrospective estimates of elapsed time, just noticeable differences between temporal intervals, and so on (e.g., Frankenhaeuser, 1959; Nichols, 1891; Ornstein, 1969; for a review, see Roedelein, 2000).

Sustained interest in FMTT first appeared in the 1950s, as psychologists began to consider how thought about, or orientation toward, the future influences behavior (for reviews, see Cottle & Klineberg, 1974; Gorman & Wessman, 1977). These initial forays examined a diversity of topics—such as the part played by future orientation on life-span development (Klineberg, 1967; Wohlford, 1966), delinquent behavior (Davids, Kidder, & Reich, 1962), emotions (Melges & Fougrousse, 1968), impulse control (Klineberg, 1968; Rozek, Wessman, & Gorman, 1977; Siegman, 1961), motivation (Nuttin, 1985), academic achievement (Teahan, 1958), and mental illness (Krauss & Ruiz, 1967; Wallace, 1956). Most of this work treated future-oriented thought as a variable that people might use or be influenced by: the cognitive and neural underpinnings (e.g., memory) of FMTT seldom figured in discussion (this most likely was due to hard-line positivism's informal ban on “black-box” psychology).

Following a brief period of benign neglect, psychological investigation of subjective temporality was reinvigorated by three conceptual meditations—Tulving (1985), Ingvar (1985), and Suddendorf (1994). However, the questions addressed had changed: influenced by the theoretical commitments of the cognitive revolution, inquiry now was trained on the relation between future-oriented thought and its memorial underpinnings. The first few empirical treatments soon followed (e.g., Dalla Barba, Cappelletti, Signorini, & Denes, 1997; Klein, Loftus, & Kihlstrom, 2002; Williams, Ellis, Tyers, Healy, Rose & MacLeod, 1996), and in less than two decades the relation between memory and FMTT had grown into a thriving research industry. This interest shows no sign of abating—as evidenced by the increasing pace and broadening scope of the questions being asked, as well as special issues (e.g., *Quarterly Journal of Experimental Psychology*, in press), symposia (e.g., Society for Personality and Social Psychology [SPSP], 2015) and edited books (e.g., the present volume) devoted to the topic.

3. MEMORY, SUBJECTIVE TEMPORALITY, AND FMTT

Although Bradley's prophetic observations waited nearly 100 years before receiving serious attention, by the mid-1980s psychologists had begun to consider what (given the intellectual climate) seemed a radical possibility—that the evolved function of memory was to focus thought and behavior on the future, rather than on the past (for reviews, see Boyer, 2009; Klein, 2013b; Tulving, 2005). Within this framework, one particular type of long-term memory—episodic—was accorded special status as the neurocognitive basis of virtually all forms of FMTT (for recent reviews, see Addis & Schacter, 2012; Irish & Piguet, 2013; Klein, 2013a; Schacter, Addis, Hassabis, Martin, Spreng, & Szpunar, 2012; Suddendorf & Corballis, 2007; Szpunar, 2010).

The assumed bond between episodic memory and FMTT was widely accepted, and scholarly treatments of the pairing—impressive both in quantity and

diversity—soon covered the academic landscape. Terms such as *episodic future thought* (Atance & O’Neill, 2005; Race, Keane, & Verfaellie, 2011; Schacter & Addis, 2007; Szpunar & McDermott, 2008) *episodic simulation/construction* (Addis, Cheng, Roberts, & Schacter, 2011; Hassabis, Kumaran, Vann, & Maguire, 2007; Hassabis & Maguire, 2007; Schacter, Addis, & Buckner, 2008), *episodic self-projection* (e.g., Buckner & Carroll, 2007), and *episodic foresight* (e.g., Atance & Sommerville, 2014; Suddendorf, 2010) became the “coin of the realm.”

One possible reason for the tight focus on episodic memory is that—with two notable exceptions (Atance & O’Neill, 2001; Klein, Loftus, & Kihlstrom, 2002)—initial theory and research had examined *only* the effects of episodic memory on FMTT (Dalla Barba et al., 1997; Suddendorf & Corballis, 1997; Tulving, 1985; Wheeler, Stuss, & Tulving, 1997; Williams et al., 1996). However, both logical concerns and empirical demonstrations recently have called into question both the exclusivity and conceptual warrant of the assumed relation between episodic memory and FMTT (these are treated extensively in Klein, in press, and will not be elaborated here).

3.1. Broadening the Scope of Memory’s Participation in FMTT

In what follows, we focus on the question of whether episodic memory is necessary for FMTT. As our brief review in the previous section suggests, this was, and continues to be, the “received view.” However, in the first years of the new millennium, Klein, Loftus, and Kihlstrom (2002) demonstrated that semantic memory can support certain forms of FMTT in the absence of *any* functioning episodic memory. Specifically, as a result of an anoxic episode brought on by cardiac arrest, patient D. B. suffered a total loss of episodic memory. In contrast, his semantic knowledge largely was preserved (for case details, see Klein, Rozendal, & Cosmides, 2002). As anticipated from previous studies on the effects of episodic amnesia on FMTT (e.g., Dalla Barba et al., 1997), D. B. was unable to mentally project himself into the future. He could, however, imagine non-personal future scenarios.

Although this finding—that FMTT might be based on intact semantic knowledge—initially was ignored, investigators began to take notice as they encountered increasing difficulty fitting their FMTT findings to an exclusively episodic model (e.g., Addis & Schacter, 2012; Anderson, 2012; Cooper, Vargha-Khadem, Gadian, & Maguire, 2011; Irish, Chapter 19 of this volume; Maguire, Vargha-Khadem, & Hassabis, 2010). For example, patients with episodic amnesia due to hippocampal abnormalities sometimes retain the ability to imagine future experiences (e.g., Maguire et al., 2010; Mullally, Hassabis, & Maguire, 2012). Explanations adhering to the tenets of the episodic model suggested that these patients possibly possessed residual hippocampal function capable of underwriting future projection (e.g., Mullally et al., 2012). However, the findings also were consistent with the possibility that semantic knowledge, in the absence of episodic function, can sustain FMTT. It thus remained a live question whether semantic knowledge by itself, or in interaction with partially intact episodic memory (inferred from residual hippocampal activity), accounted for future-oriented imagination reported by these investigators.

Empirical support for the position that FMTT cannot be grounded solely in the offerings of episodic memory recently has been demonstrated by several labs. For example, Irish, Addis, Hodges, and Piguet (2012) showed that individuals suffering semantic dementia (with corresponding impairment of semantic memory) have difficulty constructing novel future scenarios despite largely intact episodic function. The authors concluded that semantic memory is a necessary component of future-oriented thought. Echoing these results, Duval, Desgranges, de La Sayette, Belliard, Eustache, and Piolino (2012) demonstrated that patients in early to moderate stages of semantic dementia experience significant impairment in future-oriented self-projection, regardless of whether the task performed was designed to access semantic or episodic memory. Taken together, these findings (and others like them; e.g., Costi, Navarro, Vallat-Azouvi, Brami, Azouvi, & Piolino, 2015) suggest that episodic memory is not sufficient for (at least certain forms of) FMTT.

It may not be necessary either (again, at least for certain forms of FMTT; e.g., Klein, in press). Consider the case of patient J. R. (Manning, Denkova, & Unterberger, 2012). Following surgical treatment for temporal lobe epilepsy, J. R. showed preserved episodic memory alongside selective loss of semantic function. Unlike the dementia patients studied by Duval et al. (2012), J. R. was able to recall his personal past and imagine a *personal* future. However, his ability to engage in mental time travel of an *impersonal* nature was seriously impaired in both temporal directions from the present. This finding, in combination with that of patient D. B., suggests a double dissociation between types of memory (episodic/semantic) and the ability to imagine types of future-oriented scenarios (personal/non-personal).

One particularly interesting case is that of patient R. B. (e.g., Klein & Nichols, 2012). Following a serious head injury, R. B. suffered a very unusual memory impairment: while he remained able to retrieve content typically associated with episodic memory (i.e., temporally, spatially, and self-referentially propertyed), and was able to experience auto-noetic consciousness (see section 3.3), he could not conjoin the two. Absent a linkage between retrieved content and auto-noetic consciousness, no episodic memory is possible (e.g., Tulving, 1985, 1993; Wheeler, Stuss, & Tulving, 1997).

Yet despite his absence of episodic recollection he was able to form plans of a personal nature (surprisingly, he could form new episodic memories, i.e., postdating his injury; but this meager corpus—he was tested approximately 2–4 months post-injury—could not possibly provide a database sufficient for making plans, some of which were complex and temporally extensive). This case calls into question whether episodic memory is *necessary* for all forms of *personal* FMTT. Perhaps auto-noetic consciousness, absent episodic recollection, is sufficient for self-referential FMTT (an explanation favored by Klein, in press)? Perhaps retrieved mental content, unaccompanied by recollective experience (e.g., Klein, 2015), can enable (at least certain kinds of) personal planning? Unfortunately, this is not the place for extended discussion of this fascinating case, which would take us far afield (as well as exceed our chapter's word limits).

Studies performed with mnemonically healthy individuals also have begun to question the sustainability of a purely episodic model of FMTT. For example, it has been shown that the ability to construct future-oriented simulations of novel events requires contributions from *both* episodic and semantic memory (Anderson, 2012; Irish, Chapter 19 of this volume). Along similar lines, work by D'Argembeau, Lardi,

and Van der Linden (2012) and D'Argembeau and Mathy (2011) demonstrates that thinking about oneself in the future draws on resources from episodic and semantic memory.

In short, findings, mostly of recent vintage, pose a serious challenge to the explanatory adequacy of the episodic model of FMTT (for recent reviews, see Addis & Schacter, 2012; Irish, Chapter 19 of this volume; Irish & Piquet, 2013; Klein, 2013a, in press).

3.2. From Memory to Subjective Temporality

For present purposes, a central, but often overlooked, implication of the findings reported in section 3.1 is *not* that different types of memory are involved in FMTT. This no longer is in question. Rather, it is what these differential contributions tell us about the types of subjective temporality underwriting FMTT experience. The demonstration that FMTT is associated with semantic as well as episodic memory, taken in conjunction with the assumption that unique forms of subjectivity accompany different forms of memory (e.g., Tulving, 1985, 1993), led Klein and his colleagues (Klein, 2013a; Klein, Loftus, & Kihlstrom, 2002) to propose that FMTT cannot adequately be captured by a single type of temporal subjectivity: rather, the kind of subjective temporality enabling FMTT varies as a function of the type of memory called into play by task demands.

Moreover, as Klein (in press) has argued, it is the subjective temporality associated with memorial experience, not the memorial experience per se, that plays the foundational role in enabling mental time travel. Tasks that rely on episodic memory for their successful realization promote a form of subjective temporality that allows a person to project him- or herself into the future. Importantly, this entails the feeling that one is pre-experiencing the anticipated outcome. Klein and colleagues termed this “lived time.” For example, if, when asked to imagine what you will watch on television tonight, you do so by recollecting information about what you have watched on this day of the week in the past, your temporal subjectivity will be the type that accompanies episodic memory (i.e., “lived time”). The phenomenology of “lived time” is pre-reflective—that is, past experience, when acted on by this form of temporal experience, results in a directly given, non-inferential feeling that the *self* is pre-living a future possibility (see Klein, in press). “Lived time” does not require additional considerations or deliberations to justify one’s feeling that occurrent mental content points to future contingency.

In contrast, tasks that draw on semantic knowledge (e.g., when asked to anticipate environmental challenges likely to face the planet in the next decade, you formulate an answer by retrieving and reviewing what you know about ecological dangers looming on the horizon) are associated with *impersonal* forms of temporal experience. Klein and colleagues called this form of temporality “known time.” Unlike “lived time,” the phenomenology of “known time” is neither pre-reflective nor experienced as a pre-living. Rather, it is knowledge of impersonal possibilities that emerges from conceptual analyses performed on content available to consciousness. (Note that Klein, 2013a, argues that “known time” can, in principle, be self-referential. But the phenomenology is such that the self is treated as an object of conceptual analysis, rather than as first-person subjectivity.) For example, a person

may infer from subsequent analysis that retrieved content refers, by logical implication, to the future (e.g., “I know town hall meetings are on Mondays—though I no longer recollect the circumstances in which I acquired this knowledge. Since today is Saturday, the meeting is in two days”). Thus, “known time” consists in the conceptual analysis of temporal features embedded in retrieved content, rather than the unmediated feeling (perhaps, but not necessarily, grounded in retrieved content; see section 3.5) that one is pre-experiencing a personal future.³

In sum, the difference between “lived” and “known” temporal experience resides in the phenomenology that each enables. In the former case, subjective temporality is directly given as part of one’s occurrent mental state, whereas in the latter, subjective temporality is the product of inferential or interpretive acts (for more on extensive discussion, see Klein, 2013c, 2014a; in press). Further, in “lived time” temporal experience is felt as a pre-living; in contrast, the temporal experience enabled by “known time” is analytic, the outcome of inferential processing of chronologically relevant information. The take-away message is that if we hope to fully appreciate FMTT, we need to recognize that subjective temporality is not a single, undifferentiated phenomenon. Rather, there are different types of subjective temporality with different causal bases and phenomenological character.^{4,5}

3.3. A Comparison of “Lived” and “Known” Time with Tulving’s Distinction Between Auto-noetic and Noetic Consciousness

“Lived time” maps reasonably well onto Tulving’s (1985, 2005) proposal that episodic recollection entails a form of consciousness that he termed *auto-noetic* (at least the future-oriented aspect of auto-noesis; see note 5). According to Tulving, a person is auto-noetically conscious when she “is capable of becoming aware of her own past as well as her own future; she is capable of mental time travel, roaming at will over what has happened as readily as over what might happen, independently of physical laws that govern the universe” (Tulving, 1985, 5). Auto-noetic consciousness thus enables a person to relive earlier experiences as well as pre-live future possibilities (for related views, see Gardiner, 2001; Suddendorf & Corballis, 1997; Szpunar, 2010; Wheeler et al., 1997). Importantly, the temporal subjectivity made possible by auto-noesis is directly given to awareness, rather than being based on inference or interpretation (e.g., Klein, 2013c; Markowitsch, 2003; Tulving, 2005). Hence, auto-noesis, like “lived time,” is possible without, or apart from, conceptual analysis.

It is important to note that the adoption of episodic memory as the foundation of FMTT derives, at least in part, from an uncritical acceptance of a temporal symmetry between past- and future-oriented forms of auto-noesis (e.g., Klein, 2013a; Merker, 2007; Perrin, Chapter 3 of this volume). Specifically, it is (often tacitly) assumed that past-oriented auto-noetic consciousness is ontologically and phenomenologically isomorphic with future-oriented auto-noesis, thereby sanctioning extension of the functional scope of the recollective act to “what is yet to be” as well as to “what once was” (for critique and discussion see Klein, 2013a; Perrin, Chapter 3 of this volume).

However, as philosophers have argued, the phenomenological and causal natures of past and future (at least with respect to the everyday world of experiential reality; in the realms of special relativity [e.g., Hoffmann, 1998] and quantum reality [e.g., Einstein, Podolsky, & Rosen, 1935], questions of temporality become deeply puzzling) are notably asymmetric (e.g., Faye, 1989; Lockwood, 2005; McLure, 2005; Perrin, Chapter 3 of this volume). For example, while the accuracy of one's recollections can sensibly (though imperfectly; e.g., Von Leyden, 1961) be assessed by comparison with evidence (physical and mental) of a once existent past, there are no comparable criteria to guide assessment of the accuracy of future-oriented imagination. This follows directly from the definition of the future as "a mixture of coexisting latent possibilities as yet unresolved" (Merker, 2007, 326). All we can know is that "all possible futures, except *one*, will in fact *not* materialize, but not *which one*" (Merker, 2007, 326; emphases in original).

Of course, revisiting the past in anticipation of the future is not necessarily an act of imaginative futility. Past knowledge, conjoined with the experientially defensible assumption that natural laws ensure a level of uniformity in outcome, sanctions the reasonable expectation that one's pronouncements about uncertain, yet-to-exist eventualities will have some empirical warrant. But, unlike the past, knowledge of whether one's anticipatory beliefs are veridical remains evidentially opaque until "possibility" becomes "reality." The stubborn fact is that—as a consequence of both epistemological and ontological asymmetries—any simple acceptance of a past/future isomorphism is logically and phenomenologically problematic (for discussion in the context of mental time travel, see Klein, 2013a; Merker, 2007; Perrin, Chapter 3 of this volume). In this regard, Klein (2013a, in press) has called for the need to distinguish past- and future-oriented auto-noetic consciousness in discussion of FMTT (see also Perrin, Chapter 3 of this volume).

In contrast to "lived time," "known time" has no clear correlate in Tulving's taxonomy. Tulving maintained that the semantic memory is accompanied by noetic consciousness. Noesis "allows an organism to be aware of, and to cognitively operate on, objects and events, and relations among objects and events, in the absence of these objects and events" (Tulving, 1985, 3). However, unlike auto-noesis, noetic experience takes place *absent* a sense of past or future (e.g., Tulving, 1993; Szpunar, 2010). Put simply, the objects of noetic consciousness are firmly situated in the "here and now."⁶ Though "lived time" appears isomorphic with future-oriented auto-noesis, "known time" has no obvious theoretical correlate in Tulving's (or Dalla Barba's; see note 6) system.

Thus, while the "lived" versus "known" conceptualization can account for both episodic- and semantic-based FMTT, the auto-noetic versus noetic distinction (as currently configured) struggles to make sense of semantic forms of FMTT. In fact, Tulving and colleagues reject the possibility of *any* temporal experience accompanying semantic memory (e.g., Tulving, 1985; Szpunar, 2010). These definitional constraints on what constitutes temporal experience, however, can be loosened. By allowing that noetic consciousness can promote a form of temporal subjectivity based on conceptual analysis (i.e., "known time"), the construct can be modified to accommodate the type of subjective temporality associated with semantic-based FMTT.

3.4. “Lived” and Known” Time in Relation to Philosophical Conceptions of Time

The “multiple subjective temporality” postulate conforms nicely with a well-known distinction between types of temporality that traces to antiquity (e.g., Mooij, 2005; in the modern era this conceptualization most closely is associated with the work of McTaggart, 1908). The distinction trades on the difference between temporal experience conceived as (a) the constant flow from future to present to past, with temporal designators continually changing ontological status (i.e., that which once was future becomes present and that which is present will, with time’s flow, recede further into the past), and (b) a fixed, “earlier-later” chronology in which temporal placement of events is invariant (e.g., October 9, 1952 is, and always will be, prior to October 9, 1953): time is frozen into an unchanging pattern of “before and after” (McTaggart, 1908; Papa-Grimadli, 1998; Rochelle, 1998). These two modes of temporal conceptualization—which McTaggart refers to as the A- and B-series, respectively—are not logically reducible, one to the other (e.g., Loizou, 1986; McTaggart, 1908; for an opposing view, see Cornish, 2011).

Like “lived time,” the subjective temporality afforded by the A-series is pre-reflective. As McLure (2005) comments, apprehension of temporal flow is directly given to consciousness: “the ‘eye’ that spies the flow is within it, not behind it” (49). The B-series, in contrast, consists in a conceptual analysis of the events and happenings in terms of their chronological arrangement. It thus comports with the subjective temporality associated with “known time.”

It is important to mention that persons deprived of their *feeling* of “lived time” (e.g., due to neural dysfunction) still can *know about* the temporal constituents of the A-series. For example, patients K. C. and D. B., both of whom suffered complete loss of episodic memory accompanied by an inability to experience temporal flow (a review of these cases can be found in Klein, 2014b; Klein & Gangi, 2010), remained fully able to construct grammatically sound propositions using the temporal designations of past, present, and future (that is, they conceptualized the A-series in terms of “known” rather than “lived” time).

Consider the following conversations with K. C. and D. B. (reported in Klein, 2014b). In response to the question “What is the future?” K. C. replies, “Events that haven’t happened yet,” while the question “What is the past?” is answered, “Events that have already happened.” Asked “Can you change the past?” K. C. emphatically states, “No!” When queried “Can you change the future, and if so, how?” he observes, “Yes. By doing different things.” To the question “Can something that happens in the future change what has happened in the past?” K. C. again responds with an unequivocal “No,” while the query “If an event is in the future will it always stay in the future?” elicits the response “No. Because time moves on.”

Patient D. B. also presents a nuanced understanding of temporality. In response to the question “What is the future?” he answers, “Things that haven’t happened yet.” He describes the past as “Things that happened before . . . but are not happening now.” Asked, “Can you change the past, D. B. says, “Don’t think so, unless you had a time machine or something. Don’t think so . . . not really. Maybe in science fiction (laughs).” To the question “Can the past influence the present?” he replies, “Sure . . . that’s the way things work.”

In short, both patients know about the flow of time, despite being unable to experience temporal movement as part of their subjective reality. The future exists for K. C. and D. B., but not as the experienced flow of the now to the next. It is known but not felt.

3.5. Beyond Memory

Our focus has been on the type of subjective temporalities afforded by different kinds of memory. But new work suggests that we need to enlarge our conceptual net if we hope to capture the neurocognitive complexity of FMTT. For example, Zeithamova, Schlichting, and Preston (2012) have shown that other cognitive systems (e.g., perceptual) in addition to memory are involved in the ability to plan for future contingencies. Similar sentiments are voiced by de Vito, Gamboz, Brandimonte, Barone, Amboni, and Della Salla (2012), who argue that executive function plays a crucial role in Parkinson's patients' performance on future thinking tasks. Arzy, Collette, Ionata, Fornari, and Blanke (2009) have shown that brain areas associated with mental imagery must be taken into account for some forms of FMTT. These data are telling us that a full appreciation of FMTT requires that we recognize that neurocognitive mechanisms other than memory (and the subjective temporalities they entail) play an important role in our ability to orient toward the future (for discussion, see Klein, 2013a).

Recent research also suggests that certain forms of temporal self-projection may not rely on memory at all. For example, Kwan, Craver, Green, Myerson, Gao, Black, and Rosenbaum (2015; see also Kwan, Craver, Green Myerson, Boyer, & Rosenbaum, 2012) assert that memory impairment does not impact a patient's ability to make choices about future rewards (a task that seems to rely on decision rules rather than retrieved content). As another example, personal diachronicity (i.e., the sense that one is a temporal continuant) appears, at least in some of its manifestations, to be based on non-evidential feeling of continuity, rather than on factually or rationally based analyses (e.g., Klein, 2014b). Moreover, it seems perfectly reasonable to muse about one's future absent any grounding in considerations of the past (e.g., "I wonder what tomorrow will be like?").

While one might argue that these examples can be explained by positing that choice, personal diachronicity, and future-directed musings are mnemonically guided, this requires that one embrace all of these acts as species of memory. At this point, we maintain, the designation *memory* becomes so encompassing that it no longer is clear what the term picks out (for fuller discussion, see Klein, 2015). As Moyal-Sharrock (2009) observes, even allowing that most of our cognitive abilities involved memory at some stage in their development, and that this is taken as grounds for seeing them as the products of memory, "this is trivial ground . . . it is no more than to say that memory has played a role in their achievement, not that it continues to do so in their subsequent deployment [e.g., choice behavior or sense of self as a temporal continuant]" (226; text within brackets added for clarification).

In our view, the examples presented (a) highlight the multifaceted nature of the FMTT, and (b) suggest that we may need to enlarge our inventory of "forms of temporal subjectivity" (in this regard it is interesting to note that McTaggart discussed temporalities other than those captured by the A- and B-series). While some of the preceding examples *might* be accommodated by mnemonic processes (and their

temporal accompaniments—though it is unclear how this would work in the case of felt diachronicity), to do so we have to expand the scope of the term *memory* to such a degree that it threatens to undermine its conceptual utility (for discussion, see Klein, 2015; Moyal-Sharrock, 2009).

4. CONCLUSIONS

Klein, Loftus, and Kihlstrom's (2002) proposed relation between types of memory and types of subjective temporality can be seen as a useful corrective to the (typically tacit) assumption that there is a single, unitary form of temporal experience. While it may be the case that the distinction they proposed ultimately will prove too limited to fully capture the richness of FMTT experience (see section 3.5), it is a step in the right—and, we believe, necessary—direction. What is not in doubt is that we need to be more analytically precise and nuanced about what it is we refer to when we use the label *FMTT* (e.g., Klein, 2013a, in press). Is it our ability to construct personal future scenarios, to construct public future scenarios, to plan for future contingencies, to anticipate events, to maintain our sense of personal continuity, to make future-oriented judgments, muse about future contingencies, to predict our future feelings, attitudes, and beliefs? Are these simply manifestations of superficial variations of a common underlying mental faculty—an inevitable, but theoretically uninteresting, consequence of using different tasks to probe a unitary ability to orient toward and imagine the future? Or do these variants rely—at least in part—on different neurocognitive mechanisms?

In this chapter we champion the latter possibility. Specifically, we argue that, in the absence of a more sophisticated understanding of the theoretical entailments of FMTT, the term runs a serious risk of becoming a “catch-all” phrase that diverts attention from different forms of subjective temporality—each with distinctive (as well as overlapping) neurocognitive and conceptual commitments—that enable FMTT in its various manifestations.

In summary, there are reasons (both empirical and conceptual) to suspect that no single form of future-oriented temporal subjectivity is sufficient to capture the complexity of FMTT experience. Nonetheless, we acknowledge that the idea that subjective temporality can be partitioned into subtypes remains, at present, an assertion in need of investigative and theoretical attention. For instance, while available evidence suggests that “lived time” is self-referential whereas “known time” is not (e.g., Klein, Loftus, & Kihlstrom, 2002), this assertion rests on the outcome of studies that did not orthogonally vary types of subjective temporality (“lived” versus “known”) and self-referential processing (present versus absent). A necessary step toward understanding personal variants of mental time travel (into the past as well as the future) requires experimentally separating “lived” and “known” forms of temporality (perhaps by manipulating the type of memorial experience required for task performance) and examining their respective contributions to FMTT.

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NOTES

1. This concern is not novel. For example, the first author has been voicing these concerns—to relatively little effect—since 2002. Others have as well (e.g., Addis & Schacter, 2012; Szpunar, 2010). However, discussion often (though not always; e.g., Suddendorf, 2010) has appeared piecemeal, surrounded by discussion of other issues. It is our hope that by placing our concerns in bold relief (i.e., providing them their own chapter), we might reduce the signal-to-noise ratio that inevitably attends embedding a topic within additional topics.
2. The study of subjective temporality found in Eastern wisdom traditions typically is less analytic than those in Western philosophical treatment. One reason for this is that discussion, where it exists, often is the byproduct of concern with other topics such as the question of past lives (Griffiths, 1992). That being said, a recent analysis of Buddhist texts reveals that certain writings (e.g., Vasubandhu's theory of mind) show striking similarities to Western thought concerning the role of the subjective time associated in acts of memory (Chadha, 2014).
3. There is no reason that conceptual analyses could not be performed on the offerings of episodic memory. And there likely are occasions on which they are. The point simply is that such analyses need not be undertaken in order for the individual to experience subjective temporality with this form of memory. In contrast, conceptual analyses are a necessary accompaniment for subjective temporality to emerge in the context of semantic knowledge.
4. It is, of course, possible to know about "lived time" without directly experiencing it. As will be shown in section 3.4, individuals can subject the idea of temporal flow to a purely conceptual analysis (i.e., "known time"). In fact, as reported in Klein (2014b), patients suffering complete failure of episodic memory retain preserved knowledge of the concepts of past and future. But, in virtue of their disability, they are incapable of experiencing temporal movement (i.e., "lived time").
5. In this chapter we restrict analysis of subjective temporality to its future orientation. While past-oriented temporality has many of the features described for its future-oriented brethren, there are profound logical and causal asymmetries between the two (see section 3.3). Accordingly, a simple extension of future-oriented temporal subjectivity to experience of the past is difficult to justify. We plan to discuss the nature of past-oriented temporal subjectivity at a later time (see also Perrin, Chapter 3 of this volume).
6. Work by Dalla Barba and colleagues (reviewed in Dalla Barba, 2002) on the relation between memory and temporal experience has a clear resemblance to Tulving's ideas on the topic. Like Tulving, Dalla Barba proposes that two modes of consciousness can accompany the retrieval of memory content—temporal consciousness (TC) and knowing consciousness (KC). TC, like auto-noesis, is consciousness of time—it enables a person to become aware of something as part of his or her personal past, present, or future. KC, by contrast, operates like noetic consciousness—it enables a person to become aware of something as an element of knowledge without that knowledge being situated in a temporal framework. Note: An updated version of the conceptual entailments of TC and KC can be found in Chapter 6 by Dalla Barba in the present volume.

REFERENCES

- Abrahamn, A., & Bubic, A. (2015). Semantic memory as the root of imagination. *Frontiers in Psychology*, 6, 325. doi: 10.3389/fpsyg.2015.00325.
- Addis, D. R., Cheng, T., Roberts, R. P., & Schacter, D. L. (2011). Hippocampal contributions to the episodic simulation of specific and general future events. *Hippocampus*, 21, 1045–1052.
- Addis, D. R., & Schacter, D. L. (2012). The hippocampus and imagining the future: where do we stand? *Frontiers in Human Neuroscience*, 5, Article 173.
- Anderson, R. J. (2012). Imagining novel futures: the roles of event plausibility and familiarity. *Memory*, 20, 443–451.
- Arstila, V., & Lloyd, D. (2014). *Subjective time: philosophy, psychology, and neuroscience of temporality*. Cambridge, MA: MIT Press.
- Arzy, S., Collette, S., Ionata, S., Fornari, E., & Blanke, O. (2009). Subjective mental time travel: the functional architecture of projecting the self to the past and future. *European Journal of Neuroscience*, 30, 2009–2017.
- Atance, C. M., & O'Neill, D. K. (2001). Episodic future thinking. *Trends in Cognitive Sciences*, 5, 533–539.
- Atance, C. M., & Sommerville, J. A. (2014). Assessing the role of memory in preschooler's episodic performance on episodic foresight tasks. *Memory*, 22, 118–128.
- Augustine. (1997). *The confessions*. Translated by M. Boulding. Hyde Park, NY: New City Press.
- Bar, M. (Ed.) (2011). *Predictions in the brain: using our past to generate a future*. New York: Oxford University Press.
- Boyer, P. (2009). What are memories for? Functions of recall in cognition and culture. In P. Boyer & J. V. Wertsch (eds.), *Memory in mind and culture* (pp. 3–28). Cambridge, UK: Cambridge University Press.
- Bradley, F. H. (1887). Why do we remember forwards and not backwards? *Mind*, 12, 579–582.
- Buckner, R. L., & Carroll, D. C. (2007). Self-projection and the brain. *Trends in Cognitive Sciences*, 11, 49–57.
- Chadha, M. (2014). A Buddhist explanation of episodic memory: from self to mind. *Asian Philosophy*, 24, 14–27.
- Cheke, L. G., & Clayton, N. S. (2010). Mental time travel in animals. *WIREs Cognitive Science*, 1, 1–16.
- Cooper, J. M., Vargha-Khadem, E., Gadian, D. G., & Maguire, E. A. (2011). The effect of hippocampal damage in children on recalling past and imagining new experiences. *Neuropsychologia*, 49, 1843–1850.
- Cornish, D. (2011). Earlier and later if and only if past, present and future. *Philosophy*, 86, 41–58.
- Costi, C., Navarro, B., Vallat-Azouri, C., Brami, M., Azouvi, P., & Piolino, P. (2015). Disruption of temporally extended self-memory system following traumatic brain injury. *Neuropsychologia*, 71, 133–145.
- Cottle, T. J., & Klineberg, S. L. (Eds.). (1974). *The present of things future: explorations in the human experience of time*. London: Collier Macmillan Publishers.
- D'Argembeau, A., Lardi, C., & Van der Linden, M. (2012). Self-defining future projections: exploring the identity function of thinking about the future. *Memory*, 20, 110–120.

- D'Argembeau, A., & Mathy, A. (2011). Tracking the construction of episodic future thoughts. *Journal of Experimental Psychology: General*, *140*, 258–271.
- Dalla Barba, G. (2002). *Memory, consciousness and temporality*. Norwell, MA: Kluwer Academic Publishers.
- Dalla Barba, G., Cappelletti, J. Y., Signorini, M., & Denes, G. (1997). Confabulation: remembering 'another' past, planning 'another' future. *Neurocase*, *3*, 425–436.
- Danziger, K. (2008). *Marking the mind: a history of memory*. Cambridge, UK: Cambridge University Press.
- Davids, A., Kidder, C., & Riech, M. (1962). Time orientation in male and female juvenile delinquents. *Journal of Abnormal and Social Psychology*, *64*, 239–240.
- de Vito, S., Gamboz, N., Brandimonte, M. A., Barone, P., Amboni, M., & Della Salla, S. (2012). Future thinking in Parkinson's disease: an executive dysfunction? *Neuropsychologia*, *50*, 1494–1501.
- Duval, C., Desgranges, B., de La Sayette, V., Belliard, S., Eustache, F., & Piolino, P. (2012). What happens to personal identity when semantic knowledge degrades? A study of the self and autobiographical memory in semantic dementia. *Neuropsychologia*, *50*, 254–265.
- Einstein, A., Podolsky, B., & Rosen, N. (1935). Can quantum-mechanical description of physical reality be considered complete? *Physical Review*, *47*, 777–780.
- Faye, J. (1989). *The reality of the future*. Odense: Odense University Press.
- Fraisse, P. (1963). *The psychology of time*. London: Harper & Row Publishers.
- Frankenhauser, M. (1959). *Estimation of time: An experimental study*. Stockholm: Almqvist & Wiksell.
- Gardiner, J. M. (2001). Episodic memory and autoevident consciousness: a first-person approach. *Philosophical Transactions of the Royal Society B*, *356*, 1351–1362.
- Gorman, B. S., & Wessman, A. E. (eds.). (1977). *The personal experience of time*. New York: Plenum Press.
- Griffiths, P. J. (1992). Memory in classical Indian Yogacara. In J. Gyatso (ed.), *In the mirror of memory: reflections on mindfulness and remembrance in Indian and Tibetan Buddhism* (pp. 109–131). Albany: State university of New York Press.
- Hassabis, D., Kumaram, D., Vann, D. S., & Maguire, E. A. (2007). Patients with hippocampal amnesia cannot imagine new experience. *Proceedings of the National Academy of Sciences*, *104*, 1726–1731.
- Hassabis, D., & Maguire, E. A. (2007). Deconstructing episodic memory with construction. *Trends in Cognitive Sciences*, *11*, 299–306.
- Hoffmann, B. (1998). *Relativity and its roots*. Mineola, NY: Dover Publications.
- Ingvar, D. H. (1985). "Memory for the future": an essay on the temporal organization of conscious awareness. *Human Neurobiology*, *4*, 127–136.
- Irish, M., Addis, D. R., Hodges, J. R., & Piguet, O. (2012). Considering the role of semantic memory in episodic future thinking: evidence from semantic dementia. *Brain*, *135*, 2178–2191.
- Irish, M., & Piguet, O. (2013). The pivotal role of semantic memory in remembering the past and imagining the future. *Frontiers in Behavioral Neuroscience*, *7*, 27. doi: 10.3389/fnbeh.2013.00027.
- Klein, S. B. (2013a). The complex act of projecting oneself into the future. *WIREs Cognitive Sciences*, *4*, 63–79.
- Klein, S. B. (2013b). The temporal orientation of memory: it's time for a change of direction. *Journal of Research in Applied Memory and Cognition*, *2*, 222–234.

- Klein, S. B. (2013c). Making the case that episodic recollection is attributable to operations occurring at retrieval rather than to content stored in a dedicated subsystem of long-term memory. *Frontiers in Behavioral Neuroscience*, 7, 3. doi: 10.3389/fnbeh.2013.00003.
- Klein, S. B. (2014a). Autooiesis and belief in a personal past: an evolutionary theory of episodic memory indices. *Review of Philosophy and Psychology*, 5, 427–447.
- Klein, S. B. (2014b). Sameness and the self: philosophical and psychological considerations. *Frontiers in Psychology: Perception Science*, 5, 29. doi: 10.3389/fpsyg.2014.00029
- Klein, S. B. (2015). What memory is. *WIREs Cognitive Science*, 6, 1–38.
- Klein, S. B. (in press). Autooietic consciousness: reconsidering the role of episodic memory in future-oriented self projection. *The Quarterly Journal of Experimental Psychology*.
- Klein, S. B., Cosmides, L., Tooby, J., & Chance, S. (2002). Decisions and the evolution of memory: multiple systems, multiple functions. *Psychological Review*, 109, 306–329.
- Klein, S. B., & Gangi, C. (2010). The multiplicity of self: neuropsychological evidence and its implications for the self as a construct in psychological research. *Annals of the New York Academy of Sciences*, 1191, 1–15.
- Klein, S. B., Loftus, J., & Kihlstrom, J. F. (2002). Memory and temporal experience: the effects of episodic memory loss on an amnesic patient's ability to remember the past and imagine the future. *Social Cognition*, 20, 353–379.
- Klein, S. B., & Nichols, S. (2012). Memory and the sense of personal identity. *Mind*, 121, 677–702.
- Klein, S. B., Robertson, T. E., & Delton, A. W. (2010). Facing the future: memory as an evolved system for planning future acts. *Memory & Cognition*, 38, 13–22.
- Klein, S. B., Rozendal, K., & Cosmides, L. (2002). A social-cognitive neuroscience analysis of the self. *Social Cognition*, 20, 105–113.
- Klineberg, S. L. (1967). Changes in outlook on the future between childhood and adolescence. *Journal of Personality and Social Psychology*, 2, 185–193.
- Klineberg, S. L. (1968). Future time perspective and the preference of delayed reward. *Journal of Personality and Social Psychology*, 8, 253–257.
- Krauss, H. H., & Ruiz, R. E. (1967). Anxiety and temporal perspective. *Journal of Clinical Psychology*, 23, 340–342.
- Kwan, D., Craver, C. F., Green, L., Myerson, J., Boyer, P., & Rosenbaum, R. S. (2012). Future decision-making without episodic mental time travel. *Hippocampus*, 22, 1215–1219.
- Kwan, D., Craver, C. F., Green, L., Myerson, J., Gao, F., Black, S. E., & Rosenbaum, R. S. (2015). Cueing the personal future to reduce discounting in intertemporal choice: Is episodic prospection necessary? *Hippocampus*, 25, 432–443.
- Lockwood, M. (2005). *The labyrinth of time*. New York: Oxford University Press.
- Loizou, A. (1986). *The reality of time*. Aldershot, UK: Gower Publishing.
- Maguire, E. A., Vargha-Khadem, F., & Hassabis, D. (2010). Imagining fictitious future experiences: evidence from developmental amnesia. *Neuropsychologia*, 48, 3187–3192.
- Manning, L., Denkova, E., & Unterberger, L. (2012). Autobiographical significance in past and future public semantic memory: a case study. *Cortex*, 49, 2007–2020.
- Markowitsch, H. J. (2003). Autooietic consciousness. In T. Kircher & A. David (eds.), *The self in neuroscience and psychiatry* (pp. 180–196). Cambridge, UK: Cambridge University Press.
- McLure, R. (2005). *The philosophy of time*. New York: Routledge.

- McTaggart, J. M. E. (1908). The unreality of time. *Mind*, 68, 457–484.
- Melges, F. T., & Fougerousse, C. E. (1968). Time sense, emotions, and acute mental illness. *Journal of Psychiatric Research*, 4, 127–140.
- Merker, B. (2007). Memory, imagination, and the asymmetry between past and future. *Behavioral and Brain Sciences*, 30, 325–326.
- Mooij, J. J. A. (2005). *Time and mind*. Boston, MA: Brill.
- Moyal-Sharrock, D. (2009). Wittgenstein and the memory debate. *New Ideas in Psychology*, 27, 213–227.
- Mullally, S. L., Hassabis, D., & Maguire, E. A. (2012). Scene construction in amnesia: an fMRI study. *The Journal of Neuroscience*, 32, 5646–5663.
- Nichols, H. (1891). *The psychology of time: historically and philosophically considered with extended experiments*. New York: Henry Holt.
- Nuttin, J. (1985). *Future perspective and motivation*. Hillsdale, NJ: Lawrence Erlbaum.
- Ornstein, R. E. (1969). *On the experience of time*. Middlesex, UK: Penguin Books.
- Papa-Grimadli, A. (1998). *Time and reality*. Aldershot, UK: Ashgate.
- Pezzulo, G. (2008). Coordinating with the future: the anticipatory nature of representation. *Minds Machines*, 18, 179–225.
- Race, E., Keane, M. N., Verfaellie, M. (2011). Medial temporal lobe damage causes deficits in episodic memory and episodic future thinking not attributable to deficits in narrative construction. *Journal of Neuroscience*, 31, 10262–10269.
- Rochelle, G. (1998). *Behind time: the incoherence of McTaggart's atemporal replacement*. Aldershot, UK: Ashgate.
- Roeckelein, J. E. (2000). *The concept of time in psychology*. Westport, CT: Greenwood Press.
- Rozek, F., Wessman, A. E., & Gorman, B. S. (1977). Temporal span and delay of gratification as a function of age and cognitive development. *Journal of Genetic Psychology*, 131, 37–40.
- Schacter, D. L., & Addis, D. R. (2007). The cognitive neuroscience of constructive memory: remembering the past and imagining the future. *Philosophical Transactions of the Royal Society B*, 362, 773–786.
- Schacter, D. L., Addis, D. R., & Buckner, R. L. (2008). Episodic simulation of future events: concepts, data, and applications. *Annals of the New York Academy of Science*, 1124, 39–60.
- Schacter, D. L., Addis, D. R., Hassabis, D., Martin, V. C., Spreng, R. N., & Szpunar, K. K. (2012). The future of memory: remembering, imagining, and the brain. *Neuron*, 76, 677–613.
- Siegmán, A. W. (1961). The relation between future time perspective, time estimation, and impulse control in a group of young offenders and in a control group. *Journal of Counseling Psychology*, 25, 470–475.
- Sorabji, R. (1972). *Aristotle on memory*. Providence, RI: Brown University Press.
- Suddendorf, T. (1994). *The discovery of the fourth dimension: mental time travel and human evolution*. Master's thesis, University of Waikato, Hamilton, New Zealand.
- Suddendorf, T. (2010). Episodic memory versus episodic foresight: similarities and differences. *WIREs Cognitive Science*, 1, 99–107.
- Suddendorf, T., & Corballis, M. C. (1997). Mental time travel and the evolution of the human mind. *Genetic, Social, and General Psychology Monographs*, 123, 133–167.
- Suddendorf, T., & Corballis, M. C. (2007). The evolution of foresight: what is mental time travel, and is it unique to humans? *Behavioral and Brain Sciences*, 30, 299–313.
- Szpunar, K. K. (2010). Episodic future thought: an emerging concept. *Perspectives on Psychological Science*, 5, 142–162.

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- Szpunar, K. K., & McDermott, K. B. (2008). Episodic future thought and its relation to remembering: evidence from ratings of subjective experience. *Consciousness and Cognition, 17*, 330–334.
- Teahan, J. E. (1958). Future time perspective, optimism, and academic achievement. *Journal of Abnormal and Social Psychology, 57*, 379–380.
- Tulving, E. (1985). Memory and consciousness. *Canadian Psychology/Psychologie canadienne, 26*, 1–12.
- Tulving, E. (1993). What is episodic memory? *Current Directions in Psychological Science, 2*, 67–70.
- Tulving, E. (2005). Episodic memory and autoevidence: uniquely human? In H. S. Terrace and J. Metcalfe (eds.), *The missing link in cognition: origins of self-reflective consciousness* (pp. 3–56). Oxford: Oxford University Press.
- Von Leyden, W. (1961). *Remembering: a philosophical problem*. New York: Philosophical Library.
- Wallace, M. (1956). Future time perspective in schizophrenia. *Journal of Abnormal and Social Psychology, 52*, 240–245.
- Wheeler, M. A., Stuss, D. T., & Tulving, E. (1997). Toward a theory of episodic memory: the frontal lobes and autoevidence consciousness. *Psychological Bulletin, 121*, 331–354.
- Williams, J. M. C., Ellis, N. C., Tyers, C., Healy, H., Rose, G., & MacLeod, A. K. (1996). The specificity of autobiographical memory and imageability of the future. *Memory & Cognition, 24*, 116–125.
- Wohlford, P. (1966). Extension of personal time, affective states, and expectation of personal death. *Journal of Personality and Social Psychology, 3*, 559–566.
- Yates, F. A. (1966). *The art of memory*. Chicago: University of Chicago Press.
- Zeithamova, D., Schlichting, M. L., & Preston, A. R. (2012). The hippocampus and inferential reasoning: building memories to navigate the future. *Frontiers in Human Neuroscience, 6*, 1–14.