

CHAPTER 1

Varieties of Future Experience

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In this volume, the concept of “prediction” is proposed to be an overarching principle of brain function that encompasses the general capacity to anticipate a broad range of external events in the service of promoting adaptive interactions with one’s environment (Bar, 2009). Nonetheless, the various “predictive” capacities that are discussed here may be distinguished from one another and it will be important for psychologists and neuroscientists to specify how any one “predictive” capacity is different from, or similar to, other related capacities. This practice would serve the purpose of reinforcing the important observation that is central to Bar’s (2009) characterization of “prediction”—that it is a heterogeneous concept and that all “predictive” capacities that have thus far been identified, and that will undoubtedly be identified in the future, are not necessarily equal.

As a modest starting point, we propose a straightforward distinction between “predictions” that are either: (i) inherent to actions and behaviours tied to the present moment (e.g., as is typically observed when humans or other animals produce intelligible and adaptive behaviours) or (ii) inherent to mental operations predicated on the conscious awareness on the part of the individual that his or her self extends temporally into the “non-immediate” future (i.e., a time that does not follow a presently ongoing sequence of events; e.g., as occurs when human beings contemplate scenarios that have yet to take place).

For instance, over an extended period of training, a rat is capable of learning to infer that one stimulus is more preferable (i.e., leads to a reward) than another, even though the rat has never experienced those two stimuli in conjunction in the past (see Eichenbaum & Fortin, 2009). In terms that will be used in the current volume, the rat is said to correctly “predict” the most beneficial manner in which to interact with its environment. This kind of “prediction” has to do with an ongoing sequence of events (in the present moment).

Of course, the same characterization can be made about various kinds of human behaviours. For instance, consider your ability to “predict” how much force will be required to lift a carton of milk (see Linas & Roy, 2009). The fact that you are consistently able to lift a carton of milk without dropping it or hurling it up towards the ceiling is a testament to the fact that you are able to anticipate the approximate weight of the carton (again, in the present moment).

The capacity to “predict” one’s interactions with the immediate environment will be considered in much greater detail in various chapters that follow. In the remainder of this chapter, we focus on the other type of “prediction” outlined above, the kind that has to do with thinking about events that may not take place for some time to come (see Hassabis & Maguire, 2009; Schacter & Addis, 2009).

Specifically, this chapter is organized into two main sections. First, we provide an overview of

the concept of “autonoetic consciousness,” which is defined as the capacity to be consciously aware of one’s continued temporal existence (Wheeler, Stuss, & Tulving, 1997). Second, we outline various “predictive” mental activities that deal with the extended, or “non-immediate,” future of the individual. These include, future orientation, episodic future thought, planning, and prospective memory. Furthermore, we consider the nature in which these “predictive” mental activities relate to one another and how, ultimately, each depends on the capacity of autonoetic consciousness.

AUTONOETIC CONSCIOUSNESS

To take full advantage of the “predictive” capacities of the brain that extend out beyond the present moment, one must first be aware that one’s self will continue to exist in the future. It has been proposed that the capacity to appreciate the connection of one’s current self with the future (and past) reflects the functioning of a special form of conscious awareness called “autonoetic consciousness” (Tulving, 1985, 2005; Wheeler et al., 1997). Further, it has been argued that autonoetic (or self-knowing) consciousness is fundamentally different from a more general type of conscious awareness that underlies the capacity to simply know that the past and future exist, in a way that we know a myriad of other facts about the world. This latter, and more general, form of conscious awareness has been called noetic (or knowing) consciousness (see Tulving, 1995). Accordingly, only “autonoetic consciousness” is thought to bear a personally meaningful relation to time (see also Suddendorf & Corballis, 1997, 2007).

Evidence in support of this distinction was first presented in relation to the now well-known case of patient K. C. (Tulving, 1985; see also Rosenbaum et al., 2005). K. C. has global amnesia induced by diffuse brain damage sustained in a motorcycle accident. He possesses many intact cognitive capacities but can neither remember any single episode from his life nor project himself mentally into the future. When asked to do either, he states that his mind is “blank,” when asked to compare the kinds of blankness in the two situations, he says it is the “same kind of

blankness” (Tulving, 1985, p. 4) (see Rosenbaum, Gilboa, Levin, Winocur, & Moscovitch, 2009 for a more recent example of K. C.’s inability to apprehend his personal future and past). A similar profile is exhibited by patient D. B., studied by Stanley Klein and his colleagues (Klein, Loftus, & Kihlstrom, 2002); D. B. experienced an anoxic episode following cardiac arrest and can no longer project himself into the future or recollect his past.

It is critical to note that both K. C. and D. B. possess an intact understanding of the concept of time; they know that there is a future and a past and they can tell time on a clock. What they lack is the awareness that their current self extends into their personal future and past.

Relatively little attention has been devoted to the concept of “autonoetic consciousness” as a brain-based capacity that enables various mental acts (e.g., mental time travel into the personal future and past). In the remainder of this chapter, various mental activities that require the individual to appreciate that a particular personal experience may occur in the future, without necessarily being required to think about the experience itself, are identified and it is argued that each depends on the capacity of “autonoetic consciousness.”

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In this section, we focus on various future-directed, or “predictive,” mental activities that extend out beyond the present moment and that have each received a considerable amount of empirical attention. These include the following: (1) future orientation—the tendency for a particular individual to devote a considerable amount of his or her mental life to thinking about the future; (2) episodic future thinking—a particular mode of future thinking that involves imagining specific personal scenarios; (3) planning—a multi-component process aimed at achieving some goal; and (4) prospective memory—a multi-component process that underlies memory for intentions. As will become apparent, these various approaches to understanding the temporally extended future have been largely studied in isolation from one another, although close relations exist between them. As the neurocognitive study

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of the future (i.e., various “predictive” capacities of the brain) continues to evolve, it will be important to actively negotiate relations between the various concepts that have emerged and those that will doubtless emerge in the future. We attempt to draw a preliminary sketch here.

Future Orientation and Modes of Future Thought

Historically, the most common approach to studying the future, in the realm of psychological science, has been to ask people how often they actually think about it and whether the propensity to do so is associated with positive consequences. Next, are mentioned two influential contributions.

First, Jerome Singer and his colleagues developed the Imaginal Processes Inventory (IPI), a questionnaire aimed at characterizing the flavor of a person’s mental life (Giambra, 1980; Huba, Singer, Aneshensel, & Antrobus, 1982; Singer, 1966, 1975; Singer & Antrobus, 1963, 1970, 1972). Among its various scales, the IPI includes questions regarding the frequency with which people report daydreaming about various aspects of their past, present, and future. A number of studies implementing the IPI have reported that people spend most of their time daydreaming about the future (although, not surprisingly, this tendency declines with increasing age; Giambra, 2000). Although largely descriptive in nature, this line of work underscores the relevance of future-directed thought in healthy human cognition (see also Klinger & Cox, 1987).

Second, the concept of “time perspective,” which reflects the propensity of people to approach life’s experiences with their past, present, or future in mind (Lewin, 1951; Zimbardo & Boyd, 1999) is briefly considered. Research in this area has convincingly demonstrated that adopting a future orientation is associated with many positive consequences, including higher socioeconomic status, superior academic achievement, and fewer health risk behaviors (e.g., Nuttin, 1985; Zaleski, 1994). Hence, not only do people spend a considerable amount of time thinking about their personal future, but the more they apply such thoughts to their daily

experiences the more likely they are to draw positive consequences from those experiences.

One limitation of the information gleaned from studies on future orientation, although those studies were not specifically designed for this purpose, is the absence of any insight regarding the manner in which people think about their future. For instance, one’s thoughts about one’s future may be general or specific (Atance & O’Neill, 2001; Klein et al., 2002; Okuda et al., 2003; Suddendorf & Corballis, 2007). A recent study by D’Argembeau, Renaud, and Van der Linden (2009) demonstrated that people (college-age students) spend a considerable amount of time thinking about upcoming life experiences from both general and specific perspectives (e.g., a general, self-imposed, reminder that a particular event is fast approaching as opposed to imagining a specific scenario related to the upcoming event). Hence, two people who devote a considerable, and equal, amount of their mental lives to thinking about their futures may, nonetheless, exhibit strikingly different profiles when it comes to the mode in which they frame these thoughts. It will be interesting for future research to examine the utility of approaching one’s future from either perspective (i.e., general or specific).

Next, we shift focus to the considerable amount of empirical attention that has been devoted to understanding the capacity to think about one’s future in terms of specific episodes. In particular, we discuss the benefits and potential shortcomings of orienting one’s self to the future in a specific manner, allude to some provocative data regarding the manner in which specific thoughts about the future are implemented by the human brain/mind, and highlight the terminological variability associated with this particular “predictive” mental activity.

Episodic Future Thinking

Episodic future thought is defined as the ability to imagine specific personal episodes that may potentially occur in the future (Atance & O’Neill, 2001; Szpunar, 2010). Indeed, it has long been known that such specific thoughts about one’s future can be beneficial, albeit somewhat inaccurate. In terms of positive consequences,

Shelley Taylor and her colleagues have demonstrated the utility of episodic future thought in the context of dealing with personal problems (e.g., resolving relationship issues) and achieving task goals (e.g., planning where and how one will study for a test) (Pham & Taylor, 1999; Taylor, Pham, Rivkin, & Armor, 1998; Taylor & Schneider, 1989). Consider the social psychological phenomenon known as the planning fallacy. According to research on this phenomenon, people typically underestimate the resources they will need to complete a task (e.g., time and money) and overestimate the ease with which they will complete a task (Kahneman & Tversky, 1979). For example, Buehler, Griffin, and Ross (1994) asked students to predict how long it would take them to complete various class projects (e.g., term paper). Only one-third of the students surveyed met their self-imposed deadline. However, Taylor et al. (1998) discuss a study showing how goal completion in this context could be improved if students were trained to imagine how they would specifically go about accomplishing this goal in the future. In fact, students were almost twice as likely (41% versus 21%) to meet a self-imposed deadline after they had been induced to imagine how they would complete the task.

On the other hand, Daniel Gilbert and his colleagues have identified some potential shortcomings of episodic future thinking (Gilbert and others also variably refer to this capacity as “preplay” and “prospection”; Buckner & Carroll, 2007; Gilbert & Wilson, 2007, 2009). According to Gilbert, people typically draw upon episodic future thinking to inform their decisions about the future. Some of these decisions (e.g., Should I have dessert after dinner?) reflect short-term consequences, whereas other decisions (e.g., Should I accept that new job halfway across the world?) reflect more long-term consequences. That is, although people are not able to presently experience what it would feel like to eat a mouth-watering piece of chocolate cake or how happy they will be in the second or third year of their prestigious job that is located in a new city, they are able to imagine what it would feel like. However, the ability to accurately predict the future does not come easily. One common source

of error associated with imagining one’s future is the influence of current affective/physiological states. For instance, although people are able to imagine what it might feel like to consume a delectable piece of chocolate cake, the ability to do so is largely influenced by currently accessible physiological states. In one study, one group of participants was asked to imagine how much they would enjoy eating potato chips the following day. A second, satiated group of participants was also asked to imagine this future scenario. A day later, the group of participants who had made their prediction on a full stomach was found to have underestimated the extent to which they enjoyed their snack (see Gilbert, 2006). The imagination of the future event (i.e., eating the potato chips) was colored by their currently accessible physiological state (i.e., being full).

More recently, researchers have become interested in identifying how the human brain/mind implements episodic future thinking. The general idea that has emerged is that to generate a plausible future scenario, one must draw upon usable information from semantic and episodic (declarative) memory (e.g., appropriate context, emotional reactions, etc.) and recombine that information into a coherent mental representation of a novel event (Schacter & Addis, 2007). This claim is supported by converging evidence from neuroimaging (e.g., Addis, Wong, & Schacter, 2007; Botzung, Denkova, & Manning, 2008; Okuda et al., 2003; Szpunar, Watson, & McDermott, 2007), neuropsychology (e.g., Hassabis, Kumaran, Vann, & Maguire, 2007; Klein et al., 2002; Rosenbaum et al., 2009), clinical psychology (e.g., D’Armentano, Raffard, & Van der Linden, 2008; Williams et al., 1996), and developmental psychology (e.g., Addis, Wong, & Schacter, 2008; Atance & O’Neill, 2005; Busby & Suddendorf, 2005).

For instance, research from the neuroimaging literature has revealed a striking similarity in the neural activity that characterizes episodic future thinking and the capacity to call to mind specific experiences from one’s personal past (i.e., episodic memory) (e.g., Addis et al., 2007; Szpunar et al., 2007). Of particular interest are posterior cortical and subcortical regions (e.g., posterior cingulate cortex, posterior parietal cortex, parahippocampal cortex, hippocampus)

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that are known to play a particularly important role in remembering (Cabeza & St. Jacques, 2007; Maguire, 2001; Svoboda, McKinnon, & Levine, 2006). That episodic future thinking engages these regions in a similar manner as remembering suggests that a similar set of processes are involved as participants think about their past and future (Buckner & Carroll, 2007; Hassabis & Maguire, 2007; Schacter & Addis, 2007, 2009; Spreng, Mar, & Kim, 2009; Szpunar, Chan, & McDermott, 2009).

Importantly, patient populations who lack or have impoverished episodic memory exhibit an accompanying deficit in episodic future thinking. This pattern of impairment has been identified in brain-damaged amnesic patients (e.g., Hassabis et al., 2007; Klein et al., 2002; Tulving, 1985), suicidally depressed individuals (Williams et al. 1996), patients with schizophrenia (e.g., D'Argembeau et al., 2008), children under the age of 5 years (e.g., Busby & Suddendorf, 2005), and older adults (Addis et al., 2008). Taken together, the evidence suggests a close relation between future thought and memory.

Incidentally, the identification of a close relation between episodic future thinking, episodic memory, and other mental activities that involve imagining hypothetical scenarios (see Spreng et al., 2009) has led to a proliferation of terms that essentially refer to the same general capacity. These include *mental simulation* (Taylor & Pham, 1996; Taylor et al., 1998; Taylor & Schneider, 1989), *episodic simulation* (Schacter & Addis, 2007, 2009; Schacter, Addis, & Buckner, 2008), and *self-projection* (Buckner & Carroll, 2007; see also Barbey, Kruger, & Grafman, 2009; Barsalou, 2009 who provide more intricate conceptualizations and also present their own idiosyncratic terms). Such a state of affairs has the potential for negative side effects (see Gardiner & Java, 1993; Tulving, 2000). Hence, we stress the importance of terminological clarity as interest in the general imaginative capacity of the human brain/mind continues to grow (see also Szpunar, 2010).

Multifaceted Modes of Future Thought

As evidenced by the intriguing data that have emerged in relation to episodic future thinking,

it will be important to study the various modes by which healthy human adults are capable of contemplating their future. Perhaps even more important will be the task of examining how these various modes of future thinking interact with one another to produce more complex future thinking capacities. Next, we discuss two such capacities: planning and prospective memory. In so doing, we pay special attention to the manner in which each is capable of incorporating episodic future thinking as a subcomponent to the overall process of enacting a complex future-directed behavior.

Planning

Planning is considered a multicomponent process that operates at various levels of abstraction (e.g., general versus specific) and which serves as a predetermined course of action aimed at achieving some goal (Alexander & Stuss, 2000; Burgess, Veitch, de Lacy Costello, & Shallice, 2000; Fuster, 1995, 1999, 2001; e.g., Haith, 1997; Hayes-Roth & Hayes-Roth, 1979). For instance, a task as simple as planning one's daily activities involves defining a variety of goals and subgoals (e.g., attending a meeting, having lunch with a friend, dropping off the car at the shop, writing a lecture), prioritizing those goals (e.g., "I definitely have to attend this meeting" "I can always take the car to the mechanic tomorrow if there is no time today"), monitoring one's progress, reevaluating the original plan, and so on. In terms of levels of abstraction, one may have both general thoughts (e.g., "I have to remember to prepare my lecture for tomorrow") and specific thoughts (e.g., "I will prepare my lecture in my office after the meeting and will make sure to lock my door to avoid any distractions") about various goals that one wishes to accomplish (Hayes-Roth & Hayes-Roth, 1979). In relation to episodic future thinking, the ability to think about specific future events and to adjust plans according to the results of those thoughts (e.g., "Seems like I may not have enough time to prepare my lecture after the meeting, and before lunch, so I should set aside some time when I get home this evening") represents one important aspect of the planning process. However, it is important to keep in mind that evoking episodic

future thinking in the course of planning represents only one component of the process.¹

Prospective Memory

Prospective memory is defined as the ability to remember to carry out intended activities in the future (Brandimonte, Einstein, & McDaniel, 1996; Burgess, Quayle, & Frith, 2001; Einstein, McDaniel, Marsh, & West, 2008; McDaniel & Einstein, 2007; Simons, Scholvinck, Gilbert, Frith, & Burgess, 2006). Researchers have identified three varieties of prospective memory situations that people encounter in their daily lives: (1) those that are event based (e.g., remembering to relay a message to a coworker at a future meeting), (2) those that are time based (e.g., remembering to attend a meeting at a particular time), and (3) those that are activity based (e.g., remembering to write an e-mail after a meeting). In each case, intentions refer to a specific event that will plausibly occur in the future. However, forming an intention does not necessarily require one to think about that event in a specific manner. That is, one can form or be reminded of the intention in a more general sense (e.g., I have to do X). Nonetheless, imagining how that future event will transpire may greatly facilitate successfully carrying out one's intentions. Specifically, Peter Gollwitzer and his colleagues have demonstrated that imagining when, where, and how one plans on executing one's intentions provides a considerable benefit for carrying out those goals (Gollwitzer, 1993, 1996, 1999). In one study, women who set themselves the goal of performing a breast self-examination in the next month benefited considerably from specifying when and where they would perform the procedure (Orbell, Hodgkins, & Sheeran, 1997). Although future work will need to determine more clearly the extent to which implementation intentions are characterized by full-blown imaginations of personal future scenarios (i.e., episodic future thinking), there exists some indication that this

may be the case (see McDaniel, Howard, & Butler, 2008).

Relation to Autooetic Consciousness

Finally, we note the manner in which the four future-directed, or "predictive," mental activities discussed earlier (i.e., future orientation, episodic future thinking, planning, and prospective memory) depend on the capacity of "autooetic consciousness." Importantly, each noted mental activity requires the individual to be aware that his or her current self will one day encounter novel experiences. In the absence of this awareness, which reflects "autooetic consciousness," we argue that it would be difficult, if not impossible, for an individual to do the following: (1) devote a considerable amount of one's mental life to thinking about the future (future orientation), (2) conjure detailed future scenarios that revolve around personal circumstances (episodic future thought), (3) conceive that there exist future goals to plan for (planning), or (4) conceive that there exist actions that one will need to carry out in the future (prospective memory). Next, we consider a few relevant observations and data that are pertinent to this conjecture.

Perhaps the most relevant observation, and one on which the concept of "autooetic consciousness" was founded, is that of patient K. C., who spends little, if any, time thinking about his future (no future orientation) and who is incapable in engaging in episodic future thinking (Tulving, 1985; see also Klein et al., 2002 and Hassabis et al., 2007 for similar reports with other amnesic patients). Other relevant data have been reported in the context of frontal lobe patients who exhibit a profound indifference for their temporally extended existence (future or past) (e.g., Freeman & Watts, 1941; Luria, 1969; Luria & Homskaya, 1964; Robinson & Freeman, 1954; Stuss & Benson, 1986). Along the lines of this chapter, various authors have reported that frontal lobe patients have extensive difficulties with planning (e.g., Shallice & Burgess, 1991) and prospective memory tasks (e.g., Burgess et al., 2000; Cockburn, 1995).

A particularly fruitful avenue for future research will no doubt involve assessing the extent

¹ Of course, the concept of "planning" involves many executive functions aside from general and specific thoughts about the future.

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to which various future-directed, or “predictive”, capacities become impaired together following various instances of brain dysfunction.

Conclusion

In closing, as the concept of “prediction” continues to attract attention, it will be important to keep in mind the heterogeneous nature of the concept and how various “predictive” capacities are related to and differ from one another. Here, we have taken an initial step by suggesting that only those “predictive” capacities that extend out beyond the present moment require one to be consciously aware that one’s self will continue to exist in the future.

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