Autobiographical Thinking: Processes of Thinking About Personal Past and Future Events

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This thesis is presented for the degree of PhD in Human Cognition and Brain Sciences

June 2016

Statement of Candidate

I certify that the work in this thesis entitled "Autobiographical Thinking: Processes of Thinking about Personal Past and Future Events" has not previously been submitted for a degree nor has it been submitted as part of the requirements for a degree to any other university or institution other than Macquarie University.

I also certify that the thesis is an original piece of research and it has been written by me. Any help and assistance that I have received in my research work and the preparation of the thesis itself have been appropriately acknowledged.

In addition, I certify that all information sources and literature used are indicated in the thesis. The research presented in this thesis was approved by the Macquarie University Ethics Review Committee (Ethics Clearance number 5201200246).

Aline Cordonnier,

June 2016

Thesis Abstract

Autobiographical thinking is the capacity to remember past events, but also to simulate, imagine and plan hypothetical events that could have happened in one's past or that could occur in one's future. In this thesis, I examine a broad range of autobiographical thinking processes in both theoretical and empirical ways. In my theoretical chapter, I present an integrated cognitive framework for understanding processes of autobiographical thinking. This cognitive framework maps the domain of what I term "autobiographical thinking" and sets the scene for the following empirical chapters. Then, across four empirical papers, I investigate many ways of thinking about personal past and future events. In my experiments, I asked participants to remember personal memories, but also to simulate how else they could have happened. I asked them to imagine and plan future events, and to think about alternative versions of how they could occur. I investigate these various processes of thinking autobiographically, their raw materials and their products across four main levels of analyses. The first level of analysis examines the content of autobiographical thinking, and more precisely the role of scripts in past and future planning. The second level of analysis examines the phenomenology of autobiographical events. The third level of analysis examines the linguistic style used to describe narratives of autobiographical events. And the fourth level of analysis examines the perceived plausibility of past and future hypothetical events. Overall, I aim to acquire a more comprehensive understanding of how autobiographical events are constructed, perceived, and described. I also consider to what extent the different autobiographical processes differ. My research offers new theory, methods, and data to advance the discussion of autobiographical past and future thinking.

Acknowledgements

First and foremost, I would like to thank my supervisors Professor Amanda Barnier and Professor John Sutton. Amanda, thank you for teaching me about the importance of a well-designed study and moving one step at the time, but also for reminding me to always keep in mind the bigger story while still paying attention to detail. John, thank you for introducing me to the world of philosophy, for making me pause, consider carefully what I want to say and the words I have chosen. You have both been inspirational at a professional and personal level, and I am grateful for your presence during my PhD.

I would like to thank the many members of the Collective Cognition Team, past and present, for your passion, your insight and your friendship. I am most grateful for the amazing discussions and the everyday support I got from Vana Webster, Amanda Selwood, Chris McCarroll, Katya Numbers, Catherine Browning, Nikolas Williams, Misia Temler, Adam Congleton, Celia Harris, and Elizabeth Austen. A particular thanks to Doris McIlwain for her expertise on factor analysis and yoga, and to Muireann Irish for insightful advice on future thinking.

Working for the department of Cognitive Science and the CCD at Macquarie University gave me the chance to meet amazing people while sharing pods, lunches (including burritos), drinks, and board game sessions. A special mention to Steve Pritchard, Kellie Williamson, Danielle Colenbrander, Rob Ross, Rochelle Cox, Vince Polito, Shu Yau, Anna Fiveash, Nathan Caruana, Glenn Carruthers, Mel Rosen, Lincoln Colling, and Teresa Schubert.

I would like to show my gratitude to the wonderful admin staff for always being available, helpful, and friendly. A particular thanks to Lesley McKnight for taking such good care of all the students, and to Craig Richardson and Marcus Ockenden for finding solutions to all my IT problems.

Finally I would like to thank my family and friends for supporting me along the way. In particular, I want to thank my parents-in-law, Meredith and Paul, for cooking meals during the most stressful times and taking me out for lunch or dinner. I also owe a lot to my friends, from Belgium and Australia, for making me laugh and have fun. And more importantly, I want to thank my sisters, Melanie and Marie, simply for being amazing, and my parents, Marie-Jo and Pierrot, for being such an inspiration to me, as well as for their love and their encouragement. And last but not least, I want to thank Matthew Haultain-Gall, my soul-mate and my partner, for doing a great job proofreading this whole thesis, but foremost for being by my side every single day, listening to me, believing in me, and making me happy. I could not have done this without you.

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CHAPTER 1

Introduction:

From Mental Time Travel to Autobiographical Thinking

Introduction: From Mental Time Travel to Autobiographical Thinking

> Perhaps, it might be said rightly that there are three times: a time present of things past; a time present of things present; and a time present of things future. For these three do coexist somehow in the soul, for otherwise I could not see them. The time present of things past is memory; the time present of things present is direct experience; the time present of things future is expectation (The Confessions of St. Augustine, chapter XX).

Thinking about personal time, and more specifically about personal events set either in the past or the future, is a common human experience that can occur voluntarily or involuntarily. Our everyday life is filled with thoughts about events that have happened or could have happened to us, and events that will happen or might happen to us. We remember past events and imagine how different they might have been; we plan for the future in order to reach a goal that we might have "pre-experienced", so to speak, in our mind; or we simulate different versions of how a future event might occur. Across this thesis, I will argue for an inclusive understanding of what can be categorized as "personal events", so that the category comprises personally experienced episodes but also representations of hypothetical personal past or future events.

Understanding how we think about both personal past events and future events – which I have termed autobiographical thinking – has become of increasing interest throughout the cognitive scientific community over the last 20 years, perhaps for three main reasons (for reviews, see Klein, 2013; Schacter, 2012; Szpunar, 2010). First, there is a general recognition that thoughts about autobiographical events are very common in everyday life. During the course of one day, thinking about the future occurs approximately as often as thinking about the past (Berntsen & Jacobsen, 2008; Finnbogadottir & Berntsen, 2012), and on average an adult experiences around sixty future-oriented thoughts a day (D'Argembeau, Renaud, & Van der Linden, 2011). These thoughts, voluntary and involuntary, can serve a large array of functions, ranging from social functions such as sharing memories, bonding, or teaching; to self-enhancement functions, such as thinking about positive events in the past or the future; and to directive functions such as using past memories to plan, predict, or anticipate (Barsics, Van der Linden, & D'Argembeau, 2015; Bluck, 2003; Harris, Rasmussen, & Berntsen, 2014; Pillemer, 2003; Rasmussen & Berntsen, 2013).

Second, as past and future thinking are important aspects of our lives, a deficit in either one or in both creates numerous difficulties for autonomous living. Older people are worried about their memory capacity (Cutler & Grams, 1988; Reid & Maclullich, 2006), and research on dementia has become one of the most important topics of research in pharmaceutical, neurological, and psychological domains. Beyond this known decline in memory capacities, studies have shown that future thinking is generally affected in parallel to memory deficits, both in normal aging (Addis, Musicaro, Pan, & Schacter, 2010; Addis, Wong, & Schacter, 2008; Gaesser, Sacchetti, Addis, & Schacter, 2011; Lyons, Henry, Rendell, Corballis, & Suddendorf, 2014; Rendell et al., 2012) and in dementia (Addis, Sacchetti, Ally, Budson, & Schacter, 2009; Gamboz et al., 2010; Irish, Addis, Hodges, & Piguet, 2012a; Irish, Hodges, & Piguet, 2013). Likewise, neuropsychological research has shown parallel difficulties in past and future thinking in adults and children with autism (Lind & Bowler, 2010; Lind, Williams, Bowler, & Peel, 2014; Terrett et al., 2013), in schizophrenic patients (D'Argembeau, Raffard, & Van der Linden, 2008), as well as in patients suffering from hippocampal amnesia (Klein, Loftus, & Kihlstrom, 2002; Tulving, 1985). Therefore, a reduced capacity to imagine and plan the future could have strong repercussions for autonomous living, as people forget to take their medication, are unable to plan their meals ahead, or simply fail to simulate and evaluate the consequences of actions they are about to make. In particular, studies have shown age-related deficits in prospective memory, a form of memory that involves remembering the intention to do something in the future (Einstein & McDaniel, 1990; Henry, MacLeod, Phillips, & Crawford, 2004).

Finally, beyond the importance of autobiographical thinking in daily life, researchers have also highlighted the evolutionary importance of future thinking. In their seminal work, Suddendorf and Corballis (1997) argued that mental time travel – the capacity to project oneself backward or forward in time – could be an example of the discontinuity between humans and other animals. Since then, many researchers have weighed in and the debate on whether animals are “stuck in time” or not is still in full swing (e.g., Cheke & Clayton, 2010; Redshaw, 2014; Suddendorf & Corballis, 2010; Terrace & Metcalfe, 2004). However, most psychologists agree that being capable of thinking about the future is highly adaptive (Atance & O'Neill, 2001; Klein, Cosmides, Tooby, & Chance, 2002; Schacter, Guerin, & St Jacques, 2011), and that it is one of the major functions of memory (Klein, 2013; Schacter, 2012; Schacter et al., 2012; Suddendorf, Addis, & Corballis, 2009; Tulving, 2005).

Despite the amount and variety of recent studies on past and future thinking, it remains a young field of research with many unanswered questions to explore. So far, cognitive scientists have mostly investigated and compared how people remember specific past events (episodic memory) and imagine specific possible and sometimes plausible personal future events (often called episodic future thinking). This is an important first step to our understanding of how we construct personal events. However, it is somewhat narrow in focus as there are many other forms of thinking about past and future autobiographical events. For example, we often simulate counterfactual alternatives to reality by thinking about how else a past event could have happened if we had acted differently or if the situation was different (Byrne, 2016). As for the future, we think about it in many ways: we imagine events we wish would happened, we simulate how an upcoming event might occur, or we plan steps in order to reach a personal goal (Szpunar & Tulving, 2011).

Therefore, the overarching goal of my thesis is to extend research comparing episodic memory with episodic future thinking to include other forms of thinking about past and future autobiographical events. More specifically, I want to examine if the similarities and differences between episodic memory and episodic future thinking can be found in other forms of autobiographical thinking. Similarities across all autobiographical thinking forms would highlight similar underlying processes in the construction of personal events, whereas differences would highlight the role of other variables, such as temporal orientation, hypothetical thinking, or personal experience.

In this thesis, I start by proposing a theoretical cognitive framework in Chapter 2, where I broaden the focus of research on episodic memory and episodic future thinking to wider and more diverse forms of autobiographical thinking. I then empirically examine both processes and products of thinking about personal events in time in Chapters 3 to 6. I have chosen the "thesis by publication" format to present this thesis, so in order to avoid unnecessary repetition, I will only briefly review some of the most important literatures in this introduction. Specific research will be introduced and described in more detail in each empirical chapter.

As my questions and hypothesis are strongly based on the field of research investigating mental time travel, I will now review the literature associated with this phenomenon. To encompass episodic past and future thinking under a single label, many researchers have used the phrase "mental time travel" (MTT) to refer to the phenomenon of projecting oneself backward or forward it personal time (Corballis, 2014; Suddendorf & Corballis, 1997; Wheeler, Stuss, & Tulving, 1997). For ease of understanding, I will use this term in the following section in order to review the important literature that inspired my own research. However, I will then argue that the "mental time travel" label might be restrictive and I will propose to use instead the "autobiographical thinking" term.

Across the following sections, I first describe some of the main studies that initiated the current interest in future thinking and mental time travel. Second, I summarize key findings from comparisons of past and future thinking within neuropsychological, neural, and cognitive literatures. Third, I discuss the three principal accounts offered to explain similarities in thinking about past and future events, and explain how I propose to reconcile these views from a cognitive perspective (in contrast with a neurological perspective). Lastly, I provide an outline of the remaining chapters of my thesis.

Mental Time Travel

Origin and Definition

During the first half of the last century, Bartlett discussed in his landmark volume “Remembering: A Study in Experimental and Social Psychology” (1932) the functional importance of understanding memory as a reconstructive process. He argued that memory was an adaptive reaction so that the organism could respond to current environmental demands when automatic or learned responses were not elicited. This work led to major changes in our understanding of the workings of memory. This perception of memory as adaptive later inspired future thinking researchers to suggest that memory and future thinking are intrinsically related, and that one of memory’s main roles is to provide raw material to construct possible future events (for a review, see Klein, 2013; Schacter, 2012). In their article, Suddendorf and Corballis (1997) made the case that the ability to mentally time travel – the capacity to project oneself in time – is uniquely human and provides us with a clear advantage over other animals.

Tulving (1984, 1985; Wheeler et al., 1997) was the first to use the phrase “mental time travel” (MTT) when describing the inability of some of his amnesic patients to remember specific past events but also to think about specific future events, such as what they would do the next day. He used the phrase “mental time travel” to refer to the “capacity to represent the self's experiences in the past, present, and future" (Wheeler et al., 1997, p. 335). Therefore, MTT as commonly understood is delimited to events that occurred in one's past and that might occur in one's future. It is not about imagining a world in a thousand years; it is about events that have been or will be perceived by the self and about the self. Furthermore, as it includes the idea of "time travel", it suggests that MTT goes in both temporal directions, past and future.

As mentioned previously, research on MTT has principally focused on the comparison between episodic memory – memory that allows someone to remember specific past events and their content – and its future equivalent, termed "episodic future thinking" by Atance and O'Neill (2001). Therefore, in the following sections, whenever I mention "past thinking", I refer specifically to the process of remembering episodic past events (in contrast to thinking about past events that could have happened but did not); and when I mention "future thinking", I refer specifically to imagining episodic future events (in contrast, for example, to planning them). Cognitive researchers have compared these two processes from various neuropsychological, neural, and behavioral perspectives, looking for similarities between past and future thinking that would support the idea they share common underlying processes. In the next section, I describe some of the similarities but also differences between past and future thinking.

Comparison Between Past and Future MTT

Neuropsychological perspective. Some of the earliest evidence of similarities between past and future MTT came from observations of patients with memory impairment who showed deficits in their ability to plan their future or imagine novel experiences (Hassabis, Kumaran, Vann, & Maguire, 2007; Klein, Loftus, et al., 2002; Tulving, 1985). The most well-known case is that of K.C. (formerly known as N.N.), a man who had extensive bilateral hippocampal damage following a motorbike accident, as documented by Tulving

(1985). The patient suffered from anterograde amnesia and temporally graded retrograde amnesia. Whenever he was asked to describe what he would be doing tomorrow, K.C. was unable to answer the question and would describe his state of mind as being “blank”, explaining that it was “the same kind of blankness” as when he tried to think about the past (Tulving, 1985, p. 4). Similarly, Klein, Loftus, et al.’s (2002) patient D.B. could not remember episodic memories, nor imagine or plan personal future events.

As suggested at the beginning of this Introduction, researchers have also found parallel impairments in past and future MTT in dementia and in some psychopathological conditions. When asked to verbally describe past and future personal events, patients with Alzheimer’s disease or mild cognitive impairment show deficits in both tasks by generating fewer details than healthy older adults (Addis, Sacchetti, et al., 2009; El Haj, Antoine, & Kapogiannis, 2015; Gamboz et al., 2010; Irish et al., 2012a; Irish et al., 2013). Similarly, patients with schizophrenia (D'Argembeau et al., 2008) and individuals with autism spectrum disorder (Lind & Bowler, 2010; Lind et al., 2014; Terrett et al., 2013) show deficits both in recalling specific past events and in generating specific future ones.

Neural perspective. Further evidence of the link between past and future thinking has come from brain-imaging studies, where healthy participants were scanned while remembering past events and imagining future ones. Multiple experiments have revealed that past and future thinking tasks rely on the same core brain network, with some subsystems preferentially associated with one or the other (Addis, Pan, Vu, Laiser, & Schacter, 2009; Addis, Wong, & Schacter, 2007; Buckner & Carroll, 2007; D’Argembeau, Xue, Lu, Van der Linden, & Bechara, 2008; Mullally, Hassabis, & Maguire, 2012; Szpunar, Watson, & McDermott, 2007; Verfaellie, Race, & Keane, 2012). However, I will not review further the specific brain regions associated with past-oriented MTT, future-oriented MTT or both forms of MTT as this thesis has a more cognitive focus. I will simply observe that whereas the neural overlap might indicate that both temporal directions of MTT rely on similar subcomponent processes, specific brain regions activated either by past or future thinking but not both highlight that they are not identical either.

Cognitive perspective. Cognitive psychologists have investigated both content data and phenomenological data associated with remembered past events and imagined future events. By content, I mean the raw materials used to construct past and future events. By phenomenological data, I mean the subjective experiences felt when thinking about past and future events. It is worth noting that I will cover more extensively this topic in other chapters. Previous findings on content analyses of autobiographical events will be reviewed in more depth in Chapter 3 and to a lesser extent in Chapter 5, whereas previous findings on the subjective experience of past and future thinking will be reviewed in more depth in Chapter 4. In this section, I want to highlight how content and phenomenology analyses have been used as evidence to suggest the interconnectivity of past and future thinking.

Content analyses. In typical studies, participants are requested to describe specific past personal events they remember or specific future personal events they imagine. These events can be cued either with time periods such as “in the ten years” or “when you will finish your university degree” (e.g., MacLeod & Conway, 2007), with nouns such as “pool” or “holiday” (e.g., Addis et al., 2007; D'Argembeau & Demblon, 2012), or with a set of idiosyncratic cues, as in the episodic recombination paradigm (Addis et al., 2010; Addis, Pan, et al., 2009). If participants have to describe the events verbally, their narratives are then transcribed and analyzed.

Content analysis generally requires researchers to code written transcripts of generated autobiographical events. In the field of MTT, the Autographical Interview Coding scheme (Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002) is undoubtedly the most common scoring procedure (e.g., Addis et al., 2008; Cole, Morrison, & Conway, 2013; De Brigard &

Giovanello, 2012; Irish, Addis, Hodges, & Piguet, 2012b). Transcripts are broken down into details that are then categorized either as internal (episodic) or external (others). Results have shown that, in general, memories contain more internal details than imagined future events (Addis et al., 2010; Addis et al., 2008; Cole, Gill, Conway, & Morrison, 2012).

Although memories and future thoughts overall show clear differences in content, research has revealed that the amount of internal details in both processes varies in similar ways depending on different variables. For example, Addis et al. (2008) found a correlation between the quantities of internal details generated by the same person in the two tasks (see also Cole et al., 2012). This correlation indicates that individual differences might affect the content of these events. They indeed found a positive correlation between internal details and relational episodic memory performance on the Verbal Paired Associates I subscale of the Wechsler Memory Scale–Third Edition (Addis et al., 2008). Studies of older healthy participants and of participants with memory deficits showed a parallel reduction in internal details across both past and future thinking tasks (Addis et al., 2008; Cole et al., 2013). Lastly, Cole et al. (2012) examined the effect of trial duration on the production of internal and external details. They showed that giving more time to participants to describe events increased both the quantity of internal and external details. However, there was no correlation between internal and external details in past and future thinking, indicating that external details were not generated at the expense of internal details. These parallel variations in internal details in past and future thinking thus suggest that the two processes are related.

Other studies have used different coding schemes. For example, D'Argembeau and Mathy (2011) asked healthy participants to describe their thought flow while imagining specific future events. Using a coding procedure inspired by Haque and Conway (2001) they classified elements as personal semantic information, general events, or specific events. Results showed that participants usually first reported personal semantic information and/or general events before producing specific episodic events. In a second study, D'Argembeau and Mathy (2011) cued some participants with personal goals they had previously disclosed to the researcher. Compared to cues of people or location, cues referring to personal goals facilitated the production of future events as well as access to specific events and episodic details.

Overall, content analyses in mental time travel have revealed that memories and future thoughts do not have similar content, but that this content is similarly impacted by other variables, such as trial duration or age. Memories tend to have more episodic details, whereas future thoughts have more general and semantic details. Therefore, both semantic and episodic details are used to construct both past and future events, but their respective amount and order of appearance in narratives depend on the task and given cues. One type of semantic memory that has not yet been investigated is semantic scripts. Semantic scripts are an interesting form of semantic memory as they rely on repeated episodic events as well as general knowledge (Bartlett, 1932; Hudson, Fivush, & Kuebli, 1992; Schank & Abelson, 1977). In Chapter 3, I examine how semantic scripts, combined with episodic memory, support past and future thinking.

Lastly, there is one valuable method of analyzing narratives that has not yet been used with regards to past and future thinking: linguistic analyses. Linguistic styles can reflect more than the subject matter. Forensic and memory scientists have used linguistic analyses in the past in an attempt to distinguish false statements from true memories (Raskin & Esplin, 1991; Tausczik & Pennebaker, 2010; Vrij, 2005). In Chapter 5, I aim to better understand the underlying processes at play when constructing and reconstructing autobiographical events by analyzing the differences in linguistic style across a range of autobiographical processes. To do so, I use the Linguistic Inquiry and Word Count computer program (Pennebaker, Booth, & Francis, 2007), a scientifically validated text analysis software.

Phenomenological characteristics. Phenomenological characteristics of past and future events provide some insight into the subjective experience of thinking about past and future autobiographical events. Initial research on phenomenology originated from attempts to separate “true memories” from “false memories”. In their reality-monitoring model, Johnson and Raye (1981) suggested that true memories should have more sensory attributes. They created the Memory Characteristics Questionnaire to test their model and compared the phenomenology of remembered and imagined events (Johnson, Foley, Suengas, & Raye, 1988). In this questionnaire, participants rated their subjective experience on a scale from 1 to 7, including questions examining if their memory was clear, vivid, or if it involved visual details, sounds, and smells. In agreement with their model, results showed that on average memories were rated as having more sensory and contextual information than imagined events.

Inspired by this theory, MTT researchers have also compared memories with imagined events, with the slight difference that these imagined events were set in the subject’s personal future. D'Argembeau and Van der Linden (2004) asked participants to remember and imagine events following a cue displayed on the computer. Once participants had an event in mind prompted by the cue, they wrote a short description and then closed their eyes for one minute to mentally remember or imagine the event. They then rated their subjective experience on Likert-type scales adapted from the Memory Characteristics Questionnaire (Johnson et al., 1988). D'Argembeau and Van der Linden (2004) found similar results to those of Johnson et al. (1988). Future events had fewer sensory details than remembered events, and the location and spatial orientation of people and objects were also less clear. Further, future events were generally rated as being more positive than past events, a bias referred to as the “optimism bias” (Schacter & Addis, 2007b; Sharot, 2011; Weinstein, 1980). Since then, many researchers have reported similar differences between past future thinking across multiple studies (Addis, Pan, et al., 2009; D'Argembeau, Ortoleva, Jumentier, & Van der Linden, 2010; D'Argembeau & Van der Linden, 2004, 2006; De Brigard & Giovanello, 2012).

Other phenomenological characteristics are rated similarly across past and future events. Participants report similar feelings of time travelling or (p)re-experiencing past and future events (Addis, Pan, et al., 2009; D'Argembeau et al., 2010; D'Argembeau & Van der Linden, 2004, 2006; De Brigard & Giovanello, 2012; but not in Arnold, McDermott, & Szpunar, 2011). Some studies find that the frequencies of field perspective ratings (seeing the event from one's own eyes) and observer perspective ratings (seeing the event from the position of an observer) are comparable across past and future events (Addis, Pan, et al., 2009; D'Argembeau et al., 2010; D'Argembeau & Van der Linden, 2004; De Brigard & Giovanello, 2012). These similarities suggest the existence of similar underlying processes in autobiographical thinking.

Beyond the direct comparison between the phenomenology of past and future thinking, it is worth noting that both types of MTT are affected in parallel by other properties of the events, such as temporal distance, emotional valence, or familiarity of the setting (Arnold et al., 2011; D'Argembeau & Van der Linden, 2004, 2012). For example, D'Argembeau and colleagues (D'Argembeau et al., 2010; D'Argembeau & Van der Linden, 2006) fount that positive events that happened in the recent past or that will happen in the near future and set in a familiar place generated higher ratings on sensory details and spatial settings. Individual differences likewise affected both past and future MTT in similar ways, so that some people had very vivid experiences, regardless of the temporal orientation, whereas others did not (D'Argembeau et al., 2010; D'Argembeau & Van der Linden, 2006).

Overall, phenomenological analyses have revealed some strong differences between past and future thinking, but also show similarities in the way they are impacted by other variables. However, it is unclear if these differences are caused by the fact that remembered events have been experienced whereas future events have not, or if they are caused by other variables such as the temporal orientation of the event. It is unclear if the similarities only apply to episodic memory and episodic future thinking or if they apply across various autobiographical thinking processes. In Chapter 4, I examine the differences and similarities in phenomenological ratings across a broad range of autobiographical events.

Accounts of the Similarities in Mental Time Travel

In the previous section, I reviewed key findings from neuropsychological, neural, and behavioral data comparing processes of remembering past events and imagining future ones. We saw that episodic past and future thinking were equivalently impaired by brain damage and relied on a common neural core network. However, cognitive data revealed differences between the two types of MTT, with participants experiencing memories with more sensory details and a clearer visuo-spatial context as well as describing them with more episodic details than future thoughts. These differences could suggest that episodic remembering and future thinking are qualitatively different processes (Debus, 2014) or that they partially rely on different underlying processes (for a discussion, see Michaelian, 2016). Nevertheless, the content and subjective experience of past and future thoughts are affected similarly by certain variables, such as individual differences, age, visual imagery capacities, relational episodic memory capacities, temporal distance, emotional valence, or familiarity of events. Evidence thus suggests many similarities, but some important differences in past and future thinking. To consider how and why these similarities might arise, I will now review the three principal accounts of the relationship between past and future thinking.

Constructive episodic simulation hypothesis. The constructive episodic simulation hypothesis, created by Schacter and Addis (2007a), is one of the most referenced hypotheses in the MTT and future thinking literature. It states that we flexibly recombine details from past events to simulate future events. This hypothesis was inspired by Schacter, Norman, and

Koutstaal's (1998) "constructive memory framework", which emphasizes that memory is a constructive process rather than a literal reproduction of the past, and is prone to error and distortions. They argued that these "sins" of memory reflect adaptive cognitive processes (Schacter, 2002; Schacter et al., 2011), and that one of the main functions of episodic memory is to provide the building blocks (episodic details) necessary to construct future events in a flexible way (Schacter, 2012; Schacter & Addis, 2007a, 2009; Schacter, Addis, & Buckner, 2008; Schacter et al., 2012). Neuroimaging results showing strong neural overlap between past and future thinking support this hypothesis. The reliance on episodic memory when thinking about the future indeed predicts the similarities in brain activation found when remembering past events or imagining future events (Addis & Tippett, 2008; Addis et al., 2007; Schacter & Addis, 2007a). Since then, many empirical studies have put forward the constructive episodic simulation hypothesis to forecast and explain their results (e.g., Addis, Pan, et al., 2009; Gaesser et al., 2011; Gamboz et al., 2010; Madore & Schacter, 2015; Szpunar & McDermott, 2008).

Semantic scaffolding hypothesis. However, there have been recent suggestions that semantic memory has a bigger role to play in past and future thinking than initially suggested by the constructive episodic simulation hypothesis (Greenberg & Verfaellie, 2010; Irish & Piguet, 2013). Irish and colleagues (Irish et al., 2012a, 2012b) tested patients with semantic dementia and compared their performance on MTT tasks with the performance of patients diagnosed with Alzheimer's disease. Comparing both patient groups was valuable as they show opposite patterns of deficits. Semantic dementia patients have relatively preserved episodic memory but impaired semantic memory, whereas Alzheimer's disease patients have preserved semantic memory and impaired episodic memory. Both patient groups were equally impaired in future thinking tasks. Irish et al. (2012a, 2012b) suggested that Alzheimer's disease patients could not perform the task because of their deficits in episodic memory, whereas semantic dementia patient could not perform the task because of their deficits in semantic memory. The authors concluded that access to episodic elements from past events was not sufficient to generate future events. Irish and Piguet (2013) subsequently proposed their own hypothesis: the semantic scaffolding hypothesis. They argued that semantic memory supports mental time travel by providing a framework or a scaffold in which episodic details can be included. Hence, both the constructive episodic simulation and the semantic scaffolding hypotheses base their models on the assumption that episodic and semantic memory contribute to MTT, but whereas the former emphasizes the role of episodic details, the latter emphasizes semantic memory as an overall framework (see also Chapter 3).

Scene construction theory. The last major account of MTT is the scene construction theory (Hassabis & Maguire, 2007), which seeks to explain the role of the hippocampus in MTT and other tasks. The authors noticed that the neural network shared between past and future thinking, and more specifically the hippocampus, is also activated in a range of tasks other than MTT, such as autobiographical planning (planning and anticipating personal relevant future goals; Spreng, Mar, & Kim, 2008; Spreng, Stevens, Chamberlain, Gilmore, & Schacter, 2010), navigation (Spreng et al., 2008), theory of mind (Buckner & Carroll, 2007; Spreng & Grady, 2009), or when no specific task had been assigned (when the participant is mind-wandering or daydreaming; Mason et al., 2007). Hassabis and Maguire consequently suggested that the process of scene construction, defined as the process of mentally generating and maintaining a complex and coherent scene or event, better accounts for the neural and neuropsychological similarities between past and future thinking (Hassabis & Maguire, 2007; Maguire, Intraub, & Mullally, 2015). Supporting the scene construction theory, Eacott and Easton (2012) argued that the concept of MTT relied too often on subjective phenomena such as autonoetic awareness or the awareness of time, which constrained work on past and future thinking. For them, the concept of time might not be as central as initially proposed by

Tulving (2002) or Suddendorf and Corballis (1997), and an explicit temporal dimension is not necessary for the hippocampus to be involved. Thus, the capacity to construct scenes as proposed by Hassabis and Maguire (2007) seemed sufficient to explain neural and empirical similarities between past and future thinking.

Complementary accounts? The scene construction theory proposes a different role of the hippocampus in MTT than the role suggested by the constructive episodic simulation and the semantic scaffolding hypotheses (Maguire & Mullally, 2013; Schacter et al., 2012). The constructive episodic simulation and the semantic scaffolding hypotheses argue that the process of retrieval and flexible recombination of details is dependent on the hippocampal formation (Irish & Piguet, 2013; Schacter & Addis, 2009; Schacter et al., 2012), whereas the scene construction theory argues that one of the main functions of the hippocampus is to facilitate the spatial construction of scenes (Maguire et al., 2015). Yet, at the cognitive level of analysis, they might not be incompatible, as all three hypotheses acknowledge the constructive processes involved in thinking about autobiographical events. If we set aside neural localization and the role of the hippocampus, I suggest that these three hypotheses can be partially reconciled as they shed light on processes implemented in past and future thinking. First, both memory episodic and semantic memory provide *content* to the construction of autobiographical events. Then, this content needs to be combined flexibly, as suggested by the constructive episodic simulation hypothesis, to construct or reconstruct the autobiographical event, past or future. This *constructive process* can be completed at two levels. First, the storyline needs to be implemented, and its construction might rely on past experiences of similar events and semantic scripts. The constructive episodic simulation and the semantic scaffolding hypotheses best articulate this type of construction. But there is still a need to visually and spatially construct the event in order to mentally project it, as suggested by the scene construction hypothesis.

In conclusion, thinking autobiographically is a complex process. It requires content, originating from personal experiences and knowledge, to be combined into a relatively plausible event, set in a delimited spatial setting. Throughout my empirical chapters, these three accounts inform my research questions and clarify some of my findings. In Chapter 3, I examine how both episodic memories and semantic scripts provide content to the construction of plans in past and future thinking tasks. In Chapter 4, I review these accounts to explain why some phenomenological ratings correlate across all autobiographical events and form natural factors. In Chapter 5, I investigate constructive processes at play in autobiographical thinking through the analyses of linguistic style. And in Chapter 6, I consider the role of reality in estimating the plausibility of hypothetical past and future events.

From Mental Time Travel to Autobiographical Thinking

Past thinking, and more specifically future thinking, have received a lot of attention in the last twenty years, as reviewed above. As seen in the previous sections, research on MTT has advanced rapidly with a range of phenomena being investigated with the support of many different tasks (e.g., thinking about past and future events, describing the events, rating the phenomenological experience, or collecting daily thoughts). Yet more research still needs to be done if we want to understand not only how memories are recalled, but also how any personal events that could have happened in the past or that could happen in the future are mentally constructed. In this thesis, I aim to extend research on MTT to research on autobiographical thinking, notably by including autobiographical planning and counterfactual thinking as complementary processes.

Autobiographical planning – the capacity to plan steps and anticipate consequences in order to reach a personal goal – is a central element of future thinking. In research on non-human animals' ability to think about the future, one of the first lines of enquiry was to investigate if they could *plan* for future events – especially when these future events did not correspond to a current need – and do so in a flexible way (Clayton, Russell, & Dickinson, 2009). For humans, planning is regarded as a major step in infant development (McCormack & Atance, 2011). Planning is thus often described as adaptive (Klein, Robertson, & Delton, 2010, 2011) and important in our daily life (Baird, Smallwood, & Schooler, 2011). A thought-recording study showed that participants were often planning actions or events when thinking about the future, and that more than half of daily future-oriented thoughts were not about specific events but were abstract representations about long-term goals or anticipated lifetime periods (D'Argembeau et al., 2011). Finally, brain-imaging research has revealed that autobiographical planning activates the same neural network as episodic past and future thinking (Gerlach, Spreng, Madore, & Schacter, 2014). Although the concept of autobiographical planning is widely used in animal research and infant research (Cheke & Clayton, 2010; Clayton et al., 2009; McCormack & Atance, 2011) as well as in philosophy (Bratman, 1987; Preston, 2013), it has been rarely studied in relation to MTT or episodic future thinking. In my research, I discuss the importance of future planning in Chapters 3, 4, and 5 where I investigate autobiographical planning as a goal-oriented and plausible form of future thinking, and how it impacts content, phenomenology, and linguistic style.

Counterfactual thinking – the capacity to think about alternative ways past events could have occurred – is also important in daily life (Byrne, 2002; Epstude & Roese, 2008; Roese, 1997). We think about what could have happened when we feel regretful or remorseful, but also when we try to learn from our mistakes. Cognitive philosophers and scientists have suggested that thinking in a counterfactual way supports future thinking by informing causal judgments and preparing for the future (De Brigard, 2013; Hoerl, McCormack, & Beck, 2011). Recent studies have highlighted that counterfactual thinking activates similar neural regions and shares some phenomenological characteristics with future thinking. However, the perceived plausibility of counterfactual events is affected differently by reality than the perceived plausibility of future events (for a discussion, see Schacter, Benoit, De Brigard, & Szpunar, 2015). Counterfactual thinking is therefore a valuable point of comparison between remembering and future thinking, as it shares the past orientation with remembering processes, and the constructive processes of un-experienced but plausible hypothetical events with episodic future thinking. For this reason, in Chapters 4, 5 and 6, I compare counterfactual thoughts with future thoughts and memories to examine the impact of temporal orientation and hypothetical thinking on phenomenological ratings, linguistic style, and perceived plausibility.

Overview of the Thesis

My thesis is organized according to the “thesis by publication” format where the empirical chapters are independently written manuscripts related to my overarching research questions (however I have added cross-references to other chapters in order to create an integrated work). Consequently, chapters may include overlapping information. My thesis comprises one theoretical chapter (Chapter 2), four empirical chapters (Chapters 3 to 6) and one discussion (Chapter 7). One chapter (Chapter 3) is already in press for a special issue of the journal *Quarterly Journal of Experimental Psychology* (Szpunar & Radvansky, 2016), and the remaining empirical chapters have been prepared and formatted for submission to specific journals. At the beginning of each chapter, I include a brief introduction detailing how that chapter fits into the overall research project. I also provide details about the target journal (and the Special Issue in the case of Chapter 3) as an appendix to each chapter. In accordance with thesis submission guidelines and for consistency, I have retained the same format and referencing style based on the APA Publication Manual (6th Edition) throughout this thesis and regardless of specific journals’ requirements. References cited within each individual chapter are provided at the end of each respective chapter.

In this thesis, I examine the different processes of autobiographical thinking in both theoretical and empirical ways. In my theoretical chapter (Chapter 2), I map the domains of autobiographical thinking and set the scene for the empirical chapters. Then, across the four empirical papers that follow (Chapters 3 to 6), I investigate a broader range of autobiographical thinking processes across multiple levels of analysis. The first level of analysis examines the content of autobiographical thinking, and more precisely the role of scripts (Chapter 3). The second level of analysis examines two different "products"[1] of thinking about autobiographical events (Chapter 4 and 5). The third level of analysis examines the perceived plausibility of past and future hypothetical events. Across these studies I aim to acquire a more comprehensive understanding of how autobiographical events are constructed, perceived, and described.

Theoretical Chapter: An Integrated Cognitive Framework

In Chapter 2, I propose and present an integrated cognitive framework for understanding processes of autobiographical thinking. As initially suggested by Tulving (1985; Wheeler, Stuss, & Tulving, 1997) and Suddendorf and Corballis (1997), mental time travel is the capacity to project oneself into past or future events and mentally "re-experience" or "pre-experience" them. Therefore, research on mental time travel tends to focus on the similarities between episodic memory and episodic future thinking. Yet, people can think about past and future personal events in many ways other than remembering or imagining them. For example, a specific past event can be modified and alternative versions may be invented or a future event can be simulated, predicted, or planned for. In my cognitive framework, I attempt to integrate these different forms of past and future thinking and

[1] I use the term "product" to indicate that I am analyzing how the processes of thinking about personal events in different ways impact the subjective experience of the events (Chapter 4) or the way they are described (Chapter 5). However, I do not infer that the phenomenology or linguistic style of autobiographical events are totally separated from the representation of the events. This is simply an artificial way to pull apart and examine different components of complex and intertwined processes.

differentiate them on two dimensions: time and plausibility. In addition to the two dimensions, my framework also includes a core center representing the raw materials derived from episodic and semantic memory needed to construct and reconstruct past and future events. The purpose of the framework is to map the domains of autobiographical thinking and therefore is not presented as a predictive model. Nevertheless, it highlights the need to explore other ways of thinking about past and future events, such as autobiographical planning (planning and anticipating personal relevant future goals) and counterfactual thinking (simulating how else a past event could have happened).

Empirical Chapters: Scripts, Phenomenology, Linguistic Style, and Perceived Plausibility in Autobiographical Thinking

Chapter 3. One of the main reasons to study past and future thinking in parallel is the premise that past memories provide the raw material to support the construction of future events. Influenced by the constructive episodic simulation hypothesis (Schacter & Addis, 2007a, 2009), previous research has strongly emphasized the role of episodic details, almost to the neglect of semantic details. Nevertheless, studies with patients suffering from semantic demantia show that semantic memory is also important, as discussed above (Irish et al., 2012a, 2012b). In Chapter 3, I examine the role of a specific type of semantic memory, namely scripts – defined by Schank and Abelson (1977, p. 210) as “structures that describe appropriate sequences of events in a particular context” – in past and future planning. I describe my first experiment where participants recalled how they planned a past camping trip in Australia (past planning task) and imagined how they would plan a future camping trip (future planning task), set either in a familiar (Australia) or unfamiliar (Antarctica) context. Thanks to the coding scheme I specifically designed for this experiment, I aim to show that in some type of future thinking (such as future planning) scripts and therefore semantic memory have a major role to play.

Chapter 4 and Chapter 5. In Chapter 3 (above), I examine the content of past and future thoughts. In Chapter 4 and in Chapter 5, I examine two different products of thinking about autobiographical past and future events: the subjective experience of thinking about autobiographical events and the linguistic style used when describing these events. Once more, I want to reiterate that I use the term “product” to simply indicate that I am pulling apart and examining different components of autobiographical thinking. However I do not infer that the phenomenology or linguistic style are totally separated from the representation of the events. The two papers presented in these chapters should be seen as complementary pieces, as I report data collected at the same time and from the same participants.

As noted above, previous research has indicated that remembered past events tend to be experienced with more sensory details and a clearer visuo-spatial context than imagined future events (D'Argembeau & Van der Linden, 2004). In Chapter 4, I aim to expand on these results by comparing phenomenological ratings across a broader range of autobiographical thinking processes, including future planning and counterfactual thinking. I describe data collected during my second experiment, which had a between-subjects design, and my third experiment, which had a within-subjects design. Participants rated their subjective experiences after remembering past events, imagining future events, or planning future events. In a second part of the study, participants also rated their phenomenological experiences after thinking of alternative versions of these events; that is, they rated the phenomenology of counterfactual events, prefactual imagined events, and prefactual planned events. I first compare the phenomenological characteristics of remembered, imagined and planned events, before considering the phenomenological characteristics of counterfactual and prefactual events, looking for similarities and differences across the various autobiographical processes. I also investigate how these phenomenological characteristics across all events fall into natural factors, which can reveal potential common underlying processes.

In Chapter 5, I examine another type of product, which is the way autobiographical events are described. I aim to review differences in linguistic style across narratives of past and future autobiographical events, which may shed light on some of the underlying processes and characteristics associated with past or future thinking. As in Chapter 4, I describe data collected during my second and third experiments. In addition to rating their subjective experiences, participants also verbally described each remembered, imagined, or planned event, and their counterfactual or prefactual versions. I ran the transcripts through the Linguistic Inquiry and Word Count computer program (LIWC, Pennebaker, Booth, & Francis, 2007), a text analysis software that counts instances of words consistent with various linguistic, emotional, and cognitive categories. In this chapter, I explore different linguistic measures of narratives (verbs, tenses, affective, cognitive, perceptual, and relative terms) looking for similarities or differences across the various autobiographical thinking processes.

Chapter 6. As mentioned previously, counterfactual thinking is an interesting point of comparison with future thinking as both processes demand the construction of hypothetical personal events, but set in the past or the future. However, as the past cannot be changed whereas the future is yet to come, are past hypothetical events as plausible as hypothetical future events? Previous research has generated opposite results when examining the impact of repeated simulation on the perceived plausibility of past and future hypothetical events (Schacter, Benoit, De Brigard, & Szpunar, 2015). Szpunar and Schacter (2013) found that repeated simulation of future events increased their perceived plausibility, whereas De Brigard, Szpunar, and Schacter (2013) found that repeated simulation of counterfactual events decreased perceived plausibility. Therefore, in Chapter 6, I describe data from my fourth experiment where my first aim is to replicate Szpunar and Schacter's (2013) and De Brigard et al.'s (2013) studies. I also explore the perceived plausibility of different versions of how an event could occur. Epstude and Roese (2008) suggested that the first counterfactual version of an event should be the most plausible. This may not be the case for future thoughts as they are not restricted as much by reality. So as a second aim, I examine the impact of simulating multiple different versions of hypothetical past and future events.

Summary

In this thesis, I explore different processes of thinking about autobiographical events. First I propose a cognitive framework that maps the different domains of autobiographical thinking (Chapter 2). Next, I study the role of scripts as raw materials that support the constructive process of past and future planning (Chapter 3). Then, I analyze the subjective experiences associated with thinking about past and future autobiographical events (Chapter 4), as well as the linguistic style used when describing these events (Chapter 5). Finally, I investigate the perceived plausibility of hypothetical past and future events upon repeated simulations or the generation of multiple alternative versions. Overall, this research broadens our understanding of past and future thinking processes and their products.

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CHAPTER 2

Autobiographical Thinking:

An Integrated Cognitive Framework

Autobiographical thinking: An integrated cognitive framework

The power of imagination provides us with the ability to form mental representations of events or details that are not currently perceived. One of the most interesting outcomes of this capacity is that it allows us to mentally explore the past and the future. We can think of what was and what could have been, what might happen and how to achieve it. In the Introduction (Chapter 1), we saw that cognitive scientists have taken a particular interest in comparing our ability to recall autobiographical events and to imagine possible personal future events. Research on past and future thinking has developed significantly in the last twenty years, with the range of phenomena investigated becoming more complex and diverse (S. B. Klein, 2013; Schacter, Addis, & Buckner, 2008; Suddendorf, Addis, & Corballis, 2009; Szpunar, 2010).

The increasing popularity of past and future thinking research calls for a consensus in the terms used and their definitions to facilitate convergence across the different fields. Particularly with regards to future thinking, we find a wide variety of terms across the literature, such as episodic future thinking, future mental time travel, prospection, foresight, or future simulation. These terms are often used interchangeably and may reflect personal preferences of particular authors or reveal subtle differences in what is being investigated (e.g., *episodic* future thinking). Likewise, there are many terms used to describe the act of thinking about a future event: imagining, simulating, predicting, foreseeing, planning, and anticipating are common examples. They all describe the action of attending to the future, but in slightly different ways. Most people would agree that anticipating an event requires the knowledge that the event has a high probability of occurring. But what about terms such as "imagining" or "simulating"?

Research on future thinking has mainly examined episodic future thinking and compared it with episodic memory. In Chapter 1, I argued that autobiographical thinking comes in many diverse forms and there is a need for a richer and more inclusive framework that expands current knowledge of mental time travel to other types of autobiographical thinking. Consequently, I have been developing such a framework throughout my PhD.

In an effort to clarify recent findings regarding the ability to represent what might happen in the future, Szpunar, Spreng, and Schacter (2014) developed an "organizational framework for future oriented cognition" (p. 1) to connect but also differentiate the various forms of what they call "prospection". They distinguished and defined four modes: *simulation*, which is the construction of a detailed mental representation; *prediction,* which is the estimation of the likelihood of the reaction or outcome; *intention*, which is the mental act of setting a goal; and *planning*, which is the identification and organization of steps to achieve a goal. The modes can interact with one another and can connect on many levels of abstraction and complexity. For each mode, the authors discerned three types of memory or knowledge: episodic, semantic, or hybrid. These types of memory or knowledge depend on the content of the future thoughts: are the thoughts about personal events or goals (episodic), about an abstract state of the world (semantic), or about a non-specific autobiographical state (hybrid)? Hybrid knowledge represents what is more commonly referred to as personal semantics (Renoult, Davidson, Palombo, Moscovitch, & Levine, 2012) but also general future states that are autobiographical in nature. Szpunar et al. (2014) emphasized that there are strong interaction and interdependences between episodic and semantic knowledge in all modes of prospection. Consequently, their taxonomy extends further than personal future events to include thoughts about the way the world may be in the future.

This taxonomy provides an excellent framework to situate current research and delineate the multidimensional ways that future thinking can be understood. Furthermore, Szpunar et al. (2014) justly highlighted the need to have meaningful dialogue between the different strands of research in order to stimulate research programs that can consider what brings together, but also what differentiates, the various modes of prospection. While I fully agree with the authors on these points and acknowledge the importance and relevance of this framework, there is value in recognizing the importance of past thinking when examining future thinking. As their framework only focuses on future thinking, I argue that we should examine the domain of personal past and future thinking as a whole and provide an overarching framework for understanding autobiographical processes.

As discussed in Chapter 1, the relationships and interactions between episodic memory and future thinking have been heavily documented, suggesting not only that both processes rely on similar underlying constructive processes and activate a similar neural network, but also that they interact with one another (for reviews, see D'Argembeau, 2012; Hassabis & Maguire, 2007; S. B. Klein, 2013; Schacter et al., 2008; Szpunar, 2010). The constructive episodic simulation hypothesis argues that episodic memory provides the building blocks that are flexibly combined to construct future thoughts (Schacter & Addis, 2007a). Research has also started to emphasize the significant role of semantic memory, including personal semantics and script-knowledge, in constructing future thoughts (Abraham & Bubic, 2015; D'Argembeau & Mathy, 2011; Irish & Piguet, 2013). Lastly, cognitive researchers and philosophers have suggested that one function of counterfactual thinking is to inform our future thoughts and future predictions (De Brigard, 2013; Hoerl, McCormack, & Beck, 2011). Taking into account these interactions and similarities in past and future thinking, and in agreement with the need for clarity suggested by Szpunar et al. (2014), I have designed a cognitive framework that includes different processes of future thinking but also past and atemporal thinking. I decided to focus on the capacity to mentally represent personal events, which I have termed “autobiographical thinking”. I define autobiographical thinking as the process of mentally constructing autobiographical events set in the past, the future, or that do not relate to any specific point in time (atemporal). The aim of this framework is to integrate the different processes and map the domain of autobiographical thinking, and therefore is not presented as a predictive model. Rather this framework is intended to broaden the realm of enquiry and research on mental time travel to all forms of autobiographical thinking.

Integrated Cognitive Framework

In this section, I propose an integrated cognitive framework for understanding the processes of autobiographical thinking (see Figure 1 on page 50). I do not make any assumptions as to neural regions or neural functioning of the different parts of the brain involved in autobiographical thinking, although this might be a potentially interesting avenue of enquiry in future developments of the framework. Thus, I will not try to address questions about the fundamental ontology of memory (C. Klein, 2012; Michaelian, 2011b). Instead, I have constructed my framework based on cognitive literatures and empirical evidence, as well as on personal reflections about the functions and forms of autobiographical thinking. Within this framework, I attempt to go beyond the boundaries of episodic memory and episodic future thinking, and explore a wide range of autobiographical thinking.

The framework presented in Figure 1 is composed of a double-layered core center and three main sections. The core center represents the raw materials and the background needed to construct and reconstruct autobiographical events. The two-way arrows moving from the center to the other sections and back highlight their interconnectivity. The three main sections map the domains of autobiographical thinking, where the events can be seen as future, past, or atemporal (so not related to a specific point in time). The boxes placed in each section symbolize autobiographical processes of autobiographical thinking. I differentiate them on two dimensions: time and plausibility.

First, the time dimension organizes the different processes of autobiographical thinking around the perception of a single event at different points in time. This event can be thought of either as happening in the future or as having happened in the past. Therefore, the emphasis is not so much on the comparison between an individual at a specific point in time remembering a past event or simulating a future one (e.g., remembering my graduation and simulating my first day at a new job), but on an individual at different points in time thinking about a single event in multiple ways (e.g., imagining the perfect day at a hypothetical new job, simulating how it will most likely occur, planning for the steps I could take in order to make this first day as enjoyable as possible, then later on remembering how that first day went and simulating how else it could have happened). Above and beyond the dichotomy between the two temporal directions (past or future), the amount of time between the event and the moment it is thought of might influence the frequency, the use, and the plausibility of the different types of autobiographical thinking.

Second, the plausibility dimension refers to the subjective plausibility of the represented event. This dimension speaks to the function and content of autobiographical thoughts, and helps differentiate processes such as imagining or simulating. In the framework (Figure 1), I have proposed a hypothetical delineation separating the sections into higher and lower plausibility subsections to illustrate the gradient in plausibility and how some processes tend to construct more or less plausible events.

Finally, terms depicted outside the border of the framework (individual differences, emotions, goals, beliefs, see Figure 1 next page) represent other influences on the constructive process of autobiographical thinking. In the following pages, I review each part of the framework in detail, starting by describing the core center before considering the processes of autobiographical past and future thinking in each of the three sections.

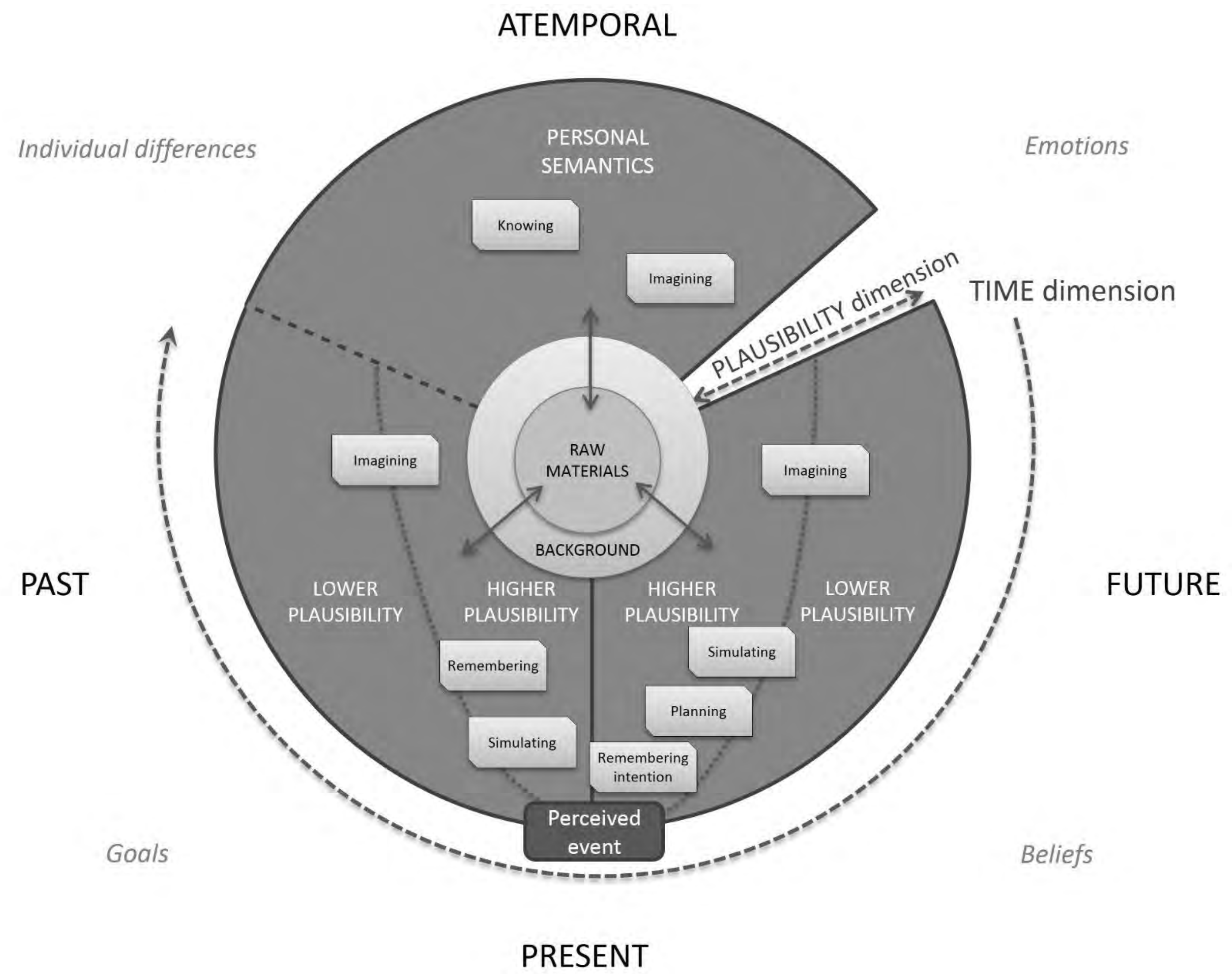

Figure 1. Integrated Cognitive Framework for Understanding Processes of Autobiographical Thinking.

Core Center of the Framework

There is consensus amongst cognitive scientists that past and future thinking are constructive processes and that they draw upon the same raw materials to construct and reconstruct autobiographical events (Conway & Loveday, 2015; Irish & Piguet, 2013; S. B. Klein, 2013; Schacter & Addis, 2007a). Similar to the constructive view of autobiographical memory as presented by Conway and colleagues (Conway, 2005, 2009; Conway & Loveday, 2015; Conway & Pleydell-Pearce, 2000), and as outlined in the Introduction (Chapter 1), accounts of the relationship between past and future thinking have emphasized the role of episodic memory as raw material in the simulation of personal future events (S. B. Klein, 2013; S. B. Klein et al., 2009; Schacter, 2012; Schacter & Addis, 2007a, 2009; Schacter et al., 2008).

As mentioned in Chapter 1, in order to measure and examine these raw materials, researchers have attempted to code and count the number of "episodic details" in transcripts (see also Chapter 3). To do so, Addis, Wong, and Schacter (2008) adapted the Autobiographical Interview's coding scheme (Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002). With this technique, there is a clear focus on episodic details, called internal details. The first step of the coding scheme requires the coder to identify a central event. Then, the complete transcript is segmented into separate details that are placed into internal or external categories. All details that do not relate to the identified central event are coded as external details. Episodic details about the central event (such as details about where, when and what) are coded as internal details, whereas any other details, such as repetitions and semantic details, are labeled external details (e.g., Addis et al., 2008; Cole, Morrison, & Conway, 2013; De Brigard & Giovanello, 2012; Levine et al., 2002). Thus, the usefulness of the external detail category is limited, as it represents a mix of semantic details, repetitions of relevant episodic details, and irrelevant episodic details.

There have been recent suggestions that semantic memory should not be ignored when investigating the raw materials of autobiographical thinking (Greenberg & Verfaellie, 2010; Irish & Piguet, 2013). As described in Chapter 1, studies of patients suffering from semantic demantia have revealed that they cannot easily think about future events even though their memory for personal past events is relatively preserved (Irish, Addis, Hodges, & Piguet, 2012a, 2012b), which led to the development of the semantic scaffolding hypothesis (Irish & Piguet, 2013). D'Argembeau and Mathy (2011) also found that when participants simulated personal future events, they usually first accessed general personal semantic knowledge before retrieving episodic details. However, one major difficulty in assessing empirically the use of semantic memory is to distinguish between episodic and semantic details, as there is not always a clear distinction between the two (Toth & Hunt, 1999). This can be seen when considering personal semantics and scripts. Personal semantics stand at the crossroads between episodic and semantic memory, and consist of personal knowledge about the self, autobiographical facts, repeated events, and autobiographically significant concepts (Grilli & Verfaellie, 2014; Renoult et al., 2012). When using any coding scheme, such as the Autobiographical Interview's coding scheme, it can be challenging to disentangle true episodic details from personal semantics (Renoult et al., 2012).

Moreover, scripts are typically categorized as semantic memory but can derive from episodic experiences, more so from recurring events (Abelson, 1981; Bower, Black, & Turner, 1979; Hudson, Fivush, & Kuebli, 1992; Nelson & Gruendel, 1981; Schank & Abelson, 1977). Thus, they are intertwined with episodic details, making them almost indistinguishable when coding transcripts. In Chapter 3, I discuss scripts in further detail and examine their role in past and future thinking by proposing a new type of coding scheme. I argue that scripts, and by extension semantic memory, are an integral part of autobiographical thinking and should be included in any model of autobiographical thinking. Finally, researchers have shown the importance of cultural life scripts – schemata of culturally expected events – in the perception and the construction of one's personal future (Berntsen & Jacobsen, 2008; Bohn & Berntsen, 2013)

Using an episodic versus semantic distinction to describe details used as raw materials in past and future events might not be the most appropriate and useful dimension. Instead, in my framework I use a definition closer to that of Conway and Pleydell-Pearce's (2000) event-specific knowledge. More specifically, I describe these raw materials as any information or details collected throughout the years. They can be details drawn from episodic memories, such as self-defining or emotional moments (e.g., face of younger sibling when she was born), from repeated events (beach house rented annually for holidays), from general events (being a student), but also from semantic knowledge about oneself, others, and the world, as well as from scripts of how certain events generally tend to unfold. Moreover, recollection of previously imagined events, past or future would also feed into this pool of raw materials (see Figure 1). Consequently, I propose that there is a constant loop between the center of the framework and the autobiographical processes. Raw materials are necessary for the construction of autobiographical processes but constructed events can also be encoded, and details later on used as raw materials.

In addition to these raw materials, I integrate an additional layer into the core center of the framework in order to acknowledge the existence of certainties that people possess about the world or themselves, a sort of background layer to any represented event (see Figure 1). This background shares some similarities with the concept of "coherence" used by Conway (2005) in his Self-Memory System (now termed the Remembering-Imagining System, Conway & Loveday, 2015). He describes coherence as "a strong force in human memory that acts at encoding, post-encoding remembering, and re-encoding, (…) to make memory consistent with an individual's current goals, self-images, and self-beliefs" (Conway, 2005, p. 595).

However, my understanding of background is more closely inspired by philosophers. In "On Certainty", Wittgenstein (1979) talks about "hinge propositions", a notion of certainties that can sometimes be unfounded: "some propositions are exempt from doubt, are as it were like hinges on which [questions and doubts] turn" (Wittgenstein, 1979, para. 341). Hinge propositions can be natural and instinctual, such as taking into account laws of physics (gravity, object boundaries, etc.). They do not need to be taught or even be articulated with words, and they can be both at the episodic and semantic level (see also Moyal-Sharrock, 2009). Wittgenstein includes what some would call basic autobiographical facts, such as someone's name, where they live, or their marital status. He writes:

> For months I have lived at address A, I have read the name of the street and the number of the house countless times, have received countless letters here and given countless people the address. If I am wrong about it, the mistake is hardly less than if I were (wrongly) to believe I was writing Chinese and not German (Wittgenstein, 1979, para. 70).

Thus, to be considered "hinges", these certainties need to be automatic and without hesitation, and a healthy individual is never mistaken about them.

Similarly, Searle suggests the concept of "Background, (…) a set of nonrepresentational mental capacities that enable all representing to take place" (Searle, 1983, p. 143). This background consists of two major divisions that he describes as follows:

> A minimal geography of the Background would include at least the following: we need to distinguish what we might call 'deep Background', which would include at least all of those Background capacities that are common to all normal human beings in virtue of their biological makeup-capacities such as walking, eating, grasping,

> perceiving, recognizing, and the preintentional stance that takes account of the solidity of things, and the independent existence of objects and other people from what we might call the 'local Background' or 'local cultural practices', which would include such things as opening doors, drinking beer from bottles, and the preintentional stance that we take toward such things as cars, refrigerators, money and cocktail parties (Searle, 1983, pp. 143-144).

This background therefore includes tacit knowledge about physical and chemical laws that our world answers to, but also knowledge on culturally bound skills and capacities. Whenever we think about an event, regardless of its position in time, we likely imagine it as happening on earth, probably in a familiar environment, where people we meet do not float around due to the laws of gravity but walk as humans walk, talk in a language we know, and use manners typical to the decade we live in. It is nonetheless possible to imagine living in a world without gravity or talking to alien animals in a language made uniquely of vibrations. Yet, similar to the cinematographic distinction between science fiction and fantasy, I want to draw a line between autobiographical events that could have been or events that could occur in the future (even if the probability is or was extremely low), and events that are make-believe or dream-like, as they would not really fall anywhere on the temporal or plausibility dimensions.

Dimensions of the Framework

Memory is a constructive process (Conway & Pleydell-Pearce, 2000). Future thinking is a constructive process (Schacter, 2012). Counterfactual thinking is a constructive process (Gerlach, Dornblaser, & Schacter, 2014). As discussed when describing the core center (see also Chapter 1), cognitive researchers have argued that all these forms of autobiographical thinking use similar raw materials to construct events (De Brigard, 2013; S. B. Klein, 2013; Schacter & Addis, 2007a). So how do we differentiate them? I suggest that there are two dimensions that separate the many forms of autobiographical thinking: time and plausibility (see Figure 1).

Time dimension. Time is a key concept in autobiographical thinking, whether it be when comparing past to future events or when examining the effect of temporal distance (Szpunar, 2011). This idea of temporal distance is usually seen from the perspective of the person, mentally travelling backward or forwards in time to re- or pre-experience the autobiographical event. The past is often compared to the future and the temporal distance between now and the event can affect the way events are remembered and imagined. Recently, Conway and Loveday (2015) proposed the *remembering-imagining system*, a window of accessibility where near events, past and future, are more accessible than distant events. For instance, D'Argembeau and Van der Linden (2004) showed that temporally close events contained more contextual and sensory details and generated stronger feelings of experiencing the event. Berntsen and Jacobsen (2008) found that involuntary memories and future thoughts about the distant past or future comprised more representations of cultural life scripts compared to recent past and future events. Therefore, the amount of time between the event and the moment it is thought of can influence the frequency, the use, and the plausibility of the different types of autobiographical thinking.

Another way to investigate the effect of time is to examine the dichotomy between the two temporal orientations (past or future). To be able to mentally travel in personal time, Tulving argued that one needs “autonoesis” (also called autonoetic consciousness), which he defined as “an awareness of self albeit in subjective time” (Tulving, 2002, p. 315); and “chronesthesia”, which he defined as “an awareness of subjective time, albeit in relation to self”. He further added that “the distinction may be subtle but it is necessary, because time can be dealt with, and usually is dealt with, independently of the self, and self can be dealt with independently of time” (Tulving, 2002, p. 315). We can think and plan the future with chronesthesia, but we need autonoesis to project ourselves and experience the event in subjective time. Yet, the concept of chronesthesia is rarely discussed in research on human mental time travel, whereas autonoesis has taken a central role, highlighting the idea of self-projection so the event can be “re-experienced” or “pre-experienced” and not only understood as happening in personal subjective time (Buckner & Carroll, 2007; S. B. Klein, 2013, 2015).

This focus on autonoesis has led to certain difficulties and constraints. First, as discussed by some authors (Clayton, Bussey, & Dickinson, 2003; Eacott & Easton, 2012; Martin-Ordas, Atance, & Louw, 2012), using self-projection as a necessary condition for mental time travel makes it difficult to measure past and future thinking in non-humans animals and pre-verbal infants. Autonoesis is usually assessed through phenomenology, and therefore is more readily accessed through language. There are non-verbal tasks that provide some evidence of episodic future thinking in animals and children, such as variants of Tulving’s (2005) “spoon test" (Cheke & Clayton, 2010; Clayton, Russell, & Dickinson, 2009; McCormack & Atance, 2011; McCormack, Hoerl, & Butterfill, 2011). However, many have argued that without language it remains impossible to tell if the future thinking capacities demonstrated in these tasks rely on autonoesis and self-projection in time, or on impersonal reasoning and functional knowledge, as well as on the knowledge of personal time – chronesthesia (Martin-Ordas et al., 2012; Raby, Alexis, Dickinson, & Clayton, 2007; Russell, Alexis, & Clayton, 2010). Most researchers tend to agree that at least some animals are not “stuck in time” and possess a certain concept of future, that extends at least to “tomorrow” (Corballis, 2014; Raby et al., 2007; see also Hoerl, 2008 for opposing views).

The importance of autonoesis in defining mental time travel has also been discussed with reference to patients with episodic amnesia. Some researchers have argued that these patients were possibly stuck in time or could not mentally travel into their past or future (Corkin, 2013; La Corte, George, Pradat-Diehl, & Dalla Barba, 2011; Tulving, 1985). Yet, a series of measures and experiments showed that amnesic individuals were not stuck in the here and now (Craver, Kwan, Steindam, & Rosenbaum, 2014; Kwan, Craver, Green, Myerson, & Rosenbaum, 2013). By using tasks that did not require narrative constructions but entailed temporal and causal thinking such as delay and probability discounting tasks, these researchers were able to demonstrate that their patients still possessed a certain understanding of subjective time and could use this understanding to attend to the future, even though they had impaired autonoetic consciousness. Once more, it shows how the concept of chronesthesia might be more fitted to research on past and future thinking than autonoesis. Consequently, in this chapter, I use the concept of time in a very inclusive way, appealing more to the concept of chronesthesia, the consciousness of a subjective time, without appealing to autonoesis. This decision allows processes not necessarily relating on autonoesis, such as future planning or atemporal thinking, to integrate the framework.

Studies on mental time travel have so far principally used the concept of time as fixed temporal relations between events, by suggesting that from this point in time (the present) the individual travels in time to a past or future self, supported by their autonoetic consciousness. In my framework, I base my perception of time on the series of positions a single event can take, ranging from future, through present, to past, supported by chronesthesia. Let me take my wedding as an example. I could first imagine the perfect wedding if I had unlimited money and time. I could then plan for how I expect the actual wedding to go on, and simulate the different parts of the day. As time draws near, I might remember intentions to call certain people or make bookings. Then, as the day happens, I perceive it, experience it, and encode it. Afterwards, I could remember it but also simulate how much better it could have been if my aunt did not fall on the dance floor or how much worse it would have been if she had injured herself badly. Therefore, the emphasis is on the autobiographical process of constructing an event, supported by chronesthesia, and not on the individual's capacity to travel backward or forward in time.

Finally, we can also think about personal events not set in a specific point in time. I include in this category personal semantics (Renoult et al., 2012) and repeated events (Barsalou, 1988; Neisser, 1981), and explain later on why I do not place them on the time dimension.

Plausibility dimension. The second dimension of my framework attempts to distinguish the different autobiographical processes depending on the subjective plausibility of the represented event (see Figure 1). I examine plausibility for three reasons. First, as there is now a consensus among cognitive scientists on the constructive nature of episodic memory, the content of a memory does not need to map exactly onto the original event, but memories do have to maintain a relatively high level of plausibility for us to accept them as memories (Conway & Pleydell-Pearce, 2000; Michaelian, 2011a; Schacter, 2012). As suggested by the source monitoring literature, the perceived plausibility of the event is used as a means of identification of something as a memory (Johnson, 1997; Johnson, Hashtroudi, & Lindsay, 1993). Furthermore, these estimates of plausibility are themselves malleable. A good example of this can be found in the literature on the imagination inflation effect. Garry, Manning, Loftus, and Sherman (1996) asked participants to first rate how likely a number of childhood events happened to them. Then, participants had to vividly imagine some of those events before rating their likelihood once more. Results revealed that vividly imagining hypothetical events made them seemed more plausible, thus rendering participants more confident that they occurred (Garry et al., 1996; Pezdek, Blandon-Gitlin, & Gabbay, 2006).

Second, plausibility is an intrinsic part of counterfactual thinking and future thinking, particularly when they have an adaptive function (Gerlach et al., 2014; Schacter, 2012). For example, Epstude and Roese (2008) argued that when thinking counterfactually, an implicit filtering mechanism inhibits all but the most plausible versions of events. De Brigard (2013) claimed that most real life episodic hypothetical thinking (past and future) supports adaptive future thinking by providing representations of plausible events. I therefore suggest that incorporating plausibility into my framework helps differentiate between different past and future processes, such as “imagining”, “simulating” and “planning” (see Figure 1).

Finally, empirical research has shown that one important difference between hypothetical past and future events resides in their perceived plausibility after repeated simulations (Schacter, Benoit, De Brigard, & Szpunar, 2015). Inspired by the idea that vividly imagined events were perceived as more likely than events not imagined, as seen above (Carroll, 1978; Garry et al., 1996), cognitive researchers wondered how repeatedly imagining hypothetical events might influence their perceived plausibility. In two recent parallel studies, one examining future events and one examining counterfactual events, researchers asked participants to repeatedly imagine these past or future hypothetical events (De Brigard, Szpunar, & Schacter, 2013; Szpunar & Schacter, 2013). They showed that whereas counterfactual thoughts decreased in perceived plausibility when participants repeatedly simulated the alternative event (De Brigard et al., 2013), future thoughts increased in perceived plausibility when participants repeatedly simulated the future event (Szpunar & Schacter, 2013). They suggested that their findings reflect the role of reality (what did happen and what will happen) in judging the plausibility of events (Schacter et al., 2015). Counterfactual events are compared to “true” memories, whereas future events always remain in the domain of the possible. In Chapter 6, I review these studies in depth as I attempt to replicate them. I also investigate how proposing various alternatives of events affects their perceived plausibility.

In the following section, I describe a range of different autobiographical processes and discuss their possible placement on the time and plausibility dimensions. As you can see in

Figure 1, I have intentionally given the same names to some past and future thinking processes (i.e., imagining and simulating) to highlight the fact that besides their temporal orientation, they follow a similar constructive process and can be placed in parallel on the dimensions in the past and future sections.

Future Thinking

As suggested by Szpunar et al. (2014), they are many ways to think about a future event. I distinguish four different hypothetical processes (see Figure 1). The first one is drawn from the literature on future thinking (e.g., Atance & O'Neill, 2001; Conway & Loveday, 2015; D'Argembeau & Van der Linden, 2004; Suddendorf & Corballis, 1997) and will be called here *imagining*. The other three are more action or goal oriented: *planning, simulating or predicting,* and *remembering intention*.

Imagining. If you were asked to 'imagine going to the beach', what would happen in your mind? Would you play a mental movie of yourself making your way to the beach and getting there? Would you create a mental frozen picture of sitting on the sand? Or would you start planning how you were going to get there? The verb "to imagine" is a widely used term that carries different meanings depending on the context or how the individual interprets it. This term can be found in many articles on future thinking, most often to simply mean "think about X happening in the future". However, defining the word 'imagination' can be a difficult task. Many philosophers have written about this subject and the associated literature is far too broad and complex to be treated here. I use the *Stanford Encyclopedia of Philosophy*'s definition of the term "imagination" (Gendler, 2011):

> *To imagine* something is to form a particular sort of mental representation of that thing. Imagining is typically distinguished from mental states such as *perceiving*, *remembering* and *believing* in that imagining *S* does not require (that the subject consider) *S* to be or have been the case, whereas the contrasting states do. It is

distinguished from mental states such as *desiring* or *anticipating* in that imagining *S* does not require that the subject wish or expect *S* to be the case, whereas the contrasting states do.

The first important point to note here is that imagining is not specifically related to time. It is an action that can be done in regards to future or past, or without any predetermined idea of when it would happen, if ever. For this reason, the process of "imagining" can be found in the past, the future, and the atemporal sections of the framework (see Figure 1). Second, as expressed in the above definition, imagining does not require the subject to believe that the event could happen or could have happened. Thus, there is no requirement to make the event plausible. Generally, the level of plausibility desired by the individual while thinking about a past or future event will depend on the function of the mental time travel and the need for accuracy. For example, we sometimes daydream implausible but highly desired events in order to make us feel better, or we tell a story about the future that might not happen in order to bond with someone or teach them something.

Consequently, I suggest future studies could apply the use of "imagining" to studies that do not need participants to think specifically of a plausible event that might happen in their future (yet still could). When talking about imagined events, it should be in the context of examining the capacity to construct mental representations of events, regardless of their plausibility. For example, studies using the recombination paradigm to test the constructive episodic simulation hypothesis investigate how we construct mental representations (Addis, Musicaro, Pan, & Schacter, 2010; see also Chapter 1; van Mulukom, Schacter, Corballis, & Addis, 2015), and thus examine the imagining process. In other words, it would be a broad and inclusive category.

Simulating. The processes of simulating a future event is very similar to the process of imagining it, as I define simulating as a detailed mental representation of specific autobiographical events. However, I propose that the process of simulating should entail a reasonable belief that the event might or will occur, and thus can be seen as a subclass of the imagining process. It is important to differentiate imagined events from simulated events as I suggest they represent different cognitive processes. Whereas imagining simply denotes a capacity to form a mental representation of an event that has not been experienced, simulating is characterized by the capacity for prediction and anticipation of a series of actions and their outcomes, mentalized in a plausible way. This process is well defined by the constructive episodic simulation hypothesis (Schacter & Addis, 2007a) and the semantic scaffolding hypothesis (Irish & Piguet, 2013). Past events as well as semantic knowledge and script knowledge can support simulation and prediction by providing information on how other similar events have occurred in the past or what general knowledge we possess about them. Therefore, asking participants to *simulate* events might be more appropriate than to *imagine* them when investigating the capacity to project oneself in its own past or future, as there should be a relatively similar level of plausibility.

Planning. If imagining is a commonly used term, so is planning. In folk psychology, we use the term *planning* to signify intention (e.g., planning to go shopping on the weekend) but also as a list of separate ends (e.g., planning to meet a client, then finishing answering emails before writing a report at the end of the afternoon). While these statements refer to actions that might or will be carried out at a later stage, most philosophers or cognitive scientists would not consider them as *plans* (Bratman, 1987; Setiya, 2015). At the beginning of her chapter on improvisation and planning, Preston (2013, p. 44) defined what she called a “prototype plan” as having four salient features: (1) there is a specific end; (2) there are specified steps (means) for achieving that end; (3) the end and the steps are formulated in advance of any action being taken; and (4) the formulation is conscious and explicit, and involves deliberation of available options. She only defines planning in such clear and strong terms so as to criticize mainstream theories of intention like Bratman (1987) that are based on the idea that we work out steps in advance, with intention, for most of our actions. Instead, Preston stresses the roles of improvisation and human collaboration in planning, more specifically when acting upon one's plan.

Cognitive scientists have generally followed Hayes-Roth and Hayes-Roth (1979) definition of planning: "the predetermination of a course of action aimed at achieving some goals" (p. 275-276). Planning is therefore only the first stage of a two-stage problem-solving process, the second stage being *control*, which monitors and guides the execution of the plan. This definition relies particularly on the individual's conscious decisions of selecting steps to reach a goal. Hence most research on planning has investigated it from a problem-solving perspective (e.g., Bishop, Aamodt-Leeper, Creswell, McGurk, & Skuse, 2001; Shallice, 1982; Warneken, Steinwender, Hamann, & Tomasello, 2014). For example, neuropsychological tests of planning generally require sequencing actions in a particular order to solve a problem or answer a future need (Shallice, 1982; Unterrainer & Owen, 2006; Wilson, Evans, Alderman, Burgess, & Emslie, 1997). Planning is also regarded as a major step in infant development and is often studied through the selection of tools and the understanding of time, order, and consequences (McCormack & Atance, 2011). Lastly, non-human animals' future thinking capacities are often measured through their ability to plan for a future need (Clayton et al., 2003).

As my framework focuses on autobiographical thinking, I examine planning as the action of thinking of and simulating the different steps to reach a personal goal or event. This means I do not see planning as a wish or intention (e.g., *I plan to be happy when I will be old*) or as an executive function, such as problem solving (I do not focus on finding the solution to the goal). Moreover, these steps do not need to be carried out the way they were planned and can be subjected to improvisation or modifications at any time, depending on personal scripts, memories, the availability of new information, a change of goal, a change or mood, etc.

Compared to the imagining process – which could be done at any time and be more or less plausible – planning has a relatively specific place on the two dimensions. First, we tend to plan relatively close in time to the realization of the event of the goal. In a thought sampling study examining the functions of future thoughts in daily life as a function of their temporal distance, results showed that about half of thoughts of the far future (more than one month away) were related to the planning of an event or action, whereas this number reached 77% for thoughts of the near future (in the next month; D'Argembeau, Renaud, & Van der Linden, 2011). Second, by virtue of its functional nature, the planning of future events requires the individual to think about the future goal and possibly simulate the different steps and their consequences. The simulated events and steps need to be relatively plausible, as including implausible or unlikely actions or consequences could lead to the non-realization of the goal. In one sense, planning uses simulation (to simulate the steps or the goals), but is a more complex and multi-components process.

Hence, using planning as a way to investigate plausible and future-oriented content can be valuable. In Chapter 3, I use planning as the content of a past and future simulation in order to maintain a high level of plausibility: this allows me to investigate both episodic memory and scripts as raw materials. Then, across the complementary Chapters 4 and 5, I add the process of planning future events to the more classic comparison between remembering past events and imagining future events, to examine two different types of “products”: phenomenological ratings and linguistic style (see also Chapter 1).

Remembering intention. The process of remembering intention stands at the crossroads between memory and future thinking. Usually examined within the prospective memory literature (for a recent review on prospective memory, see Brandimonte, Einstein, &

McDaniel, 2014), remembering intention is the capacity to recollect previously encoded intentions that could not be realized at the time of encoding and in order to act upon them in the present or near future. If it happens generally just before the event takes place, the process is more related to memory than future thinking (I have to *remember* that I planned to do something before and that now is the time to do it). Three types of cues support the remembering intention process: time-based cues, meaning the action or event has to be carried out at a point in time, event-based cues, meaning it has to be carried out when the specific circumstances are present, or activity-based cues, meaning it has to be carried out before or after another activity (Einstein & McDaniel, 1990; Kvavilashvili & Ellis, 1996). In order to complete the intended action, remembering accurately what was originally planned is of the essence. Consequently, the plausibility of what is being remembered has to be quite high in order to feel confident about the past intention being remembered.

Previous research has proposed interesting links between the simulation of future events and intentions. Studies of implementation intentions have shown that using an "if *X* then *Y*" plan helped people to translate their intention into action (Gollwitzer, 1999). More recently, Madore and colleagues found that training participants to recollect episodic details of past experiences (which they called an episodic specificity induction) enhanced performance on imagination and problem-solving tasks (Madore, Addis, & Schacter, 2015; Madore & Schacter, 2014, 2015). Finally, Neroni, Gamboz, and Brandimonte (2014) have shown that episodic future thinking could improve prospective memory. Participants performed prospective tasks more accurately if they had mentally simulated the sequence of events expected to occur the day before. These links between memories, future thoughts, plans, and intentions are very interesting and provide a promising avenue for future research.

Past Thinking

Once an autobiographical event has occurred, or did not but could have (even if highly unlikely), we can think about the past event in different ways: remember it, simulate how else it could have happened, or imagine an entirely new event that did not happen (see Figure 1).

Remembering. Autobiographical memory has a long history of research on diverse phenomena including everyday events, false memories, and traumatic events. Providing an extensive review of all these phenomena is outside the scope of this chapter, but a few important points are of interest here. As mentioned previously, remembering personal events is a reconstructive process (Bartlett, 1932; Conway & Pleydell-Pearce, 2000; Schacter, 2002). The content of the memory might not exactly match the original event as elements might be omitted, added, or modified. Yet, the complete event should maintain a high level of plausibility to be recognized and accepted as a memory. Even if time impacts the accuracy of recall, the level of plausibility should be maintained. When details are added or modified, the constructive process at play is similar to the process of constructing future events (Atance & O'Neill, 2001; Dudai & Carruthers, 2005; Schacter, 2012; Suddendorf & Corballis, 1997). It uses comparable past events, scripts, and general knowledge about oneself, others, and the world to "fill in the blanks" and reconstruct the memory while maintaining a certain correspondence with the original event and coherence with the self (Conway & Loveday, 2015).

However, there is one major difference between memories and all other autobiographical processes: they have been experienced. Debus (2014) argued that remembered events and imagined events are mental occurrences of two different kinds because an agent can only be experientially aware of remembered events. To include this proposition in the constructive framework, I borrow Michaelian's (2011a) terminology described in his updated version of Martin and Deutscher's (1966) causal theory of memory.

Michaelian proposed to use the term *constructive* to refer to processes at encoding and during consolidation, and to use the term *reconstructive* to refer to processes at retrieval. Therefore, I could argue that recalling memories depends both on constructive and reconstructive processes, whereas imagining an event that has never happened, set in the past or future, is first and foremost a constructive process. It is as if the event was encoded for the first time, as it is mentally constructed.

Finally, as noted previously, episodic memories have an important role in providing some of the raw materials to construct and reconstruct autobiographical events, as indicated by the two-way arrows (in Figure 1, page 50).

Simulating. In the future thinking section above, I discussed the difference between simulating and imagining. I want to apply the same distinction here for past thinking. Hence, simulating past events can be understood as what has been called "counterfactual thinking". Thinking counterfactually is wondering what could have happened instead of what did (Roese, 1997). Simulated past events need to maintain a relatively high level of plausibility, as they are compared to "true" memories (Byrne, 2016; Epstude & Roese, 2008). The perceived plausibility can also be challenged by repeated simulations, as discussed previously (De Brigard et al., 2013), but also by the discovery of new information or by discussing the possibilities with other people (Byrne, 2016).

Counterfactual thinking is usually described as going in one of two directions: when the alternative version is evaluated better than the original, researchers talk about upward counterfactual thinking, but when the alternative version is evaluated worse than the original, researchers talk about downward counterfactual thinking (Markman, Gavanski, Sherman, & McMullen, 1993; Roese, 1997). The direction of counterfactual thinking can shed light on its functional basis. There are multiple reasons to think in a counterfactual way: we do it out of regret or remorse, wishing we had acted differently; we do it to entertain ourselves, just to think of what could have been; or we do it to fulfill self-enhancement goals, by thinking it could have been worse (Byrne, 1997, 2002; Epstude & Roese, 2008; Roese, 1997). Many scientists and philosophers have argued that we also do it to learn from our mistakes, so that we do not repeat them in the future, or simply to simulate other possible outcomes that could later on be remembered whenever a similar event or choice occurs (Boninger, Gleicher, & Strathman, 1994; Byrne, 2016; De Brigard, 2013; Van Hoeck et al., 2013).

In summary, I suggest that, past and future simulations of plausible events are similar in their constructive process and work towards the same goal of planning and predicting the future. As discussed in Chapter 1, counterfactual thoughts can provide a valuable point of comparison between memories and future thoughts, as they share the past temporal orientation with memories and the hypothetical character of future thoughts. Across Chapter 4 and 5, I compare two types of "products" (phenomenology and linguistic style) of remembering past events with thinking about these events in a counterfactual way. I also compare counterfactual thinking with what I term "prefactual" thinking (thinking about alternative versions of future events). Furthermore, in Chapter 6, I examine the role of reality in affecting the perceived plausibility of hypothetical events depending on their temporal orientation (past or future).

Imagining. Imagined past events are often examined in relation to the literature on source monitoring and false memories (Johnson et al., 1993; Johnson & Raye, 1981). Source monitoring is the process by which an individual attempts to determine the source or origin of an apparent memory, and distinguish memories from imagined events. According to the source monitoring framework, memories contain unique features and characteristics specific to that event, such as perceptual, affective or contextual information (Johnson, Foley, Suengas, & Raye, 1988; Johnson et al., 1993). Researchers have attempted to find ways to measure these qualitative differences between true and false memories through phenomenological ratings (Johnson et al., 1988) or linguistic style analyses (Newman, Pennebaker, Berry, & Richards, 2003).

The imagination inflation effect described in the plausibility section stems from the literature on source attribution errors (Garry et al., 1996). In this paradigm, participants are given specific instructions to vividly imagine several possible childhood events, such as giving someone a haircut of getting in trouble for calling 911. Results show that vividly imagining events inflates participants' confidence that the event occurred in their childhood, highlighting once more how familiarity informs the way we judge the source of events. However, these types of imagined events are more representative of "false memories" and are a consequence of the reconstructive nature of episodic memory and the functioning of our source monitoring system (Schacter, 2002, 1997).

We can imagine past events in a voluntary way. For example, we can imagine what could have been if we were born somewhere else or if our lives were totally different. And we can also imagine actual events that we did not experience (for example I can imagine my friend's happiness when he got the parcel I sent him). In the context of this framework, I suggest that similar to imagining future events, there is no requirement to keep these imagined events plausible or set at a specific time.

We tend to imagine past events when daydreaming or fantasizing (Markman, Klein, & Suhr, 2009). Neuroimaging studies of mind-wandering have found it activates the same set of brain regions, called the default network (Buckner, Andrews-Hanna, & Schacter, 2008; Mason et al., 2007), activated by past and future autobiographical thinking processes (Buckner & Carroll, 2007; Hassabis, Kumaran, & Maguire, 2007; Hassabis & Maguire, 2007). The capacity to take someone else's perspective by imagining what they feel or perceive, called theory of mind, also activates the same brain network (Spreng & Grady, 2009). As previously discussed (Chapter 1), the neural similarities might indicate a similar constructive process in these different forms of autobiographical thinking.

Atemporal Thinking

Knowing. Finally, I add the atemporal process of knowing, usually described as semantic knowledge (see Figure 1). As my framework is about autobiographical thinking, I focus here on personal semantic knowledge and on personal schemas. Thus my atemporal section is similar to the “hybrid” types of memory and knowledge identified by Szpunar et al. (2014). Personal semantics consist of personal knowledge about the self (e.g., I have a curious mind), autobiographical facts (e.g., I have an older sister), repeated events (e.g., I spent Christmas at my grandparents’ house), and autobiographically significant concepts, which are semantic concepts associated with vivid episodic memories (e.g., knowledge that Kruger Park is in South Africa from visiting it one day when I was 9; Grilli & Verfaellie, 2014; Renoult et al., 2012).

Even though I have placed the process of knowing in the atemporal segment, I acknowledge that some personal semantics can be set in the past (e.g., I was a stubborn child) or the plausible future (I will be a doctor) with a clear beginning and sometimes a clear end (Renoult et al., 2012). Yet, knowledge itself cannot be placed on a specific time continuum that may be first seen as future, then happens in the present, before becoming part of the past. And more often than not, personal semantics cross over past, present, and future; or repeat themselves across one’s lifetime. This is the case when considering what Barsalou (1988) called “summarized events”, or what Neisser (1981) calls “repisodes”, which are decontextualized summaries of similar and repeated events. Semantic knowledge is, by definition, knowledge removed from its context (Tulving, 1972, 1984). Laying aside the possibilities that knowing can sometimes be temporally delineated, I position the process of knowing on the atemporal section of my framework to signify that personal semantics cannot be placed in a specific point in time and usually represent content removed from its temporal context.

Personal semantics also interact with the other sections of the framework (see Figure 1). On the one hand, past events and even more repeated events maintain and update personal semantic knowledge the same way they do personal schemas (Bartlett, 1932; Wagoner, 2013) and scripts (Abelson, 1981; Bower et al., 1979; Hudson et al., 1992; Nelson & Gruendel, 1981; Schank & Abelson, 1977). On the other hand, semantic knowledge, and more specifically personal semantics, support and scaffold all autobiographical constructive processes by providing content and structure (Irish & Piguet, 2013). Thus, repeated events, scripts, schemas, and personal semantics have an important role in autobiographical thinking as they help structure past events, but also simulate, imagine, and plan plausible hypothetical events (see also Chapter 3).

Imagining. Lastly, imagining could also be considered as taking place in atemporal time (see Figure 1). For example, I could imagine being taller than I am, having three brothers, or being born in a small village in rural Argentina. To the best of my knowledge, there is no research that looks into this kind of imagining. However, it is hard to conceptualize real life moments where an individual might consider hypothetical personal semantics without doing it in association with episodic past or future imagining. In other words, the hypothetical personal semantic takes the role of the context in imagining a hypothetical specific event (e.g., if I was taller, I would be better at basketball). It provides content and context for other mental representations. Therefore, I simply acknowledge the possibility without expanding further on this section.

Other Influences on the Constructive Process in Autobiographical Thinking

Autobiographical thinking is a complex, multi-component concept. There are many ways to think about autobiographical events, and regardless of their place in time and how plausible they are, events always seems to be constructed based on some combination of personal memories, scripts and schemas, and knowledge about oneself, others and the world (Conway & Loveday, 2015; Hassabis & Maguire, 2007; Irish & Piguet, 2013; Schacter & Addis, 2007a). However, internal and external influences can modify the way autobiographical events are thought of. I now briefly review four of them for further reflection (see Figure 1). Some of these influences will be picked up in Chapter 4, as I examine how some phenomenological ratings fall into natural factors and correlate with one another.

Individual differences such as age, mnesic, and imaginative abilities, have been shown to affect autobiographical thinking. For example, Addis et al. (2008) found a correlation between the amounts of episodic details generated by the same person in past and future thinking tasks, indicating that individual differences such as story telling style or imagination capacity might impact the content of these events. Likewise, normal aging or memory deficits generally reduce the amount of episodic details in parallel across both tasks (Addis et al., 2008; Cole et al., 2013). D'Argembeau and Van der Linden (2006) found that individual differences, such as the capacity for visual imagery or the openness to experience personality trait, modified how participants experienced past and future events (see also D'Argembeau, Ortoleva, Jumentier, & Van der Linden, 2010).

Emotions can also affect and be affected by the different autobiographical thinking processes. Positive thinking has been associated with well-being (MacLeod & Conway, 2007; Scheier & Carver, 1985), and healthy people tend to see the future in an overly optimistic way, which has been termed the “optimism bias” (Schacter & Addis, 2007b; Sharot, 2011; Weinstein, 1980). Accordingly, research has revealed that patients suffering from depression or posttraumatic stress disorder, show an inability to retrieve certain specific memories, and instead recall general or summarized memories (Williams et al., 2007). Similarly, these patients do not show the usual optimism bias (MacLeod & Byrne, 1996; MacLeod &

Conway, 2007). Therefore, emotional thoughts can satisfy important functions, often related to goal pursuit and emotion regulation (Barsics, Van der Linden, & D'Argembeau, 2015; Rasmussen & Berntsen, 2013).

We should also differentiate emotions felt when thinking about the event from emotions that occur during the realization of the event. Debus (2007) argued that what she calls autobiographical past-directed emotions are “new” emotional responses to the remembered event. However, in his chapters about narrative thinking about one’s past and future, Goldie (2012) made the interesting claim that both experientially imagined emotion and actual emotion are possible and their occurrence can create a dramatic irony. Thus, depending on the mood of the moment, but also on the way the event is recalled, the emotion attached to the event might differ from the emotion felt during the past event or when and if the event does occur in the future.

The function of the autobiographical thought, coupled with personal short term and long term goals, most likely impacts the way the event is constructed and narrated (D'Argembeau, 2012; D'Argembeau & Mathy, 2011; Szpunar, 2010). Autobiographical thinking fulfils a multitude of functions, ranging from social functions such as sharing memories, bonding, teaching or compromising; to self-enhancement functions, such as thinking about positive events in the past or the future; or to directive functions such as using past memories to plan, predict, or anticipate (Barsics et al., 2015; Bluck, 2003; Harris, Rasmussen, & Berntsen, 2014; Pillemer, 2003; Rasmussen & Berntsen, 2013). Therefore, a past event recalled in order to teach might contain different details than if the same event was recalled to amuse. Similarly, future events might be made more or less plausible or positive when thinking about the future to reduce boredom compared to planning steps in order to reach a personal goal. A few researchers have highlighted the importance of personal goals (Cole & Berntsen, 2015; Conway & Loveday, 2015; D'Argembeau & Van der Linden, 2012), yet more research is needed to investigate their direct and indirect impact on autobiographical thinking.

Finally, beliefs can influence the way autobiographical events are constructed and their content. Belief can impact what I termed the background and the raw materials. Beliefs about the self, the continuity of the self, beliefs about other people and about the world, but also the way we perceive and understand subjective time can modify and form what Wittgenstein (1979) called hinges or certainties, the background of my framework. These beliefs and certainties affect all types of autobiographical thinking, and generally in an automatic way. Yet, to the best of my knowledge, there has been little research done on how meta-knowledge and beliefs impact the way past and future events are constructed.

Conclusion

The aim of this chapter is to present an integrated cognitive framework for understanding the different processes of autobiographical thinking. This framework has been constructed in light of existing literature on memory, mental time travel, and future thinking. I have suggested differentiating the processes depending on their position in subjective and relative time (thinking about the event before or after is assumed occurrence); and depending on the perceived plausibility of the thought event. I have described nine processes, set in future (imagining, simulating, planning, and remembering intention), past (remembering, simulating, and imagining) or atemporal (knowing and imagining) time. I have suggested that these forms of autobiographical thinking depend on a similar constructive process that relies on the same raw materials as “building blocks”. Furthermore, certainties about the self and the world form a background for any autobiographical event. Therefore, this framework is intended to steer debate towards acknowledging the diversity of autobiographical thinking and to highlight the similarities and differences across all processes.

In the following empirical chapters, I will test different elements of my framework, aiming to extend research on episodic past and future thinking to other autobiographical concepts. I start by examining the core center of the framework and its interaction with autobiographical processes in Chapter 3. Then, across the complementary Chapters 4 and 5, I compare some of the autobiographical processes described in the framework, and examine how participants experience these events and how they describe them, and what the differences and similarities across the various types of autobiographical thinking can tell us about their underlying processes. Lastly, in Chapter 6, I assess the role of reality in affecting the perceived plausibility in hypothetical events depending on their temporal orientation (past or future).

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CHAPTER 3

Scripts and Information Units in Future Planning: Interactions Between a Past and a Future Planning Task

This Chapter was published as:

Cordonnier, A., Barnier, A. J., & Sutton, J. (2016). Scripts and information units in future planning: Interactions between a past and a future planning task. *Quarterly Journal of Experimental Psychology*. (Advance online publication for a Special Issue on Episodic Future Thinking). doi: 10.1080/17470218.2015.1085587

For reference, the published version is attached as Appendix B to this thesis.

In this chapter, I describe the results from my first experiment where I examined the raw materials used to construct past and future events. Following my theoretical cognitive framework (Chapter 2), I sought to investigate the core center and its interactions with the different autobiographical processes. Specifically, I considered the role of semantic scripts as well as the role of previous similar memories in future planning. I also examined interactions between the process of remembering and the process of imagining through their use of the raw materials.

In terms of measures, I focused on the amount of information units and the use of semantic scripts in a past planning task (remembering how a past camping trip in Australia was planned) and in a future planning task (imagining how a future camping trip in Australia or in Antarctica could be planned). To measure semantic scripts, I coded each information unit according to semantic categories and compared the use of the different semantic categories between both tasks.

This chapter was prepared for submission to the *Quarterly Journal of Experimental Psychology* for a Special Issue on *Episodic Future Thinking*. The descriptions of the journal and the Special Issue are appended to this chapter (p. 130), while the published version is Appendix B of this thesis. Because the article was written for this Special Issue, it is particularly grounded in the context of “episodic future thinking”. While this was a co-authored manuscript with my two supervisors, I was the major contributor to all aspects of the experimental design, the data analysis, the preparation of the manuscripts, and its revision in response to the feedback of three anonymous reviewers. Additionally, each of these stages was conducted with input and advice from Amanda Barnier and John Sutton. This manuscript was written and accepted in 2015 and will be published in 2016. It is presented here almost exactly as published, with the addition of some cross-references to other chapters of this thesis. Furthermore, I have placed tables in the appropriate place in the text as per Macquarie University thesis guidelines.

The data described in this chapter were also presented at three international conferences and one invited colloquium:

Cordonnier, A., Barnier, A.J., & Sutton, J. (2013, June). *How imagining planning the future helps us remember planning a past event.* Paper presented at the 10th Biennial Meeting for the Society for Applied Research in Memory and Cognition (SARMAC X), Rotterdam, The Netherlands.

Cordonnier, A., Barnier, A.J., & Sutton, J. (2013, November). *Past and future planning: Same content, different stories?* Poster session presented at the ARC Centre of Excellence in Cognition and its Disorders Annual Workshop, Sydney, Australia.

Cordonnier, A., & Barnier, A.J. (2013, June). *Past and future planning: Same content, different stories?* Poster session presented at the Social Aspects of Autobiographical Memory: Memory and Imagination Conference, Aarhus, Denmark.

Cordonnier, A., Barnier, A.J., & Sutton, J. (2014, June). *On the diversity of mental time travel.* Invited colloquium at the Department Colloquium Series, Catholic University of Louvain-la-Neuve, Louvain-la-Neuve, Belgium.

Scripts and Information Units in Future Planning:

Interactions Between a Past and a Future Planning Task

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Acknowledgements

This work was supported by a Macquarie University Research Excellence Scholarship to Aline Cordonnier, by an Australian Research Council (ARC) Discovery Project and ARC Future Fellowship to Amanda Barnier, by an ARC Discovery Project to John Sutton, and by the Memory Program of the ARC Centre of Excellence in Cognition and its Disorders and the Department of Cognitive Science, Macquarie University. We also want to thank M. Irish for some helpful clarifications, as well as the anonymous reviewers for their constructive comments and suggestions, which have helped improve this manuscript.

Cordonnier, A., Barnier, A. J., & Sutton, J. (2016). Scripts and information units in future planning: Interactions between a past and a future planning task. Quarterly Journal of Experimental Psychology, 69(2), pp.324–338. DOI: 10.1080/17470218.2015.1085587

Abstract

Research on future thinking has emphasized how episodic details from memories are combined to create future thoughts, but has not yet examined the role of semantic scripts. In this study, participants recalled how they planned a past camping trip in Australia (past planning task) and imagined how they would plan a future camping trip (future planning task), set either in a familiar (Australia) or unfamiliar (Antarctica) context. Transcripts were segmented into information units that were coded according to semantic category (e.g., where, when, transport, material, actions). Results revealed a strong interaction between tasks and their presentation order. Starting with the past planning task constrained the future planning task when the context was familiar. Participants generated no new information when the future camping trip was set in Australia and completed second (after the past planning task). Conversely, starting with the future planning task facilitated the past planning task. Participants recalled more information units of their past plan when the past planning task was completed second (after the future planning task). These results shed new light on the role of scripts in past and future thinking and on how past and future thinking processes interact.

Keywords: future thinking, planning, memory, scripts, mental time travel

Scripts and information units in future planning: Interactions between a past and a future planning task

The future might be unknown, but it is predictable to some extent. Events tend to repeat themselves, people do not change drastically over time, and the laws of physics continue to operate in day-to-day life. This continuity of the self and of the world provides us with the framework needed to think about the future. With memories and knowledge as building blocks, humans have been shown to successfully simulate future events and to predict outcomes or plan actions in order to achieve specific goals (Atance & O'Neill, 2001). For example, a job seeker going to an interview might simulate the questions he will be asked, drawing both on similar past experiences and on specific knowledge of the company and the offered position; a teenager can predict how her parents will react if they find out she lied about her test results; or a couple may discuss a plan for the different steps needed to build their house. During the course of one day, people think about the future as often as they think about the past (Berntsen & Jacobsen, 2008; Finnbogadottir & Berntsen, 2012), with on average 60 future-oriented thoughts a day (D'Argembeau, Renaud, & Van der Linden, 2011).

Even though future thoughts are as common as memories in our daily life, our capacity to remember has received significantly more scientific attention than our capacity to think about the future. But in the last 20 years, researchers have shown an increased interest in future thinking, specifically in one particular aspect of it: *episodic future thinking* (also known as episodic foresight, episodic simulation, or prospection) (for reviews, see Klein, 2013; Schacter, 2012; Szpunar, 2010). Episodic future thinking is usually defined as the capacity to project oneself into the future, and is often studied in parallel with episodic memory for three principal reasons (Dudai & Carruthers, 2005; Schacter & Addis, 2007; Suddendorf & Corballis, 1997). First, the two phenomena partially rely on the same component processes and neural mechanisms (Addis, Musicaro, Pan, & Schacter, 2010; Addis, Pan, Vu, Laiser, &

Schacter, 2009; D'Argembeau, Xue, Lu, Van der Linden, & Bechara, 2008; Tulving, 1985). Second, they draw on the same information stored in our episodic and semantic memory (Atance & O'Neill, 2001; Buckner & Carroll, 2007; Klein, Cosmides, Tooby, & Chance, 2002; Schacter, Addis, & Buckner, 2008; Suddendorf & Corballis, 2007). Third, researchers have argued that thinking about the future is one of the major functions of memory (Klein, 2013; Schacter, 2012; Schacter et al., 2012; Suddendorf, Addis, & Corballis, 2009; Tulving, 2005).

Thinking about a future event can take many forms. A thought-sampling study showed that in everyday life, future thoughts served a wide array of functions such as dreaming about one's future, simulating an upcoming event, or making decisions (D'Argembeau et al., 2011). Notably, more than half of self-reported future thoughts were related to *planning* an event or an action (see also Baird, Smallwood, & Schooler, 2011). In their recent taxonomy, Szpunar, Spreng, and Schacter (2014) defined four different modes of future thinking, namely simulation, prediction, intention, and planning, and divided each mode into three forms (episodic, semantic, or hybrid). Similarly, in our own cognitive framework (Chapter 2), we identify four main processes of thinking about a potential upcoming event: (a) imagining, which does not entail any belief that the future event might happen; (b) simulating, which implies that the event will probably occur; (c) planning, a multi-component goal-directed process that includes simulating the different steps and their consequences; and (d) forming and remembering intentions, also known as prospective memory. We distinguish these different forms of future thinking by the temporal distance between the moment the event is thought of and its possible realization; and by the subjective plausibility of the thought event. We also argue that the content of the future thoughts might rely more or less on episodic or on semantic memory depending on the accessibility of memories of similar past events, as well as on the sought plausibility of the thought future event.

The majority of studies to date have focused on how participants imagine future events without taking into account how plausible or probable they might be. Instead, research has emphasized the role of episodic details, influenced by the constructive episodic simulation hypothesis, which suggests that humans recombine episodic details from past events to simulate future ones (Schacter & Addis, 2007, 2009). This episodic focus can be observed at two levels: in experimental methods and in coding schemes. In terms of method, participants generally are instructed to imagine and describe specific episodic future events, either cued with time periods such as “in five years” or “when you will retire” (e.g., MacLeod & Conway, 2007), with nouns such as “dog” or “birthday” (e.g., Addis, Wong, & Schacter, 2007; D'Argembeau & Demblon, 2012), or with a set of idiosyncratic cues, as in the episodic recombination paradigm (Addis et al., 2010; Addis, Pan, et al., 2009). Consequently, although the events produced by these different styles of cues are all imagined future events, their content, as well as their plausibility, may differ substantially contingent on the cue and the instructions received. Time period cues, especially when set in the distant future, would most likely trigger cultural life script events that might be highly plausible but lack episodic specificity (Berntsen & Bohn, 2010), noun cues might prompt mundane or repeated events, whereas idiosyncratic cues, as in the recombination paradigm, might potentially generate unlikely events that score high on episodic specificity but low on plausibility. In our research, we wanted to examine the use of episodic and semantic memory in plausible future thoughts. Following our framework, we thought that investigating future planning could help us achieve this goal.

In terms of coding schemes that specify and quantify details in transcripts of past and future thinking, episodic details have usually been regarded as more important than other types of details. One of the most widely used coding schemes concentrates on the quantity of internal (or episodic) details participants generate while remembering past events or imagining future ones (e.g., Addis, Wong, & Schacter, 2008; Cole, Morrison, & Conway, 2013; De Brigard & Giovanello, 2012; Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002). Any detail not considered internal is labelled external. External details include: repetitions, other episodic details not relevant to the specific episodic event, and semantic details. A reduction in internal details (often accompanied but not correlated with an increase in external details) has been usually seen in older adults (Addis et al., 2008; Cole et al., 2013) or in patients with hippocampal damage (Addis, Sacchetti, Ally, Budson, & Schacter, 2009; Hassabis, Kumaran, & Maguire, 2007; Klein, Loftus, & Kihlstrom, 2002; Tulving, 1985). It is also important to note that to code for these internal and external details, the procedure requires identifying a clear central episodic event. This step can only be completed in episodic tasks; other types of future thinking, such as planning, cannot be analyzed using this procedure.

If episodic details have been considered central in future thinking, a number of recent studies, although differing in aim and method, support the claim that semantic memory is just as important for the simulation of future events and, in all likelihood, provides the scaffolding needed to give meaning and structure to the simulated event (Szpunar, 2010). D'Argembeau and Mathy (2011) explored the construction of mental representations of future events by asking healthy participants to report their thought flow while imagining specific future events. Participants usually first reported personal semantic information and/or general events before producing specific episodic details. Also, cuing them with personal goals facilitated the production of future events as well as access to episodic details. Cole, Gill, Conway, and Morrison (2012) examined the effect of trial duration on the production of episodic and semantic details. They showed that the amount of semantic details in past and future thinking was not related to the amount of episodic details, which indicates that semantic details are not generated at the expense of episodic details. Irish, Addis, Hodges, and Piguet (2012) investigated the role of semantic knowledge in past and future thinking by testing patients with semantic dementia. Irish et al. found that while these patients demonstrated intact retrieval of recent memories, they showed a compromised capacity to simulate novel events in the future. Neuroimaging results revealed that future thinking deficits in these semantic dementia patients were strongly correlated with atrophy in the anterior temporal lobes, which are critical for the representation of semantic knowledge (Irish et al., 2012). Interestingly, there also have been instances of patients with hippocampal amnesia who have shown preserved ability to imagine future events (Maguire, Vargha-Khadem, & Hassabis, 2010; Mullally, Hassabis, & Maguire, 2012). Together, these findings speak to the importance of semantic representations, such as general semantic knowledge but also personal semantics and semantic scripts, in the construction and simulation of future events. This has led Irish and Piguet (2013) to propose a new hypothesis–the semantic scaffolding hypothesis–which suggests that semantic memory helps scaffold both past and future thinking.

While the constructive episodic simulation and the semantic scaffolding hypothesis agree that episodic and semantic memory contribute to future thinking, the former emphasizes the role of episodic details whereas the latter emphasizes the importance of semantic information to provide the framework of the event, which is then populated by episodic details and semantic knowledge depending on familiarity. Familiar events would more likely draw upon episodic details, whereas unfamiliar or novel events would more likely draw upon semantic knowledge and scripts. However, distinguishing the separate contributions of episodic and semantic memory can be challenging, mainly because the distinction between the two is not always well defined. For example, scripts, defined by Schank and Abelson (1977, p. 210) as "a structure that describes appropriate sequences of events in a particular context", are categorized as semantic memory but can derive from repeated episodic experiences (Abelson, 1981; Bower, Black, & Turner, 1979; Hudson, Fivush, & Kuebli, 1992; Nelson & Gruendel, 1981). As it scaffolds and cues episodic remembering, script knowledge becomes intertwined with episodic details in an almost indistinguishable way. Although scripts have been shown to support the remembering process, even more so when recalling goal-directed events (Lichtenstein & Brewer, 1980), we suggest their particular structures make them essential for any type of future thinking requiring the event to have a good level of plausibility. They provide knowledge of how events tend to unfold, and can be derived both from semantic knowledge and episodic memories, especially when they are about recurring events. However, research on future thinking has yet to integrate scripts into analysis, as they cannot be coded with the traditional internal/external coding scheme. For example, when analyzing a restaurant script, what matters is not specific details such as what food was selected on the menu or how the bill was paid; what is important is that the person considered these topics. Therefore, one way to investigate scripts is to compare higher-order categories of details regardless of specific content.

In this introduction, we have discussed the need to expand research on future thinking by considering the role of scripts in plausible future events, depending on familiarity of the context. Therefore, in our study, we created a novel experimental paradigm that focused on the mental simulation of planning, which means we used planning as the content of both the remembering and imagining tasks (participants remembered planning a past event or imagined planning a future one). This was done for three reasons. First, planning is an important part of our daily life and seems to be a major aspect of future thinking (Baird et al., 2011; D'Argembeau et al., 2011). At the same time, planning has evolutionary benefits (Klein, 2013; McCormack, Hoerl, & Butterfill, 2011) and is regarded as an important developmental achievement, with many studies investigating planning in children (McCormack & Atance, 2011). Indeed, being able to simulate and anticipate what could occur as well as the consequences for our actions offers a unique advantage in our day-to-day lives. This makes it ideal for expanding research on future thinking, as our design might capture aspects of real life future thinking not yet tapped by other paradigms.

Second, future planning is a multi-component goal-directed process (Hayes-Roth & Hayes-Roth, 1979). However, we wanted to look at one particular component of the process that relates more to episodic future thinking: simulation of the planning (Szpunar et al., 2014). Unlike other aspects of future thinking, such as daydreaming, planning requires anticipation of the future by inferring how things might plausibly unfold in a given situation. To do so, one needs general knowledge of the context of the event, of the causal relationships between actions and their consequences, and even knowledge about one's own self and others. An easy way to obtain this knowledge is to bring to mind a similar situation that has been encountered previously, and compare it to the current one. Therefore, using planning as the content of the simulation allowed us to constrain and control the type of content in each telling to make it comparable across tasks, and to examine how a past planning experience influences the planning of a similar future event.

Finally, scripts can be of great value in successful planning, especially when no comparable event has been planned before and the context is unfamiliar. They provide general knowledge about the sequences of events that can be expected in a given situation, regardless of personal experience. Consequently, it gave us the opportunity to explore the use of scripts in past thinking and future thinking in familiar but also unfamiliar contexts.

To investigate how participants rely on past memories and on semantic scripts to simulate planning a future event, we divided our experiment into two tasks. We asked participants to remember how they planned a past camping trip and how they imagined they would plan a future one. The past camping trip was always set in Australia (as all our participants had been on a camping trip in Australia) whereas the context of the future trip was either identical to the past planning task–in Australia–or totally new to the participant–in

Antarctica. This last condition (imagining how to plan a camping trip in Antarctica) was created to explore the construction of future thoughts when participants could not rely on an episodic recollection of having planned a similar event in the past. To the best of our knowledge, the only study investigating the quantity of details in familiar and unfamiliar future events found that familiar events contained more internal details than unfamiliar events (de Vito, Gamboz, & Brandimonte, 2012). However, scripts and semantic knowledge might have a bigger role to play in future planning than in future simulation. If so, we would expect participants to provide as many details in familiar and unfamiliar context by relying on scripts, and that these scripts would be similar in past and future thinking tasks. Furthermore, as we counterbalanced the order of presentation of the tasks, we hypothesized that past and future planning scripts in a familiar context would be more alike when the past planning task was completed first.

Method

Participants

We recruited forty undergraduate university students (28 female and 12 male, mean age = 20.05 years, SD = 2.42; range: 18 – 30 years) enrolled in an introductory psychology course at Macquarie University (Sydney, Australia) as participants for this experiment. We selected them from a participant pool if English was their first language and they had been on a camping trip in Australia in the past 5 years. They gave informed consent prior to testing, including agreement to be audio recorded, and received course credit as compensation for their time, in accordance with the Macquarie University Ethics Committee.

We tested participants in a 2 (task order: past planning first, then future planning vs. future planning first, then past planning) x 2 (familiarity of future planning context: familiar (Australia) vs. unfamiliar (Antarctica)) mixed design, as detailed below.

Materials and Procedure

Upon arrival, participants gave their consent and received the following instructions:

> You will carry out two main tasks followed by some questions. One of the tasks consists of remembering how you planned a past event; the other consists of imagining how you would plan a future event. I will ask you to tell me your answers out loud, so I can record them, and then to write a summary of them.

For their first task, we randomly assigned participants to one of three scenarios, adapted from Klein, Robertson, and Delton (2010)[1]: (a) *a past planning scenario*, where we told participants to remember the different steps they had to undertake to successfully plan and prepare for their past camping trip in Australia; (b) *a future planning in a familiar context scenario*, where we told participants to imagine the different steps they would undertake to successfully plan and prepare for their future camping trip in Australia; and (c) *a future planning in a unfamiliar context scenario*, where we told participants to imagine the different steps they would undertake to successfully plan and prepare for their future camping trip in Antarctica. Participants had one minute to remember or imagine the planning before they described it to the experimenter for up to 5 minutes. We audio-recorded their answers using the freeware computer-recording program Audacity. Subsequently, participants summarized their answer on a sheet of paper. Once they completed their summary, a distractor task was presented to them in the form of a set of mazes.

At the end of the distractor task, we gave participants a second scenario. If they received the past planning scenario (a) as their first task, they were given one of the two future planning scenarios (b or c); and if they received one of the two planning scenarios (b or

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[1] We designed the paradigm in a way that would let us include a subtest at the end of the session replicating Klein et al.'s (2010) experiment. However, the condition of the testing and the sample size were relatively different from the original. As we did not replicate the results, we decided not to include them in this article. The data for the replication was collected after the data presented in this paper; therefore it cannot be considered as a confounding factor.

c) as their first task, they were given the past planning scenario (a). In summary, each participant completed a past planning task and a future planning task that was set either in a familiar context or an unfamiliar context. We counterbalanced the order of the tasks across participants. Therefore we had four conditions in total: “past then future – familiar future context (Australia)”, “past then future – unfamiliar future context (Antarctica)”, “future then past – familiar future context (Australia)”, “future then past – unfamiliar future context (Antarctica)”.

To conclude the experiment, participants completed a short questionnaire about their demographic details, camping habits, and knowledge of Antarctica. They also provided ratings on a 10-point Likert scale on how difficult they found both the past planning and future planning tasks. We then fully debriefed participants and thanked them for their time.

Data Analysis

With help from the written summaries, we transcribed each audio recording. Because of the nature of our tasks and also because we wanted to investigate script similarities between past and future planning, we created a new coding scheme. We divided sentences into small segments, each containing one new piece of information or “information unit”. To avoid inflating results, we scored adjectives and nouns in the same noun phrase as one single information unit (e.g. windproof jacket was scored 1). Then, we scored these information units according to a higher-order semantic category (to record what the information unit was about), such as information about *who* would be coming, *where* they were planning to go, or the type of *material* they were going to bring. We also coded actions that needed to be undertaken and conditions to take into account (such as health conditions, time constraints, etc.). Overall there were 19 semantic categories, which represented the type of information that could be found in a general script of how to plan a camping trip. These semantic categories were not chosen a priori but were derived from the data. We used a dynamic process of creating the coding scheme by adding new categories when needed and reanalyzing the transcripts with the modified coding scheme until every information unit could be placed in a category. In the final analyses, we did not include repetitions (information units previously mentioned by participants), and we also excluded event details that were not related to the planning of the camping trips (such as details about how the trip itself went) as these details were only found in the past planning task and were not relevant to the planning itself.

The categories were: (1) who, (2) where, (3) when, (4) duration, (5) transport, (6) why, (7) weather, (8) money, (9) food, (10) accommodation, (11) personal items, (12) general material, (13) security concerns, (14) leisure activities, (15) chores, (16) seeking information, (17) general knowledge, (18) actions, and (19) conditions. For example, the sentences "The four of us and my little brother planned to go camping around Umina beach, which is north of Sydney to learn how to surf. We decided to go by car and we would take Jack's tent." contains 7 information units from 6 different semantic categories (in order): *who (x2)*, *where*, *general knowledge*, *why*, *transport,* and *accommodation*.

To check inter-rater reliability, the first author scored all transcripts and one extra independent judge, blind to the aims of the study and trained on the coding technique scored 53.75% of all transcripts (at least 50% in each condition). The initial agreement percentages were adequate (75.4%). Any discrepancy was resolved by discussion between coders until agreement.

These categories could be taken to constitute a complete script of what needs to be considered and done when planning a camping trip. A good planner would not necessarily provide more information units; however they would provide information units coded under many different categories in order to cover the different steps of the plan. We therefore analyzed both the total number of information units and the number of semantic categories mentioned in a transcript.

Furthermore, we wanted to analyze script similarity for each participant across the two tasks they completed. For example, if one participant considered place, time, food, weather, security, and leisure activities when planning his past trip, would he consider the same categories when planning his future trip? In other words, would participants retain a similar script of their plan, regardless of the specific content (e.g., food that you can cook on a fire vs. dry food that does not need to be cooked) and the quantity of information units (full list of items vs. mentioning planning for food), or would they provide information units from other categories depending on context? Therefore, we calculated for each participant the number of categories mentioned in both of their tasks, in their past planning task only, in their future planning task only, or in neither their past nor their future planning task.

Results

Camping Experiences, Knowledge of Antarctica, and Difficulty Ratings of the Tasks

To ensure there was no discrepancy in prior knowledge and experience across conditions (“past planning then future planning in Australia, “past planning then future planning in Antarctica”, “future planning in Australia then past planning”, “future planning in Antarctica then past planning”), participants filled in a questionnaire about their camping experiences and general knowledge of Antarctica at the end of the study. There were no significant differences in the frequency of camping trips taken in Australia, how long ago was the camping they described in the past planning task, and their general knowledge of Antarctica (see Table 1). Therefore, subsequent differences between our conditions cannot be explained by differences in camping experiences or general knowledge of Antarctica.

Table 1

Camping experiences, knowledge of Antarctica and difficulty ratings of the tasks, as a function of the tasks order and the future scenario familiarity.

Tasks order		**Past-future**		**Future-past**		**Significant**
Future scenario familiarity		**Familiar** (n=10)	**Unfamiliar** (n=10)	**Familiar** (n=10)	**Unfamiliar** (n=10)	**differences**
Frequency of camping trips taken in Australia (number of participants)	*Often (4-6)*	4	3	3	3	NS
	Rarely (1-3)	3	3	3	3	NS
	Regularly (7+)	3	4	4	4	NS
How long ago was the camping they described in the experiment (months)		27.2 (24.5)	19.3 (17.0)	28.1 (14.9)	34.3 (23.9)	NS
Knowledge of Antarctica (10pt scale)		2.5 (1.4)	4.3 (1.8)	4.0 (1.7)	3.5 (1.7)	NS
Difficulty of the past planning task (10pt scale)		4.6 (1.3)	5.0 (2.0)	3.8 (1.8)	4.8 (2.1)	NS
Difficulty of the future planning task (10pt scale)		3.7 (1.5)	4.8 (2.0)	3.9 (1.3)	5.2 (2.0)	*

* $p < .05$

Participants also rated how difficult they found both past and future planning tasks on a scale from 1 to 10. A 2 (task order) x 2 (familiarity of future planning context) univariate ANOVA revealed no significant differences for the self-rated difficulty of the past planning task ($M = 4.55$, $SD = 1.84$). However there was a significant main effect for the self-rated difficulty of the future planning task when the context was unfamiliar to participants (Antarctica), $F(1, 36) = 4.88$, MSE = 2.95, $p = .034$, $\eta_p^2 = .119$. The future planning task was rated as more difficult when the scenario was set in Antarctica ($M = 5.0$, $SD = 1.95$) compared to Australia ($M = 3.8$, $SD = 1.36$), regardless of the order the tasks were presented in. Finally, it is worth noting than participants did not find the past planning task easier or more difficult than the future planning task, $t(1, 39) = 0.51$, $p = .613$.

Quantity of Information Units Produced in Past and Future Planning Tasks

First, we analyzed the quantity of information units produced in past and future planning tasks. We removed two outliers (with a z score of at least + 2.5) from the initial sample for this set of analyses.[2] As participants rated the future planning task with the unfamiliar context (Antarctica) harder than the future planning task with the familiar context (Australia), we started by comparing the average number of information units produced in the two future planning scenarios only. A 2 (task order) x 2 (familiarity of future planning context) univariate ANOVA revealed no main effect of task order but, more importantly, no main effect of the familiarity of the future scenario, $F(1, 34) = 1.02$, MSE = 153.10, $p = .320$. However, there was a significant two-way interaction between task order and familiarity of the context, $F(1, 34) = 6.06$, MSE = 153.10, $p = .019$, $\eta_p^2 = 0.15$. While there was no difference in quantity of information units produced between the two contexts (Australia and Antarctica) when the future planning task was completed first, participants provided less information units when the future planning task was completed second and when the context was familiar (Australia), $F(1,34) = 6.03$, MSE = 153.10, $p = .019$, $\eta_p^2 = 0.19$.

Subsequently, we investigated the difference in quantity of information units produced in each task. We ran a mixed-design ANOVA with type of task (past planning vs. future planning) as a within-subject factor and task order (past-future vs. future-past) and familiarity of future planning context (familiar vs. unfamiliar) as between-subject factors. Mean and standard deviation are summarized in Table 2.

[2] One participant was in the “past planning then future planning in Antarctica” condition; the other was in the “future planning in Australia then past planning” condition. These two participants had a significant number of information units in a single category that inflated their total number of information units. For example, one participant simply listed every items of food he would pack. Including them in our analyses would not alter their outcome; on the contrary, it would increase our effect size and therefore gives an erroneous inflated view of our results.

Although there were no significant main effects, the analysis yielded a two-way interaction between the tasks and the order they were presented in, $F(1, 34) = 21.70$, MSE = 36.22, $p < .001$, $\eta_G^2 = .07$.[3] For the past planning task, participants recalled more information units about the way they planned their past camping trip if they imagined planning a future camping trip first, $F(1, 34) = 8.74$, MSE = 36.22, $p = .006$, $\eta_p^2 = .20$. For the future planning task, participants recalled a similar number of information units irrespective of when they completed the task: first or second.

Table 2

Total number of information units in each task as a function of the order of tasks presentation and the familiarity of the future planning scenario.

Tasks order	**Future scenario familiarity**	**TASK**			
		Past planning		**Future planning**	
		M (*SD*)	95% CI	*M* (*SD*)	95% CI
Past-future	Familiar	31.20 (14.00)	[23.19, 39.01]	29.60 (12.84)	[21.65, 37.55]
	Unfamiliar	33.56 (9.49)	[25.22, 41.89]	43.56 (8.52)	[35.17, 51.94]
	TOTAL	32.33 (11.81)	[26.58, 38.08]	36.58 (12.88)	[30.80, 42.36]
Future-past	Familiar	46.00 (13.34)	[37.66, 54.34]	38.44 (14.21)	[30.06, 46.83]
	Unfamiliar	42.30 (11.77)	[34.39, 50.21]	32.60 (13.01)	[24.65, 40.55]
	TOTAL	44.15 (12.33)	[38.40, 49.90]	35.52 (13.54)	[29.74, 41.30]

The three-way interaction between the type of task, task order and the familiarity of the future planning scenario also was significant, $F(1, 34) = 6.09$, MSE = 36.22, $p = .019$, $\eta_G^2 = .02$. Bonferroni contrasts found a global increase of information units generated between the first task and the second task in all conditions but one. That is, participants invariably gave more details on the second task compared to the first, except when they started by

[3] We used generalised eta squared to report effect sizes as this design has a within-subject variable (Bakeman, 2005; Lakens, 2013; Olejnik & Algina, 2003).

remembering how they planned a past camping trip and then imagined planning a camping trip also in Australia.

To summarize, this set of analyses shows that participants recalled more information units if they imagined planning a future event first, regardless of the familiarity of the context of the future event. However, remembering how they planned the past event first did not help participants plan the future event, especially when the context of the future event was familiar.

General Use of Semantic Categories in Past and Future Planning Tasks

Second, we investigated the general use of semantic categories in both past and future planning tasks by analyzing the presence or absence of at least one information unit in each semantic category of our coding system. For each category, participants received either a score of 1 if they provided at least one information unit coded in this category or 0 if they provided no information unit related to the category, giving them a total maximum of 19 and a total minimum of 0. On average, participants mentioned information units belonging to 12.7 categories for the past planning task (SD = 2.57) and 13.1 categories for the future planning task (SD = 2.81). There were no significant outliers so we used the whole sample for this analysis. Means and standard deviations are summarized in Table 3.

As in the previous set of analysis, we first wanted to investigate the effect of the familiarity of the context on the number of categories used in the future planning task only. Similarly to the analysis on the quantity of information units, the 2 (task order) x 2 (familiarity of future planning context) univariate ANOVA showed no main effect of the familiarity of the future scenario, $F(1, 36) = 0.01$, MSE = 6.53, $p = .947$; and no order effect. Furthermore, we found a similar two-way interaction between task order and familiarity of the context, $F(1, 36) = 8.82$, MSE = 6.53, $p = .005$, $\eta_p^2 = .20$. While there was no difference in the number of semantic categories used between the two contexts (Australia and Antarctica) when the future planning task was completed first, participants provided details coded in fewer semantic categories than when the future planning task was completed second and when the context was familiar (Australia), $F(1, 36) = 9.92$, MSE = 6.53, $p = .003$, $\eta_p^2 = 0.22$.

We also ran another mixed-design ANOVA with type of task (past planning vs. future planning) as a within-subject factor and task order (past-future vs. future-past) and familiarity of future planning context (familiar vs. unfamiliar) as between-subject factors, on the total number of semantic categories used. There were no significant main effects or interactions, which indicates that participants used the same average number of semantic categories in each scenario, regardless of the condition they were in or the task they were completing.

This set of analyses shows that participants used most of the semantic categories in both past and future planning tasks, as predicted by the literature on scripts. Yet, the number of categories used in the future planning task was significantly lower when the context of the event was familiar and when future planning was completed after the past planning task.

Table 3

Total number of semantic categories used in each task as a function of the order of tasks presentation and the familiarity of the future planning scenario.

Tasks order	**Future scenario familiarity**	**TASK**			
		Past planning		**Future planning**	
		M (*SD*)	95% CI	*M* (*SD*)	95% CI
Past-future	Familiar	11.20 (2.78)	[9.61, 12.79]	11.20 (3.15)	[9.56, 12.84]
	Unfamiliar	12.60 (1.58)	[11.01, 14.19]	14.80 (2.04)	[13.16, 16.44]
	TOTAL	11.90 (2.31)	[10.78, 13.02]	13.10 (3.18)	[11.84, 14.16]
Future-past	Familiar	13.80 (2.86)	[12.21, 15.39]	13.80 (2.20)	[12.16, 15.44]
	Unfamiliar	13.20 (2.49)	[11.61, 14.76]	12.60 (2.67)	[10.96, 14.24]
	TOTAL	13.50 (2.63)	[12.38, 14.62]	13.20 (2.46)	[12.04, 14.36]

Analysis of Script Similarity Across Past and Future Planning Tasks

To investigate script similarities across tasks, for each participant we counted how many of our 19 semantic categories were present *in both tasks* (past and future planning), *in the past planning task only*, *in the future planning task only*, and *in neither tasks* (categories that were never mentioned). For example, if a participant mentioned planning for food in his/her past and future plans (regardless of him/her stating 1 food item or 10 food items), the food category would be placed in the *both tasks* variable. We therefore compiled four values for each participant that represent script similarity (or lack of) between both completed tasks. These values were then averaged across participants to create these new dependent variables. As some assumptions were violated, we ran 2 (task order) x 2 (familiarity of future planning context) factorial ANOVAs with bootstrapping procedures[4] on each of these four dependent variables. Results are shown in Table 4.

Table 4

Average presence of semantic categories for each participant in neither tasks, in both tasks, in the past planning task only or in the future planning task only, as a function of the order of tasks presentation and the familiarity of the future planning scenario.

Tasks order	**Past-future**		**Future-past**	
Future scenario familiarity	**Familiar** M (*SD*)	**Unfamiliar** M (*SD*)	**Familiar** M (*SD*)	**Unfamiliar** M (*SD*)
Categories present in **neither** tasks	5.3 (2.41)**	2 (1.05)	2.4 (1.84)	3.1 (2.51)
Categories present in **both** tasks	8.7 (2.95)	10.4 (1.90)	11 (3.50)	9.9 (2.51)
Categories present only in the **past planning** task	2.5 (1.72)	2.2 (1.40)	2.8 (1.69)	3.3 (1.16)
Categories present only in the **future planning** task	2.5 (1.96)	4.4 (1.84)	2.8 (1.93)	2.7 (1.34)

** $p < .01$

[4] Bootstrapping procedures are robust methods that can be used when some assumptions are violated (Field, 2009).

There were no significant main effects or interactions when the dependent variables were the number of semantic categories present *in both tasks*, *in the past planning task only* or *in the future planning task only*. There was, however, a strong two-way interaction for the analysis with *in neither task* as the dependent variable, $F(1, 36) = 9.64$, MSE = 4.15, $p = .004$, $\eta_p^2 = .21$. When the scenario was familiar (Australia) for both tasks, not mentioning certain semantic categories during the past planning task completed first made them less likely to be mentioned during the future planning task completed second. In the other three conditions ("past planning then future planning in Antarctica", "future planning in Australia then past planning", "future planning in Antarctica then past planning"), most categories were at least discussed in one of the two tasks, if not in both.

Together, these results show that when participants provided details coded in one category in the first task, they usually provided details coded in that same category in the second task. However, semantic categories not mentioned when recalling past planning were less likely to be discussed when planning a future camping trip in Australia.

Discussion

In the present study, we investigated the quantity of information units as well as the use of semantic scripts in a past and a future planning task, with the future planning task set in either a familiar (Australia) or an unfamiliar (Antarctica) context. First, we investigated potential differences between the two contexts of the future planning task. Similarly to previous studies (Arnold, McDermott, & Szpunar, 2011), participants rated the unfamiliar scenario as harder than the familiar scenario. Yet our results showed no differences between the two conditions in terms of the quantity of information units produced. In spite of the fact that participants had experiences of camping in Australia and had never been to Antarctica, they produced as many information units when imagining their plans for camping in Antarctica as in Australia when they completed the future planning task first. We also found no difference between the two contexts when investigating the number of semantic categories. The inconsistency of our results with de Vito et al.'s (2012) study – who found that familiar events contained more internal details than unfamiliar events – might be because they focused on the simulation of events, whereas we focused on the role of simulation in planning. Therefore, our results could indicate that future planning is not so constrained by familiarity, and that scripts and semantic knowledge could suffice to plan a future event. Our results also support the semantic scaffolding hypothesis, which suggests that depending on the familiarity of the event, one would be more likely to draw upon either episodic details or on semantic memory (Irish & Piguet, 2013).

Second, we analyzed the similarities and interactions across both past and future planning tasks. Our results found interactions between the tasks and the order they were presented in. This order effect can be divided into two separate findings. The first major finding from task interaction can be found in the higher number of information units in the past planning task when completed second compared to first. It is important to note that familiarity of the future context did not influence our results. This finding was relatively surprising as until now research had only investigated the influence of memory on future thinking and not the opposite. We can therefore propose a tentative account of this effect through the concept of scripts, but further research is needed to investigate the underlying processes at play. Similar to Bartlett's (1932) concept of schemas, scripts represent a general sequence of events and can originate from repeated events, as well as from general semantic knowledge. Because of this, even if they are conventionally considered semantic memory, scripts might have more in common with concepts such as Neisser's (1981) "repisodic memory", Barsalou's (1988) "extended events" or Conway and Pleydell-Pierce's (2000) "general events", which are neither truly semantic nor episodic (Greenberg & Verfaellie, 2010; Martin-Ordas, Atance, & Louw, 2012). They are representative versions of similar events and can both support remembering and future thinking processes. Thus, when asked, as a first task, to imagine how they would plan for a future camping trip, participants could have relied on scripts to help them decide what they needed to plan, as well as on memories of how they planned past camping trips. Subsequently, when asked to recall how they planned a camping trip in the past, these scripts were accessible and facilitated the remembering process. Therefore they recalled more details than participants who did not already have these extensive scripts activated. We also found a similar influence of scripts when participants imagined planning a future camping trip in Antarctica as their second task. Scripts as well as episodic details could also have facilitated their future plans. However, as they had never camped or even been to Antarctica, on top of the activated scripts, they had to actively think of new details to consider and rely also on semantic knowledge they had about Antarctica.

Yet, we did not find the same influence of scripts when the future planning task was set in Australia and completed second. Compared to the other conditions where there was an increase in the amount of information units produced from the first to the second task, participants imagining how they would plan a future camping trip in Australia as their second task generated no more information units than they did when they remembered how they planned a similar past trip during the first task. The numbers even showed a small but non-significant reduction in the quantity of information units generated between the two tasks. A possible interpretation would be that in this case, participants relied more on episodic memory as a complete relevant plan had just been produced. Consequently when participants imagined how they would plan for a camping trip also in Australia, they might have simply produced a very similar version to what they had just told us but in a future tense, without trying to think of new details or possible changes in the context. If their plans were successful in the past, repeating them in the future could be an efficient approach.

However, we could also find another potential interpretation of this result in the retrieval-induced forgetting phenomenon, where the act of remembering an item can inhibit the retrieval of related items later on (Anderson, Bjork, & Bjork, 1994). It is possible that in this case, remembering the past plan inhibited the search for additional similar details. Nevertheless, we found converging evidence for the first interpretation in our analysis of script similarities across past and future planning tasks. Our results indicated that, in general, if a category was mentioned in one of the tasks, participants also generated information units from that category in the second task. This result shows that similar scripts were used in both tasks. Moreover, the analysis revealed that if a category was not mentioned in the first task, participants might still generate information units from that category in the second task. This was true of all conditions except when participants had to imagine planning a future event in a familiar context as the second task. In this case, categories not mentioned during the past planning task were also unlikely to be mentioned during the future planning task set in the familiar context. This indicates that participants simply followed the same script as the one they had just mentioned without adding categorically new details to their plan.

In summary, if the simulating subcomponent of the planning process is a type of episodic future thinking, then our study shows that the interaction between past and future thinking goes both ways. On the one hand, our findings suggest that starting by remembering the planning of a past event can influence the capacity to plan a future one in a similar context. On the other hand, starting by planning a future event might activate semantic categories that could later support the remembering process. Hence, future thinking seems to rely on episodic memory–especially when the information has been recently recalled–but is not constrained by it. However, episodic details are not the only components of future thinking; our results also indicate that semantic knowledge and script-knowledge play important roles when imagining and planning future events.

Importantly, our findings also highlight that the order of presentation of past and future thinking tasks matters, as they can influence one another. Future studies should keep in mind this order effect, as we know now that past memories can affect the way we think about similar future events and vice versa (order effect will become important in Chapter 4). Randomizing the task order might not be enough to control for the effect and might even confound results. Depending on the goal of the study, this order effect could potentially be reduced by running conditions on different days, by avoiding similar events in past and future tasks, or by accounting for it when running statistics. However, future studies should investigate the extent to which past and future interact and the underlying processes, depending on the familiarity of the events, their occurrence in everyday life and the prevalence of cultural semantic scripts. Finally, research should continue to explore the role of semantic knowledge in the formation of future thoughts and planning as a function of the quantity of related memories available and the need to make the future thought or the future plan as plausible as possible.

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Journal Description (impact factor = 2.13)

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Special Issue Description

"The purpose of the Special Issue of the The *Quarterly Journal of Experimental Psychology* is to spur further interest in the development of cognitive studies of episodic future thinking. In this context, the Special Issue highlight recent approaches to the study of episodic future thinking from a largely cognitive standpoint, such as studies of the frequency with which people think about the future, techniques for enhancing the specificity with which people are able to simulate the future, and considerations of how episodic future thinking may interact with other modes of future-oriented cognition." (Szpunar & Radvansky, 2016)

Szpunar, K., & Radvansky, G. A. (2016). Cognitive approaches to the study of episodic future thinking, *Quarterly Journal of Experimental Psychology.* Advance online publication. doi: 10.1080/17470218.2015.1095213

CHAPTER 4

Phenomenology in Autobiographical Thinking

This Chapter was prepared as:

Cordonnier, A., Barnier, A. J., & Sutton, J. (in preparation). Phenomenology in autobiographical thinking. *Consciousness and Cognition.*

In this chapter, I describe one set of results from my second and third experiments, where I examined the phenomenology of autobiographical past or future events. As this chapter was prepared for submission, I followed APA guidelines and renumbered my experiments accordingly. Therefore in this chapter, experiment 2 is presented as experiment 1, and experiment 3 is presented as experiment 2. Furthermore, I have placed tables in the appropriate place in the text as per Macquarie University thesis guidelines. Following my theoretical cognitive framework (Chapter 2), I sought to compare how the different processes of thinking autobiographically impacted the subjective experience of participants. Specifically, I compared the phenomenology of remembered past events, imagined future events, and planned future events using a between-subjects design in experiment 1 and using a within-subjects design in experiment 2. In both experiments, I also compared the phenomenology of these originals events with the phenomenology of alternative versions of these events.

In terms of measures, I focused on how participants rated 27 phenomenological characteristics of their autobiographical thoughts on a 7-point Likert scale. I compared each characteristic across conditions, looking for differences and similarities. I also compared each characteristic between original and alternative events. Finally, I investigated how these phenomenological characteristics fell into natural factors, and how these factors could indicate common underlying features in autobiographical thinking.

This chapter was prepared specifically for submission to the journal *Consciousness and Cognition*, as the study of phenomenology has strong connections with the study of consciousness. Furthermore, many studies that have inspired this research have been published in this journal. The description of the journal is appended to this chapter (p. 207). While this is a co-authored manuscript with my two supervisors, I was the major contributor to all aspects of the experimental design, the data analysis, and the preparation of the manuscripts. Each of these stages was conducted with input and advice from Amanda Barnier and John Sutton.

The data described in this chapter was also presented at two international conferences:

Cordonnier, A., Barnier, A.J., & Sutton, J. (2014, June). *On the diversity of mental time travel.* Invited colloquium at the Department Colloquium Series, Catholic University of Louvain-la-Neuve, Louvain-la-Neuve, Belgium.

Cordonnier, A., Barnier, A. J., & Sutton, J. (2014, August). *The phenomenology of mental time travel: What differentiate past and future thinking.* Poster session presented at the 'Comparative Perspectives of Autobiographical Memory - What Animals and Humans Remember about their Past' Conference, Aarhus, Denmark.

Phenomenology in Autobiographical Thinking

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Acknowledgements

This work was supported by a Macquarie University Research Excellence Scholarship to Aline Cordonnier, by an Australian Research Council (ARC) Discovery Project and ARC Future Fellowship to Amanda Barnier, by an ARC Discovery Project to John Sutton, and by the Memory Program of the ARC Centre of Excellence in Cognition and its Disorders and the Department of Cognitive Science, Macquarie University.

Abstract

The subjective experience associated with thinking about autobiographical events can reveal on how these events are constructed and perceived. Previous research has shown that remembered past events tend to be experienced with more sensory details and a clearer visuo-spatial context than imagined future events. Across two experiments, we expanded these results by comparing phenomenological ratings across a broader range of autobiographical thinking processes, including future planning, counterfactual thinking, and prefactual thinking. Results showed that remembered past events were associated with a stronger feeling of experiencing the events and were visually and spatially clearer than imagined or planned future events, but only in a within-subjects design where participants compared the different autobiographical directly. Counterfactual events differed from memories on a range of dimensions, whereas prefactual imagined, and prefactual planned events received similar ratings to their original versions. Together, these findings suggest that phenomenological ratings are relative and not absolute. Finally, results from our factor analyses indicated the presence of underlying features common in all types of autobiographical events.

Keywords: future thinking, phenomenology, autobiographical thinking, factor analysis, mental time travel, episodic memory, counterfactual thinking

Phenomenology in Autobiographical Thinking

Humans have the ability to mentally experience scenes or events that are not presently experienced by way of their senses. We can close our eyes and picture a blue sky even when it is raining outside, or hear the voice of a friend who has passed away. When remembering past events, the remembering process can also be accompanied by visual details or emotions, sometimes creating a sensation of almost “re-experiencing” the event. Similarly, when thinking about the future, one can visualize movements that are about to occur, feel the excitement of an upcoming reward, or mentally “pre-experience” events that may or may not happen later on.

The subjective experience associated with thinking about a personal event – also called the phenomenology of the event – has been investigated in the context of empirical research on the similarities of past and future thinking. Based on a range of neural and cognitive evidence, scientists have proposed that past and future thinking rely on a similar constructive process (for reviews, see D'Argembeau, 2012; Klein, 2013; Szpunar, 2010; see also Chapter 1). Schacter and Addis (2007a), as well as Irish and Piguet (2013), have argued that this constructive process flexibly combines similar content from episodic and semantic memory to construct autobiographical events, whereas Hassabis and Maguire (2007) have argued that it integrates semantic and episodic information into a coherent visuo-spatial context for the event, therefore focusing on the spatial aspect of scene construction (see Chapter 1 for a more in-depth discussion).

In our cognitive framework (Chapter 2), we suggested that other types of past and future thinking also rely on this constructive process. We discussed the importance of broadening research on episodic memory and episodic future thinking to include a wider range of autobiographical processes, as there are many more ways to think about both the past and the future. The past can be remembered or alternative versions can be simulated, and the future can be imagined, simulated, or planned. Previous research on the phenomenology of autobiographical events has mainly focused on the capacity to remember past events and imagine future events, so in this experiment, we expand current research by examining the subjective experience associated with a variety of ways of thinking about autobiographical events.

Phenomenology of Autobiographical Events

Empirical interest in the phenomenology of memories was strongly influenced by Johnson, Foley, Suengas, and Raye's landmark study (1988) of reality monitoring, the processes by which perceived and imagined events are discriminated and confused in memory. They created a Memory Characteristics Questionnaire and used it to compare memories to imagined atemporal events. They found that memories were rated as having more perceptual and contextual information than imagined events, suggesting that such differences provide the basis for reality monitoring decisions.

Researchers in the field of future thinking wondered if similar results could be found when comparing memories with imagined future events. D'Argembeau and Van der Linden (2004) were the first to test this question. They asked participants to remember four specific past events that they experienced and to imagine four specific future events that could reasonably happen to them. Participants had to remember two events set in the recent past (within the last year but at least one month ago) and two events set in the more distant past (five to ten years ago), as well as to imagine two events set in the near future (in the next year, after a minimum of one month) and two events set in the more distant future (in the next five to ten years). In each category, one event had to be positive and one event had to be negative. Participants were cued with the type of task (remembering or imagining), the temporal distance (recent/near or distant) and the emotional valence (positive or negative), and asked to first describe the event they had in mind. Then, they closed their eyes for one minute to remember or imagine the event as clearly as possible, before rating the phenomenology of their representation on 7-point scales adapted from the Memory Characteristics Questionnaire. In particular, the events were rated for visual details, sounds, smell/taste, clarity of location, clarity of the spatial arrangement of objects, clarity of the spatial arrangement of people, clarity of the time of day, valence of the emotions involved in the event, intensity of the emotions involved in the event, feeling of (p)re-experiencing the event, and importance of the event for the self-image. Participants also reported their visual perspective as being from a field perspective (seen from their own eyes), an observer perspective (seen from an observer's position), or neither. The authors found that past events contained more sensory details and were more clearly represented than imagined future events, which mirrors the results to those of Johnson et al. (1988).

Since then, other studies have investigated phenomenology of episodic memory and episodic future thinking. In most studies, participants are generally asked to remember or imagine specific personal events and rate their phenomenology on a varying number of characteristics. Most experiments have found several phenomenological differences between remembered past events and imagined future events. Replicating results from D'Argembeau and Van der Linden (2004), remembered past events generally contain more sensory details and have clearer location and spatial orientation of people and objects, whereas imagined future events are usually expected to be more positive by participants (Addis, Pan, Vu, Laiser, & Schacter, 2009; Arnold, McDermott, & Szpunar, 2011; D'Argembeau, Ortoleva, Jumentier, & Van der Linden, 2010; D'Argembeau & Van der Linden, 2006; De Brigard & Giovanello, 2012). This tendency to overestimate the likelihood of positive future events and underestimate the likelihood of negative future events has been dubbed the "optimism bias" (Schacter & Addis, 2007b; Sharot, 2011; Weinstein, 1980; as noted in Chapter 1).

Other characteristics were rated alike in remembered and imagined events, such as the feeling of (p)re-living or (p)re-experiencing the event (D'Argembeau et al., 2010; D'Argembeau & Van der Linden, 2004, 2006), but not in every experiment (Arnold et al., 2011). The visual perspective (field or observer) in which the event was perceived also received similar ratings across memories and imagined future thoughts (Addis et al., 2009; D'Argembeau & Van der Linden, 2004; De Brigard & Giovanello, 2012), but again not in every experiment (D'Argembeau & Van der Linden, 2006). Yet, in these studies, visual perspective was principally measured as a dichotomy (either field or perspective scale) and did not account for the fact that some people could switch from one perspective to the other (Rice & Rubin, 2009). In a recent experiment investigating visual perspective in depth, researchers found that not only were there more observer than field perspectives in both past and future thinking, future thoughts were also more likely to be imagined from an observer perspective than memories (McDermott, Wooldridge, Rice, Berg, & Szpunar, 2016).

Other phenomenological characteristics were sometimes rated similarly and sometimes differently between remembered past events and imagined future events. For example, across a number of experiments, the emotional intensity of the event was stronger in the past than the future (Addis et al., 2009; D'Argembeau & Van der Linden, 2004), stronger in the future than the past (De Brigard & Giovanello, 2012, study 1) or identical in both temporal orientations (Addis, Wong, & Schacter, 2007; D'Argembeau et al., 2010; D'Argembeau & Van der Linden, 2006; De Brigard & Giovanello, 2012, study 2).

Beyond these similarities and differences, studies have shown that phenomenological characteristics of remembered past events and imagined future events were affected in parallel by individual differences or by properties of the events. For instance, D'Argembeau and Van der Linden (2006) found that individual differences in visual imagery and emotion regulation strategies affected phenomenological characteristics of both past and future events. In their previous study detailed above, they showed that past and future events were similarly influenced by valence and temporal distance: positive events, but also temporally close events were rated as more detailed and more experienced than negative events (D'Argembeau & Van der Linden, 2004). Surprisingly, Arnold et al. (2011) did not replicate the effect of temporal distance on phenomenological ratings. Using temporal distance as a between-subjects variable, they asked participants to rate the phenomenology of remembered and imagined future events set at a specific point in time (1 day, 1 week, 1 year, 5 years, or 10 years in the past or in the future). They used a between-subjects design "so that phenomenological ratings could not be based on comparisons across temporal distances or naïve theories of how the vividness of future events and memories set at different temporal distances *should* vary" (Arnold et al., 2011, pp. 955-956). Only one characteristic, the clarity of location, showed a main effect of temporal distance. Arnold et al. hypothesized that their use of a between-subjects design might account for the conflicting findings between their experiment and D'Argembeau and Van der Linden's study (2004). This interesting point on the effect of between-subjects design needs further investigation.

Finally, it is noteworthy that temporal orientation (past or future) might not be the only way to understand differences between remembered past events and imagined future events. Debus (2014, p. 337) defended the claim that memories and imagined future thoughts were "mental occurrences of two different kinds" as one could only be experientially aware of perceived past events. This hypothesis might explain why previous research has shown that counterfactual thoughts, although theoretically set in the past, were sometimes more similar to future thoughts than to memories. For example, De Brigard and Giovanello (2012) compared past, future, and counterfactual events in two separate studies. In the first study, each participant first reported memories before generating either future or counterfactual events. In the second study, participants completed the three conditions (past, future, and counterfactual) in a random order. They found that the scene of past events was clearer than the scene of both counterfactual and future events. Yet, memories had more sensory details than the other conditions in only one of the two studies. Other phenomenological ratings differed between the two studies, indicating that more research needs to be done. Nevertheless, exploring the capacity to think about hypothetical past events could help to better understand the role of temporal orientation in the construction of autobiographical events.

Aims

In light of the inconsistencies in past experiments as well as the above results from counterfactual studies, there is a clear need to investigate further how phenomenological characteristics are rated in different types of past and future events. In this paper, we report on two experiments investigating phenomenological characteristics of autobiographical thinking. Experiment 1 used a between-subjects comparison, like Arnold et al. (2011), whereas Experiment 2 used a within-subjects comparison, like D'Argembeau and Van der Linden (2004, 2006). Previous experiments had generally used within-subjects design, however following the order effects and interactions of our previous experiment (see Chapter 3), as well as the interesting conflicting results between Arnold et al. (2011) and D'Argembeau and Van der Linden (2004, 2006) discussed above, we decided to start by examining phenomenology between-subjects to avoid potential order effects.

Inspired by D’Argembeau’s procedure, each experiment had two parts. In the first part, participants generated remembered past events, imagined future events, and/or planned for future events. Each mental simulation of the event was followed by an extensive phenomenological questionnaire. This questionnaire combined most items from the multiple sources reviewed above in order to obtain a wide range of phenomenological measures (Arnold et al., 2011; D'Argembeau & Van der Linden, 2004, 2006; Johnson et al., 1988). In the second part, in a clear extension of D’Argembeau’s procedure we investigated counterfactual, prefactual imagined, and prefactual planned thinking by asking participants to propose alternative versions of part one's events.

The aim of our research was twofold. First, we aimed to expand current research on the phenomenology of autobiographical events by analyzing how different ways of thinking about an event in time might influence the phenomenological characteristics of the event. This was completed over three steps. In step one, we compared remembered past events, imagined future events, and planned future events. Planning is an important part of our everyday life and is valuable in future thinking research (D'Argembeau, Renaud, & Van der Linden, 2011; see also Chapter 3). Having a personal goal in mind when thinking about future events helps structure events and increases their perceived plausibility (D'Argembeau & Demblon, 2012; D'Argembeau & Van der Linden, 2012). However, as suggested in our theoretical framework (Chapter 2), imagining and planning future events are two different forms of future thinking, and may differ in phenomenology from remembering and from each other.

In step two, we compared counterfactual past events, prefactual imagined events, and prefactual planned events. Whereas the idea of prefactual thinking is rarely mentioned in the future thinking literature, counterfactual thinking has received some attention in relation to future thinking in the last few years. Philosophers have argued that thinking counterfactually about past events informs causal judgments and, by extension, supports future thinking (Byrne, 2016; De Brigard, 2013; Hoerl, McCormack, & Beck, 2011). Furthermore, evidence from neuroimaging and behavioral research has revealed that counterfactual thinking activates similar neural regions and shares some phenomenological characteristics with future thinking (for a discussion, see Schacter, Benoit, De Brigard, & Szpunar, 2015). Consequently, including counterfactual and prefactual thinking allowed us to examine more generally the role of temporal orientation between memories and future events, but also between hypothetical past and future events.

Finally, in step three, we examined the changes in phenomenological ratings between original events and alternative events. In other words, we investigated which type of changes (counterfactual, prefactual imagined, or prefactual planned) modified the phenomenology of the event the most.

Second, we aimed to investigate how phenomenological characteristics of autobiographical events fall into natural factors, which might indicate underlying features of autobiographical thinking. In previous studies, researchers have sometimes averaged together some phenomenological characteristics to form new indexes or factors: sensory details have been clustered together to form a “sensory factor”, clarity of location and of spatial arrangement have been clustered together to form a “location factor” also called a “composition factor”, and the feeling of time traveling as well as the feeling of experiencing the event have been clustered together to form a “subjective experience factor” (D'Argembeau & Van der Linden, 2004; De Brigard & Giovanello, 2012; Szpunar & McDermott, 2008). However, to the best of our knowledge, only one experiment (D'Argembeau et al., 2010) has run a factor analysis to check if and how these items correlated with one another. It was carried out on five phenomenological characteristics and yielded two factors that accounted for 64% of the variance (D'Argembeau et al., 2010). The first factor was called “episodic details” and included characteristics measuring visual details, spatial context and temporal context. The second factor was called “feeling of experiencing” and included characteristics measuring how the emotional participants felt when thinking about the event and how much they felt they were mentally “re-experiencing” or “pre-experiencing” the event.

Therefore, in this study, we ran exploratory factor analyses on our 25 scale items to examine whether phenomenological characteristics fall into natural clusters or factors, such as the ones proposed in past studies (D'Argembeau et al., 2010; D'Argembeau & Van der Linden, 2004; De Brigard & Giovanello, 2012; Szpunar & McDermott, 2008). We then compared factor scores across our conditions to look for indications of common underlying factors in autobiographical thinking.

Experiment 1

Method

Participants. We recruited 51 university undergraduate students (42 female and 9 male, mean age = 20.14 years, SD = 4.00, range: 18 – 42 years) enrolled in an introductory psychology course at Macquarie University (Australia) as participants for this experiment.[1] We selected them from a participant pool on the condition that English was their first language. They gave informed consent prior to testing, which included agreement to be audio recorded, and received course credit as compensation for their time, in accordance with the Macquarie University Ethics Committee. We tested participants individually in a single one-hour session. Each participant was randomly allocated to one of three conditions: the remembering condition (R), the imagining condition (I), or the planning condition (P).

Materials and procedure. This experiment was composed of two parts. In the first part, participants remembered past events, imagined future events, or planned for future events. In the second part of the experiment, participants provided alternative versions of these events.

Part 1. Upon arrival, we informed participants they would be asked to talk about three specific events that happened to them before they started their university degree (for the remembering condition) or that could happen to them after they finished their university undergraduate degree (for the imagining and planning conditions). We chose these time constraints so the generated events would most likely be set in a different lifetime period (Conway & Pleydell-Pearce, 2000) than the one they were currently in. As discussed in

[1] Previous similar studies have used a wide range of numbers of participants, some with as few as 16 and others with more than 100, depending on the difficulty of the procedure. Taking into account the length or our testing session, which included multiple oral descriptions of events, we settled on 51 participants describing six events each across two parts.

Brown's Transition Theory (Brown, Hansen, Lee, Vanderveen, & Conrad, 2012) each lifetime period has a high degree of stability in the fabric of daily life, with many repeated events (see also Barsalou, 1988; or Neisser, 1981). Therefore, we introduced the time constraints to reduce strong similarities between past and future events and to avoid participants generating past events as future ones.

We told participants that these events did not need to be important or significant; however they had to be unique, single events occurring at a specific point in time and lasting for a few minutes or a few hours, but no longer than a day. We also asked them to avoid extended events or events that blend into other similar events. We provided examples of repeated and extended events to make sure they understood their meanings. We then ran a practice trial where participants told us about a family dinner. If they did not generate a specific personal event, we gave them feedback and more explanation.

After the practice trial, we showed participants three pairs of cues and asked them to select one cue from each pair. The pairs of cues were: (a) *a birthday celebration* or *a date/a meeting with a friend*; (b) *a first day of work/volunteering* or *an exam/a test*[2]; (c) *a day trip* or *a major public event*. We selected these cues as we expected everyone to be able to generate both past and future specific events related to them. After pilot testing, we decided to present the cues in pairs, following a permutation order decided in advance.

Regardless of the condition (R, I, or P), each event elicitation triggered a series of four steps: general questions, process task, description task, and phenomenological questionnaire (similar to D'Argembeau & Van der Linden design). Upon receiving the first cue, participants answered a series of general questions about where the event was set, when (month and year), at what time of the day the event started and the name or a description of another person present (e.g. "Jack" or "the bus driver"). We chose to restrict events to ones where at least one

[2] Participants were told that the exam or test did not need to be about school, it could be a music exam, a driving test, a test for a job, etc.

other person was present because later in the experiment the counterfactual and prefactual manipulation involved modifying the person present in the event.

After answering these general questions, participants closed their eyes for one minute and mentally remembered, imagined, or planned the event. In the remembering condition, the experimenter provided the following instructions: “I am going to give you 1 minute to close your eyes and mentally remember this event. Keeping in mind the answers to the general questions you just gave me, be sure to remember it as it happened. It is important that you try to make it as clear and as detailed as possible.” In the imagining condition, the experimenter provided the following instructions: “I am going to give you 1 minute to close your eyes and mentally imagine this event. Keeping in mind the answers to the general questions you just gave me, be sure to keep it in the future when things might not be the same as they were in the past. It is important that you try to make it as clear and as detailed as possible.” Finally, in the planning condition, the experimenter provided the following instructions: “I am going to give you 1 minute to close your eyes and mentally plan for this event. Keeping in mind the answers to the general questions you just gave me, be sure to keep it in the future when things might not be the same as they were in the past. Also be sure to really think about the different steps you will need to undertake to successfully plan for this event. It is important that you try to make it as clear and as detailed as possible.” We called this task the “process task” as we wanted to investigate how the different processes of thinking about an event in time (remembering, imagining or planning) would influence the way the event was experienced afterwards.

The third step involved verbally describing the event to the experimenter for up to three minutes, and was called the “description task”. In the planning condition, participants were requested to describe the event itself and not the planning. This way, every participant described the occurrence of a personal specific event. In the fourth and last step, participants answered a questionnaire using a 7-point Likert scale while keeping the event they had just described in mind.

As discussed in the introduction, most questions were initially drawn from the Memory Characteristic Questionnaire (Johnson et al., 1988). However, our final set of questions was adapted from several studies by D'Argembeau et al. (D'Argembeau & Mathy, 2011; D'Argembeau et al., 2010; D'Argembeau & Van der Linden, 2004, 2006, 2012), as well as other researchers (De Brigard & Giovanello, 2012; Szpunar & McDermott, 2008). We selected various measures about the clarity of the mental representation (vividness, visual details, sounds, smells/tastes, location, time of day, object and people spatial arrangements), the feeling of experiencing the event (experiencing, visual perspective, valence and intensity of emotions during the event and when thinking about the event, similarity of these emotions between now and then), the storyline (came in words, coherence, complexity), and the placement in personal history (mental time travel, familiarity of the settings, personal importance, past and future occurrences). All the questions are summarized in Table 1.

Table 1

Scale Items Forming the Questionnaire Used to Assess the Phenomenological Characteristics of the Remembered, Imagined, and Planned Events

Characteristics	**Questions**	**Scale**
Experiencing	Did you feel as though you were experiencing the event?	1 = not at all, 7 = completely
Mental time travel	Did you feel that you travelled backward/forward to the time when the event happened/might happen?	1 = not at all, 7 = completely
Field perspective	To what degree was the event experienced from your own eyes?	1 = not at all, 7 = completely
Observer perspective	To what degree was the event experienced from an observer's perspective?	1 = not at all, 7 = completely
Observer vs. field dichotomy	If you had to choose between both perspectives, would you say you saw the event through your own eyes or as an outside observer?	-3 = observer, 3 = own eyes
Vividness	Was the representation vivid in your mind?	1 = not at all, 7 = completely
Visual details	Did it involve visual details?	1 = not at all, 7 = completely
Sounds	Did it involve sounds?	1 = not at all, 7 = completely
Smells/tastes	Did it involve smells or tastes?	1 = not at all, 7 = completely
Location	Was the location where the event took/might take place clear?	1 = not at all, 7 = completely
Familiar setting	Was it set in a very familiar setting?	1 = not at all, 7 = completely
Object spatial arrangement	Was the relative spatial arrangement of objects clear?	1 = not at all, 7 = completely
People spatial arrangement	Was the relative spatial arrangement of people clear?	1 = not at all, 7 = completely
Time of day	Was the time of day when the event took place clear?	1 = not at all, 7 = completely
In words	Did it come to you in words?	1 = not at all, 7 = completely
Coherent story	Did it come to you as a coherent story and not as an isolated scene?	1 = not at all, 7 = completely

Characteristics	Questions	Scale
Complexity of the storyline	Was the storyline very complex?	1 = not at all, 7 = completely
Intensity of emotions during the event	How intense were/would your emotions (be) during the event?	1 = not intense, 7 = very intense
Valence of emotions during the event	Were those emotions negative or positive?	-3 = very negative, 3 = very positive
Similarity of emotion now and during the event	To what degree did you feel the same emotions as the ones you felt/would feel when/if the event occurred?	1 = not at all, 7 = completely
Intensity of emotions when thinking about the event	How intense were/would your emotions (be) when thinking about event?	1 = not intense, 7 = very intense
Valence of emotions when thinking about the event	Were those emotions negative or positive?	-3 = very negative, 3 = very positive
Personal importance	Is this event important to you (it involves an important theme or episode in your life)?	1 = not at all, 7 = very important
Past occurrences	How often have you encountered similar events in the past?	1 = never, 7 = very often
Future occurrences	How often do you expect to encounter similar events in the future?	1 = never, 7 = very often
Similarity to a past event [a]	How similar is this event to a previously encountered event?	1 = not similar to any past event, 7 = very similar to a past event
Planning during process task [b]	When you had to mentally plan for the event, did you think about the planning steps or more about the event itself?	1 = only about the planning, 7 = only about the event

[a] Characteristic only measured in the future tasks.

[b] Characteristic only measured in the planning task.

With regards to the visual perspective measures, we deviated slightly from previous measures. Although most studies have used a single continuous scale ("do you see the event through your own eyes or as an outside observer?"), Rice and Rubin's (2009)'s research suggested that the experience of perspective during retrieval of a past event could sometimes be both from the field (seen from their own eyes) or observer (seen from an observer's position) perspective. Therefore, in addition to the traditional dichotomy perspective scale, we included a separate field perspective scale as well as a separate observer perspective scale.

From the complete questionnaire, the question "How similar is this event to a previously encountered event?" was only asked in the imagining and the planning conditions to investigate how often participants produced future events similar to a specific past event and the question "When you had to mentally plan for the event, did you think about the planning steps or more about the event itself?" was only asked in the planning condition to investigate how much the event itself was considered when thinking about how to plan for it. Once participants completed the questionnaire, the same four steps were repeated with a new cue, until they had completed them three times in total.

Part 2. During the second part of the study, we investigated how generating an alternative version for each of the events participants had just described would impact the event's phenomenological characteristics. Depending on the cue associated with the event, we asked participants to apply a specific counterfactual (for past events) or prefactual (for future events) change. "Work" and "exam" cues led to a change in emotional valence; "birthday" and "date" cues led to a change in person; and "trip" and "public event" cues led to a change in location. For the change in emotional valence, we asked them to "think about what would have happened/happen if instead of being a *[positive/negative/neutral, depending on their ratings of the valence of the event]* event, it was a *[opposite valence, if neutral, we asked for positive]* event". For the change in person, we asked them to "think about what would have happened/happen if instead of *[the name of the person they provided during the general questions step]*, it was someone else who was present during the event (and they could decide who else it would be)". For the change in location, we asked them to "think about what would have happened/happen if instead of *[the location they provided during the general questions step]*, the event was set somewhere else (and they could decide where else it would be)".

Once they had an idea of how else the event would occur, they completed the process task again. They closed their eyes for one minute and thought about how it could have happened/happen, considering the change. Then they had up to three minutes to describe this new version of the event to the experimenter before completing the questionnaire once more. We repeated the same steps for the other two events.

In summary, participants generated three events (remembering the past, imagining the future, or planning the future, depending on their allocated condition) and provided one alternative version for each original event, one following a change of emotion, one following a change of person, and one following a change of location. For each original and alternative event, participants took one minute to remember, imagine, or plan the event, and then described the event before answering the questionnaire. Consequently, we obtained 306 transcripts of events and their 306 corresponding questionnaires in total (6 transcripts and questionnaires for each of our 51 participants). At the end of the experiment, participants completed a final questionnaire about their demographics and how difficult they found the various tasks. Then, they were fully debriefed and thanked for their time.

Data analysis. From each event, we gathered two different sets of data: answers to the questionnaire and audio recordings of the description of the events. However, as this article focuses on the phenomenological rating, results from the analysis of the verbal descriptions are not presented here (see Chapter 5). Therefore, in the following section, we report data from the questionnaire.

When entering data, we recoded some scale items to keep a similar range across the questionnaire: scales ranging from -3 to 3 (field vs. observer perspective, valence of emotions during the event, valence of emotions when thinking about the event, planning during process task) were recoded on a scale from 1 to 7 (so -3 became 1, -2 became 2, etc.). Additionally, for ease of comparison between the two perspective scales (field and observer) and the dichotomy perspective scale, we reverse coded the observer perspective scale, so that a rating of 1 now meant "completely from an observer's perspective" and a rating of 7 now meant "not at all from an observer's perspective".

Results

Difficulty ratings. At the end of the testing session, participants rated the perceived difficulty of each task on a scale from 1 (very easy) to 7 (very hard). Generally, they found our tasks neither too easy nor too hard (means ranged between 3.06 and 4.53, see Table 2). There was no difference across conditions regarding how difficult it was to think about the events or how difficult it was to answer the scales ($p > .05$). Therefore, the difficulty of our tasks cannot explain the following results.

Table 2.
Means and Standard Deviations For Each Difficulty Rating as a Function of Condition

Task	Part	Condition		
		Remembering *M* (*SD*)	Imagining *M* (*SD*)	Planning *M* (*SD*)
Process task	Part 1 - original	3.24 (1.82)	3.65 (1.62)	3.06 (1.52)
	Part 2 - alternative			
	Change of location	4.82 (1.51)	3.65 (1.58)	3.82 (1.70)
	Change of person	4.47 (1.66)	3.29 (1.96)	3.24 (1.56)
	Change of emotion	3.41 (2.06)	3.94 (1.95)	4.18 (2.13)
Questionnaire	Overall	3.53 (1.42)	3.18 (1.42)	4.53 (1.43)

Part 1: Remembering vs. imagining vs. planning.

Content and temporal distance. In total, we collected data from 153 events: 51 remembered past events, 51 imagined future events, and 51 planned future events. To give an idea of the content of the events generated in this study following the pairs of cues, 34 events were about a day trip (22.2%) whereas 17 events were about a major public event (11.1%), 31 events were about a birthday celebration (20.3%), whereas 20 events were about a date or a meeting with a friend (13.1%), and 27 events were about an exam or a test (17.6%) whereas 24 events were about a first day at work or first day volunteering (15.7%). These events were collapsed together in our analyses as they were not distributed equally across conditions.

To investigate the temporal distance of events, we first coded an approximate date for each event by using the information provided by participants during the general questions phase. Participants only had to provide the month and year of the event (not the exact day), so we decided to use the 15^{th} of the given month as the date. We then calculated the number of days separating the estimated date of the event from the day of the testing. The non-parametric Kruskal-Wallis test on the number of days as dependent variable revealed significant differences across conditions, $H(2) = 57.99$, $p < .001$. Considering that we have skewed distributions, we report here the median values. The median of remembered events was set at 476 days, the median of imagined events was set at 1991 days (or 5.45 years), and the median of planned events was set at 1788 days (or 4.90 years). Future events, imagined and planned, were therefore set at a more distant time than past events. This difference makes sense considering our constraints on the time of the events (before or after their university degree), and with the knowledge that most of our participants were first year university students.

Phenomenological characteristics. The averaged means and standard deviations for each characteristic across conditions are presented in Table 3. As two scale items ("similarity to past events" and "planning during process task") were not presented in all conditions, we first analyzed them separately. On average, imagined and planned events were similarly felt to be neither totally novel nor very similar to past events (see Table 3). Moreover, participants in the planning condition reported that during the process task (when they closed their eyes and planned the events), they thought both about the planning and about the event itself (see Table 3). We expected this result as we hypothesized that in order to plan for the event, participants would also need to think about what they wanted to achieve. Because participants did not complete these scale items in all conditions, we did not include them in the following analyses, which use the other 25 items.

Table 3

Means, Standard Deviations and Univariate ANOVAs for Each Phenomenological Characteristic Measured as a Function of Condition

Characteristics	**Past**		**Future**				**Univariate ANOVAs**	
	Remembering		Imagining		Planning			
	M	*SD*	*M*	*SD*	*M*	*SD*	*F*(2, 48)	*p*
Experiencing	4.76	0.91	5.04	0.90	5.04	0.88	0.53	.593
Mental time travel	4.35	1.38	4.86	1.54	5.37	1.01	2.52	.091
Field perspective	5.53	1.12	5.69	1.06	5.94	1.13	0.60	.552
Observer perspective*	5.65	1.23	5.24	1.25	5.33	1.17	0.35	.591
Observer vs. field dichotomy*	6.08	0.88	5.47	1.12	6.09	1.02	2.07	.137
Vividness	5.02	1.11	5.31	1.02	5.41	0.87	0.70	.503
Visual details	5.96	1.30	5.73	0.79	5.74	1.05	0.26	.776
Sounds	3.43	1.77	2.80	1.41	3.82	1.44	1.88	.164
Smells/tastes	2.71	1.14	1.96	0.99	2.67	1.19	2.05	.140
Location	6.14	1.04	5.61	0.66	5.88	0.75	1.71	.191
Familiar setting	4.76	1.41	4.16	1.35	4.76	1.11	1.24	.297
Object spatial arrangement	4.90	1.39	5.16	1.09	4.84	0.94	0.35	.705
People spatial arrangement	4.94	1.29	4.86	1.02	4.49	1.21	0.71	.496
Time of day	5.78	1.15	5.69	1.03	5.59	1.03	0.14	.868
In words	3.78	1.53	2.92	2.03	3.20	1.58	1.11	.338
Coherent story	4.82	1.26	4.14	1.22	4.57	0.90	1.58	.217
Complexity of the storyline	3.39	1.20	2.69	1.04	3.14	0.84	2.02	.143
Intensity of emotions during the event	4.18	1.14	4.29	1.38	4.51	0.77	0.38	.684
Valence of emotions during the event*	4.84	0.93	5.49	0.76	5.39	0.81	2.97	.061
Similarity of emotion now and during the event	4.06	1.02	4.76	1.43	4.23	1.30	1.37	.263
Intensity of emotions when thinking about the event	3.63	1.03	3.55	1.54	3.74	0.91	0.22	.801
Valence of emotions when thinking about the event*	4.78	1.01	5.06	0.95	5.14	0.84	0.66	.520
Personal importance	4.48	1.09	4.37	1.36	5.06	0.88	1.84	.170
Past occurrences	3.39	0.81	2.51	1.07	3.39	1.06	**7.79**	**.001**
Future occurrences	4.00	0.90	4.51	0.75	4.65	0.97	2.58	.086
Similarity to a past event			3.10	1.37	3.71	1.16	1.19	.172
Planning during process task					3.39	1.59		

* Recoded variable, see in-text for detailed explanations.

Before comparing our three main conditions, we investigated potential mediators of our results in order to rule them out if necessary. First, we saw in the previous section that imagined and planned events were generally set at a more distant time than past events. Consequently, we ran a multivariate analysis of variance (MANOVA) on the phenomenological characteristics, with condition (R, I, P) as an independent variable and temporal distance (in days) as a covariate. We found no reliable evidence of an effect of temporal distance, so we dropped this variable from further analyses, F (25, 123) = 1.10, p = .350, Wilk's Λ = 0.808.

Second, each participant provided ratings for three separate events, so these data points cannot be treated as independent. Therefore, a second MANOVA examined the effect of event order (first, second, or third event) in conjunction with the condition (R, I, P) on the phenomenological characteristics. As there was no main effect of event order, F (50, 236) = 0.92, p = .619, Wilk's Λ = 0.699, and no interaction, F (100, 484) = 0.88, p = .779, Wilk's Λ = 0.506, we collapsed data for each participant to create a compiled score by averaging their ratings of the three events on each phenomenological characteristic.

Subsequently, we ran univariate ANOVAs to compare ratings of each characteristic across remembered, imagined, and planned events. However, as can be seen in Table 3, only one of our characteristics – past occurrences – yielded significant differences across conditions: participants were more likely to say that they had encountered similar events in the past when rating past events than imagined events, which is unsurprising (p = .001). Moreover, participants were also more likely to say that they had encountered similar events in the past when rating planned events than imagined events (p = .037). These results suggest that planned events might rely more on previous memories than imagined events.

The lack of reliable differences across conditions was somewhat unexpected. Previous research on phenomenological characteristics generally has showed differences between past and future thinking, especially for sensory details (e.g., Addis et al., 2009; D'Argembeau et al., 2010; D'Argembeau & Van der Linden, 2004, 2006; De Brigard & Giovanello, 2012; McDermott et al., 2016). However, these differences were not systematically found for the same characteristics in each study and were often dependent on the design of the experiment and individual differences. Furthermore, most studies comparing past and future events used a within-subjects design, which allowed participants to directly contrast their phenomenological ratings of past events with future events, and vice versa. As our experiment had a between-subjects design, participants completed one condition only and consequently may have lacked a comparison baseline. Therefore, differences may be more likely to arise when people make explicit comparisons, which would suggest that phenomenology is relative and not absolute. We return to this issue in Experiment 2.

Exploratory factor analysis. Another aim of this paper was to investigate how correlations between some phenomenological characteristics might inform us of the underlying constructive processes of thinking about a personal event in time. We wanted to find correlations across various phenomenological ratings that would not be dependent on the type of event nor its temporal orientation. Consequently, we did not take into account the hierarchical nature of the data, nor their associated condition, and ran an exploratory factor analysis on all events generated during the first part of the experiment to explore how some items cluster under higher-level factors. Kaiser–Meyer–Olkin (KMO) sampling adequacy test (0.757), which provides an index of the proportion of variance among the variables that might be common variance, and Bartlett’s sphericity tests, $\chi 2(253) = 1347.57$, $p < .001$, which compares the observed correlation matrix to the identity matrix, indicated that factor analysis was appropriate. We used principal components extraction with Varimax Rotation to preserve orthogonality. The analysis of the scree plot and Eigenvalues indicated a four- or five-factor solution. However, only one phenomenological characteristic loaded on the fifth factor, and this characteristic also loaded heavily on another factor. We therefore selected the four-factor solution. We removed two characteristics ("in words" and "smells/tastes") from the analysis, as they did not load onto any factor. Our final four-factor solution accounted for 53.01% of the total variance (see Table 4).

Table 4
Factor Loadings for Explanatory Factor Analysis with Varimax Rotation of Phenomenological Characteristics

Characteristics	**Factors**			
	1	**2**	**3**	**4**
Intensity of emotions when thinking about the event	**.73**	.10	-.02	.31
Personal importance	**.71**	-.06	-.05	.14
Experiencing	**.66**	.08	.21	.14
Intensity of emotions during the event	**.66**	-.04	-.21	-.14
Mental time travel	**.64**	.10	.16	< .01
Vividness	**.64**	.20	.39	-.09
Coherent story	**.56**	.11	.28	.05
Similarity of emotion now and during the event	**.55**	.18	< -.01	.48
Sounds	**.53**	.27	< .01	.17
Complexity of the storyline	**.48**	.20	-.35	-.09
Familiar setting	.08	**.75**	-.09	.06
Location	.12	**.74**	.13	.10
People spatial arrangement	.22	**.66**	.18	-.22
Object spatial arrangement	.14	**.66**	.10	-.28
Past occurrences	-.02	**.56**	-.23	.17
Visual details	.47	**.49**	.29	-.02
Time of day	< -.01	**.47**	.34	.27
Field vs. observer dichotomy*	.12	.13	**.78**	< .01
Field perspective	.36	.14	**.73**	-.04
Observer perspective*	-.10	-.05	**.69**	.06
Valence of emotions during the event*	-.01	-.09	.11	**.82**
Valence of emotions when thinking about the event*	.20	-.09	.14	**.80**
Future occurrences	.10	.14	-.15	**.55**

Note. Factor loadings for each phenomenological characteristic in a given factor are in boldface.
* Recoded variable, see in-text for detailed explanations.

We conceptualized our first factor as representative of *autonoesis* ($\alpha = .84$). This factor consisted of phenomenological characteristics related to mental time travel (experiencing the event, mental time travelling), emotional intensity during the event and when thinking about the event, similarity of emotions between now and then, vividness, sounds, personal importance, complexity, and coherence of the story. It is interesting to note that the visual details characteristic placed in factor two also loaded on factor one almost equally (.47). We conceptualized our second factor as representative of *scene construction* (α = .76). This factor consisted of phenomenological characteristics related to the location, spatial arrangement of people and object, time of day, how familiar the setting was, and how often similar events occurred in the past. We conceptualized our third factor as representative of *visual perspective* (α = .74). This factor consisted of the three perspective characteristics only.[3] Finally, we conceptualized our fourth factor as representative of *optimism bias* (α = .66). This factor consisted of the two emotional valence characteristics (both during the event and when thinking about it) and the measure of how often similar events might occur in the future. The characteristic measuring the similarity between the emotions now and then, placed in factor one, also loaded on this factor (.48).

Comparing factor scores across conditions. For each participant, we added up the scores from the items in each factor to create factor scores (i.e., to create the "perspective factor score", we averaged participants' ratings from the field perspective characteristic, the observer perspective characteristic, and the dichotomy perspective characteristic). The means, standard deviations and 95% confidence intervals for each factor and in each condition are described in Table 5. There are many ways to estimate factor scores, with more complex and more sophisticated techniques that include weighing the items by factor loading or by Cronbach's alpha. However, as most articles investigating phenomenology in past and future thinking used averages to create their factor scores (D'Argembeau & Van der Linden, 2004; De Brigard & Giovanello, 2012; Szpunar & McDermott, 2008), we also estimated our factor

[3] As explained in the method section, the observer perspective scale was reverse coded to allow for a positive correlation between the different visual perspective scales.

scores by averaging the different items loading on each factor. Once more, our univariate ANOVAs did not yield any effect of condition on factor scores associated with our *autonoesis factor*, $F(2, 48) = 0.86$, $p = .431$; our *scene construction factor,* $F(2, 48) = 1.62$, $p = .200$; our *visual perspective factor,* $F(2, 48) = 0.63$, $p = .535$; and our *optimism bias factor*, $F(2, 48) = 3.04$, $p = .057$. In summary, remembered, imagined, and planned events were all experienced in similar ways.

Table 5
Averaged Factor Scores as a Function of Condition

Factors	**Past**		**Future**			
	Remembering		Imagining		Planning	
	M (*SD*)	95% CI	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI
Autonoesis factor	4.21 (0.81)	[3.83, 4.60]	4.18 (0.88)	[3.80, 4.57]	4.50 (0.68)	[4.12, 4.89]
Scene construction factor	5.19 (0.96)	[4.84, 5.54]	4.81 (0.44)	[4.46, 5.17]	4.96 (0.66)	[4.61, 5.31]
Visual perspective factor	5.75 (0.88)	[5.30, 6.20]	5.46 (0.97)	[5.02, 5.91]	5.79 (0.90)	[5.34, 6.24]
Optimism bias factor	4.54 (0.70)	[4.21, 4.87]	5.02 (0.68)	[4.67, 5.35]	5.06 (0.66)	[4.73, 5.39]

Part 2: Counterfactual thinking vs. prefactual imagining vs. prefactual planning.

Phenomenological characteristics. Before analyzing the phenomenological changes between original events from part 1 and their alternative counterparts from part 2, we first compared ratings of alternative events across our three conditions. As shown in Table 6, univariate ANOVAs of scale items showed that nine characteristics were significantly different depending on the condition. Follow up post hoc Tukey tests indicated that three characteristics ("experiencing", "mental time travel", and "vividness") received lower ratings for counterfactual events compared to both prefactual imagined and prefactual planned events (which did not differ from one-another). Three characteristics ("visual details", "similarity of emotion now and during the event", and "valence of emotions when thinking about the event") received lower ratings for counterfactual events compared to prefactual imagined events only, whereas the "field perspective" characteristic received lower ratings for counterfactual compared to prefactual planned events only. Together, these results mean that participants thinking of alternative past events had lower feelings of experiencing the event in a positive and vivid way compared to participants thinking of alternative future events. These alternative past events were also less seen from a field perspective, and contained fewer visual details.

Furthermore, participants felt that in the past, more events occurred in a similar way to the counterfactual events or the prefactual planned events they thought of than to the prefactual imagined events they thought of. This result suggests that alternative versions of past events or planned future events rely more on past memories and therefore, might be more plausible. Finally, even if the univariate ANOVA was significant, a post hoc test did not reveal any significant differences for the characteristic measuring the valence of emotions during the event. In summary, counterfactual events seemed to be less vivid, less experienced, and less visually clear than prefactual events, planned or imagined.

Table 6

Means, Standard Deviations and Univariate ANOVAs for Each Phenomenological Characteristic Measured as a Function of Condition

Characteristics	**Past**		**Future**				**Univariate ANOVAs**	
	Counterfactual thinking		Prefactual imagining		Prefactual planning			
	M	*SD*	*M*	*SD*	*M*	*SD*	*F*(2, 48)	*p*
Experiencing	3.24	1.00	5.06	1.09	5.18	1.01	**18.74**	**< .001**
Mental time travel	2.96	1.07	4.71	1.55	5.39	0.91	**18.26**	**< .001**
Field perspective	4.27	1.85	5.47	1.24	5.82	1.19	**5.29**	**.008**
Observer perspective*	5.00	1.63	5.24	1.59	5.92	1.04	1.87	.166
Observer vs. field dichotomy*	4.63	1.53	5.31	1.65	5.65	1.15	2.16	.126
Vividness	3.49	1.26	5.12	1.34	5.08	1.29	**8.71**	**.001**
Visual details	4.35	1.46	5.55	1.19	5.39	1.35	**4.01**	**.024**
Sounds	2.63	1.24	3.27	2.08	3.43	1.41	1.18	.317
Smells/tastes	2.16	1.07	2.12	1.38	2.43	1.21	0.33	.721
Location	5.25	1.26	5.33	1.08	5.27	1.20	0.02	.980
Familiar setting	5.06	1.21	4.08	1.46	4.51	1.10	2.56	.088
Object spatial arrangement	4.27	1.57	5.04	1.00	4.75	1.13	1.60	.213
People spatial arrangement	3.78	1.59	4.90	1.12	4.55	1.21	3.17	.051
Time of day	5.06	1.17	4.78	1.65	5.67	1.07	1.98	.149
In words	3.65	1.43	2.82	1.98	3.24	1.80	0.94	.397
Coherent story	3.73	0.97	4.06	1.67	4.78	1.09	3.05	.057
Complexity of the storyline	2.51	1.03	2.69	1.27	2.88	1.21	0.43	.653
Intensity of emotions during the event	3.98	1.31	4.37	1.38	4.16	0.79	0.46	.633
Valence of emotions during the event*	4.57	1.15	5.27	0.90	5.35	0.85	**3.33**	**.044**
Similarity of emotion now and during the event	3.33	1.15	4.43	1.37	3.92	0.85	**3.93**	**.026**
Intensity of emotions when thinking about the event	2.71	1.24	3.39	1.55	3.67	0.87	2.65	.081
Valence of emotions when thinking about the event*	4.20	1.00	4.94	0.79	4.73	0.66	**3.63**	**.034**
Personal importance	3.69	1.03	4.16	1.39	4.53	0.92	2.37	.104
Past occurrences	3.78	0.82	2.25	0.97	3.45	1.10	**11.73**	**< .001**
Future occurrences	3.78	0.96	3.75	0.95	4.12	1.03	0.74	.482
Similarity to a past event	3.81	0.94	2.61	1.32	3.69	1.39	0.99	.378
Planning during process task					3.88	1.40		

* Recoded variable, see in-text for detailed explanations.

Comparing factor scores across conditions. Similar to part 1, we again created four factor scores by adding up the scores from the items in each factor from part 1 and compared them across conditions (see Table 7). Univariate ANOVAs indicated a main effect of condition for the *autonoesis factor*, $F(2, 48) = 7.18$, $p = .002$, $\eta_p^2 = .23$. When thinking about alternative events, participants in the counterfactual condition had less of a feeling of mental time travel to the events and experienced them in less emotional, complex and coherent ways than participants in the prefactual imagined and prefactual planned conditions. The *visual perspective factor* also showed a main effect of condition, $F(2, 48) = 3.42$, $p = .041$, $\eta_p^2 = .12$. Prefactual planned events were usually visualized more from a field perspective than counterfactual events, yet they did not differ from prefactual imagined events. The *scene construction factor* and the *optimism bias factor* had similar factor scores across conditions. The clarity of the visuo-spatial scene was similar in all types of alternative events. Furthermore, participants in all conditions felt these events were relatively positive and likely to occur often in the future. In summary, participants felt like they were experienced counterfactual events less than prefactual events, but participants could visualize the scene of the event similarly in all conditions.

Table 7

Averaged Factor Scores of Alternative Events as a Function of the Condition

Factors	**Past**		**Future**			
	Counterfactual thinking		Prefactual imagining		Prefactual planning	
	M (*SD*)	95% CI	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI
Autonoesis factor	3.22 (0.76)	[2.79, 3.66]	4.12 (1.18)	[3.69, 4.56]	4.30 (0.63)	[3.87, 4.74]
Scene construction factor	4.51 (0.99)	[4.10, 4.92]	4.56 (0.70)	[4.15, 4.97]	4.80 (0.80)	[4.39, 5.21]
Visual perspective factor	4.63 (1.43)	[4.00, 5.27]	5.34 (1.43)	[4.70, 5.98]	5.80 (1.01)	[5.16, 6.44]
Optimism bias factor	4.18 (0.74)	[3.85, 4.52]	4.65 (0.67)	[4.32, 4.99]	4.73 (0.65)	[4.40, 5.07]

However, these differences between past and future alternative events might not truly be representative of the differential effect of temporal orientation of these alternative events. Instead, they might originate from the comparison between original events and their alternative versions, which we examine in the next section.

Part 1 vs. part 2: Counterfactual changes vs. prefactual imagined changes vs. prefactual planned changes.

Phenomenological characteristics. To determine how counterfactual and prefactual changes to events influenced their phenomenology, we subtracted part 2 ratings from part 1 ratings for each event, such that positive numbers indicated higher ratings for part 1 and negative numbers indicated higher ratings for part 2 (see Table 8).

The first important point to see in Table 8 is that prefactual changes for imagined and planned future events had a relatively low impact on the phenomenological characteristics, as the maximum difference in both conditions and across all characteristics was less than 0.70 points. On the other hand, counterfactual changes modified ratings by up to 1.61 points on our scale. That is, alternative changes to future events, imagined or planned, did not really modify the way the events were perceived and rated. However, thinking of alternative ways that past events could occur reduced participant's phenomenological experience of these events.

For our next step, we examined which characteristics changed the most after counterfactual changes compared to prefactual imagined and prefactual planned changes. Univariate ANOVAs were significant for eleven characteristics (see Table 8). Post hoc Tukey tests revealed that, compared to prefactual changes (for both imagined and planned future events), counterfactual changes led to reduced feelings of experiencing or mental time travel, creating events that were less seen from a field perspective, and with fewer visual details and a clear spatial arrangement of people. The events were also less vivid and coherent. Counterfactual changes also led to a reduced observer perspective, and less intense emotions when thinking about the event, but only compared to prefactual changes to planned events; and to a less complex storyline but only compared to prefactual changes to imagined events. Finally, the time of day became less clear in both counterfactual events and prefactual imagined events, compared to prefactual planned events. In summary, counterfactual changes had the most important impact on phenomenology, principally by reducing the subjective experience.

Table 8

Means of Difference Scores Between Original and Alternative Events, Standard Deviations, and Univariate ANOVAs for Each Phenomenological Characteristic Measured as a Function of Condition

Characteristics	**Past**		**Future**				**Univariate ANOVAs**	
	Remembering – Counterfactual thinking		Imagined – Prefactual imagining		Planning – Prefactual planning			
	M	*SD*	*M*	*SD*	*M*	*SD*	*F*(2, 48)	*p*
Experiencing	1.53	0.73	-0.04	0.70	-0.15	1.17	**19.30**	**< .001**
Mental time travel	1.39	0.91	0.10	1.01	-0.02	0.67	**13.43**	**< .001**
Field perspective	1.25	1.31	0.15	1.51	0.06	1.01	**4.11**	**.022**
Observer perspective*	0.65	1.46	-0.06	1.25	-0.63	0.85	**4.48**	**.016**
Observer vs. field dichotomy*	1.45	1.14	0.08	1.78	0.38	0.99	**4.51**	**.016**
Vividness	1.53	0.71	0.10	0.72	0.29	0.75	**16.31**	**< .001**
Visual details	1.61	0.90	0.19	0.78	0.33	0.61	**17.92**	**< .001**
Sounds	0.80	1.32	-0.50	1.31	0.44	1.28	**4.37**	**.018**
Smells/tastes	0.55	1.11	-0.23	0.81	0.25	0.76	3.11	.054
Location	0.88	0.89	0.17	0.91	0.67	0.76	2.00	.147
Familiar setting	-0.29	0.91	0.02	1.14	0.31	1.58	0.89	.418
Object spatial arrangement	0.63	0.86	-0.08	1.16	0.21	0.74	1.35	.270
People spatial arrangement	1.16	1.21	-0.06	1.13	-0.04	0.92	**7.14**	**.002**
Time of day	0.73	0.98	0.67	0.90	-0.10	0.99	**3.86**	**.028**
In words	0.14	1.49	0.10	1.24	-0.06	0.46	0.11	.893
Coherent story	1.10	1.41	0.04	1.13	-0.27	1.06	**5.61**	**.006**
Complexity of the storyline	0.88	0.93	0.02	1.04	0.29	1.07	**3.53**	**.037**
Intensity of emotions during the event	0.20	0.83	-0.02	1.59	0.33	0.84	0.64	.531
Valence of emotions during the event*	0.27	1.63	0.25	1.16	0.06	1.33	0.14	.873
Similarity of emotion now and during the event	0.73	1.41	0.17	1.50	0.38	1.08	0.41	.668
Intensity of emotions when thinking about the event	0.92	1.19	0.19	0.90	0.10	0.69	**3.93**	**.027**
Valence of emotions when thinking about the event*	0.59	0.95	0.19	0.85	0.46	1.15	0.98	.383
Personal importance	0.78	0.74	0.21	0.89	0.52	1.02	1.83	.172
Past occurrences	0.04	0.83	0.27	0.92	-0.04	1.11	0.50	.612
Future occurrences	0.22	1.24	0.69	0.56	0.58	1.41	1.00	.374
Similarity to a past event			0.49	0.97	0.2	1.40	1.30	.263
Planning during process task					0.49	0.88		

* Recoded variable, see in-text for detailed explanations.

Comparing factor scores across conditions. Lastly, and following what we did previously, we combined the difference scores from the items in each factor of part 1 to create difference factor scores. Univariate ANOVAs showed a main effect of condition for the *autonoesis factor*, $F(2, 48) = 14.56$, $p < .001$, $\eta_p^2 = .38$; the *scene construction factor*, $F(2, 48) = 3.71$, $p = .032$, $\eta_p^2 = .13$; and the *visual perspective factor*, $F(2, 48) = 5.09$, $p = .001$, $\eta_p^2 = .17$; but not for the *optimism bias factor*, $F(2, 48) = 0.01$, $p > .999$. Post hoc Tukey tests indicated that in all three cases, counterfactual changes produced factor scores relatively lower than their original event, whereas both types of prefactual changes (imagined and planned) produced factor scores relatively similar to their original counterpart (see Table 9). Therefore, our results show that compared to the phenomenology of memories that are being remembered, thinking of alternative versions of past events led to a reduced feeling of traveling back in time and experiencing the events clearly, creating counterfactual events with less visuo-spatial details and less seen from a field perspective. However, original and alternative future events, whenever imagined or planned, had similar phenomenological characteristics.

Table 9
Averaged Difference Factor Scores Between Original and Alternative Events as a Function of the Condition

Factors	**Past**		**Future**			
	Remembering – Counterfactual thinking		Imagined – Prefactual imagined		Planning – Prefactual planned	
	M (*SD*)	95% CI	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI
Autonoesis factor	0.99 (0.94)	[0.72; 1.25]	0.06 (0.93)	[-0.21; 0.32]	0.20 (1.02)	[-0.06; 0.47]
Scene construction factor	0.68 (1.00)	[0.39; 0.97]	0.25 (0.87)	[-0.04; 0.54]	0.16 (1.06)	[-0.13; 0.45]
Visual perspective factor	1.12 (1.56)	[0.57; 1.67]	0.12 (1.82)	[-0.42; 0.67]	-0.01 (1.35)	[-0.56; 0.54]
Optimism bias factor	0.36 (1.54)	[-0.07; 0.79]	0.37 (1.47)	[-0.06; 0.79]	0.33 (1.68)	[-0.10; 0.75]

Effect of type of change (location, person, emotion) on difference factor scores. Finally, we examined the impact of the type of counterfactual or prefactual change (location, person, emotion) on our difference factor scores. As each participant provided three alternative events, which are therefore not independent, we analyzed our data by nesting the three events under participants. We ran multilevel linear models with condition and type of change as fixed events, and with event order (first, second, or third event) nested under participants. The only element of interest here was the significant interaction between type of change and condition, which was for the *autonoesis factor*, $F(4, 140) = 2.88$, $p = .025$. Planned contrasts revealed a difference between the three types of change (location, person, emotion) for the counterfactual condition only. Thinking about how else a past event could have happened if it was with someone else or if it was somewhere else led to reduced feelings of experiencing the events in an emotional, coherent, and complex way. Yet, thinking of how else it could have happened if the overall emotion was of the opposite valence did not reduce the feeling of experiencing the event in such a way (see Figure 1). It is worth noting that our other types of changes had no impact on other results.

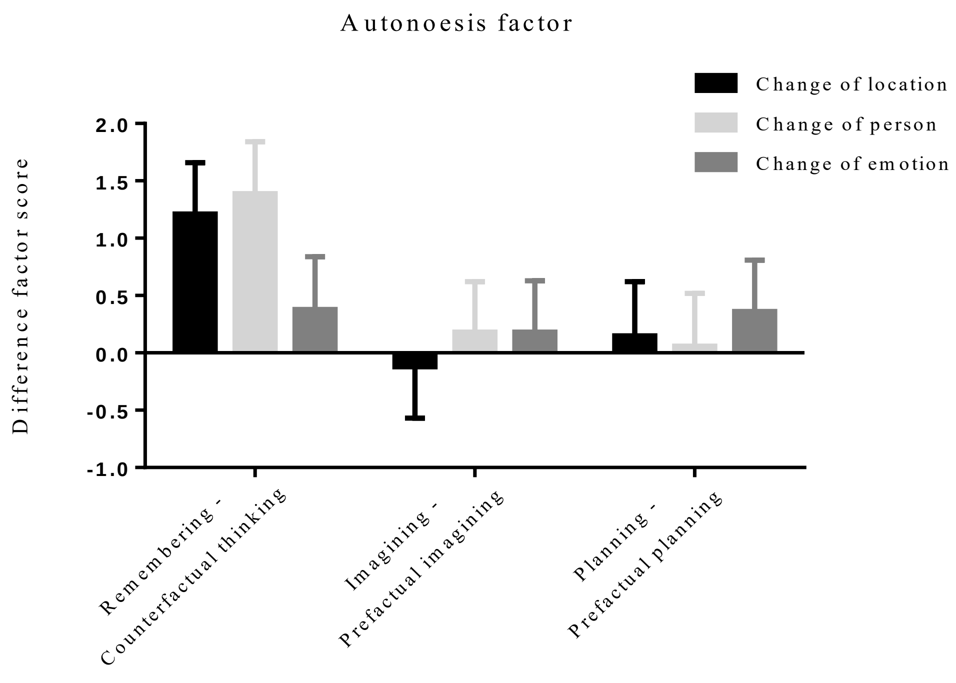

Figure 1. Difference factor scores for each factor as a function of condition.

Discussion

In the first part of experiment 1, we compared the phenomenology of remembered, imagined, and planned events, examining differences across conditions but also running a factor analysis to seek correlations between different characteristics that could indicate underlying component processes. As we created factor scores to further compare phenomenology across conditions, we first review the findings from our factor analysis before analyzing how participants experienced the different autobiographical events.

Our factor analysis provided valuable insight into the underlying components of autobiographical thinking. We extracted four principal factors from our questionnaire: an autonoesis factor, a scene construction factor, a visual perspective factor, and an optimism bias factor. Together, they explained 53% of the total variance. These four factors are consistent with existing concepts in past and future thinking literature. The importance of autonoetic consciousness in mental time travel has been widely discussed (for a discussion, see Klein, 2016; Tulving, 2005) and it is not surprising that feelings of (p)re-experiencing events and mental time traveling to them are correlated with the vividness and the intensity of the emotion elicited by the thought event. Our scene construction factor fits nicely with the scene construction hypothesis (Hassabis & Maguire, 2007) but also with the constructive episodic simulation hypothesis (Schacter & Addis, 2007a). Participants rated their visuo-spatial details as clearer when similar events had often occurred in the past. Moreover, the scene construction process seems to be a complementary but separate process to autonoetic consciousness. We were surprised that our third factor was composed of our perspective scales only. However, past research has shown that the use of field or observer perspective depends on individual differences or on the type of events (McDermott et al., 2016; Nigro & Neisser, 1983; Rice & Rubin, 2009; Sutin & Robins, 2008), or might be dependent on whether participants focused on the experience of the event or the coherence of the event with the self (Libby & Eibach, 2011). Hence our results might be indicative of these individual and event-specific differences that do not correlate with other phenomenological characteristics. Finally, our last factor was somewhat unexpected but corresponds to the literature on optimism bias. In accordance with this, participants rated events that they believed would occur often in the future as being more positive. Together, our four factors encompass interesting themes relevant to the literature on past and future thinking.

With regards to differences in phenomenological ratings of autobiographical events, previous studies revealed that more often than not, imagined events (future or atemporal) are perceived less vividly and with fewer sensory details than memories (D'Argembeau & Van der Linden, 2004; Johnson et al., 1988). Yet, analyses of our characteristics indicated that only ratings of the occurrence of similar events in the past were significantly different: remembered past events had occurred in a similar way more often in the past than future imagined events. Future planned events also had occurred in a similar way more often in the past than future imagined events. These results might indicate that when planning future events, participants rely on previous events even more so than when imagining events, possibly in the process of achieving a high level of plausibility (see also Chapter 2).

Besides this characteristic, most ratings were in the average range of our scale across remembered, imagined, and planned events (with some exceptions, such as the perception of smells or tastes which was relatively low). This absence of reliable other differences, especially between past and future thinking, was unexpected. However, we suggested that phenomenological differences may be more likely to arise when participants make explicit comparisons across conditions, as they do in a within-subjects design. A similar type of effect was already suggested by Arnold et al. (2011). In our experiment, participants were assigned to a single condition, possibly lacking any kind of base rate to compare their events to. We examined this suggestion in the following experiment.

In the second part of experiment 1, we found that phenomenological characteristics of counterfactual events received lower ratings than phenomenological characteristics of prefactual events, imagined and planned, and mainly for items loading onto our autonoesis factor. However, we suggested that these results were driven by initial differences between memories and counterfactual events. Similar to past studies (De Brigard & Giovanello, 2012), counterfactual events received lower ratings on factor scores representing autonoesis (especially after changes of person or location), scene construction, and the use of field perspective. On the other hand, modifying the way a future event could happen did not impact on the way the event was perceived and constructed. This divergence between counterfactual and prefactual thinking suggests that the future is not set in stone and that we can generate multiple versions of a single event. But the past is not as flexible, and even if we can create alternative versions of what could have happened, there is a different phenomenological feel to remembered events as they have been experienced (Debus, 2014). However, the belief that positive events will occur more often in the future is not affected by counterfactual or prefactual changes.

There were limitations to our design. The first limitation lies in the imposed constraints on the time of the events. Because of the nature of our participant sample (composed mainly of first year psychology students), past events were usually set at a more recent time than future events. However, we might have expected this difference in temporal distance to increase the differences between past and future thinking instead of reducing them, as near events tend to be better remembered or imagined than distant events (Conway & Loveday, 2015; D'Argembeau & Van der Linden, 2004). Yet this is not what we found as the effect of temporal distance was ruled out in our statistical analyses. Nonetheless, we decided to remove temporal constraints in the next experiment.

The second limitation relates to our suggested changes for alternative versions. As our results did not generally show an effect of the type of change on our analyses (aside from the impact on our autonoesis factor), this diversity of changes might have weakened some of our findings. More specifically, changes of location and person could either result in extreme changes (a trip to India is not the same as a trip to Antarctica), or in insignificant ones (going to a birthday with my friend Annie or my friend Jane). It seemed that the change of emotion brought the most consistent changes to past and future events. Consequently, in our second experiment we kept only the change of emotion as we felt it was the most appropriate.

Experiment 2

Experiment 2 replicated experiment 1 but with a partial within-subject design in order to further examine the differences in phenomenological ratings across conditions when participants are given the opportunity to directly compare the different types of events.

Method

Participants. We initially recruited 57 university undergraduate students enrolled in an introductory psychology course at Macquarie University (Australia) as participants for this experiment. However, three participants failed to follow instructions and were removed from the sample. Our final sample was composed of 54 participants (38 female and 16 male, mean age = 21.13 years, SD = 5.90, range: 18 – 54 years).[4] The selection method was the same as the one described above. Participants gave informed consent prior to testing, including agreement to be audio recorded, and received course credit as compensation for their time, in accordance with the Macquarie University Ethics Committee.

[4] We used a slightly larger sample size than the first experiment, which had 51 participants. We wanted to make the experiments as comparable as possible; however due to the partial within-subjects nature of our design, in this experiment we created six different groups of participants, which required a sample size number that could be divided by six: 54.

Materials, procedure and data analysis. The materials and procedure were similar to experiment 1 with minor changes. The first and most important difference was that we moved from a between-subjects to a partial within-subjects design, where each event was generated under a different condition. It allowed us to directly compare conditions across participants. As our previous study showed that order could impact past and future thinking (Chapter 3), we only requested two events from each participant so we could control for order. We employed a partial Latin square design to allocate participants to conditions and orders, giving us a total of six combinations: *remembering then imagining* (RI), *remembering then planning* (RP), *imagining then planning* (IP), *imagining then remembering* (IR), p*lanning then remembering* (PR) and *planning then imagining* (PI).

We used the same six cues from experiment 1 for this experiment. Before the first event, we asked participants to select one cue from the six presented, and before the second event, we asked participants to select another cue from the remaining five cues presented. Finally, participants did not receive any time constraint for past and future events, in order to avoid an unbalanced design as in experiment 1 where generated past events were temporally closer to the present than future events.

The procedure was identical to experiment 1: for each event, participants completed the four steps described previously: general questions, process task, description task, and phenomenology questionnaire. Once again, the results from the description task are outside the scope of this paper (see Chapter 5), so only the data from the questionnaire will be analyzed here. As in experiment 1, we recoded the observer perspective scale, the valence of emotions during the event scale, the valence of emotions when thinking about the event scale, and the planning during the process task scale.

Finally, to simplify and ease comparisons between participants and across conditions, participants only modified the emotional valence of all their events when thinking how their counterfactual and prefactual events could happen.

Results

Difficulty ratings. At the end of the testing session, participants rated the perceived difficulty of each task on a scale from 1 (very easy) to 7 (very hard). Comparatively, participants found the process task in the remembering condition (*M* = 1.81, *SD* = 1.09) easier than in the imagining (*M* = 2.89, *SD* = 1.58) or in the planning conditions (*M* = 2.86, *SD* = 1.59), $F(2, 105) = 6.63$, $p = .002$, $\eta_p^2 = 0.11$. The fact that we did not find this difference in the between-subjects experiment suggests that it was the direct comparison between remembered past events and imagining or planning future events that created the difference in difficulty ratings. For the second part, participants found the process task in the prefactual planned condition (*M* = 4.61, *SD* = 1.76) harder than in the prefactual imagined (*M* = 3.47, *SD* = 1.44; $p = .011$) or the counterfactual conditions (*M* = 3.69, *SD* = 1.67; $p = .057$), $F(2, 105) = 4.93$, $p = .009$, $\eta_p^2 = 0.09$.

As participants only provided one difficulty rating of how easy or difficult it was to answer the questionnaires overall, we cannot separate the results by condition. However, across our six groups depending on the combination of conditions they received, participants provided similar difficulty ratings, $F(5, 48) = 1.20$, $p = .323$, with a range from 2.22 (SD = 1.48) to 3.44 (SD = 1.01) .

Part 1: Remembering vs. imagining vs. planning.

Content and temporal distance. In total, we collected data from 108 events: 36 remembered past events, 36 imagined future events, and 36 planned future events. For each event, we also collected one alternative version with the opposite emotional valence from the initial event. To give an idea of the content of the events generated in this study, 26 events were about an exam or a test (24.1%), 25 events were about a first day at work or first day volunteering (23.1%), 21 events were about a day trip (19.4%), 17 events were about a birthday celebration (15.7%), 11 events were about a date or a meeting with a friend (10.2%) and 8 events were about a major public event (7.4%). These events were collapsed together in our analyses as they were not distributed equally across our conditions.

To investigate the temporal distance of events, we first coded an approximate date for each event by using the information provided by participants during the general question phase. If participants only provided the month and year of the event, or gave an indication that the event was set in the middle of the month, we used the 15^{th} of the given month as the date. If they indicated that the event happened at the beginning of the month, we used the 7^{th} of the given month as the date. If they indicated that the event happened at the end of the month, we used the 23rd of the given month as the date. We then calculated the number of days separating the estimated date of the event from the day of the testing. The non-parametric Kruskal-Wallis test on the number of days as dependent variable revealed significant differences between conditions, $H(2) = 24.50$, $p < .001$. Considering that we have skewed distributions, we report here the median values. The median of remembered events was set at 355 days, the median of imagined events was set at 40.50 days, and the median of planned events was set at 56.50 days. This time, past remembered events were set at a more distant time than imagined and planned future events. This result is unsurprising as previous studies have found that future events were not set as far in future as memories were set in the past (Berntsen & Jacobsen, 2008).

Phenomenological characteristics. The analysis of the two scale items that were not presented in all conditions ("similarity to a past event" and "planning during process task") revealed that on average, imagined and planned events were neither totally novel nor very similar to past events. As in experiment 1, participants in the planning condition reported that during the process task (when they closed their eyes and planned the events), they thought both about the planning and about the event itself (see Table. Once again, we did not include these characteristics in the following analyses.

Before comparing our three main conditions, we again investigated potential mediators of our results in order to rule them out if necessary. First, we saw in the previous section that imagined and planned events were generally set at a closer time to the present than past events. Consequently, we ran a multivariate analysis of variance (MANOVA) on the phenomenological characteristic, with condition (R, I, P) as an independent variable and temporal distance (in days) as a covariate. We found no reliable evidence of an effect of temporal distance, so we dropped this variable from further analyses, F (25, 80) = 0.965, p = .521, Wilk's Λ = 0.768.

Second, we considered the potential order effect by running an initial MANOVA on the phenomenological characteristics with condition (R, I, P) and event order (first or second) as independent variables. There was no main effect of condition, F (50, 158) = 1.37, p = .075, Wilk's Λ = 0.483; however we found a main effect of event order, F (25, 78) = 1.69, p = .042, Wilk's Λ = 0.649, η_p^2 = 0.35. In experiment 1, we inferred that regardless of condition, participants provided similar average ratings as they lacked a base rate to compare it to. In this experiment, the first event potentially served as a baseline to rate the second event against, which would explain this order effect. Therefore, we ran two parallel analyses to examine first and second events separately.

Once more, analyses of first events did not show any main effect of condition for all but one characteristic (see Table 10). Unexpectedly, participants rated planned events as being set in more familiar settings that remembered events (p = .024). Yet, all other characteristics received similar ratings for remembered, imagined, and planned events.

Table 10

Means, Standard Deviations and Univariate ANOVAs for Each Phenomenological Characteristic Measured as a Function of Condition

EVENT 1 Characteristics	**Past**		**Future**				**Univariate ANOVAs**	
	Remembering		Imagining		Planning			
	M	*SD*	*M*	*SD*	*M*	*SD*	$F(2, 51)$	*p*
Experiencing	4.39	1.38	4.83	1.10	4.44	1.10	0.74	.484
Mental time travel	4.67	1.33	4.72	1.41	4.83	0.99	0.08	.921
Field perspective	5.67	1.53	5.33	1.46	5.78	1.22	0.49	.618
Observer perspective*	4.61	1.72	4.17	1.89	4.28	1.84	0.29	.748
Observer vs. field dichotomy*	5.44	2.04	5.00	2.11	5.33	1.85	0.24	.787
Vividness	5.44	1.50	5.50	1.15	5.44	1.20	0.01	.989
Visual details	5.28	1.71	6.00	0.97	5.72	1.23	1.34	.272
Sounds	4.11	2.08	3.33	1.97	3.22	1.70	1.14	.328
Smells/tastes	2.67	1.57	2.28	1.41	2.06	1.47	0.78	.464
Location	5.78	1.31	5.78	1.48	6.22	1.35	0.62	.541
Familiar setting	4.11	2.25	4.89	2.08	5.89	1.49	**3.69**	**.032**
Object spatial arrangement	4.83	1.62	5.06	1.80	5.11	1.53	0.14	.868
People spatial arrangement	5.00	1.41	4.44	1.65	4.94	1.43	0.74	.480
Time of day	5.72	1.45	6.00	1.08	5.94	1.00	0.27	.762
In words	4.44	2.06	3.56	1.42	3.78	1.40	1.40	.255
Coherent story	5.17	1.47	4.33	1.41	4.56	1.25	1.76	.182
Complexity of the storyline	3.11	1.57	2.78	0.94	3.00	0.97	0.36	.698
Intensity of emotions during the event	4.78	1.31	4.56	1.29	4.39	1.79	0.31	.733
Valence of emotions during the event*	4.44	1.95	5.28	1.53	5.61	1.46	2.36	.104
Similarity of emotion now and during the event	4.44	1.34	4.67	1.19	4.44	1.29	0.18	.834
Intensity of emotions when thinking about the event	3.89	1.45	4.22	1.31	3.89	1.08	0.40	.671
Valence of emotions when thinking about the event*	4.44	1.29	5.33	1.71	5.33	1.46	2.11	.131
Personal importance	5.06	1.35	5.33	1.71	5.83	1.62	1.14	.329
Past occurrences	3.39	2.00	4.06	2.18	4.17	1.62	0.84	.438
Future occurrences	4.06	1.70	4.94	1.80	4.94	1.70	0.37	.548
Similarity to a past event			4.39	2.30	4.78	1.44		
Planning during process task					3.39	1.58		

* Recoded variable, see in-text for detailed explanations.

The pattern of results was quite different for second events. As we can see in Table 11, ten phenomenological characteristics now yielded a main effect of condition. We subsequently ran post hoc Tukey tests. For five characteristics (“experiencing”, “observer perspective” “observer vs. field perspective dichotomy”, “location”, and “coherent story”), it was only the comparison between remembered and planned events that was significant; participants reported a stronger feeling of experiencing the event, which was represented less often from an observer perspective but with a clearer location and a more coherent story for planned events. Remembered events were also more often set in a familiar setting and contained more visual details, but these comparisons failed to reach significance (p = .070 in both cases). Furthermore, the object spatial arrangement was clearer in remembered events than in imagined or planned future events, whereas the people spatial arrangement was clearer in both remembered and imagined events, compared to planned events. Finally, compared to remembered events, imagined events had more similar emotions between the emotions they expected to feel during the event and the emotions felt when thinking about the event. In summary, participants generally felt a stronger feeling of experiencing remembered past events than future events, especially when the future events were planned, and remembered past events were visually and spatially clearer with a more coherent story than future events. Imagined and planned future events were mostly experienced in a similar way.

Table 11

Means, Standard Deviations and Univariate ANOVAs for Each Phenomenological Characteristic Measured as a Function of Condition

EVENT 2	**Past**		**Future**				**Univariate**	
Characteristics	Remembering		Imagining		Planning		**ANOVAs**	
	M	*SD*	*M*	*SD*	*M*	*SD*	$F(2, 51)$	*p*
Experiencing	5.72	1.18	5.06	1.39	4.33	1.61	**4.40**	**.017**
Mental time travel	5.39	1.20	5.00	1.33	4.72	1.18	1.32	.276
Field perspective	6.39	1.38	5.44	1.50	5.17	2.09	2.59	.084
Observer perspective*	6.06	1.55	4.94	1.73	4.61	2.03	**3.24**	**.047**
Observer vs. field dichotomy*	6.39	1.29	5.39	1.85	4.83	2.23	**3.33**	**.044**
Vividness	5.33	1.53	4.78	1.66	4.44	1.58	1.43	.249
Visual details	6.22	1.22	5.11	1.75	5.11	1.41	**3.41**	**.041**
Sounds	3.67	2.28	3.67	2.28	3.72	1.84	0.00	.996
Smells/tastes	3.56	2.12	2.33	1.78	2.89	1.75	1.89	.162
Location	6.61	0.85	6.00	1.24	5.00	1.68	**7.04**	**.002**
Familiar setting	6.11	1.71	4.61	2.38	4.56	2.04	**3.30**	**.045**
Object spatial arrangement	6.33	1.08	4.89	1.81	4.00	1.85	**9.52**	**.000**
People spatial arrangement	5.72	1.49	4.94	1.35	3.56	1.82	**8.85**	**.001**
Time of day	6.22	1.40	5.67	1.28	5.56	1.29	1.31	.279
In words	3.78	1.93	3.72	1.64	4.06	1.86	0.17	.840
Coherent story	5.56	1.62	4.28	1.64	4.00	1.68	**4.58**	**.015**
Complexity of the storyline	3.00	1.57	2.89	1.41	2.50	1.34	0.60	.555
Intensity of emotions during the event	4.83	1.25	4.89	1.41	4.33	1.71	0.78	.464
Valence of emotions during the event*	5.17	1.62	5.06	2.07	5.39	1.38	0.18	.839
Similarity of emotion now and during the event	3.61	1.85	5.11	1.37	4.17	1.58	**3.98**	**.025**
Intensity of emotions when thinking about the event	3.78	1.22	4.44	1.15	4.00	1.57	1.18	.315
Valence of emotions when thinking about the event*	5.33	1.37	5.06	1.86	5.00	1.37	0.24	.789
Personal importance	4.72	1.53	5.67	1.19	5.11	1.60	1.93	.156
Past occurrences	3.28	1.41	4.39	1.75	4.00	2.30	1.66	.200
Future occurrences	4.33	1.37	5.44	1.10	5.11	1.75	2.86	.066
Similarity to a past event			4.89	1.81	4.17	2.09	1.22	.276
Planning during process task					3.00	1.57		

* Recoded variable, see in-text for detailed explanations.

Exploratory factor analysis. As this experiment was slightly different from the previous one (within-subjects instead of between-subjects design, no time constraint, etc.), we ran a new exploratory factor analysis. Kaiser–Meyer–Olkin (KMO) sampling adequacy (0.705) and Bartlett's sphericity tests, $\chi^2(231) = 1027.69$, $p < .001$, indicated that factor analysis was appropriate. We used principal components extraction with Varimax Rotation to preserve orthogonality. Analysis of the scree plot and Eigenvalues indicated once more a four-factor solution. Similar to experiment 1, we removed the characteristics "in words" and "smells/tastes" as they did not load on any factor. However, we also removed for the same reason the characteristic "complexity of the storyline". Our final four-factor solution accounted for 52.91% of the total variance (see Table 12).

Table 12
Factor Loadings for Explanatory Factor Analysis with Varimax Rotation of Phenomenological Characteristics

Characteristics	**Factors**			
	1	**2**	**3**	**4**
Intensity of emotions when thinking about the event	**.84**	-.04	.07	-.08
Mental time travel	**.69**	< -.01	.36	.16
Similarity of emotion now and during the event	**.65**	-.14	-.06	.10
Experiencing	**.64**	.20	.40	-.2
Vividness	**.56**	.18	.29	.14
Intensity of emotions during the event	**.53**	.09	.05	-.07
Personal importance	**.53**	.22	-.12	-.10
Visual details	**.50**	.22	.38	.20
Sounds	**.47**	.07	< .01	.12
Object spatial arrangement	-.01	**.73**	.41	-.14
Familiar setting	.08	**.69**	-.08	-.41
Location	.26	**.66**	.17	.02
People spatial arrangement	-.03	**.57**	.33	-.05
Time of day	.08	**.51**	.04	.13
Field perspective	.23	.11	**.82**	-.04
Observer perspective*	-.08	.17	**.78**	-.02
Field vs. observer dichotomy*	.18	.12	**.78**	-.13
Coherent story	.09	.32	**.41**	.25
Valence of emotions when thinking about the event*	.36	.16	-.16	**.75**
Past occurrences	.06	.11	-.09	**-.72**
Valence of emotions during the event*	.30	.13	-.11	**.71**
Future occurrences	.18	.20	-.02	**-.62**

Note. Factor loadings for each phenomenological characteristic in a given factor are in boldface.
* Recoded variable, see in-text for detailed explanations.

Our first factor was very similar to our *autonoesis factor* in experiment 1 (α = .80). Once again it gathered phenomenological characteristics related to mental time travel, emotion intensity, vividness and sounds. It also included visual details, which in experiment 1 was placed in factor 2 but also correlated with this factor. Our second factor was similar to our *scene construction factor* (α = .72). Yet it differed slightly from experiment 1, as two characteristics were lost to other factors (visual details moved to factor 1 and past occurrences moved to factor 4). Our third factor was very similar to our *perspective factor* in experiment 1 but also included the coherence of the story characteristic (α = .76). Our fourth factor, however, differed from our *optimism bias factor* in experiment 1. As before, this factor consisted of the two emotional valence characteristics (both during the event and when thinking about it) and the characteristic measuring the occurrence of similar events in the future. However, the characteristic measuring the occurrence of similar events in the past also loaded on the factor (α = .70). It is worth noting that the two occurrence measures loaded negatively onto the factor. This was quite unexpected and conflicted with the results of experiment 1. Consequently, we investigated this result by correlating the four characteristics of the factor together, independently for each type of event cue (birthday, trip, exam, first day of work or date). Remarkably, different event cues produced very different correlational patterns. For example, when participants (mainly first year psychology students) chose “an exam/a test” as the cue, the event usually was rated as negative and having high occurrences in the past and the future. It is important to note that this cue was chosen more often than others, probably due to the fact that there were no time constraints in this experiment and exams are an important part of students’ life. Therefore, differences depending on the type of events might shed some light on our results, but due to low numbers in each cell when taking into account the type of cue received, the condition and the valence of the event, statistical analysis at this level cannot be conducted. More research is needed to elucidate these effects.

For the following analyses in this experiment, we will refer to this factor as the valence and occurrence factor.

Procrustean factor analysis. Before comparing our factor scores, we wanted to compare our factor solutions between the two experiments. We ran a procrustean factor analysis, which judges structural and metric equivalence (Fischer, 2012; Fischer & Fontaine, 2010). Rotated loadings of phenomenological characteristics present in both factor analyses were directly compared. Tucker's Phi indicated a relatively good congruence coefficient for the *autonoesis factor* (.88). However the congruence coefficient was smaller for the *scene construction factor* (.77) and the *perspective factor* (.65). Expectedly, it was extremely poor for the fourth factor (named *optimism bias factor* in the experiment 1 and *valence and occurrence factor* in experiment 2) (.17). Yet, if we take into account the few differences in our design and the fact these types of analyses are usually more effective with a larger sample, these results indicate the presence of stable underlying processes that impact the way we generally perceive an event, regardless of condition or experimental design.

Comparing factor scores across conditions. From the factor analysis, we again composed four factor scores by adding up the scores from the items in each factor. We reverse coded the characteristics measuring the "occurrence of similar events in past" and the "occurrence of similar events in future" to allow positive correlations between items on the same factor.

As discussed previously, in this analysis we examined our factor scores for first and second events depending on condition. Our analysis of factors scores for first events did not yield any main effect of condition for the *autonoesis factor*, F (2, 51) = 0.11, p = .896; for the *scene construction factor*, F (2, 51) = 1.53, p = .226; for the *visual perspective factor*, F (2, 51) = 0.90, p = .411; nor for the *valence and occurrence factor*, F (2, 51) = 0.26, p = .974 (see Table 13).

Table 13

Averaged Factor Scores as a Function of the Condition

EVENT 1	**Past**		**Future**			
Factors	Remembering		Imagining		Planning	
	M (*SD*)	95% CI	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI
Autonoesis factor	4.67 (0.91)	[4.27, 5.07]	4.80 (0.88)	[4.39, 5.20]	4.69 (0.75)	[4.29, 5.09]
Scene construction factor	5.09 (0.97)	[4.64, 5.54]	5.23 (0.88)	[4.79, 5.68]	5.62 (0.98)	[5.18, 6.07]
Visual perspective factor	5.22 (1.09)	[4.68, 5.76]	4.71 (1.26)	[4.16, 5.25]	4.99 (1.08)	[4.44, 5.53]
Valence and occurrence factor	4.36 (1.06)	[3.76, 4.96]	4.40 (1.52)	[3.80, 5.00]	4.46 (1.20)	[3.85, 5.06]

Univariate analyses of factor scores for second events showed a different pattern of results (see Table 14). There was no main effect of condition for our *autonoesis factor*, F (2, 51) = 0.89, p = .415, which indicated that participants felt like they were mental time travelling to all events, and experiencing them in a similar emotional, complex, and coherent way. However, our *scene construction factor* yielded a main effect of condition, F (2, 51) = 10.12, p < .001, η_p^2 = .28. Participants had a clearer visuo-spatial representation of the scene of past remembered events compared to future events, imagined, and planned. Our *visual perspective factor* also yielded a main effect of condition, F (2, 51) = 5.23, p = .009, η_p^2 = .17. Participants saw remembered events more from a field perspective than planned events. Imagined events were somewhere in between, but did not differ from remembered events or from planned events. Finally, our valence and occurrence factor did not yield any main effect, F (2, 51) = 1.43, p = .248.

Table 14
Averaged Factor Scores as a Function of the Condition

EVENT 2	Past		Future			
Factors	Remembering		Imagining		Planning	
	M (*SD*)	95% CI	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI
Autonoesis factor	4.81 (0.93)	[4.32, 5.30]	4.86 (0.96)	[4.37, 5.35]	4.44 (1.18)	[3.32, 5.30]
Scene construction factor	6.20 (0.91)	[5.67, 6.73]	5.22 (1.15)	[4.69, 5.75]	4.53 (1.26)	[4.00, 5.06]
Visual perspective factor	6.10 (1.04)	[5.44, 6.76]	5.01 (1.30)	[4.35, 5.67]	4.65 (1.75)	[3.99, 5.31]
Valence and occurrence factor	4.72 (1.09)	[4.16, 5.28]	4.06 (1.17)	[3.49, 4.62]	4.32 (1.30)	[3.76, 4.88]

The results presented here provide valuable information on how participants rated the phenomenology of autobiographical events. As in experiment 1, first events were rated similarly in all conditions across almost all our characteristics. However, second events showed differences across conditions, with participants perceiving past events with more visuo-spatial details and more from a field perspective. This order effect can be viewed as a lack of base rate for the first event and a direct comparison from the participant's point of view between the first and second events. The event cues were the same for all conditions and represented relatively common events; therefore, regardless of the condition they were in, participants provided similar ratings of phenomenological categories for their first event. It is only when the second event was generated in a different condition that participants altered their ratings by comparing the second type of autobiographical thought to the first.

Part 2: Counterfactual thinking vs. prefactual imagining vs. prefactual planning.

Event order and type of change. In this experiment, we only asked participants to change the emotional valence of the event. Out of our 108 events, 72 events were initially rated as positive and underwent negative counterfactual and prefactual changes (R = 22, I =

23, P = 27), 15 were initially rated as being neutral and underwent positive counterfactual and prefactual changes (R = 5, I = 6, P = 4), and 21 were initially rated as being negative and underwent positive counterfactual and prefactual changes (R = 9, I = 7, P = 5). It is interesting to note than out of these 21 negative events, 14 followed the "exam" cue. Furthermore, only planned events related to exams were rated as negative. For this reason, when possible, we analyzed only the type of change (positive or negative changes) by collapsing neutral and negative events. However, results should be examined with caution as not many events in each condition received a positive change.

As we expected that participants had already established their baseline from part 1, we first examined if event order impacted the phenomenology ratings of counterfactual, prefactual imagined, and prefactual planned events. Consequently, we ran a MANOVA on our entire set of characteristics with condition (R, I, P) and event order (first or second) as independent variables. Results showed there was no main effect of event order, F (25, 77) = 0.71, p = .826, Wilk's Λ = 0.812; and no interaction, F (50, 154) = 1.41, p = .060, Wilk's Λ = 0.471. Therefore we did not separate first and second events any longer.

We similarly examined the impact of the type of change. The MANOVA revealed a main effect of type of change, F (25, 77) = 14.12, p < .001, Wilk's Λ = 0.179; but no interaction, F (50, 154) = 1.23, p = .172, Wilk's Λ = 0.511. Regardless of condition, participants rated positive alternative events as more often set in a familiar setting than negative alternative events. Compared to negative alternative events, positive alternative events also generated similar emotions during the event and when thinking about the event, and these emotions were more positive. On the other hand, participants rated negative alternative events as having a clearer storyline than positive alternative events. They also expected more intense emotions during the negative events and felt similar events happened less in the past and would happen less in the future. As neither the event order nor the type of change variables interacted with condition, we did not include them in the following analyses.

Phenomenological characteristics. The averaged means, standard deviations, and univariate ANOVAs for each characteristic across conditions are presented in Table 15. Whereas a few characteristics differed across conditions in experiment 1, only two of our separate univariate ANOVAs yielded main effects of condition in this experiment. Follow up post hoc Tukey tests indicated that counterfactual events had clearer object spatial arrangements than prefactual imagined and planned events. They also had clearer people spatial arrangements than prefactual events, with no significant differences with prefactual imagined events. Yet, counterfactual, prefactual imagined, and prefactual planned events could not be differentiated on any of our other phenomenological measures.

Table 15

Means, Standard Deviations and Univariate ANOVAs for Each Phenomenological Characteristic Measured as a Function of Condition

Characteristics	**Past**		**Future**				**Univariate ANOVAs**	
	Counterfactual thinking		Prefactual imagining		Prefactual planning			
	M	*SD*	*M*	*SD*	*M*	*SD*	*F*(2, 48)	*p*
Experiencing	3.80	1.39	4.53	1.36	4.08	1.73	1.52	.225
Mental time travel	4.46	1.31	4.58	1.44	4.39	1.70	0.09	.917
Field perspective	5.00	1.64	4.86	1.66	4.92	1.93	0.16	.848
Observer perspective*	4.69	1.87	4.53	1.92	4.69	1.93	0.48	.620
Observer vs. field dichotomy*	4.63	2.17	4.67	1.94	4.42	2.23	0.19	.830
Vividness	4.00	1.39	4.67	1.29	4.17	1.95	1.06	.351
Visual details	4.89	1.55	5.22	1.44	4.72	1.81	0.54	.582
Sounds	3.20	1.75	3.00	1.69	3.14	1.68	0.55	.578
Smells/tastes	2.37	1.73	1.75	1.11	2.14	1.46	1.76	.177
Location	5.77	1.52	5.53	1.32	4.89	2.03	1.23	.296
Familiar setting	5.11	1.98	4.56	2.06	4.53	1.92	0.59	.558
Object spatial arrangement	4.86	1.46	3.89	1.67	3.67	1.81	**4.10**	**.019**
People spatial arrangement	5.03	1.38	4.22	1.79	4.00	1.72	**3.38**	**.038**
Time of day	5.34	1.55	5.56	1.40	5.00	1.76	0.60	.549
In words	3.57	1.75	3.53	1.77	3.31	1.69	0.00	.998
Coherent story	4.14	1.29	4.19	1.60	3.97	1.75	0.04	.962
Complexity of the storyline	3.09	1.36	3.39	1.66	3.03	1.59	0.34	.713
Intensity of emotions during the event	4.91	1.48	4.61	1.50	4.31	1.51	1.76	.178
Valence of emotions during the event*	3.37	2.14	3.39	2.16	3.31	1.72	1.13	.326
Similarity of emotion now and during the event	3.97	1.56	4.11	1.67	4.33	1.74	0.74	.480
Intensity of emotions when thinking about the event	3.46	1.24	4.08	1.42	4.00	1.62	0.99	.374
Valence of emotions when thinking about the event*	3.49	1.46	3.39	1.86	3.44	1.68	2.01	.139
Personal importance	4.37	1.97	5.08	1.54	4.81	1.88	0.87	.423
Past occurrences	2.83	1.77	2.89	1.60	3.22	2.00	2.47	.090
Future occurrences	3.06	1.75	3.42	1.70	3.61	1.86	1.49	.230
Similarity to a past event	2.92	1.78	3.06	1.94	3.56	2.01	1.81	.169
Planning during process task					4.11	1.72		

* Recoded variable, see in-text for detailed explanations.

Comparing factor scores across conditions. Similar to part 1, we created four factor scores by adding up the scores from the items in each factor (see Table 16). Once more, our univariate ANOVAs did not yield any effect of condition on factor scores associated with our *autonoesis factor*, $F(2, 105) = 1.18$, $p = .310$; our *scene construction factor,* $F(2, 105) = 2.84$, $p = .063$; our *visual perspective factor,* $F(2, 105) = 0.02$, $p = .976$; and our *valence and occurrence factor*, $F(2, 105) = 0.70$, $p = .500$. In summary, participants experienced all alternative event in a similar way.

Table 16

Averaged Factor Scores of Alternative Events as a Function of Condition

Factors	**Past**		**Future**			
	Counterfactual thinking		Prefactual imagining		Prefactual planning	
	M (*SD*)	95% CI	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI
Autonoesis factor	4.06 (0.96)	[3.71, 4.40]	4.43 (0.78)	[4.09, 4.78]	4.22 (1.31)	[3.87, 4.56]
Scene construction factor	5.12 (1.19)	[4.71, 5.54]	4.75 (1.01)	[4.33, 5.17]	4.42 (1.52)	[4.00, 4.99]
Visual perspective factor	4.57 (1.28)	[4.08, 5.06]	4.56 (1.49)	[4.08, 5.05]	4.50 (1.61)	[4.02, 4.98]
Valence and occurrence factor	4.25 (1.01)	[3.93, 4.56]	4.12 (1.00)	[3.80, 4.43]	3.98 (0.86)	[3.66, 4.30]

Part 1 vs. part 2: Counterfactual changes vs. prefactual imagined changes vs. prefactual planned changes.

Phenomenological characteristics. We investigated the difference in phenomenological ratings between original events and their alternative versions. We subtracted part 2 ratings from part 1 ratings for each event so that positive numbers indicated higher ratings for part 1 and negative numbers indicated higher ratings for part 2 (see Table 17). Univariate ANOVAs for the “experiencing” and the “coherent story” characteristics showed a main effect of condition. However, post hoc Tukey tests did not find any significant differences between counterfactual and prefactual changes for the feeling of experiencing the event. As for the coherence of the story, counterfactual changes maintained the perceived coherence whereas changing the emotional valence of imagined events modified it.

Table 17

Means of Difference Scores Between Original and Alternative Events, Standard Deviations, and Univariate ANOVAs for Each Phenomenological Characteristic Measured as a Function of Condition

Characteristics	**Past**		**Future**				**Univariate ANOVAs**	
	Remembering – Counterfactual thinking		Imagined – Prefactual imagining		Planning – Prefactual planning			
	M	*SD*	*M*	*SD*	*M*	*SD*	*F*(2, 48)	*p*
Experiencing	1.26	1.95	0.29	1.41	0.31	1.88	**3.49**	**.034**
Mental time travel	0.54	1.82	0.14	1.50	0.39	1.76	0.49	.612
Field perspective	1.00	1.35	0.40	1.94	0.56	2.05	1.04	.358
Observer perspective*	0.60	1.94	-0.03	2.14	-0.25	1.92	1.72	.185
Observer vs. field dichotomy*	1.26	2.33	0.37	2.21	0.67	2.50	1.29	.280
Vividness	1.40	2.09	0.34	1.75	0.78	2.09	2.52	.086
Visual details	0.83	1.76	0.20	1.32	0.69	1.75	1.45	.238
Sounds	0.77	1.61	0.37	2.13	0.33	2.22	0.52	.599
Smells/tastes	0.80	1.78	0.51	1.29	0.33	1.15	0.96	.386
Location	0.40	1.22	0.31	1.49	0.72	2.21	0.57	.567
Familiar setting	-0.06	1.91	0.14	1.52	0.69	1.82	1.75	.179
Object spatial arrangement	0.69	1.59	1.00	1.83	0.89	1.58	0.32	.728
People spatial arrangement	0.34	1.53	0.43	1.15	0.25	1.32	0.16	.854
Time of day	0.60	1.63	0.26	1.34	0.75	1.86	0.86	.428
In words	0.63	1.52	0.20	1.37	0.61	1.48	0.98	.380
Coherent story	1.23	1.77	-0.06	1.83	0.31	1.86	**4.64**	**.012**
Complexity of the storyline	0.03	1.56	-0.46	1.44	-0.28	1.80	0.82	.445
Intensity of emotions during the event	-0.06	2.16	0.11	2.22	0.06	2.32	0.05	.948
Valence of emotions during the event*	1.46	3.76	1.66	3.64	2.19	2.85	0.44	.646
Similarity of emotion now and during the event	0.14	2.45	0.63	1.73	-0.03	2.01	0.94	.393
Intensity of emotions when thinking about the event	0.46	1.46	0.26	1.54	-0.06	1.64	0.99	.375
Valence of emotions when thinking about the event*	1.43	2.55	1.71	3.16	1.72	2.63	0.13	.881
Personal importance	0.54	2.12	0.26	1.01	0.67	1.90	0.51	.600
Past occurrences	0.49	1.65	1.26	1.79	0.86	1.76	1.73	.182
Future occurrences	1.14	1.70	1.69	1.71	1.42	1.70	0.89	.414
Similarity to a past event			1.58	2.13	0.92	1.71		
Planning during process task					3.27	1.26		

* Recoded variable, see in-text for detailed explanations.

Comparing factor scores across conditions. Finally, following what we did previously, we combined the difference scores from the items in each factor of part 1 to create difference factor scores. In order to examine further our results, and as this measure included ratings from part 1, we separated again first and second events in our analyses. A univariate ANOVA of difference factor scores for first events revealed a main effect of condition for our *scene construction factor*, F (2, 51) = 3.58, p = .035, η_p^2 = .12. Whereas alternative versions of remembered events maintained the visuo-spatial clarity of the scene, changing the emotional valence of planned events reduced it. There was no main effect of condition for our other factors: *autonoesis factor*, F (2, 51) = 1.19, p = .313; *visual perspective factor*, F (2, 51) = 2.80, p = .071; *valence and occurrence factor*, F (2, 51) = 0.26, p = .774 (see Table 18).

Table 18
Averaged Difference Factor Scores Between Original and Alternative Events as a Function of Condition for the First Event Only

EVENT 1	**Past**		**Future**			
Factors	Remembering – Counterfactual thinking		Imagined – Prefactual imagined		Planning – Prefactual planned	
	M (*SD*)	95% CI	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI
Autonoesis factor	0.69 (1.20)	[0.11; 1.26]	0.32 (0.63)	[-0.26; 0.89]	0.93 (1.59)	[0.36; 1.50]
Scene construction factor	-0.07 (0.77)	[-0.63; 0.49]	0.52 (0.94)	[-0.04; 1.08]	0.99 (1.65)	[0.43; 1.55]
Visual perspective factor	0.94 (1.19)	[0.21; 1.68]	-0.15 (1.42)	[-0.89; 0.59]	0.88 (1.96)	[0.14; 1.61]
Valence and occurrence factor	0.08 (1.71)	[-0.72; 0.88]	0.14 (1.99)	[-0.66; 0.94]	0.46 (1.30)	[-0.34; 1.26]

Univariate analyses of factor scores for second events showed a different pattern of results (see Table 18). As in experiment 1, we found a main effect of condition for the *autonoesis factor*, F(2, 51) = 3.28, p = .046, η_p^2 = .11; and the *visual perspective factor*, F(2,

51) = 5.26, p = .008, η_p^2 = .17; but not for the *valence and occurrence factor*, F(2, 51) = 0.31, p = .733. The main effect of condition was not significant for the *scene construction factor* but showed a trend, F(2, 51) = 3.09, p = .054, η_p^2 = .11. Also similar to experiment 1, post hoc Tukey tests indicated that for our three factors (*autonoesis, visual perspective, and scene construction*), counterfactual changes produced factor scores that were relatively lower than their original event, whereas prefactual planned changes produced factor scores that were relatively similar to their original counterpart. Prefactual imagined changes always scored in between counterfactual and prefactual planned changes (see Table 19). Consequently, compared to the phenomenology of memories that were being remembered, thinking of alternative versions of past events led to reduced feelings of traveling back in time and experiencing the events clearly, fewer perceptual details and less often represented from a field perspective. On the other hand, original and alternative future events, especially when planned, had similar phenomenological characteristics.

Table 19
Averaged Difference Factor Scores Between Original and Alternative Events as a Function of the Condition for the Second Event Only

EVENT 2	**Past**		**Future**			
Factors	Remembering – Counterfactual thinking		Imagined – Prefactual imagined		Planning – Prefactual planned	
	M (*SD*)	95% CI	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI
Autonoesis factor	0.69 (1.06)	[0.15; 1.22]	0.48 (1.43)	[-0.06; 1.01]	-0.24 (0.80)	[-0.77; 0.30]
Scene construction factor	1.11 (1.41)	[0.63; 1.60]	0.43 (0.71)	[-0.05; 0.92]	0.33 (0.79)	[-0.15; 0.82]
Visual perspective factor	1.24 (1.17)	[0.58; 1.89]	0.75 (1.77)	[0.09; 1.41]	-0.24 (1.14)	[-0.89; 0.42]
Valence and occurrence factor	0.51 (1.50)	[-0.21; 1.23]	0.11 (1.62)	[-0.61; 0.83]	0.36 (1.46)	[-0.36; 1.08]

Discussion

In experiment 2, we replicated our experiment 1 design with small changes: participants completed two out of our three conditions in a pre-determined order, and received no time constraints. Our sample size was also slightly larger with 54 participants compared to 51 in the first experiment, which, combined with a within-subject design (although partial), increased the statistical power of our analyses. As we did in the discussion for experiment 1, we first examine the underlying similarities in how autobiographical events are perceived by reviewing our factor analysis. We then discuss the phenomenological differences across remembered, imagined, and planned events.

Because of the differences in design between experiment 1 and experiment 2, we ran a new exploratory factory analysis on our phenomenological ratings. Once more it revealed a four-factor solution, composed of an autonoesis factor, a scene construction factor, a perspective factor, and a valence and occurrence factor. Together these factors explained almost 53% of the total variance. Three of our four factors shared strong similarities but were not identical to the factors found in experiment 1, as demonstrated by the procrustean factor analysis. However, as already discussed, our last factor proved quite different. We inferred that this result was brought about by the different methodology of this experiment, more specifically the absence of time constraints coupled with cues that were more relevant to our participants' current life. For example, when forced to talk about the distant past and the distant future in experiment 1, participants chose the cue "an exam or a test" 17.6% of the time, compared to 24.1% in experiment 2, where they had no time constraints. Furthermore, the exam or test events from experiment 1 were broader in content as participants chose to talk about driving tests, cooking classes, tests to be considered for a job, etc., whereas in experiment 2 participants chose to mainly discuss university exams.

With regards to analyses of phenomenological ratings, we highlighted differences between first and second events. By using a within-subjects design, we avoided the lack of direct comparison between conditions from experiment 1, but ran into an order effect (see also Chapter 3 for another example of an order effect). Replicating results from experiment 1, participants gave similar ratings on most of our characteristics for their first event, regardless of the condition they were in. On the other hand, participants rated their second event differently, probably adjusting their ratings depending on how they had rated their first event. Compared to future events, past events tended to be felt as visually and spatially clearer, often in a familiar location and seen more from a field perspective. Participants also felt that past events had a more coherent story than future events. Generally speaking, imagined and planned future events were very similar, with imagined events usually rated somewhere between remembered and planned events. These findings highlight once again the important role of base rate in phenomenology ratings.

With regards to alternative events, results showed once more that participants felt they were not travelling back in time and experiencing counterfactual events to the same extend as they did for remembered events. Furthermore, counterfactual events were perceived less visually and spatially clearer than remembered events, and were seen less from a field perspective. However, because of the order effect found in part 1, results from part 2 should be interpreted with caution. Indeed, we cannot tell from our data if participants used their original events as the baseline against which to rate alternative events, or if they also compared them against the other condition they completed. For example, did they only compare their counterfactual events to the original remembered event, or did they also compare it to the event they had to imagine? Therefore, future research is needed to untangle these complex order effects. For example, researchers could provide original ratings to participants and ask them to make a more direct comparison.

General Discussion

Many studies have investigated the neural and behavioral similarities in autobiographical thinking, proposing that remembered past events and imagined future events rely on similar underlying processes (D'Argembeau, 2012; Schacter, 2012; Suddendorf & Corballis, 1997; Szpunar, 2010). However, previous research had suggested that even if they are similarly constructed, the phenomenological experience associated with thinking about these personal events can differ. For example, D'Argembeau and Van der Linden (2004, 2006) revealed that participants rated memories as containing more sensorial details and being more clearly represented than imagined future events.

However, we suggested two gaps in the current literature. First, previous research had mainly focused on remembered past events and imagined future events, and did not examine other types of autobiographical thinking. In Chapter 2, we argued for the value of considering a wider range of autobiographical events. Second, researchers sometimes combined phenomenological characteristics together to create new indexes or factors (D'Argembeau & Van der Linden, 2004; De Brigard & Giovanello, 2012; Szpunar & McDermott, 2008), but no study had run a complete factor analysis on a broad sample of phenomenological characteristics.

Consequently, across two separate but similar experiments, we investigated a wide range of phenomenological characteristics associated with different types of autobiographical thinking, such as remembering past events, imagining future events, planning for future events, or counterfactually and prefactually thinking about alternative versions for all of these event types. It is worth noting that even if the differences in design combined with the difference in statistical power make the two experiments harder to compare directly, their results are complementary and they provide valuable insight into the processes at play. We had two major objectives: to examine the correlation pattern across a wide range of processes of autobiographical thinking, which might indicate common underlying features of autobiographical thinking, and to investigate the potential differences across our autobiographical processes. Our findings can be separated into two separate points. The first point relates to what our factor analyses revealed and how each factor differed across our autobiographical processes. The second point relates to the possibility that phenomenology might be relative and not absolute.

Factor Analyses and Differences Across Autobiographical Processes

We examined the correlation pattern across our phenomenological measures, as these correlations could provide insight into the underlying processes in autobiographical thinking. Both of our experiments provided a four-factor solution that accounted for 53% of the variance. The factor solutions compared relatively well between both experiments. We conceptualized our first three factors similarly, whereas the fourth one differed more strongly between the two experiments.

As discussed in the introduction, the capacity to mentally live events in a vivid manner, hear sounds and see details, or feel similar emotions to the ones experienced during the real event is enabled by autonoetic consciousness (Klein, 2016; Tulving, 1985). For this reason, we conceptualized our first factor as representative of autonoesis, as it was defined by phenomenological characteristics such as a feeling of experiencing the event or mental time travelling back/forward to it, intensity of emotion both during the event and when thinking about it, vividness, sounds and visual details, or the importance of the event for the self. In accordance with past studies, autonoesis factor scores did not reliably differ between remembered past events, imagined future events, and planned future events (Addis et al., 2009; D'Argembeau et al., 2010; D'Argembeau & Van der Linden, 2004, 2006; De Brigard & Giovanello, 2012). However, compared to remembered events, participants gave lower ratings on characteristics indicative of autonoesis for counterfactual events. Yet, thinking of alternative versions for imagined and planned events did not reduce the autonoetic feeling.

Our second factor gathered phenomenological characteristics relevant to the visuo-spatial setting of the scene. In accordance with Hassabis and Maguire (2007), creating a visuo-spatial context for the event seems to be an essential part of autobiographical thinking. The fact that this factor was dissociated from our autonoesis factor suggests that these two concepts rely on different underlying processes. Interestingly, in our first experiment, high occurrences of similar events in the past loaded positively onto the scene construction factor too. As two-thirds of our events were future events, this cannot be explained only by the fact that high-occurring past events are more clearly remembered in terms of visuo-spatial details than low-occurring ones. The constructive episodic simulation hypothesis (Schacter & Addis, 2007a) provides a possible explanation for this result. Episodic details from high-occurring past events might be used to construct future events, resulting in a richer visuo-spatial setting. However, it is worth noting than when given the opportunity to directly compare past and future events in experiment 2, past events ranked higher on the scene construction factor than imagined and planned future events. This result is unsurprising given that past events have been phenomenologically experienced whereas future events have not (Debus, 2014).

Our third factor was composed of the three perspective scales, with the addition of the characteristic measuring the coherence of the story in experiment 2 only. In previous studies, memories retrieved with an observer perspective correlated with fewer visual details, less sensory information, and less personal importance (Berntsen & Rubin, 2006). In our experiment, however, our perspective scales were on a separate factor from these characteristics as if they were independent from one another. Furthermore, we had some unclear differences between past and future events, where past events sometimes received higher field perspective ratings than future events when compared to one another, but not in every case. But once more, counterfactual changes led to reduced ratings of field perspective and increased ratings of observer perspective, whereas there was no difference after prefactual changes.

As discussed earlier, these results might then be more indicative of personal and event-specific differences than dependent on temporal orientation (Libby & Eibach, 2011; Rice & Rubin, 2009). Nevertheless, our results show that in all cases, participants gave more field than observer perspective ratings, which contradicts McDermott et al.'s (2016) study.

However, their experiment had a stronger focus on the observer perspective (with many questions related to the viewpoint of the observer perspective), which could have influenced their results. A more comprehensive scale, similar to theirs, might have yielded different results in our study.

Finally, our fourth factor differed significantly across the two experiments. In the first experiment we conceptualized this factor as representative of the optimism bias (Schacter & Addis, 2007b; Sharot, 2011; Weinstein, 1980). The two emotional valence measures as well as the expected occurrence of similar events in the future all loaded positively onto the fourth factor, which meant that the more positive participants rated the events and the way they felt about them, the more often they believed it would occur in the future. Furthermore, ratings on this factor were as high for remembered events as for imagined or planned events. However, in experiment 2, the characteristic measuring the occurrence of similar events in the future loaded negatively on the fourth factor. The characteristic measuring the occurrence of similar events in the past also loaded negatively. We hypothesized that this conflicting result might have been caused by our new design without time constraints. Exams were the most commonly chosen cue and they were usually rated negatively. Unsurprisingly, they were expected to occur often in the future and they had occurred often in the past. However, this was the only factor that was not affected by the type of autobiographical thinking.

Phenomenology: Absolute or Relative?

In experiment 1, remembered, imagined, and planned events received similar ratings on our phenomenological characteristics scales. This result was unexpected as previous studies showed reliable differences between past and future thinking for measures of sensory details or visuo-spatial information about the location, people, and object (Addis et al., 2009; D'Argembeau et al., 2010; D'Argembeau & Van der Linden, 2004, 2006; De Brigard & Giovanello, 2012). This absence of reliable differences seemed to be principally caused by a lack of baseline for participants in different conditions to compare their experience to. As most generated events were relatively mild and common, they were given ratings in the middle range of most scale items, regardless of condition. This tendency was confirmed in experiment 2 where first events were once more rated similarly across conditions. However, when participants received a different condition to the previous one for their second event, variations in phenomenological ratings across types of autobiographical thinking appeared. This time, participants felt they were experiencing remembered events more than planned future events. They also indicated that past events were less seen from an observer perspective; their location and spatial details were clearer; they were set in a more familiar setting; and their storyline was more coherent, compared to future events. Ratings from first events took on the role of a baseline against which to rate further events. Arnold et al. (2011) already highlighted this possibility when they failed to replicate the temporal orientation effect found by D'Argembeau and Van der Linden (2004) and suggested it was due to design differences.

With regards to our future planning condition, it is noteworthy that most differences were stronger between planned and remembered events than between imagined and remembered events. This result can either suggest that planning is simply a stronger form of future thinking, and therefore increases the usual phenomenological differences between past and future thinking, or that the process of remembering shares more similarities with the process of future imagining than future planning. In Chapter 3, we suggested that future planning, due to its goal-directed nature, might rely more heavily on semantic scripts than episodic memory. It is therefore possible than these content differences might provide participants with a different phenomenological feeling.

Results from the second part of our experiments, where we asked participants to provide alternative versions of each remembered, imagined or planned event, also indicated that participants rated their phenomenology by comparing original and alternative events as well as conditions with one another. Interestingly, in both experiments, when participants proposed alternative versions of future events (imagined or planned), they provided similar ratings on our four factors. Yet, when participants thought counterfactually about a past event, they reported lower ratings on autonoesis, scene construction, and perspective factors. This difference between the phenomenology associated with thinking counterfactually about the past and prefactually about the future suggests an essential difference between episodic memory and episodic future thinking. As discussed in Debus (2014), participants can be experientially aware of past events (that have been experienced) but not of future events or counterfactual events. However, different types of autobiographical processes did not impact the estimated occurrence of similar events in the past or the future, nor the emotional valence associated with the event.

To conclude, methodological designs created to compare the phenomenology of different types of autobiographical thinking have to be carefully devised as phenomenology seems to be relative more than absolute. When comparing across subjects, scientists run the risk of creating a “lack of base rate bias”, whereas when comparing within subjects, scientists run the risk of creating intricate order effects. However, we were able to show that out of our wide range of phenomenological characteristics, at least three principal factors could be reliably extracted. These factors have strong links with existing literature such as autonoetic consciousness, as initially proposed by Tulving (1985); scene construction, which relates to Hassabis and Maguire’s (2007) research, as well as Schacter and Addis’ (2007a) constructive episodic simulation hypothesis; field or observer perspective, as initially proposed by Nigro and Neisser (1983); and the optimism bias (Schacter & Addis, 2007b; Sharot, 2011; Weinstein, 1980). We also highlighted that when directly compared to one another, memories generally contained more sensory and visuo-spatial details than future events, even more so when compared to planned future events. Furthermore, counterfactual events were more similar to prefactual imagined and prefactual planned events than to memories. This might highlight differences in the underlying processes when remembering past events or when constructing hypothetical past and future events. Consequently, future research is required to disentangle the many effects discussed in this paper and examine the underlying processes involved in the different forms of autobiographical thinking.

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CHAPTER 5

Linguistic Style of Narratives in Autobiographical Thinking

This Chapter was prepared as:

Cordonnier, A., Barnier, A. J., & Sutton, J. (in preparation). Linguistic style of narratives in autobiographical thinking. *Journal of Memory and Language*.

In this chapter, I describe another set of results from my second and third experiments where I examined the linguistic style of autobiographical past or future events. These experiments are the same ones as reported in Chapter 4. Because of this overlap and because this chapter has been written as a stand-alone manuscript, there will be some overlap, particularly in the method section. Once more, as this chapter was prepared for submission, I followed APA guidelines and renumbered my experiments accordingly. Therefore in this chapter, experiment 2 is presented as experiment 1, and experiment 3 is presented as experiment 2. Following my theoretical cognitive framework (Chapter 2), I sought to compare how the different processes of thinking autobiographically impacted the linguistic style used by participants to describe their events. Specifically, I compared the linguistic style of remembered past events, imagined future events, and planned future events using a between-subjects design in experiment 1 and using a within-subjects design in experiment 2. In both experiments, I also compared the linguistic style of these original events with the linguistic style of alternative versions of these events.

In terms of measures, I ran transcripts of the narratives through the Linguistic Inquiry and Word Count computer program (LIWC, Pennebaker, Booth, & Francis, 2007). I focused particularly on measures of verbs, tenses, affective terms, cognitive terms, perceptual terms, and relativity terms. I compared each measure across conditions, looking for differences and similarities. I also compared each measure between original and alternative events.

This chapter was prepared specifically for submission to the *Journal of Memory and Language*, as this article examines linguistic style in relation to memory and future thinking. The description of the journal is appended to this chapter (p. 280). While this is a co-authored manuscript with my two supervisors, I was the major contributor to all aspects of the experimental design, the data analysis, and the preparation of the manuscripts. Each of these stages was conducted with input and advice from Amanda Barnier and John Sutton.

The data described in this chapter was also presented at two international conferences and received the award for the best student's presentation at the second one:

Cordonnier, A., Barnier, A.J., & Sutton, J. (2014, June). *On the diversity of mental time travel.* Invited colloquium at the Department Colloquium Series, Catholic University of Louvain-la-Neuve, Louvain-la-Neuve, Belgium.

Cordonnier, A., Barnier, A. J., & Sutton, J. (2014, October). *Temporal direction, constructive process, and mental time travel.* Paper presented at the ARC Centre of Excellence in Cognition and its Disorders, Memory Program Retreat "Memory in the Treetops", Avoca Beach, Australia.

Linguistic Style of Narratives in Autobiographical Thinking

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Acknowledgements

This work was supported by a Macquarie University Research Excellence Scholarship to Aline Cordonnier, by an Australian Research Council (ARC) Discovery Project and ARC Future Fellowship to Amanda Barnier, by an ARC Discovery Project to John Sutton, and by the Memory Program of the ARC Centre of Excellence in Cognition and its Disorders and the Department of Cognitive Science, Macquarie University.

Abstract

Linguistic style analyses can reveal how personal events are constructed, perceived, and assessed. Previous research has suggested that remembered future events are experienced differently to imagined future events, but no study has compared how these events are described. Across two experiments, we examined differences in linguistic style across narratives of past and future autobiographical events. Participants verbally described remembered, imagined, or planned events, and their counterfactual or prefactual versions. The transcripts were then run through the Linguistic Inquiry and Word Count (LIWC) text analysis software. We explored different linguistic measures, including verbs and tenses, but also including affective, cognitive, perceptual, and relativity terms. Results showed that remembered events were described using different terms than both imagined and planned future events. However, counterfactual events were described more similarly to future events than to remembered events. The differences in linguistic style were thus mainly between experienced and hypothetical autobiographical events.

Keywords: Future thinking, memory, linguistic analysis, LIWC, autobiographical thinking

Linguistic style of narratives in autobiographical thinking

Spoken or written narratives of personal events are a form of externalization of mental representations. Yet the words used are not only a reflection of content, they can tell us about the individual's current emotional state or their personal thoughts (Pennebaker, Mehl, & Niederhoffer, 2003). Words can also reveal some of the underlying processes at play when constructing and reconstructing events, depending on the personal meaning of the event, as well as the current function of the narrative (Tausczik & Pennebaker, 2010). Across this paper, we examine the linguistic style of a range of autobiographical narratives.

Scientific interest in comparing how we feel and talk about personal past and future events has grown over the last twenty years. Cognitive scientists have argued that the capacity to remember past events is intrinsically linked with the capacity to imagine personal future events (Atance & O'Neill, 2001; Suddendorf & Corballis, 1997) and that both rely on similar underlying constructive processes (for reviews, see D'Argembeau, 2012; Klein, 2013; Szpunar, 2010). Researchers have compared past and future thinking, looking for similarities and differences between the two processes from various neuropsychological, neural, and cognitive perspectives (for a review, see Chapter 1).

In cognitive experiments, researchers have principally investigated two main measures of past and future thinking: the raw materials (input) and the phenomenology (product[1]). The raw materials, derived from episodic and semantic memory, are similarly used in past and future thinking to construct personal events (Irish, Hodges, & Piguet, 2013; Schacter & Addis, 2007a; see also Chapter 3). They are usually measured by coding narratives of past and future events, often using an adapted version of the Autobiographical Interview coding

[1] By using the word "product", we do not infer that the subjective experience of the event is totally separated from the representation of the event. Instead, we use the word "product" as a mean to signify that we examine a single part of complex and interacting systems, such as the subjective experience felt when thinking about an autobiographical event, but also the linguistic style used to describe the event.

scheme that categorizes details as internal or external (Addis, Musicaro, Pan, & Schacter, 2010; Addis, Wong, & Schacter, 2008; Cole, Gill, Conway, & Morrison, 2012; Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002). Phenomenology represents the subjective experience associated with thinking about autobiographical events (Johnson, Foley, Suengas, & Raye, 1988). It is usually measured by asking participants to rate their experience of thinking about events on scale items (Arnold, McDermott, & Szpunar, 2011; D'Argembeau & Van der Linden, 2004, 2006, 2012; De Brigard & Giovanello, 2012). However, another interesting product of personal events is the way they are described. To the best of our knowledge, no study has examined the narratives of different types of autobiographical thinking for their linguistic style, which is what we aim to do in this paper.

So far, research has generally focused on investigating the differences and similarities between the process of remembering personal past events and the process of imagining personal future events. In our cognitive framework (Chapter 2), we discussed the importance of refining and distinguishing different forms of autobiographical thinking. Therefore, in this paper, we examine not only the processes of remembering past events and imagining future events, but also the process of planning future events, which is an essential part of future thinking and tends to be more plausible and goal-oriented (D'Argembeau & Mathy, 2011; see also Chapter 3), as well as the process of simulating alternative versions of past events (or, in other words, thinking counterfactually), which shares the temporal orientation of memories but the hypothetical characteristic of future thoughts (Byrne, 2016). In the first part of the two experiments reported here, we compare remembered past events, imagined future events and planned future events. In the second part, we compare counterfactual (alternative versions of remembered past events), prefactual imagined (alternative versions of imagined future events) and prefactual planned events (alternative versions of planned future events) with one another, but also with their corresponding original events.

Linguistic Analyses

Linguistic analyses of narratives have a long tradition in psychology. For example, researchers have shown that certain linguistic variables, such as words associated with insightful and causal thinking, predict improvements in psychological and physical health (Pennebaker, Mayne, & Francis, 1997). Researchers have also shown that the use of pronouns predict the quality of interpersonal relationships, such as romantic relationships (Simmons, Gordon, & Chambless, 2005). Forensic and memory scientists have used linguistic analysis to help distinguish true from false statements, true memories from false memories. Techniques based on text-analysis, such as Criterion Base Content Analysis, have sought to assess the veracity of child witnesses' testimony in trials for sexual offences (Raskin & Esplin, 1991; Vrij, 2005). The underlying hypothesis is that truthful statements based on experienced events should differ in content and quality from unfounded, falsified, or distorted stories (Undeutsch, 1989). If memories can be differentiated from narratives about personal past events that did not happen based on the way they are described, can the same technique be used to differentiate memories from narratives about hypothetical personal future events?

In our previous paper (Chapter 4), we asked a similar question with regards to phenomenological ratings, as they have also been used to attempt to differentiate true from false memories (Johnson et al., 1988). Across two experiments,[2] we examined the phenomenology of a range of autobiographical events, including remembered past events, imagined future events, planned future events, and alternative versions of these events. We first noted similar underlying components to all autobiographical processes, such as autonoesis and scene construction, but we also found differences. Our analyses indicated that remembered events were seen more clearly and with more visuo-spatial details than hypothetical future events as well as hypothetical past events (which we called counterfactual

[2] The same experiments as the ones described in this chapter.

events), but only when directly compared. Phenomenology therefore seemed to be more affected by the fact that remembered events had been experienced and hypothetical events had not, than by the fact that some autobiographical thinking processes were oriented towards the past and others towards the future. These results support the idea that remembered events might be “mental occurrences” of a different kind than hypothetical events, as one can only be experientially aware of experienced past events (Debus, 2014).

One way to understand how remembered events might differ from other non-experienced events is through the difference between constructive and reconstructive processes. Here, we follow Michaelian’s (2011) terminology, where the term *constructive* refers to processes at encoding and the term *reconstructive* refers to processes at retrieval. Therefore, we could argue that recalling memories depends both on constructive and reconstructive processes, whereas imagining an event that has never happened, set in the past or future, is first and foremost a constructive process. It is as if the event was encoded for the first time as it is mentally constructed (see also Chapter 2). Consequently, if these different types of autobiographical events are constructed and reconstructed differently, the difference might transpire in the language used to describe these events. Examining the linguistic style can thus shed light on the underlying constructive processes.

Aims

Ratings of participants’ subjective experience are, however, only one type of product of thinking autobiographically. While this product focuses on the phenomenological experience, the way we feel and perceive the events, there is also the linguistic style we use when we talk about and describe these events. In this paper we investigate a second product, namely event narratives, which we collected during the same sessions as the phenomenological data mentioned above. In the same way that examining phenomenological ratings highlighted similar components of all types of autobiographical thinking but also disparities across them, we expected that linguistic analyses of a range of autobiographical narratives would provide additional evidence of these similarities and differences.

In our experiments, we decided to use the Linguistic Inquiry and Word Count computer program (LIWC, Pennebaker, Booth, & Francis, 2007), text analysis software that counts instances of words consistent with various linguistic, emotional, and cognitive categories. LIWC is a powerful tool that has been scientifically validated and used in many studies in personality, social, and clinical psychology (for a review, see Tausczik & Pennebaker, 2010). As discussed above, linguistic indicators reflect more than just content as they can disclose aspects of the narratives and their representation that are less deliberative (Pennebaker & Graybeal, 2001). For example, empirical studies using LIWC showed that deceptive statements tended to be more negative, contained more motion terms, and were less descriptive than truthful statements (Bond & Lee, 2005; Newman, Pennebaker, Berry, & Richards, 2003).

In this paper, we report on two experiments investigating linguistic style across a broad range of autobiographical thinking processes. Experiment 1 followed a between-subjects design, which avoided the risk of an order effect (see Chapter 3 and Chapter 4), whereas experiment 2 followed a within-subject design, where clearer comparisons of linguistic style can be made with individuals. We explored different linguistic measures of narratives across three conditions (remembering past events, imagining future events, and planning future events), two parts (original events and their alternative events, called counterfactual, prefactual imagined, and prefactual planned events), and two experiments.

We selected a range of categories from the ones available within LIWC that we deemed of interest for our research. First, we selected measures indicative of verbs and tense use. As we compared events that were either goal-directed (planned events) or more related to a specific state in time (remembered or imagined events), we expected goal-directed events to contain more common verbs. Also of particular interest was the use of past, present, and future tense. Hoerl (2008) suggested that one way to examine the capacity for mental time travel into the past or the future is to analyze the ability to be engaged in tensed thought. Therefore, we expected that all past events (remembered and counterfactual) would be described in past tense, whereas future events (imagined, planned, prefactual imagined and prefactual planned) would be described in future tense.

However, a study using LIWC to analyze the function of narratives showed that after reading a story, narratives from participants who had to create and tell an entertaining version of the story contained a greater percentage of present tense verbs than when the event was retold while trying to be as accurate as possible (Dudukovic, Marsh, & Tversky, 2004). The authors suggested that present tense represented the fact that participants were “in the moment” when describing the event, maybe constructing it as they were telling it. Another study also showed that the present tense was more often found in undisclosed than in disclosed personal events, suggesting that undisclosed events might not be integrated into personal history (Pasupathi, 2007). As counterfactual events are not part of someone’s history and nor are future events, we might also expect them to be told in present tense.

Second, we examined the number of positive and negative emotion terms in narratives. Past studies have hypothesized that healthy adults tend to see the future more positively and less negatively that it realistically would be, calling this an optimism bias (Schacter & Addis, 2007b; Sharot, 2011; Weinstein, 1980). Therefore, we expected to find more positive and fewer negative terms in future than past events.

Third, we selected the eight measures associated with the category that LIWC calls “cognitive processes”. To the best of our knowledge, no study has yet investigated narratives of future events with LIWC, but some research examining self-relevant past events, as well as story narratives and deceptive statements, has analyzed the use of cognitive process terms (e.g., Dudukovic et al., 2004; Newman et al., 2003; Pasupathi, 2007). In an article reviewing how LIWC has been used in research, Tausczik and Pennebaker (2010) suggested that terms indicative of cognitive processes represented the way people connect thoughts, construct, or evaluate events. For example, the use of causation terms (e.g., because, effect, hence) or insight terms (e.g., think, know, consider) suggest the active process of reappraisal or reconstruction of events, while the use of or tentative terms (e.g., maybe, guess, depends) could indicate that the story is still being formed (Pasupathi, 2007; Tausczik & Pennebaker, 2010).

In our experiments, we anticipated differences in the type of cognitive mechanisms terms found in autobiographical narratives. First, we expected remembered past events to contain more certainty, causation, and insight terms than future and counterfactual events, as participants had already experienced the events and therefore had a representation in mind they could reconstruct with more certainty. Second, we suggested in our cognitive framework (see Chapter 2) that imagined events were not required to be plausible. Hence, participants might not have considered other possible ways the event could happen or the causal link leading to its conclusion when simply describing an imagined possible future event, compared to when planning for a future event. Consequently, we expected more tentative and causation terms in planned than imagined events. And third, we expected alternative events, both past and future, to contain more discrepancy terms, such as “could” or “would”, as participants constructed their event thinking of plausible details to insert.

Finally, we also included measures of perceptual processes; specifically terms indicative of visual, auditory, and kinesthetic details as well as terms indicative of the relation in space and time (and their combined version that refers to movement). Research on the phenomenology of autobiographical events, including our own (presented in Chapter 4), has shown that remembered events contains more sensory details and has a clearer visuo-spatial context than imagined events (Arnold et al., 2011; D'Argembeau & Van der Linden, 2004, 2006). Therefore, we expected to find more perceptual and relativity terms in remembered events than in any other condition.

In conclusion, we aimed to find the linguistic styles used to describe narratives of remembered past events, imagined future events, and planned future events, but also narratives of alternative versions of these events. We looked for similarities and differences across conditions, and expected that these would shed light on some of the underlying processes and characteristics associated with autobiographical thinking.

Experiment 1

Method

Participants. Fifty-one university undergraduate students enrolled in an introductory psychology course at Macquarie University, Australia, and native English speakers (42 female and 9 male, mean age = 20.14 years, *SD* = 4.00, range: 18 – 42 years) participated in our study.[3] They gave informed consent prior to testing, including agreement to be audio recorded, and received course credit as compensation for their time, in accordance with the Macquarie University Ethics Committee. The testing session was one hour long. As we followed a between-subjects design, upon arrival, participants were randomly allocated to one of three conditions: the remembering condition (R), the imagining condition (I), or the planning condition (P).

Materials and procedure. We separated the experiment into two parts. During the first half, participants remembered past events, imagined future events or planned for future events. In the second half, participants provided alternative versions of these events.

[3] We collected two types of data from the same sample of participants and within the same experiment. Phenomenological ratings are analyzed in chapter 4, whereas this chapter examines the linguistic styles of narratives. The sample size was determined by estimating the number of participants necessary to analyse both phenomenological ratings and linguistics data. Based on previous research, and taking into account the length or our testing session, which included multiple oral descriptions of events, we settled on 51 participants describing six events each across two parts.

Part 1. Participants were informed they would talk about three specific autobiographical events that happened to them before they started their university degree (for the remembering condition) or that could happen to them after they finished their university degree (for the imagining and planning conditions). We specified that the events did not need to be important or significant; however they had to be unique, single events occurring at a specific point in time and lasting for a few minutes or a few hours, but no longer than a day. Furthermore, we told participants to avoid extended events or events that blended into other similar events. We provided examples of repeated and extended events to make sure they understood their meanings. Participants then told us about a family dinner as a practice test. If they did not generate a specific personal event, they received feedback and additional explanations.

Participants were then shown three pairs of cues and asked to select one cue from each pair. The pairs of cues were: (a) *a birthday celebration* or *a date/a meeting with a friend*; (b) *a first day of work/volunteering* or *an exam/a test*[4]; (c) *a day trip* or *a major public event*. We selected these cues as we expected everyone to be able to generate both past and future specific events related to them.

For each generated event, participants completed a series of four steps: general questions, process task, description task, and phenomenological questionnaire, inspired by D'Argembeau and Van der Linden's procedure (2004, 2006). The first step required participants to take a few seconds after receiving the first cue to think of an event, and then answer general questions about where this event was set, when (month and year), at what time of the day the event started, and the name or a description of another person present (e.g. "Jack" or "the bus driver"). We restricted events to ones where at least one other person was

[4] Participants were told that exam or test did not need to be about school, it could be a music exam, a driving test, a test for a job, etc.

present because the second part of the experiment required participants to generate an alternative version of the event with another person instead of the original one.

The second step involved participants closing their eyes for one minute and mentally remembering, imagining, or planning the event. In the remembering condition, the experimenter provided the following instructions: “I am going to give you 1 minute to close your eyes and mentally remember this event. Keeping in mind the answers to the general questions you just gave me, be sure to remember it as it happened. It is important that you try to make it as clear and as detailed as possible.” In the imagining condition, the experimenter provided the following instructions: “I am going to give you 1 minute to close your eyes and mentally imagine this event. Keeping in mind the answers to the general questions you just gave me, be sure to keep it in the future when things might not be the same. It is important that you try to make it as clear and as detailed as possible.” Finally, in the planning condition, the experimenter provided the following instructions: “I am going to give you 1 minute to close your eyes and mentally plan for this event. Keeping in mind the answers to the general questions you just gave me, be sure to keep it in the future when things might not be the same. Also be sure to really think about the different steps you will need to undertake to successfully plan for this event. It is important that you try to make it as clear and as detailed as possible. We named this task the “process task” because it was the moment where participants applied one of the autobiographical processes of thinking about an event in time (remembering, imagining, or planning).

The third step, the description task, examined the effect of the process task on the way participants verbally described, for up to three minutes, the event they had just remembered, imagined, or planned. In the planning condition, participants described the event itself and not the planning process, so every participant described the occurrence of a personal specific event, regardless of the condition. In the fourth and last step, participants answered a questionnaire using a 7-point Likert scale while keeping the event they had just described in mind. We will not discuss the questionnaire any further here as it was fully described and analyzed in a previous paper (see Chapter 3).

Part 2. To investigate counterfactual and prefactual thinking, we created a second part to our study by asking participants to generate an alternative version for each of the events they just had described. Each pair of cues was associated with a different type of counterfactual (for past events) or prefactual (for future events) change. “Work” and “exam” cues led to a change in emotional valence; “birthday” and “date” cues led to a change in person; and “trip” and “public event” cues led to a change in location. For the change in emotional valence, we asked participants to “think about what would have happened/happen if instead of being a *[positive/negative/neutral, depending on their ratings of the valence of the event]* event, it was a *[opposite valence, if neutral, we asked for positive]* event”. For the change in person, we asked them to “think about what would have happened/happen if instead of *[the name of the person they provided during the general questions step]*, it was someone else who was present during the event (and they could decide who else it would be)”. For the change in location, we asked them to “think about what would have happened/happen if instead of *[the location they provided during the general questions step]*, the event was set somewhere else (and they could decide where else it would be)”.

Participants had a few seconds to think of how else the event would occur before they once more completed the process task. With their eyes closed for one minute, they thought about how it could have happened/could happen considering the change. Similarly to part 1, they subsequently described this new version of the event to the experimenter for up to three minutes, before completing the questionnaire again. Finally, the same steps were repeated for the other two events.

In summary, each participant remembered, imagined, or planned three events (past or future, depending on their allocated condition) and provided one alternative version for each original event, one following a change of emotion, one following a change of person, and one following a change of location. For each original and alternative event, participants took one minute to remember, imagine or plan the event, then verbally described the event before answering the questionnaire. At the end of the experiment, participants completed a final questionnaire about their demographics and how difficult they found the various tasks. Then we fully debriefed them and thanked them for their time.

Data analysis. A professional transcriber, blind to the aims of the study, transcribed all our audio-recordings. The main author checked that the transcriptions were accurate before analyzing the data. To compare narratives in a quantitative way, we ran them through the LIWC text analysis software. Of particular interest in the present study was the total word count, the use of verbs and tenses, and the use of terms relating to affective, cognitive, or perceptual processes, as well as to relativity. Table 1 lists the categories analyzed, with example words categorized in them, as well as the number of words in the category (Pennebaker, Chung, Ireland, Gonzales, & Booth, 2007).

The understanding of the meaning behind some categories can be straightforward in some cases (e.g., verbs and verb tenses categories), whereas other dimensions are more subjective and up for interpretation (e.g., “discrepancy”, “exclusive”). To create the lists used in LIWC, two out of three judges had to agree that each word proposed to be part of a category should indeed be included (Pennebaker, Chung, et al., 2007). One of the most interesting categories for us is the category of cognitive processes. This category might reflect issues of meta-cognition or the presence of underlying cognitive mechanisms at play during the thought process, such as causal thinking (“causation”), making distinctions (“exclusive”), showing inconsistency or many possibilities (“discrepancy”) or uncertainty (“tentative”).

These words can thus inform us about the depth, the complexity, or the evaluation of the event. It is important to note that aside from the total word count, the output of categories is given as a percentage of the total number of words in the text sample. For example, the past tense category would calculate the percentage of verbs that are conjugated in the past tense compared to the total number of words. Furthermore, some categories have lower or higher incidences of words (see Table 1) and thus, are not really comparable between one another.

Table 1

Summary of the LIWC Categories Analyzed in this Paper, some Examples and the Number of Words Contained in Each Category

Category type	**Category**	**Examples**	**Words in category**
Verbs	Common verbs	Walk, went, see	383
	Auxiliary verbs	Am, will, have	144
Verb tenses	Past tense	Went, ran, had	145
	Present tense	Is, does, hear	169
	Future tense	Will, gonna	48
Affective processes	Positive emotion	Love, nice, sweet	406
	Negative emotion	Hurt, ugly, nasty	499
Cognitive processes	Inclusive	And, with, include	18
	Exclusive	But, without, exclude	17
	Insight	Think, know, consider	195
	Causation	Because, effect, hence	108
	Discrepancy	Should, would, could	76
	Tentative	Maybe, perhaps, guess	155
	Certainty	Always, never	83
	Inhibition	Block, constrain, stop	111
Perceptual processes	See	View, saw, seen	72
	Hear	Listen, hearing	51
	Feel	Feels, touch	75
Relativity	Motion	Arrive, car, go	168
	Space	Down, in, thin	220
	Time	End, until, season	239

Results

Difficulty ratings. At the end of the testing session, participants rated the perceived difficulty of each task on a scale from 1 (very easy) to 7 (very hard). Generally, they found our tasks neither too easy nor too hard (means ranged between 3.06 and 5.24, see Table 2). There was no difference across conditions regarding how difficult it was to think about original events or how difficult it was to describe them ($p > .05$). Regarding counterfactual and prefactual events, participants rated the process tasks equally across conditions, regardless of the type of change they had to apply ($p > .05$). Therefore, the difficulty of our tasks cannot explain the following results.

Table 2

Means and Standard Deviations For Each Difficulty Rating as a Function of Condition

Part	**Task**		**Condition**	
		Remembering *M* (*SD*)	Imagining *M* (*SD*)	Planning *M* (*SD*)
Part 1 - original	Process task	3.24 (1.82)	3.65 (1.62)	3.06 (1.52)
	Content task	3.71 (1.65)	4.82 (1.47)	4.53 (1.42)
Part 2 - alternative				
Change of location	Process task	4.82 (1.51)	3.65 (1.58)	3.82 (1.70)
	Description task	5.24 (1.48)	4.29 (1.53)	3.71 (1.26)
Change of person	Process task	4.47 (1.66)	3.29 (1.96)	3.24 (1.56)
	Description task	4.71 (1.40)	4.12 (1.83)	3.18 (1.51)
Change of emotion	Process task	3.41 (2.06)	3.94 (1.95)	4.18 (2.13)
	Description task	4.00 (1.90)	4.53 (1.66)	4.29 (1.76)

Part 1: Remembering vs. imagining vs. planning.

Content. In total, we collected data from 153 events: 51 remembered past events, 51 imagined future events, and 51 planned future events. To give an idea of the content of the events generated in this study following the pairs of cues, 34 events were about a day trip (22.2%) whereas 17 events were about a major public event (11.1%), 31 events were about a birthday celebration (20.3%) whereas 20 events were about a date or a meeting with a friend (13.1%), and 27 events were about an exam or a test (17.6%) whereas 24 events were about a first day at work or first day volunteering (15.7%). These events were collapsed together in our analyses as they were not distributed equally across conditions.

As the three original events generated by the same participant were not independent, we averaged them to create a single score on each selected LIWC measure. Unless specifically noted, we ran one-way between-subjects ANOVAs on these LIWC measures to compare the effect of autobiographical thinking processes (remembering, imagining and planning) on how events were described. We corrected our contrasts for multiple comparison by applying the Bonferroni correction.[5]

Total word count. We analyzed the *total word count*. A univariate ANOVA revealed no differences across our three conditions, $F(2, 48) = 2.55$, $p = .089$. Participants provided the same number of words when remembering, imagining, or planning events (see Table 3). Consequently, further differences cannot be explained by the different length of narratives.

Table 3

Total Word Count as a Function of Condition

LIWC Category	Condition	Mean (SD)	95% CI
Word count	Remembered	340.76 (130.33)	[308.57; 372.96]
	Imagined	301.43 (110.34)	[269.24; 333.62]
	Planned	260.76 (107.01)	[228.57; 292.96]

Verbs. We analyzed the percentage of *common verbs* and *auxiliary verbs* (see Table 4). For *common verbs*, a univariate ANOVA revealed a difference across conditions, $F(2, 48) = 12.02$, $p < .001$, $\eta_p^2 = 0.34$. Pairwise contrasts showed that planned events contained more verbs than remembered events ($p < .001$). Imagined events also contained more verbs than remembered events and less than planned events, but these differences failed to reach significance ($p = .054$ for both comparisons). For *auxiliary verbs*, a univariate ANOVA

[5] To facilitate understanding, we used a reversed Bonferroni. Instead of dividing our alpha by the number of tests, we multiplied our p-values by the number of tests and compared that new p-value against an alpha at .05

revealed a difference across conditions, $F(2, 48) = 19.45$, $p < .001$, $\eta_p^2 = 0.45$. Remembered events had significantly fewer auxiliary verbs than both imagined and planned future events ($p < .001$), with no difference between the two types of future events ($p = .150$).

Table 4

Percentage of Common Verbs and Auxiliary Verbs as a Function of Condition

LIWC Category	Condition	Mean (SD)	95% CI
Common verbs	Remembered	14.22 (2.37)	[13.44; 15.00]
	Imagined	16.11 (3.39)	[15.33; 16.90]
	Planned	18.01 (2.63)	[17.23; 18.79]
Auxiliary verbs	Remembered	7.94 (2.30)	[7.19; 8.70]
	Imagined	10.74 (3.18)	[9.99; 11.49]
	Planned	12.12 (2.61)	[11.37; 12.87]

Verb tenses. We compared the use of *present, past,* and *future tenses* (see Table 5). A 3 (condition: R, I, P) x 3 (tense: past, present, future) ANOVA with condition as a between-subjects variable and tense as a within-subjects variable revealed a significant interaction between condition and tense, $F(4, 94) = 78.60$, $p < .001$, $\eta_G^2 = 0.74$. As expected, participants used the past tense more often than the present or future tense when remembering past events ($p < .001$ for both comparisons). Yet, when imagining or planning future events, participants used present tense considerably more often than future tense or past tense ($p < .001$ for all comparisons). It is also worth noting that future tense appeared more often in planned than imagined ($p = .019$) or remembered events ($p = .001$).

Table 5

Percentage of Verb Tenses as a Function of Condition

LIWC Category	Condition	Mean (SD)	95% CI
Past	Remembered	10.44 (2.12)	[9.85; 11.02]
	Imagined	2.52 (2.78)	[1.93; 3.10]
	Planned	1.24 (1.09)	[0.65; 1.82]
Present	Remembered	2.89 (1.90)	[2.09; 3.69]
	Imagined	9.47 (3.66)	[8.67; 10.27]
	Planned	10.54 (2.85)	[9.74; 11.34]
Future	Remembered	0.19 (0.31)	[0.00; 0.70]
	Imagined	1.62 (2.17)	[1.11; 2.12]
	Planned	3.13 (2.27)	[2.63; 3.64]

Affective processes. We analyzed the percentage of *positive* and *negative terms*. As we can see in Table 6, participants generated more positive than negative terms in all conditions. For *positive terms*, a univariate ANOVA revealed no difference across conditions, $F(2, 48) = 0.22$, $p = .804$. Participants used the same percentage of positive terms in all types of events. For *negative terms*, a univariate ANOVA revealed a difference across conditions, $F(2, 48) = 5.01$, $p = .011$, $\eta_p^2 = 0.17$. Participants used fewer negative terms in planned events. However, this difference was only significant when compared to imagined events ($p = .010$) but not compared to remembered events ($p = .101$).

Table 6

Percentage of Affective Processes Terms as a Function of Condition

LIWC Category	Condition	Mean (SD)	95% CI
Positive emotion	Remembered	2.35 (1.26)	[1.96; 2.74]
	Imagined	2.53 (1.40)	[2.14; 2.92]
	Planned	2.57 (1.53)	[2.18; 2.96]
Negative emotion	Remembered	0.73 (0.70)	[0.52; 0.95]
	Imagined	0.87 (0.94)	[0.66; 1.09]
	Planned	0.38 (0.65)	[0.17; 0.60]

Cognitive processes. We analyzed the eight cognitive categories provided by LIWC. As can be seen in Table 7, all events contained more inclusive terms than any of our other cognitive processes measures. Yet, this is not surprising as inclusive terms comprise words such as "and" or "with", which are common in narratives.

Univariate ANOVAs revealed no difference across conditions for five characteristics: *inclusive*, $F(2, 48) = 1.51$, $p = .232$; *exclusive*, $F(2, 48) = 0.13$, $p = .880$; *causation*, $F(2, 48) = 1.98$, $p = .149$; *certainty*, $F(2, 48) = 0.74$, $p = .483$; and *inhibition*, $F(2, 48) = 1.87$, $p = .165$. However, univariate ANOVAs revealed a difference across conditions for the other three characteristics: *insight*, $F(2, 48) = 5.01$, $p = .010$, $\eta_p^2 = 0.17$; *discrepancy*, $F(2, 48) = 9.10$, $p < .001$, $\eta_p^2 = 0.28$; and *tentative*, $F(2, 48) = 5.97$, $p = .005$, $\eta_p^2 = 0.20$. We followed up these ANOVAs with planned contrasts.

The *insight* category comprised words such as "think", "know", or "consider". Remembered events contained more insight terms than both imagined and planned events ($p = .024$ for both comparisons). The *discrepancy* category comprised words such as "should", "would", or "could". Remembered events contained fewer discrepancy terms than both imagined ($p = .036$) and planned ($p = .001$) future events.[6] The two types of future events were similar in their use of insight and discrepancy terms ($p > .10$ for both comparisons). Finally, the *tentative* category comprised words such as "maybe", "guess", or "depends". The only significant comparison was between remembered and planned events ($p = .003$), with planned future events containing more tentative terms. Imagined events scored in the middle, with no significant differences with planned or remembered events ($p > .10$ for both comparisons).

[6] As the variances were not homogenous, we used bootstrapped contrasts.

Table 7

Percentage of Cognitive Processes Terms as a Function of Condition

LIWC Category	Condition	Mean (SD)	95% CI
Insight	Remembered	1.90 (1.29)	[1.59; 2.22]
	Imagined	1.17 (1.07)	[0.85; 1.49]
	Planned	1.17 (1.07)	[0.85; 1.49]
Causation	Remembered	1.08 (0.84)	[0.81; 1.36]
	Imagined	1.23 (0.99)	[0.96; 1.50]
	Planned	1.52 (1.11)	[1.25; 1.80]
Discrepancy	Remembered	0.51 (0.45)	[0.02; 1.00]
	Imagined	1.67 (2.09)	[1.18; 2.15]
	Planned	2.65 (2.17)	[2.16; 3.14]
Tentative	Remembered	2.48 (1.37)	[1.94; 3.03]
	Imagined	3.44 (2.21)	[2.90; 3.99]
	Planned	4.39 (2.18)	[3.85; 4.94]
Certainty	Remembered	1.34 (1.14)	[1.04; 1.64]
	Imagined	1.05 (1.12)	[0.75; 1.35]
	Planned	1.33 (1.01)	[1.03; 1.63]
Inhibition	Remembered	0.39 (0.50)	[0.26; 0.52]
	Imagined	0.44 (0.48)	[0.31; 0.57]
	Planned	0.24 (0.42)	[0.11; 0.37]
Inclusive	Remembered	10.92 (3.32)	[9.92; 11.94]
	Imagined	9.87 (3.96)	[8.86; 10.88]
	Planned	9.35 (3.63)	[8.34; 10.36]
Exclusive	Remembered	2.73 (1.48)	[2.31; 3.16]
	Imagined	2.54 (1.54)	[2.11; 2.97]
	Planned	2.70 (1.62)	[2.27; 3.13]

Perceptual processes. We analyzed the three perceptual categories provided by LIWC (see Table 8). Univariate ANOVAs revealed no differences across conditions: *see*, $F(2, 48) = 2.16$, $p = .127$; *hear*, $F(2, 48) = 0.26$, $p = .770$; and *feel*, $F(2, 48) = 0.34$, $p = .713$. Participants used the same percentage of visual, auditory, and kinesthetic terms when remembering past events or when imagining or planning future events. However, as we can see in Table 8, the percentage of perceptual terms was very low (less than 2%).

Table 8

Percentage of Perspective Processes Terms as a Function of Condition

LIWC Category	Condition	Mean (SD)	95% CI
See	Remembered	0.80 (0.79)	[0.51; 1.10]
	Imagined	1.38 (1.33)	[1.09; 1.67]
	Planned	1.05 (0.96)	[0.76; 1.34]
Hear	Remembered	0.55 (0.65)	[0.31; 0.79]
	Imagined	0.64 (0.99)	[0.41; 0.88]
	Planned	0.49 (0.88)	[0.26; 0.73]
Feel	Remembered	0.46 (0.53)	[0.29; 0.63]
	Imagined	0.55 (0.70)	[0.37; 0.72]
	Planned	0.44 (0.65)	[0.26; 0.61]

Relativity. Finally, we analyzed motion, space, and time terms (see Table 9). Univariate ANOVAs revealed no differences across conditions: *motion*, $F(2, 48) = 2.33$, $p = .108$; *space*, $F(2, 48) = 0.99$, $p = .280$; and *time*, $F(2, 48) = 2.43$, $p = .099$. Participants used the same percentage of relativity terms to describe their events. It is worth noting that if we add our three measures of relativity together, participants used terms indicative of their relation in space and time in a relatively high percentage (around 17%) in all narratives.

Table 9

Percentage of Relativity Terms as a Function of Condition

LIWC Category	Condition	Mean (SD)	95% CI
Motion	Remembered	3.62 (1.63)	[3.16; 4.09]
	Imagined	2.97 (1.59)	[2.51; 3.43]
	Planned	3.77 (1.78)	[3.31; 4.24]
Space	Remembered	7.54 (2.00)	[6.76; 8.32]
	Imagined	8.23 (3.76)	[7.45; 9.01]
	Planned	7.17 (2.43)	[6.39; 7.95]
Time	Remembered	6.86 (1.77)	[6.17; 7.55]
	Imagined	6.18 (2.51)	[5.49; 6.86]
	Planned	7.63 (3.00)	[6.94; 8.31]

Summary. In part 1, we found some interesting differences between the linguistic styles of remembered, imagined, or planned events. Remembered events tended to be described in the past tense and contained more insight terms, which indicates an understanding of how and why the events happened the way they did in the past, and followed our predictions. Imagined and planned future events tended to be described in the present tense, which suggests that participants mentally think about future events as if they are “in the moment”, possibly to support the constructive process of imagining or planning a future event (Dudukovic et al., 2004). Imagined and planned future events also contained more discrepancy terms, which may reflect the hypothetical nature of future events. Furthermore, planned future events contained more verbs and more tentative terms than remembered events, and fewer negative terms. Together, these results speak to the action-oriented characteristic of planned events, where participants are trying to reach a goal by acting upon it, avoiding negative consequences, considering multiple possibilities, and leaving room for improvisation depending on context (Hayes-Roth & Hayes-Roth, 1979; Preston, 2013).

However, we were surprised to find no reliable evidence of differences between remembered, imagined, or planned events in their use of words indicative of perception or their relative position in space and time. Previous studies have consistently shown that past events were subjectively perceived as containing more sensory details, but also as having a clear visuo-spatial context for remembered events (Arnold et al., 2011; D'Argembeau & Van der Linden, 2004). However, it is possible that differences in perceptions do not translate into differences in the linguistic style of narratives used to describe events.

Part 2: Counterfactual thinking vs. prefactual imagining vs. prefactual planning. During the second part of the experiment, participants provided alternative versions of their original events. These alternative versions followed three different types of changes: change of person, change of location, and change of emotional valence. We first ran our analyses taking into account the type of change applied to the event, however there was no relevant evidence of an effect of the type of change. Consequently, we once more averaged the three events generated by each participant to a single score.

Before comparing original events with their alternative versions (so comparing part 1 with part 2), we analyzed the similarities and differences between counterfactual, prefactual imagined, and prefactual planned events.

Total word count. We analyzed the *total word count*. A univariate ANOVA revealed no differences across our three conditions, $F(2, 48) = 0.93$, $p = .402$. Similar to part 1, participants provided the same number of words in counterfactual events, prefactual imagined events, or prefactual planned events (see Table 10). Consequently, further differences cannot be explained by the different length of narratives.

Table 10

Total Word Count as a Function of Condition

LIWC Category	Condition	Mean (SD)	95% CI
Word count	Counterfactual	231.41 (101.45)	[202.46; 260.37]
	Prefactual imagined	275.02 (96.90)	[246.06; 303.98]
	Prefactual planned	247.76 (114.78)	[218.81; 276.72]

Verbs. We analyzed the percentage of *common verbs* and *auxiliary verbs* (see Table 11). For *common verbs*, a univariate ANOVA revealed a difference across conditions, $F(2, 48) = 14.34$, $p < .001$, $\eta_p^2 = 0.37$. Whereas remembered events had the lowest percentage of verbs in part 1, counterfactual events now contained significantly more verbs than prefactual imagined ($p < .001$) and prefactual planned events ($p = .006$). For *auxiliary verbs*, a univariate ANOVA revealed a difference across conditions, $F(2, 48) = 10.21$, $p < .001$, $\eta_p^2 = 0.30$. Counterfactual events contained more auxiliary verbs than prefactual imagined ($p < .001$) and prefactual planned events ($p = .012$).

Table 11

Percentage of Common Verbs and Auxiliary Verbs as a Function of Condition

LIWC Category	Condition	Mean (SD)	95% CI
Common verbs	Counterfactual	22.18 (4.96)	[21.03; 23.33]
	Prefactual imagined	16.50 (3.66)	[15.35; 17.65]
	Prefactual planned	18.70 (3.71)	[17.55; 19.85]
Auxiliary verbs	Counterfactual	16.24 (4.78)	[15.14; 17.34]
	Prefactual imagined	11.45 (3.51)	[10.35; 12.55]
	Prefactual planned	12.97 (3.48)	[11.87; 14.06]

Verb tenses. We compared the use of *present*, *past*, and *future tenses* (see Table 12). A 3 (condition: R, I, P) x 3 (tense: past, present, future) ANOVA with condition as a between-subjects variable and tense a as within-subjects variable revealed a significant interaction between condition and tense, $F(4, 94) = 10.35$, $p < .001$, $\eta^2_G = 0.27$. When describing counterfactual events, participants used past and present tenses equally ($p = 1.00$) but rarely future tense ($p < .001$ for both comparisons). However, when imagining alternative versions of events, this was mostly done using present tense ($p < .001$ for both comparisons), with no difference between past and future tense ($p = .913$). Finally, alternative planned events were mainly told in present tense ($p < .001$ for both comparisons), and sometimes in future tense, but rarely in past tense ($p = .020$).

It is also interesting to compare the use of tenses across conditions. Participants still used past tense more often in the counterfactual than in any of the prefactual conditions ($p = .001$ for both comparisons[7]), yet present tense was used as often in the three conditions ($p > .10$ for each comparison). Surprisingly, future tense was the tense least often found in prefactual imagined events, followed by prefactual planned events ($p = .022$). Counterfactual narratives were more often described in future tense than imagined prefactual events ($p = .003$) but did not differ significantly from prefactual planned narratives ($p = 1.00$).

[7] As the variances were not homogenous, we used bootstrapped contrasts.

Table 12

Percentage of Verb Tenses as a Function of Condition

LIWC Category	Condition	Mean (SD)	95% CI
Past	Counterfactual	7.64 (3.83)	[6.87; 8.40]
	Prefactual imagined	2.62 (2.64)	[1.85; 3.39]
	Prefactual planned	1.52 (1.20)	[0.75; 2.29]
Present	Counterfactual	8.06 (3.52)	[7.06; 9.06]
	Prefactual imagined	9.71 (3.97)	[8.71; 10.71]
	Prefactual planned	9.52 (3.35)	[8.52; 10.52]
Future	Counterfactual	4.31 (2.46)	[3.62; 5.01]
	Prefactual imagined	1.78 (2.27)	[1.08; 2.47]
	Prefactual planned	3.82 (2.76)	[3.13; 4.52]

Affective processes. We analyzed the percentage of *positive* and *negative terms*. As we can see in Table 13, and similar to part 1, participants generated more positive than negative terms in all conditions. Univariate ANOVAs revealed no difference across conditions for both *positive*, $F(2, 48) = 0.92$, $p = .407$, and *negative terms*, $F(2, 48) = 0.56$, $p = .576$. However, absolute percentages of negative terms were very low once more.

Table 13

Percentage of Common Verbs and Auxiliary Verbs as a Function of Condition

LIWC Category	Condition	Mean (SD)	95% CI
Positive emotions	Counterfactual	3.00 (1.89)	[2.49; 3.51]
	Prefactual imagined	2.98 (1.46)	[2.47; 3.49]
	Prefactual planned	3.42 (2.10)	[2.91; 3.93]
Negative emotions	Counterfactual	0.96 (1.10)	[0.67; 1.26]
	Prefactual imagined	0.89 (1.00)	[0.59; 1.18]
	Prefactual planned	0.78 (1.07)	[0.49; 1.07]

Cognitive processes. We analyzed the eight cognitive categories provided by LIWC (see Table 14). Univariate ANOVAs revealed that three out of the five characteristics that were not significant in part 1 remained that way: *inclusive*, $F(2, 48) = 0.124$, $p = .884$; *causation*, $F(2, 48) = 1.15$, $p = .324$; and *inhibition*, $F(2, 48) = 1.13$, $p = .333$. In contrast, *insight* terms and *tentative* terms, which differed across conditions in part 1, were no longer different: *insight*, $F(2, 48) = 0.28$, $p = .759$; *tentative*, $F(2, 48) = 2.30$, $p = .111$. Whereas remembered events contained more insight terms and fewer tentative terms than imagined and planned events in the first part, counterfactual, prefactual imagined, and prefactual planned events contained similar levels of insight (e.g., think, know) and tentative (e.g., maybe) terms.

Similar to part 1, *discrepancy terms* differed across conditions, $F(2, 48) = 10.09$, $p < .001$, $\eta_p^2 = 0.30$. In part 1, discrepancy terms were less often found in remembered events. In part 2, however, they were found more often in counterfactual events than prefactual imagined ($p < .001$) or prefactual planned events ($p = .040$).

Exclusive and *certainty terms*, used alike in all conditions in part 1, differed in part 2: *exclusive*, $F(2, 48) = 3.54$, $p = .037$, $\eta_p^2 = 0.13$; and *certainty*, $F(2, 48) = 3.81$, $p = .029$, $\eta_p^2 = 0.14$. Yet, planned contrasts for both categories did not yield any statistical differences. Counterfactual events tended to have more exclusive terms than prefactual events (prefactual imagined: $p = .066$; prefactual planned: $p = .090$), which might simply reflect direct comparison with original events as it comprised words such as “but”, “without”, or “not”. Prefactual imagined events tended to have fewer certainty terms than prefactual planned ($p = .064$) or counterfactual ($p = .060$) events, however it is worth noting that our absolute percentages were near floor.

Table 14

Percentage of Cognitive Processes Terms as a Function of Condition

LIWC Category	Condition	Mean (SD)	95% CI
Insight	Counterfactual	1.56 (1.37)	[1.20; 1.92]
	Prefactual imagined	1.41 (1.18)	[1.05; 1.77]
	Prefactual planned	1.38 (1.37)	[1.02; 1.74]
Causation	Counterfactual	1.49 (1.30)	[1.17; 1.81]
	Prefactual imagined	1.38 (1.03)	[1.06; 1.70]
	Prefactual planned	1.73 (1.11)	[1.41; 2.05]
Discrepancy	Counterfactual	5.48 (2.91)	[4.77; 6.20]
	Prefactual imagined	2.03 (2.30)	[1.31; 2.75]
	Prefactual planned	3.50 (2.52)	[2.78; 4.21]
Tentative	Counterfactual	5.05 (2.90)	[4.32; 5.78]
	Prefactual imagined	3.66 (2.19)	[2.93; 4.39]
	Prefactual planned	4.83 (2.78)	[4.10; 5.56]
Certainty	Counterfactual	1.37 (1.26)	[1.06; 1.68]
	Prefactual imagined	0.86 (0.99)	[0.55; 1.17]
	Prefactual planned	1.37 (1.10)	[1.06; 1.68]
Inhibition	Counterfactual	0.24 (0.31)	[0.12; 0.35]
	Prefactual imagined	0.37 (0.46)	[0.26; 0.49]
	Prefactual planned	0.32 (0.48)	[0.21; 0.44]
Inclusive	Counterfactual	8.29 (3.53)	[7.32; 9.27]
	Prefactual imagined	8.52 (3.04)	[7.54; 9.50]
	Prefactual planned	8.75 (3.95)	[7.77; 9.73]
Exclusive	Counterfactual	4.76 (1.89)	[4.23; 5.29]
	Prefactual imagined	3.63 (2.01)	[3.10; 4.16]
	Prefactual planned	3.69 (1.88)	[3.16; 4.23]

Perceptual processes. We analyzed the three perceptual categories provided by LIWC (see Table 15). Once again, univariate ANOVAs revealed no differences across conditions: see, $F(2, 48) = 1.54$, $p = .224$; hear, $F(2, 48) = 0.53$, $p = .594$; and feel, $F(2, 48) = 1.11$, $p = .339$. All events contained a small percentage of words describing auditory, visual, or kinesthetic senses.

Table 15

Percentage of Perceptual Processes Terms as a Function of Condition

LIWC Category	Condition	Mean (SD)	95% CI
See	Counterfactual	0.61 (0.77)	[0.23; 0.99]
	Prefactual imagined	1.29 (1.19)	[0.91; 1.67]
	Prefactual planned	1.06 (1.92)	[0.68; 1.45]
Hear	Counterfactual	0.43 (0.74)	[0.23; 0.64]
	Prefactual imagined	0.57 (0.82)	[0.37; 0.78]
	Prefactual planned	0.45 (0.65)	[0.25; 0.66]
Feel	Counterfactual	0.61 (0.77)	[0.23; 0.99]
	Prefactual imagined	1.29 (1.19)	[0.91; 1.67]
	Prefactual planned	1.06 (1.92)	[0.68; 1.45]

Relativity. Finally, we analyzed *motion, space*, and *time terms* (see Table 16). Univariate ANOVAs revealed no differences across conditions for *motion*, $F(2, 48) = 1.08$, $p = .349$; and *time*, $F(2, 48) = 2.68$, $p = .079$. However, the quantity of terms indicative of position in *space* fluctuated depending on condition, $F(2, 48) = 4.14$, $p = .022$, $\eta_p^2 = 0.15$. Prefactual imagined events had significantly more terms relative to space than counterfactual events ($p = .018$). Prefactual planned events were in between the other two conditions but were not significantly different from either ($p > .10$ in both comparisons).

Table 16

Percentage of Common Verbs and Auxiliary Verbs as a Function of Condition

LIWC Category	Condition	Mean (SD)	95% CI
Motion	Counterfactual	2.99 (1.74)	[2.51; 3.47]
	Prefactual imagined	3.13 (1.69)	[2.65; 3.61]
	Prefactual planned	3.54 (1.77)	[3.06; 4.02]
Space	Counterfactual	5.96 (2.68)	[5.25; 6.67]
	Prefactual imagined	7.43 (2.73)	[6.73; 8.14]
	Prefactual planned	6.58 (2.25)	[5.87; 7.29]
Time	Counterfactual	5.48 (2.55)	[4.84; 6.11]
	Prefactual imagined	5.73 (1.85)	[5.10; 6.37]
	Prefactual planned	6.64 (2.43)	[6.01; 7.28]

Summary. In part 2, the differences between counterfactual events, prefactual imagined events, and prefactual planned events were few, but most were related to counterfactual events differing from both types of prefactual events. It is unclear why counterfactual events contained more common and auxiliary verbs. However, theories of counterfactual thinking suggest that counterfactual thoughts are compared to the "true memory" (Byrne, 2016; Epstude & Roese, 2008). Therefore, a possible explanation is that participants in the counterfactual condition might have been using phrasing such as "instead of doing X, we could have done X". Participants in prefactual conditions might have simply suggested another future event, without comparing it verbally to the original version, and hence used fewer verbs. Furthermore, counterfactual events contained more discrepancy terms than prefactual events, which might indicate the process of comparing the alternative versions of past memories to the "true" memory itself, and thus revealing the discrepancies between the two (Byrne, 2002).

Surprisingly, some differences noted during part 1 were not found again in part 2. Participants used the present tense equally to describe counterfactual, prefactual imagined, and prefactual planned events. These results suggest that the temporal orientation of the event is not enough to predict which tense participants will use. The constructive process associated with creating counterfactual past events can lead participants to use the present tense. Similarly, all events contained insight and tentative terms to the same extent. As these terms represent uncertainty (or lack of), it is not surprising to find them in all our hypothetical events.

Finally, prefactual imagined events used significantly more terms relative to space than counterfactual events. This result is unexpected and more research is needed to separate what might be due to individual differences, from diverse responses to our type of changes (and more specifically the change of location), or from true differences between counterfactual and prefactual imagined events.

Part 1 vs. part 2: Counterfactual changes vs. prefactual imagined changes vs. prefactual planned changes. Finally, we wanted to analyze the impact of proposing alternative versions by comparing terms employed in original events with terms used in alternative counterparts. We only examined linguistic categories that revealed differences in part 1, part 2, or both. Unless specified otherwise, we ran mixed ANOVAs with original condition (remembering, imagining or planning) as a between-subjects variable and part (1 or 2) as a within-subjects variable. As we already analyzed part 1 and 2 separately, we concentrated here on the interaction between condition and part.

First, three categories that showed main effects in part 1 or part 2 did not yield any significant interaction: *negative emotions*, $F(2, 48) = 2.63$, $p = .083$; *insight*, $F(2, 48) = 2.14$, $p = .129$; *space*, $F(2, 48) = 1.95$, $p = .153$. The changes in the percentage of negative terms, insight terms, and space terms between original and alternative events were similar across all our conditions.

The measures that yielded significant interactions are illustrated in Figure 1. For each measure, we have represented the percentage of words for original events (on the left hand side) and for alternative events (on the right hand side) across conditions. What should be clearly visible in our figure is that the black line linking remembered and counterfactual past events is not flat, and therefore indicates changes in the way original and alternative narratives are described; whereas the line between both types of future events and their prefactual versions remains flat almost everywhere. In other words, the linguistic style of counterfactual events was different from memories, whereas the linguistic style of prefactual events, imagined and planned, were similar to the original future events.

Therefore, our statistical results yielded a very similar pattern for each significant interaction. In all cases but one, the interaction was solely driven by a strong ($p < .001$) difference between remembered and counterfactual events, whereas original and alternative future events, imagined or planned, remained similar. This was the case for *verbs*, $F(2, 48) = 30.47$, $p < .001$, $\eta_G^2 = 0.31$; *auxiliary verbs*, $F(2, 48) = 34.43$, $p < .001$, $\eta_G^2 = 0.59$; *past tense*, $F(2, 48) = 14.28$, $p < .001$, $\eta_G^2 = 0.11$; *present tense*, $F(2, 48) = 35.89$, $p < .001$, $\eta_G^2 = 0.21$; *future tense*, $F(2, 48) = 31.29$, $p < .001$, $\eta_G^2 = 0.19$; *discrepancy terms*, $F(2, 48) = 32.80$, $p < .001$, $\eta_G^2 = 0.24$; and *tentative terms*, $F(2, 48) = 12.58$, $p < .001$, $\eta_G^2 = 0.08$.

Exclusive terms also showed a significant interaction, $F(2, 48) = 3.20$, $p = .049$, $\eta_G^2 = 0.03$. Yet in this case, this interaction was mostly driven by a main effect of the part, $F(1, 48) = 55.69$, $p < .001$, $\eta_G^2 = 0.42$. All alternative versions narrated in part 2 contained more exclusive terms than original events narrated in part 1 ($p < .05$ for all comparisons). We suggest that this result indicates the act of thinking of how else these events could have happened or could happen. For example, many participants said sentences such as "Instead, we would not have gone to the beach, but to the shops."

In summary, compared to remembered events, participants used more verbs for counterfactual events, but described them more in the present tense and sometimes in the future tense, and less in the past tense. The percentage of discrepancy (e.g., could or would), tentative (e.g., maybe), and exclusive (e.g., not, but) terms also increased in counterfactual events. These results reveal that future thinking and prefactual thinking are described in a similar narrative style, but remembered and counterfactual events are described in a quite different narrative style.

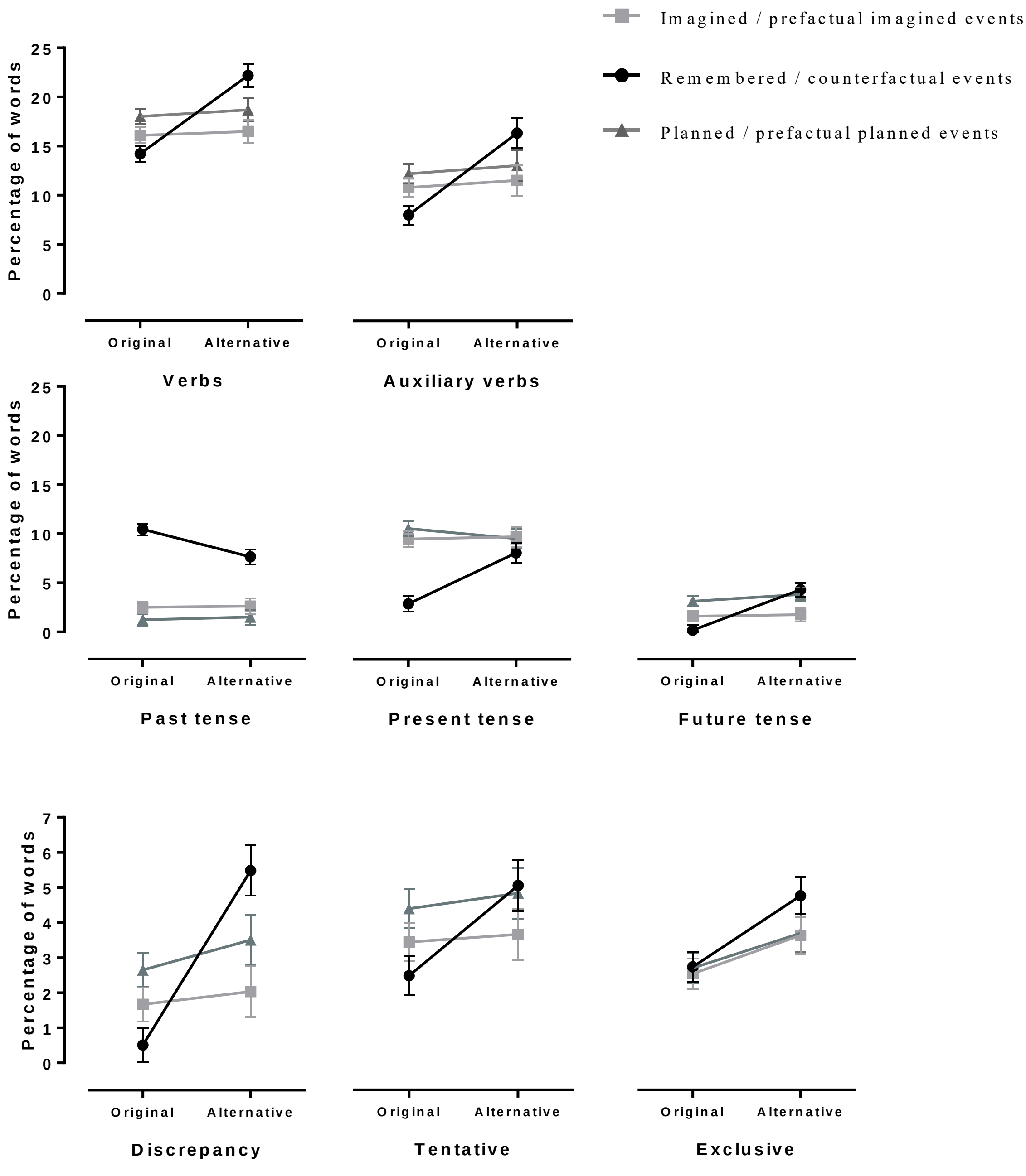

Figure 1. Comparison between original and alternative events across conditions for the percentage of verbs, past tense, present tense, future tense, discrepancy, tentative, and exclusive terms. Error bars represent 95% CI.

Discussion

In the present study, we examined the linguistic style in narratives from a range of autobiographical thinking processes. In the first part of our experiment, participants took a minute to close their eyes and remember past events, imagine future events, or plan future events, before describing to the experimenter how the event did or would occur. In the second part of our experiment, we invited participants to consider how else the event they had just described could have occurred or could occur if it was with someone else, if it was somewhere else, or if the emotional valence of the event was the opposite. Once more, they had a minute to think about it before verbally describing the alternative event. We then transcribed the narratives and used the LIWC text-analysis software to investigate the use of verbs and tenses, but also the presence of terms representative of affective, cognitive, perceptual and relativity characteristics.

Our three conditions differed on a few measures. Narratives of remembered past events contained fewer common and auxiliary verbs, used mainly the past tense, and included more insight terms and fewer discrepancy and tentative terms. Narratives of imagined future events contained more common and auxiliary verbs, which were mainly in the present tense, but rarely in the future tense. Moreover they contained more discrepancy terms than past events. Narratives of planned future events were similar to those of imagined future events: more common and auxiliary verbs, more discrepancy and fewer insight terms than past events. However, although they were also usually described in the present tense, planned events were more often described in the future tense than imagined future events. They also contained fewer negative terms than imagined future events but more tentative terms. Finally, all events displayed similar percentages of positive terms; inclusive, exclusive, causation, certainty, and inhibition terms; perceptive terms, and relativity terms.

Beyond establishing an “identity sheet” of what remembered, imagined, and planned event narratives look like, some differences can inform us of the underlying processes and particularities of thinking about and describing autobiographical events. The substantial use of present tense when describing future events was unexpected to a certain extent. It might indicate how future events need to be constructed, and that thinking of it as if it is happening in the present could support this constructive process (Dudukovic et al., 2004). The presence of discrepancy and tentative terms in larger quantity in future thinking speaks to the hypothetical character of future events. Conversely, as remembered events have been experienced, they contained more terms reflective of the participants’ insight about the event (Pasupathi, 2007; Tausczik & Pennebaker, 2010).

With regards to alternative events, most of the differences between past and future narratives were driven by changes between remembered and counterfactual events. Prefactual events, imagined and planned, remained similar in their use of verbs, tenses, and terms both compared to each other and to their original versions in part 1. However, this was not the case for counterfactual events, which differed strongly from their original remembered events. Counterfactual events generally contained more verbs than remembered and prefactual events. Even though counterfactual events still used the past tense more often than prefactual events, they also used the present tense as much as prefactual events. Surprisingly, they used the future tense more often than prefactual imagined events too. Narratives of counterfactual events also showed a higher percentage of words indicative of uncertainty, such as exclusive, discrepancy, and tentative terms compared to remember events. Together, these results suggest that temporal orientation (past or future) does not impact narrative style as much as the hypothetical or non-hypothetical nature of the events. In turn, this supports the idea that remembered past events and hypothetical past and future events might be “mental occurrences” of different types (Debus, 2015).

One of our most surprising results is the similar use of perceptual terms across all our conditions, original and alternative versions too, as analyses of phenomenological ratings have revealed that past events were subjectively perceived as containing more sensory details, but also as having a clear visuo-spatial context for remembered events (Arnold et al., 2011; D'Argembeau & Van der Linden, 2004, 2006). However, some theories suggest that both past and future thinking rely strongly on a similar scene construction process, which might explain the similarities found here (Hassabis & Maguire, 2007). Indeed, in our own measures of phenomenological ratings collected during the experiment, we did not find any significant differences across remembered, imagined, and planned events (see Chapter 4). We suggested that this absence of reliable evidence of an effect could be explained by our between-subjects design and the lack of direct comparison across conditions. It is therefore possible a similar process is at play here.

Consequently, the use of a between-subjects design might be a limitation to our study. Participants were placed in a single condition, so they either described three remembered past events, three imagined future events, or three planned future events. The individual linguistic style of each participants thus affected the specific condition they were in, which might have impacted similarities or differences across conditions. In the next experiment, we attempted to replicate our results but in a within-subjects design in order to directly compare conditions across participants. However, we expected that differences in linguistic style would be revealed independent of the between or within-subjects design.

Experiment 2

Method

Participants. Fifty-seven university undergraduate students enrolled in an introductory psychology course at Macquarie University, Australia, and native English speakers participated in our study.[8] However, three participants failed to follow instructions and were removed from the sample. Our final sample was composed of 54 participants (38 female and 16 male, mean age = 21.13 years, *SD* = 5.90, range: 18 – 54 years). They gave informed consent prior to testing, including agreement to be audio recorded, and received course credit as compensation for their time, in accordance with the Macquarie University Ethics Committee. The testing session lasted for one hour.

Materials and procedure. The materials and procedure were similar to experiment 1 with minor changes. The first and most important difference was that we moved from a between-subjects to a partial within-subjects design, where each event was generated under a different condition. It allowed us to directly compare conditions across participants. As our previous studies showed that order could impact past and future thinking (see Chapter 3 and Chapter 4), we only requested two events from each participants so we could control for order. We employed a partial Latin square design to allocate participants to conditions and orders, giving us a total of six combinations: *remembering then imagining* (RI), *remembering then planning* (RP), *imagining then planning* (IP), *imagining then remembering* (IR), *planning then remembering* (PR) and *planning then imagining* (PI).

We used the same six cues from experiment 1 and told participants there were no time constraints for past and future events. Before the first event, participants selected one cue from the six presented, and before the second event, they selected another cue from the remaining five cues presented. The procedure was identical to experiment 1: for each event, participants completed the four steps described previously: general questions, process task,

[8] We collected two types of data from the same sample of participants and within the same experiment. Phenomenological ratings are analyzed in chapter 4, whereas this chapter examines the linguistic styles of narratives. As already explained in chapter 4, we used a slightly larger sample size in this experiment than the first experiment, which had 51 participants. We wanted to make the experiments as comparable as possible; however due to the partial within-subjects nature of our design, we created six different groups of participants, which required a sample size number that could be divided by six: 54.

description task, and questionnaire. Once more, the results from the questionnaire will not be analyzed here (see Chapter 4).

Finally, to simplify and facilitate comparisons between participants and across conditions, participants only modified the emotional valence of all their events when thinking about how their counterfactual and prefactual events could happen. Hence, if in the questionnaire they had rated the original event as positive, they were then asked to think of how else the event could have happened or could happen if the event was negative. If they had rated the original event as negative or neutral, they were then asked to think of how else the event could have happened or could happen if the event was positive.

Results

Difficulty ratings. At the end of the testing session, participants rated the perceived difficulty of each task on a scale from 1 (very easy) to 7 (very hard). Means and standard deviations are presented in Table 17. Comparatively, participants found the remembering condition easier than the imagining or planning condition, both during the process task, $F(2, 105) = 6.63$, $p = .002$, $\eta_p^2 = 0.11$; and during the description task, $F(2, 105) = 6.03$, $p = .003$, $\eta_p^2 = 0.10$. The fact that we did not find this difference in the between-subjects experiment indicates that it was the direct comparison between remembered past events and imagining or planning future events that created the difference in difficulty ratings. We have shown previously that when confronted with a ratings questionnaire, participants tend to use their first example as a base rate (see Chapter 4).

Participants rated prefactual changes for planned events as being harder to think of, $F(2, 105) = 4.93$, $p = .009$, $\eta_p^2 = 0.09$; more so compared to prefactual imagined events ($p = .011$) than compared to counterfactual events ($p = .057$). However, the description task was rated similarly across conditions, $F(2, 105) = 1.84$, $p = .164$.

Table 17

Means and Standard Deviations For Each Difficulty Rating as a Function of Condition

Part	**Task**		**Condition**	
		Remembering *M* (*SD*)	Imagining *M* (*SD*)	Planning *M* (*SD*)
Part 1 - original	Process task	1.81 (1.09)	2.89 (1.58)	2.86 (1.59)
	Description task	2.47 (1.36)	3.61 (1.69)	3.53 (1.58)
Part 2 - alternative	Process task	3.69 (1.67)	3.47 (1.44)	4.61 (1.76)
	Description task	4.03 (1.73)	3.78 (1.55)	4.53 (1.78)

Part 1: Remembering vs. imagining vs. planning.

Content. In total, we collected data from 108 events: 36 remembered past events, 36 imagined future events, and 36 planned future events. For each event, we also collected one alternative version with the opposite emotional valence from the initial event. To give an idea of the content of the events generated in this study, 26 events were about an exam or a test (24.1%), 25 events were about a first day at work or first day volunteering (23.1%), 21 events were about a day trip (19.4%), 17 events were about a birthday celebration (15.7%), 11 events were about a date or a meeting with a friend (10.2%) and 8 events were about a major public event (7.4%). These events were collapsed together in our analyses as they were not distributed equally across our conditions.

Each participant provided two events from two different conditions (R, I, or P), so we did not collapse events and used the whole sample as is. We first ran all analyses taking into account event order (first vs. second event described). However, this variable did not produce any major effects or interactions.[9] We therefore did not include this variable in the following analyses.

[9] There was an interaction between condition and event order for the total number of words (p = .042), but the effect size was very small (η_p^2 = 0.06). Moreover, other measures already take into account the total number of words when creating the percentages, so this result did not truly impact our other analyses.

Total word count. We analyzed the *total word count*. In contrast to experiment 1, a univariate ANOVA revealed a significant difference in total word count across our three conditions, $F(2, 105) = 30.93$, $p < .001$, $\eta_p^2 = 0.37$. Participants generated more words when describing remembered events than imagined or planned events ($p < .001$ for both comparisons, see Table 18). [10] However, as LIWC calculates other measures as a percentage of the words in the category compared to the total word count, this initial difference is already taken into account in further analyses.

Table 18

Total Word Count as a Function of Condition

LIWC Category	Condition	Mean (SD)	95% CI
Word count	Remembered	388.08 (123.27)	[353.89; 422.27]
	Imagined	231.19 (102.09)	[197.01; 265.38]
	Planned	214.11 (80.57)	[179.92; 248.30]

Verbs. We analyzed the percentage of *common verbs* and *auxiliary verbs* (see Table 19). For both type of verbs, univariate ANOVAs revealed a difference across conditions, *common verbs* $F(2, 105) = 4.27$, $p = .016$, $\eta_p^2 = 0.08$; and *auxiliary verbs*, $F(2, 105) = 7.29$, $p = .001$, $\eta_p^2 = 0.12$. Remembered events contained fewer verbs than imagined or planned future events ($p < .05$ for all comparisons).[10] We expected to replicate our results in experiment 1, which found that planned events contained more verbs than imagined future events, however we did not.

[10] As the variances were not homogenous, we used bootstrapped contrasts.

Table 19

Percentage of Common Verbs and Auxiliary Verbs as a Function of Condition

LIWC Category	Condition	Mean (SD)	95% CI
Common verbs	Remembered	14.36 (1.97)	[13.30; 15.43]
	Imagined	16.13 (3.66)	[15.06; 17.20]
	Planned	16.42 (3.74)	[15.35; 17.48]
Auxiliary verbs	Remembered	8.35 (2.02)	[7.24; 9.45]
	Imagined	11.19 (3.95)	[10.08; 12.29]
	Planned	10.62 (3.71)	[9.52; 11.73]

Verb tenses. We compared the use of *present, past,* and *future tenses* (see Table 20). A 3 (condition: R, I, P) x 3 (tense: past, present, future) ANOVA with condition as a between-subjects variable and tense as a within-subjects variable revealed a significant interaction between condition and tense, $F(4, 210) = 110.91$, $p < .001$, $\eta_G^2 = 0.67$. When remembering past events participants used past tense more often than present tense, which also was used more often than future tense ($p < .001$ for all comparisons). In contrast, when imagining or planning future events, participants used present tense more often than future tense, which was used more often than past tense ($p < .05$ for all comparisons). Imagined and planned events did not significantly differ in their use of tenses. We therefore replicated our results from experiment 1.

Table 20

Percentage of Verb Tenses as a Function of Condition

LIWC Category	Condition	Mean (SD)	95% CI
Past	Remembered	9.77 (2.27)	[9.10; 10.44]
	Imagined	1.52 (1.56)	[0.85; 2.19]
	Planned	1.23 (2.19)	[0.56; 1.90]
Present	Remembered	3.25 (1.89)	[2.38; 4.13]
	Imagined	8.28 (2.77)	[7.40; 9.16]
	Planned	9.62 (3.17)	[8.75; 10.50]
Future	Remembered	0.28 (0.35)	[0.00; 0.90]
	Imagined	2.91 (2.29)	[2.28; 3.53]
	Planned	2.69 (2.32)	[2.06; 3.31]

Affective processes. We analyzed the percentage of *positive* and *negative terms*. As we can see in Table 21, participants generated more positive than negative terms in all conditions. For *positive terms*, a univariate ANOVA revealed no difference across conditions, $F(2, 105) = 1.69$, $p = .190$. For *negative terms*, as in experiment 1, a univariate ANOVA revealed a difference across conditions, $F(2, 105) = 3.82$, $p = .025$, $\eta_p^2 = 0.07$. Participants used significantly fewer negative terms in planned than in remembered events ($p = .021$), but not compared to imagined events ($p = .349$), although the overall percentage of negative words was quite low.

Table 21

Percentage of Affective Processes Terms as a Function of Condition

LIWC Category	Condition	Mean (SD)	95% CI
Positive emotion	Remembered	2.44 (1.10)	[1.93; 2.94]
	Imagined	2.70 (1.77)	[2.20; 3.20]
	Planned	3.09 (1.61)	[2.59; 3.59]
Negative emotion	Remembered	0.95 (1.06)	[0.63; 1.27]
	Imagined	0.68 (1.16)	[0.36; 1.00]
	Planned	0.32 (0.54)	[0.01; 0.64]

Cognitive processes. We analyzed the eight cognitive categories provided by LIWC (see Table 22). In experiment 1, we found a main effect of condition on the percentage of *insight*, *discrepancy*, and *tentative* terms. In this experiment, *discrepancy*, $F(2, 105) = 6.46$, $p = .002$, $\eta_p^2 = 0.11$, and *tentative* terms, $F(2, 105) = 9.15$, $p < .001$, $\eta_p^2 = 0.15$ also differed across conditions. Follow up contrasts revealed that remembered events contained fewer discrepancy terms than imagined ($p = .010$) or planned ($p = .002$) future events.[11] They also contained fewer tentative terms than imagined ($p = .002$) or planned ($p = .001$) future events. We also found a main effect of condition for *inclusive* terms, $F(2, 105) = 3.13$, $p = .048$,

[11] As the variances were not homogenous, we used bootstrapped contrasts.

$\eta_p^2 = 0.06$. However the effect size was relatively small and contrasts did not show any significant differences across conditions. Finally, other cognitive processes did not yield any significant main effect or interactions.

Table 22

Percentage of Cognitive Processes Terms as a Function of Condition

LIWC Category	Condition	Mean (SD)	95% CI
Insight	Remembered	2.35 (1.68)	[1.75; 2.94]
	Imagined	1.95 (1.59)	[1.36; 2.55]
	Planned	1.81 (2.09)	[1.21; 2.41]
Causation	Remembered	1.45 (1.35)	[1.07; 1.84]
	Imagined	1.16 (1.06)	[0.77; 1.55]
	Planned	1.21 (1.06)	[0.82; 1.59]
Discrepancy	Remembered	0.82 (0.56)	[0.26; 1.39]
	Imagined	1.92 (2.11)	[1.36; 2.48]
	Planned	2.18 (1.98)	[1.62; 2.74]
Tentative	Remembered	2.34 (1.37)	[1.57; 3.10]
	Imagined	4.22 (2.53)	[3.45; 4.99]
	Planned	4.47 (2.79)	[3.71; 5.24]
Certainty	Remembered	1.09 (0.64)	[0.70; 1.48]
	Imagined	1.35 (1.24)	[0.97; 1.74]
	Planned	1.50 (1.46)	[1.11; 1.88]
Inhibition	Remembered	0.46 (0.55)	[0.29; 0.63]
	Imagined	0.29 (0.45)	[0.12; 0.46]
	Planned	0.32 (0.54)	[0.15; 0.49]
Inclusive	Remembered	10.86 (3.29)	[9.72; 11.99]
	Imagined	9.03 (3.28)	[7.89; 10.16]
	Planned	9.18 (3.73)	[8.04; 10.32]
Exclusive	Remembered	2.80 (1.48)	[2.31; 3.29]
	Imagined	2.25 (1.44)	[1.76; 2.74]
	Planned	2.58 (1.54)	[2.08; 3.07]

Perceptual processes. We analyzed the three perceptual categories provided by LIWC (see Table 23). As in experiment 1, univariate ANOVAs revealed no differences across conditions: *see*, $F(2, 105) = 0.43$, $p = .653$; *hear*, $F(2, 105) = 0.38$, $p = .686$; and *feel*, $F(2, 105) = 1.45$, $p = .239$. Participants used the same percentage of visual, auditory, and kinesthetic terms when remembering past events or when imagining or planning future events.

Table 23

Percentage of Perspective Processes Terms as a Function of Condition

LIWC Category	Condition	Mean (SD)	95% CI
See	Remembered	0.80 (1.00)	[0.48; 1.12]
	Imagined	0.67 (0.62)	[0.35; 0.99]
	Planned	0.88 (1.19)	[0.56; 1.20]
Hear	Remembered	0.40 (0.50)	[0.16; 0.63]
	Imagined	0.52 (0.79)	[0.28; 0.75]
	Planned	0.38 (0.81)	[0.15; 0.62]
Feel	Remembered	0.56 (0.52)	[0.34; 0.77]
	Imagined	0.57 (0.69)	[0.36; 0.79]
	Planned	0.34 (0.73)	[0.12; 0.56]

Relativity. Finally, we analyzed motion, space, and time terms (see Table 24). Once more, univariate ANOVAs revealed no differences across conditions: *motion*, $F(2, 105) = 1.24$, $p = .295$; *space*, $F(2, 105) = 1.74$, $p = .180$; and *time*, $F(2, 105) = 0.954$, $p = .388$. As in experiment 1, participants used the same percentages of relativity terms to describe their events.

Table 24

Percentage of Relativity Terms as a Function of Condition

LIWC Category	Condition	Mean (SD)	95% CI
Motion	Remembered	3.49 (1.59)	[2.90; 4.09]
	Imagined	3.25 (1.51)	[2.65; 3.84]
	Planned	3.91 (2.21)	[3.31; 4.50]
Space	Remembered	6.76 (2.36)	[5.98; 7.54]
	Imagined	7.77 (2.54)	[6.99; 8.56]
	Planned	6.76 (2.36)	[5.98; 7.54]
Time	Remembered	7.27 (2.58)	[6.37; 8.16]
	Imagined	7.93 (3.35)	[7.04; 8.83]
	Planned	7.10 (2.05)	[6.20; 8.00]

Summary. In this experiment, we mostly replicated our results from experiment 1, which suggests that the different linguistic styles used to describe remembered, imagined, or planned events was not affected by previous tasks. It also indicates that the differences found in experiment 1 were not the result of strong individual differences in linguistic styles across our participants.

Once more, we found that past events were described in the past tense and future events were described in the present tense, which supports again the role of the present tense in constructing events that have not been experienced (Dudukovic et al., 2004). Future events, imagined and planned, also contained more discrepancy and tentative terms. It is not surprising that due to their hypothetical nature, they contained more words such as “could” or “would”, as well as words such as “maybe” or “guess”, which indicates uncertainty or the presence of multiple (and sometimes contradictory) alternatives of how the events could occur. Planned events still contained fewer negative terms than both remembered and imagined events, which speaks of the goal-directed function of future planning (Hayes-Roth & Hayes-Roth, 1979). However, we did not find more insight terms in remembered events in this experiment.

Finally, all types of autobiographical events still used the same percentage of perceptual terms or words indicative of space and time. However, in the phenomenological ratings collected at the same time in this experiment and described in another paper (see Chapter 4), participants felt they were experiencing remembered events with more sensory details than imagined and planned future events. They also felt like they perceived the visual and spatial settings of remembered events more clearly than the visual and spatial settings of imagined and planned future events. We will discuss this apparent dissociation between what is experienced and what is reported in more depth in the general discussion.

Part 2: Counterfactual thinking vs. prefactual imagining vs. prefactual planning. To analyze the data from part 2, we followed the same order as in experiment 1. First, we compared narratives of the alternative versions across our three conditions. We then directly compared original events with their alternative version across conditions.

Participants were required to propose alternative versions of events by changing their emotional valence. In total, we had 71 original positive events (R: 22, I: 22, P: 27), 15 original neutral events (R: 5, I: 6, P: 4) and 22 original negative events (R: 9, I: 8, P: 5). Participants were asked to suggest a positive alternative event for negative and neutral events, and a negative alternative event for positive events. Consequently, we took into account the type of change (making it a positive event or making it negative event) in the following analyses, by conducting 3 (condition) x 2 (type of change) mixed ANOVAs.

Total word count. We analyzed the *total word count*. A univariate ANOVA revealed no difference in the total word count across our three conditions, $F(2, 102) = 0.49$, $p = .613$ (see Table 25), nor were there any other main effects or interactions.

Table 25

Total Word Count as a Function of Condition

LIWC Category	Condition	Mean (SD)	95% CI
Word count	Counterfactual	225.39 (109.19)	[187.46; 263.32]
	Prefactual imagined	255.44 (119.00)	[217.52; 293.37]
	Prefactual planned	229.42 (115.89)	[191.49; 267.34]

Verbs. To examine the use of verbs, we analyzed the percentage of *common verbs* and *auxiliary verbs* (see Table 26). Univariate ANOVAs revealed no difference across conditions for *common verbs*, $F(2, 102) = 0.71$, $p = .493$; nor for *auxiliary verbs,* $F(2, 102) = 2.34$, $p = .102$. Participants used the same number of common and auxiliary verbs when describing counterfactual, prefactual imagined, or prefactual planned events. In experiment 1, we were surprised to find that participants used more verbs in the counterfactual condition than in the prefactual imagined and prefactual planned conditions. However, our results from experiment 2 did not replicate this unexpected finding.

Table 26

Percentage of Common Verbs and Auxiliary Verbs as a Function of Condition

LIWC Category	Condition	Mean (SD)	95% CI
Common verbs	Counterfactual	18.43 (3.86)	[16.97; 19.88]
	Prefactual imagined	18.94 (5.61)	[17.49; 20.40]
	Prefactual planned	17.79 (3.44)	[16.33; 19.24]
Auxiliary verbs	Counterfactual	11.89 (3.38)	[10.50; 13.28]
	Prefactual imagined	13.23 (5.19)	[11.84; 14.62]
	Prefactual planned	11.69 (3.84)	[10.30; 13.08]

Verb tenses. We compared the use of *present*, *past,* and *future* tenses (see Table 27). A 3 (condition: R, I, P) x 3 (tense: past, present, future) x 2 (type of change: making it positive or negative) mixed ANOVA revealed only a main effect of tense, $F(2, 204) = 65.67$, $p < .001$, $\eta_G^2 = 0.39$; with no other main effects or interactions. Counterfactual and prefactual events alike were described mainly using present tense ($p < .05$ for all comparisons). When describing counterfactual events, past tense was used more often than future tense ($p = .030$). It is also worth noting that the use of past, present, and future tenses did not differ across conditions ($p > .10$ for all comparisons). These results are therefore similar to those of experiment 1.

Table 27

Percentage of Verb Tenses as a Function of Condition

LIWC Category	Condition	Mean (SD)	95% CI
Past	Counterfactual	3.71 (3.66)	[2.40; 5.03]
	Prefactual imagined	5.49 (4.11)	[4.17; 6.81]
	Prefactual planned	3.78 (4.16)	[2.46; 5.10]
Present	Counterfactual	9.68 (4.31)	[8.33; 11.04]
	Prefactual imagined	8.59 (3.50)	[7.24; 9.95]
	Prefactual planned	8.73 (4.44)	[7.37; 10.08]
Future	Counterfactual	2.08 (2.33)	[1.31; 2.84]
	Prefactual imagined	2.29 (2.50)	[1.52; 3.05]
	Prefactual planned	2.07 (2.10)	[1.31; 2.84]

Affective processes. We analyzed the percentage of positive and negative terms (see Table 28). For both type of affective processes terms, univariate ANOVAs revealed a main effect of the type of change, *positive terms,* $F(1, 102) = 47.86$, $p < .001$, $\eta_p^2 = 0.32$; *negative terms,* , $F(1, 102) = 22.65$, $p < .001$, $\eta_p^2 = 0.18$. Predictably, positive alternative events contained more positive words than negative alternative events and negative alternative events contained more negative terms than positive alternative events.

Furthermore, for *negative terms,* results also revealed a main effect of condition, $F(2, 102) = 4.48$, $p = .014$, $\eta_p^2 = 0.08$. Prefactual planned events contained fewer negative terms than counterfactual events ($p = .027$) or prefactual imagined events ($p = .030$). This was not due to the type of change as the interaction was not significant. Once again, when participants described planned future events, they did not include many negative terms, even when they were instructed to make it negative.

Table 28

Percentage of Affective Processes Terms as a Function of Condition and Type of Change

LIWC Category	Condition	Making the event positive		Making the event negative	
		Mean (SD)	95% CI	Mean (SD)	95% CI
Positive emotion	Counterfactual	4.56 (1.17)	[3.78; 5.33]	1.87 (0.92)	[1.25; 2.49]
	Prefactual imagined	4.37 (2.39)	[3.57; 5.12]	2.75 (1.42)	[2.13; 3.37]
	Prefactual planned	4.63 (1.60)	[3.67; 5.60]	2.66 (1.33)	[2.10; 3.22]
Negative emotion	Counterfactual	1.10 (1.05)	[0.42; 1.78]	2.67 (1.58)	[2.12; 3.21]
	Prefactual imagined	1.29 (0.91)	[0.61; 1.98]	2.45 (1.42)	[1.9; 2.99]
	Prefactual planned	0.47 (1.08)	[0.00; 1.32]	1.54 (1.24)	[1.05; 2.03]

Cognitive processes. We analyzed the eight cognitive categories provided by LIWC (see Table 29). Univariate ANOVAs revealed no significant effect of condition across the eight categories (see Table 29). Counterfactual, prefactual imagined, and prefactual planned events used similar percentages of terms indicative of the presence of underlying cognitive processes.

Table 29

Percentage of Cognitive Processes Terms as a Function of Condition

LIWC Category	Condition	Mean (SD)	95% CI
Insight	Counterfactual	2.42 (1.86)	[1.83; 3.01]
	Prefactual imagined	2.21 (1.48)	[1.62; 2.80]
	Prefactual planned	2.92 (1.94)	[2.33; 3.50]
Causation	Counterfactual	1.65 (1.37)	[1.25; 2.04]
	Prefactual imagined	1.66 (1.14)	[1.27; 2.06]
	Prefactual planned	1.28 (1.03)	[0.88; 1.67]
Discrepancy	Counterfactual	3.03 (2.70)	[2.12; 3.94]
	Prefactual imagined	3.76 (3.13)	[2.85; 4.67]
	Prefactual planned	2.79 (2.39)	[1.88; 3.71]
Tentative	Counterfactual	4.78 (3.11)	[3.78; 5.78]
	Prefactual imagined	4.47 (3.17)	[3.47; 5.48]
	Prefactual planned	4.02 (2.80)	[3.02; 5.02]
Certainty	Counterfactual	1.39 (1.26)	[1.02; 1.76]
	Prefactual imagined	1.36 (1.02)	[0.99; 1.73]
	Prefactual planned	1.48 (1.05)	[1.11; 1.85]
Inhibition	Counterfactual	0.41 (0.61)	[0.23; 0.59]
	Prefactual imagined	0.47 (0.55)	[0.29; 0.66]
	Prefactual planned	0.32 (0.49)	[0.14; 0.50]
Inclusive	Counterfactual	8.43 (4.09)	[7.21; 9.65]
	Prefactual imagined	7.88 (3.65)	[6.66; 9.10]
	Prefactual planned	8.02 (3.29)	[6.80; 9.24]
Exclusive	Counterfactual	4.41 (2.53)	[3.62; 5.19]
	Prefactual imagined	4.21 (2.35)	[3.42; 4.99]
	Prefactual planned	4.20 (2.24)	[3.42; 4.99]

Two categories, however, were affected by the type of change: certainty, $F(1, 102) = 50.69$, $p < .001$, $\eta_p^2 = 0.33$; and exclusive, $F(1, 102) = 50.69$, $p < .001$, $\eta_p^2 = 0.12$. Positive alternative events contained more certainty terms, such as “always” or “never” ($M = 2.25$, $SD = 1.31$) than negative alternative events ($M = 0.97$, $SD = 0.80$). In contrast, negative alternative events contained more exclusive terms “not” or “if” ($M = 4.85$, $SD = 2.46$) than positive alternative events ($M = 3.17$, $SD = 1.69$).

Perceptual processes. We analyzed the three perceptual categories provided by LIWC (see Table 30). A univariate ANOVA revealed a difference across conditions for *visual terms*, $F(2, 102) = 3.96$, $p = .022$, $\eta_p^2 = 0.07$. Prefactual planned events contained more terms related to visual processes than prefactual imagined events ($p = .022$) or counterfactual events ($p = .012$).[12] However, once more we had a floor effect. With regards to terms relating to *auditory processes*, results revealed an interaction between condition and type of change, $F(2, 102) = 4.68$, $p = .011$, $\eta_p^2 = 0.08$. Bootstrapped contrasts revealed that negative prefactual imagined events contained more auditory terms ($M = 0.64$, $SD = 0.61$) than positive prefactual imagined events ($M = 0.20$, $SD = 0.31$). However, it is worth noting that we had a floor effect for our visual and auditory measures. Finally, counterfactual and prefactual imagined and planned narratives contained a similar number of kinesthetic terms, $F(2, 102) = 1.25$, $p = .289$. Overall, participants did not use many perceptual terms in their narratives.

Table 30

Percentage of Perceptual Processes Terms as a Function of Condition

LIWC Category	Condition	Mean (SD)	95% CI
See	Counterfactual	0.62 (0.66)	[0.44; 0.80]
	Prefactual imagined	0.34 (0.44)	[0.16; 0.52]
	Prefactual planned	0.37 (0.53)	[0.19; 0.55]
Hear	Counterfactual	0.47 (0.72)	[0.28; 0.67]
	Prefactual imagined	0.31 (0.46)	[0.11; 0.50]
	Prefactual planned	0.47 (0.57)	[0.27; 0.66]
Feel	Counterfactual	0.80 (1.02)	[0.47; 1.12]
	Prefactual imagined	0.71 (0.77)	[0.39; 1.04]
	Prefactual planned	1.16 (1.12)	[0.83; 1.48]

Relativity. Finally, we analyzed motion, space, and time terms (see Table 31). Univariate ANOVAs revealed no differences across conditions for *space terms*, $F(2, 102) =$

[12] As the variances were not homogenous, we used bootstrapped contrasts.

0.50, p = .609; *time terms*, $F(2, 102) = 0.57$, p = .569; and *motion terms*, $F(2, 102) = 0.41$, p = .668 when describing events. We did not replicate the unexpected finding from experiment 1 where prefactual imagined events contained more terms relative to space than other events. However we suggested that this surprising effect might have been caused either by individual differences or our specific design, and particularly the requested change of location.

Table 31

Percentage of Common Verbs and Auxiliary Verbs as a Function of Condition

LIWC Category	Condition	Mean (SD)	95% CI
Motion	Counterfactual	2.98 (1.63)	[2.45; 3.50]
	Prefactual imagined	2.76 (1.25)	[2.24; 3.28]
	Prefactual planned	2.81 (1.81)	[2.29; 3.34]
Space	Counterfactual	5.36 (1.71)	[4.71; 6.02]
	Prefactual imagined	5.26 (2.23)	[4.61; 5.91]
	Prefactual planned	5.36 (1.71)	[4.71; 6.02]
Time	Counterfactual	6.34 (2.29)	[5.55; 7.13]
	Prefactual imagined	5.95 (2.28)	[5.16; 6.74]
	Prefactual planned	6.34 (2.29)	[5.55; 7.13]

Summary. In part 2, as in experiment 1, we found few differences between counterfactual events, prefactual imagined events, and prefactual planned events. Once more all alternative events were mainly described in the present tense. This suggests that the present tense might support the constructive process needed to think about and describe events that have never been experienced, regardless of them being set in the past or the future. Participants also used a similar percentage of terms indicative of underlying cognitive processes in all alternative events, which suggests that counterfactual, prefactual imagined and prefactual planned events are thought of and constructed in a similar way, and that their temporal orientation does not strongly impact these processes. And similar to experiment 1, but also to part 1, all events contained a comparable percentage of perceptual terms and terms indicative of position in space and time.

The only two differences across conditions we found were related to prefactual planned events. Once again, when participants described planned future events, they did not include many negative terms, even when they were instructed to make it negative. These results might reflect the positive goal-directed side of future planning or the demands of the laboratory settings. Prefactual planned events also contained slightly more visual terms, however our absolute percentages were very low and this result is most likely due to a floor effect.

Finally, as we asked participants to modify their original events by changing the event valence, we also examined how making the event positive or making the event negative affected the way it was described. We found that for most measures, it did not impact the linguistic style. As expected, events requested to be positive were more positive than events requested to be negative, and vice versa. However, we did find that positive alternative events contained more certainty terms than negative alternative events. As negative events are often seen as unpredictable and unintentional (accidents, calamities, etc.), but also can be perceived as less common (as per the optimism bias), participants might have felt more certain of how events may have occurred when these events were positive. In contrast, negative alternative events contained more exclusive terms ($M = 4.85$, $SD = 2.46$) than positive alternative events ($M = 3.17$, $SD = 1.69$). This result is not surprising as exclusive terms comprise words such as “not” or “if”, which might be more present in negative events (e.g., “we would not have had a good time”).

Part 1 vs. part 2: Counterfactual changes vs. prefactual imagined changes vs. prefactual planned changes. Finally, we analyzed the impact of proposing alternative versions by comparing terms employed in original events with terms used in alternative events. We only examined linguistic categories that revealed differences in either part 1, part 2, or both. Unless specified otherwise, we ran 3 (original condition: R, I, P) x 2 (type of change: making it positive or making it negative) x 2 (part: 1 or 2) mixed ANOVAs. As we have already analyzed part 1 and 2 separately, we concentrate here on the interaction between condition and part, as well as on the interaction between condition, type of change, and part.

Once more, we can see very clearly in Figure 2 the same pattern of response we saw in experiment 1: whereas the lines connecting future original events and future alternative events remain flat (which means the percentages were similar across part 1 and part 2), the black line between remembered and counterfactual past events are at an angle. In other words, each significant interaction between condition and part followed once more the same pattern: memories and counterfactual events differed substantially in the type of terms used, whereas prefactual events, imagined or planned, remained similar. This was the case for the *total word count*, $F(2, 102) = 22.73$, $p < .001$, $\eta_G^2 = 0.31$; *verbs*, $F(2, 102) = 4.66$, $p = .012$, $\eta_G^2 = 0.08$; *auxiliary verbs*, $F(2, 102) = 10.90$, $p < .001$, $\eta_G^2 = 0.18$; *past tense*, $F(2, 102) = 32.631$, $p < .001$, $\eta_G^2 = 0.38$; *present tense,* $F(2, 102) = 19.92$, $p < .001$, $\eta_G^2 = 0.28$; *future tense*, $F(2, 102) = 13.72$, $p < .001$, $\eta_G^2 = 0.20$; *discrepancy terms*, $F(2, 102) = 6.20$, $p = .003$, $\eta_G^2 = 0.10$; *tentative terms*, $F(2, 102) = 4.42$, $p = .014$, $\eta_G^2 = 0.08$; and *inclusive terms*, $F(2, 102) = 3.70$, $p = .028$, $\eta_G^2 = 0.07$. Once again, compared to remembered events, counterfactual events contained more verbs, which were less in the past tense but more often in the present tense, and sometimes even in the future tense. Also, there were more discrepancy (e.g., “could”) and tentative (e.g., “maybe”) terms in counterfactual events, but fewer inclusive (“and”, “with”) terms.

As in experiment 1, these results suggest that alternative versions of future events have the same narrative style as their original future events. However, counterfactual events are narrated in a different style than memories. Finally, it is worth noting that there was no significant three-way interaction between part, condition, and type of change across our measures. Changing the emotional valence of the event did not impact our linguistic measures.

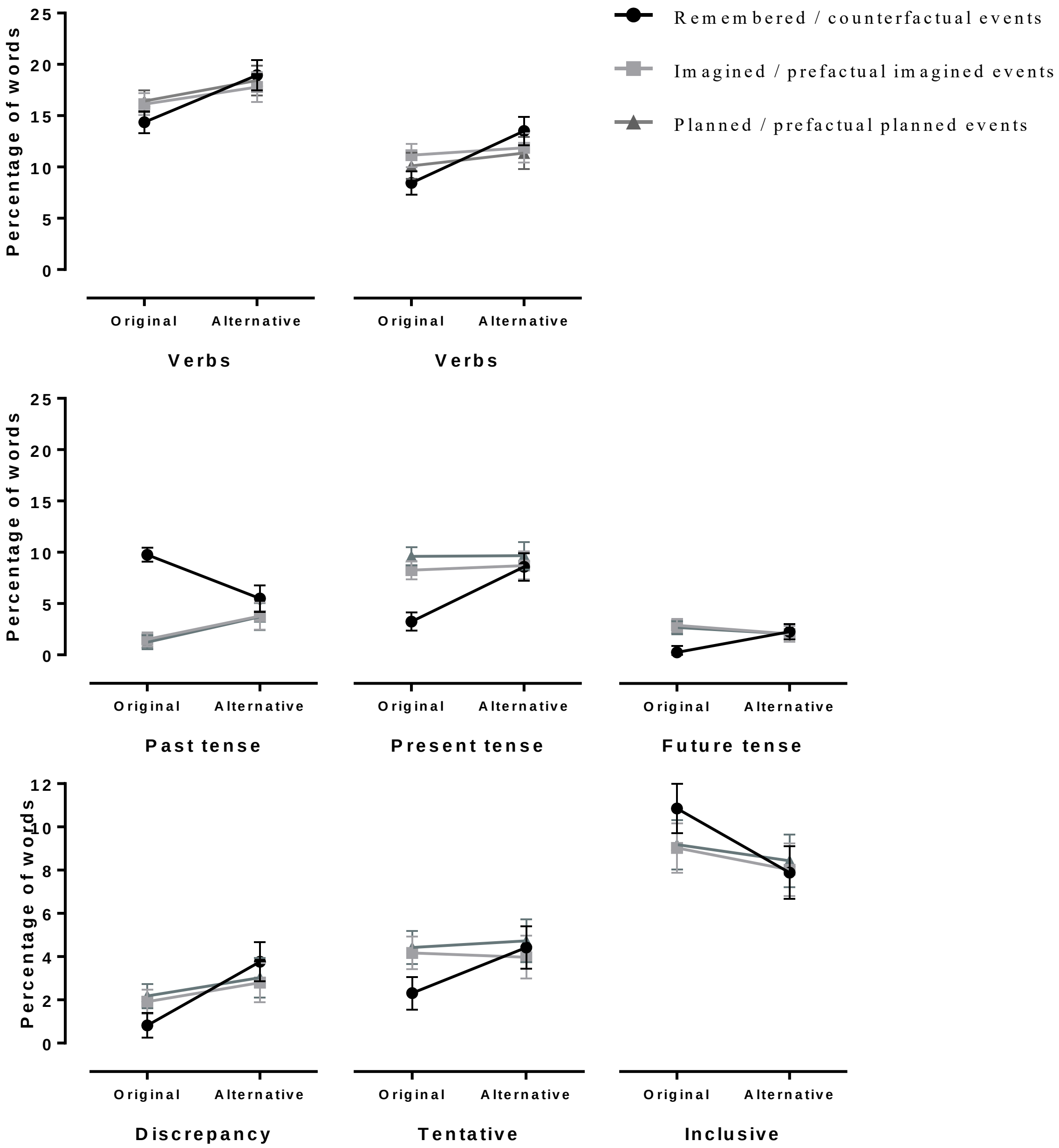

Figure 2. Comparison between original and alternative events across conditions for the percentage of verbs, past tense, present tense, future tense, discrepancy, tentative, and exclusive terms. Error bars represent 95% CI.

Discussion

In this second experiment, we once again examined the linguistic style in narratives from a range of autobiographical thinking processes. In experiment 1, participants were assigned a single condition (remembering past events, imagining future events or planning future events) and described three events. In experiment 2, however, participants were assigned two conditions and described one event for each condition. The procedures were matched between the two experiments, with participants closing their eyes for a minute to mentally remember, imagine or plan their event before describing it to the experimenter. In the second part of the study, they also suggested alternative versions for each event, where positive events became negative, and neutral and negative events became positive. It is worth noting that our sample size was slightly larger in this experiment with 54 participants, compared to 51 in the first experiment, which, combined with a within-subject design (although partial), increased the statistical power of our analyses. Once again we used the LIWC software to investigate the use of verbs, tenses, and the presence of terms representative of affective, cognitive, perceptual and relative processes.

Our results replicated experiment 1 and the “identity sheets” we described mostly stayed the same. Narratives of remembered past events contained fewer common and auxiliary verbs, used mainly the past tense, and included fewer discrepancy and tentative terms. However, unlike experiment 1 and against our predictions, remembered events did not show reliable evidence a higher percentage of insight terms compared to imagined and planned events. It is unclear why we did not replicate this result. More research is needed to further investigate this potential difference.

With regards to narratives of future events, this experiment did not reveal any reliable evidence of difference between imagined and planned future events. In experiment 1, planned events were more often described in the future tense and with fewer negative emotion terms than imagined events. In experiment 2, descriptions of imagined and planned events similarly used the future tenses and negative emotion terms. Compared to remembered events, future narratives contained more common and auxiliary verbs and were described mainly in the present tense and more rarely in the future tense. They also included more discrepancy and tentative terms but fewer insight terms. Consequently, these results establish that imagined and planned future events are narrated in a very similar way. Due to their hypothetical nature, participants exhibited uncertainty by using words such as “could”, “would”, or “maybe”. Furthermore, they were narrated in present tense, maybe to support the constructive process of describing an event never experienced.

Similar to experiment 1, differences between original events and their alternative versions were restricted to changes between narratives of remembered events and narratives of their counterfactual versions. Compared to remembered events, counterfactual narratives contained more verbs, mostly used the present tense, and included more discrepancy and tentative terms, but fewer inclusive terms. Therefore, unlike memories, which differed from future events, counterfactual events resembled prefactual imagined and planned events on most measures, showing once more that similarities in their narratives styles represent the constructive and reconstructive processes of experienced and hypothetical autobiographical events more than simple temporal orientation.

General Discussion

In the last few years, a large body of research has examined the similarities between remembering the past and imagining the future. Neuroimaging studies have revealed the activation of a common brain network in past and future thinking, and suggested that they both rely on similar underlying processes (Hassabis & Maguire, 2007; Schacter & Addis, 2007a; Szpunar, 2010). Cognitive studies, on the other hand, have shown that the self-rated phenomenological experience of thinking autobiographically differs between remembered past events and imagined future ones (Arnold et al., 2011; D'Argembeau & Van der Linden, 2004, 2006, 2012). In a previous study (see Chapter 4), we added to these results by comparing the phenomenology of remembered past events and imagined future events with the phenomenology of planned future events, counterfactual past events, and prefactual imagined and planned events. We found that differences in subjective experience were not so much between past and future events, but between events that had been experienced (remembered events) and hypothetical events (future events but also counterfactual past events).

In this article, we aimed to investigate narratives, which are another product of autobiographical thinking. We looked for differences and similarities in linguistic style across certain autobiographical processes, arguing that these results will shed light on the constructive and reconstructive processes at work in autobiographical thinking. Across two parallel experiments, one using a between-subjects design and one using a within-subjects design, we examined the linguistic style of narratives across a range of autobiographical events. Participants either described past events they had just remembered, future events they had just imagined, or future events they had just planned. In a second phase, they then described alternative versions of these events, which we called counterfactual events, prefactual imagined events, and prefactual planned events. We analyzed these narratives by running them through text-analysis software called LIWC, and examined how they differed and what these differences indicated.

One of the first important points of discussion is that despite using different designs, with slightly different statistical powers, and slightly different instructions, we replicated most of our results from experiment 1 in experiment 2. These similarities strengthen the reliability of our findings; all the more so when considering the findings from the phenomenological ratings collected from the same experiments and reported in another article (see Chapter 4).

We found that phenomenological ratings were relative and not absolute, as our between-subjects experiment did not reveal any differences in the phenomenology of remembered, imagined, and planned events, whereas our within-subjects experiment did. We suggested that participants were using their first event as a base rate against which to compare the following events. However, as repeated in this article, we found no indication that the order of tasks or the type of design influenced the linguistic style of narratives. Rather, the type of autobiographical events described influenced the linguistic style in a consistent way, which brings us to our next point.

There were some clear differences in the linguistic style of remembered past events, imagined future events, or planned future events. Unsurprisingly, the linguistic style used to describe remembered events tended to emphasize their “past-ness”, but also the fact that these events had occurred in a specific way and were integrated into personal history (Pasupathi, 2007). In contrast, the linguistic style used to describe future events, imagined or planned, tended to emphasize the underlying process of having to construct a hypothetical event, sometimes as if participants were experiencing it “in the moment” (Dudukovic et al., 2004); but also the uncertainty of the sequence of events proposed, with their discrepancies or incompatibilities. Furthermore, the linguistic style of planned future events showed almost a complete absence of negative terms, but the presence of action verbs and future tenses, which speaks of the action and goal-oriented aspect of future planning (Hayes-Roth & Hayes-Roth, 1979; see also Chapter 2).

We did not find reliable evidence suggesting differences between the different types of autobiographical events everywhere we expected them. As has been briefly discussed in previous sections, we were surprised to find that remembered, imagined, and future events mostly used the same percentage of visual, auditory, and kinesthetic words, as well as terms indicative of the relation in space and time. In our phenomenological analyses of autobiographical events (see Chapter 4), we showed that remembered events contained more sensory details and had a clearer visuo-spatial context than future events. Yet, our linguistic analyses in this article did not show the same pattern. Participants scarcely used perceptual terms, but they used more terms to situate their events in space and time. These results were surprising since other studies have used the number of sensory details to estimate the veracity of a memory (Schooler, Gerhard, & Loftus, 1986; Suengas & Johnson, 1988). However, our comparisons were of a different kind, as our future events were not lies, but rather events that hypothetically could happen.

We propose several possible explanations for the divergence between results from our phenomenological analyses and linguistic style analyses. The first possibility is that the subjective experience is just that: subjective. As the differences only appeared in a direct comparison setting, it is possible that participants had naïve theories of how the subjective experience of memories and future events should feel comparatively (Arnold et al., 2011; Caruso, Gilbert, & Wilson, 2008; Koriat, Bjork, Sheffer, & Bar, 2004). In other words, participants might have believed that remembered events should be clearer and contain more details, and thus rated them this way. In contrast, linguistic styles used to describe the different types of events might not be influenced to the same extent by such meta-knowledge. Another possible explanation is that the subjective experience does not translate into words. Participants might have a clearer mental picture of memories than hypothetical events without necessarily describing the event differently. They might have deemed this type of information unimportant for the story they were telling or it could simply depend on individual differences in narrative styles (Pennebaker & Graybeal, 2001; Pennebaker et al., 2003; Tausczik & Pennebaker, 2010). Future research could explore this interesting divergence in findings.

Finally, one of the most interesting outcomes from our experiments came from the analyses of the linguistic styles of counterfactual, prefactual imagined, and prefactual events, which showed very few differences in the linguistic style used when describing hypothetical past events and future events. Whereas participants described original and alternative future events (imagined and planned alike) in a similar linguistic style, counterfactual narratives strongly contrasted with their original remembered events. More importantly, counterfactual and prefactual narratives ranked similarly on most linguistic measures. These results accord with our suggestion that memories are both constructive and reconstructive, whereas hypothetical events are inherently based on constructive processes (Michaelian, 2011). And these findings are consistent with the results from our phenomenological analyses, which also revealed many similarities in the subjective experience associated with thinking about past or future hypothetical events (see Chapter 4).

Our results, however should be interpreted with a little caution, since LIWC remains a blunt tool. For example, LIWC does not take into account the context surrounding the measured terms. Saying “I was happy” would be placed in the positive emotion category the same way as saying “I was not happy”. It also ignores irony, sarcasms, and idioms. For example, the word “mad” is coded as a negative term, even in a sentence such as “he is as mad as a hatter”. Furthermore, LIWC relies on percentages over the total word count. Some differences could thus be due more to the influence of the denominator (number of words that do not relate to the category) than the influence of the numerator (number of words related to the category). However, these limitations are relatively minor compared to what LIWC allowed us to examine. Creating new coding schemes can be precarious, and investigating mechanisms such as cognitive processes would be almost impossible to do manually. LIWC is a tool that has been validated, recognized, and used in many scientific studies, both spoken and written (Tausczik & Pennebaker, 2010). Moreover, the fact that we replicated our most important results across two similar but not identical experiments increases the validity of our findings.

In conclusion, we found that the linguistic style used to describe experienced past events is relatively different from the linguistic style used to describe hypothetical events, whether set in the past or the future. The temporal orientation, as well as the type of future thinking process (imagining or planning) did not determine how the events were narrated or experienced. Instead, we believe that what matters most is the fact that past events have been experienced and integrated into a coherent story, whereas future and counterfactual events remain hypothetical and uncertain. In other words, remembered past events might be a mental occurrence of a different kind to hypothetical events (see also Debus, 2014). Future research examining similarities between past and future thinking should include more types of autobiographical thinking, such as counterfactual thinking and future planning, in order to distinguish the processes at play when constructing and reconstructing personal past and future events.

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Journal Description (impact factor = 4.24)

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CHAPTER 6

Perceived Plausibility in Hypothetical Simulations of Future and Counterfactual Events

This Chapter was prepared as:

Cordonnier, A., Barnier, A. J., & Sutton, J. (in preparation). Perceived plausibility in hypothetical simulations of future and counterfactual events. *Journal of Experimental Psychology: General.*

In this chapter, I describe the results from my fourth experiment where I examined the perceived plausibility of hypothetical past and future events. Following my theoretical cognitive framework (Chapter 2), I sought to investigate the interaction between the two main dimensions I proposed. That is I investigated how temporal orientation affects the perceived plausibility of autobiographical events. First, I considered the role of repetitions in changing the perceived plausibility of hypothetical past or future events. Over two sessions, participants simulated once or four times future events or counterfactual events and rated how plausible they felt the event was. Second, I considered the impact of creating multiple alternative versions of the same hypothetical past or future event in changing its perceived plausibility. Over two sessions, participants provided one or four possible versions of how a particular future or counterfactual event could happen and rated how plausible they felt the last version proposed was.

In terms of measures, I focused on comparing the perceived plausibility as rated by participants on a 5-point scale. I first compared the perceived plausibility across event type (future events vs. counterfactual events). Then I compared the perceived plausibility across sessions (session 1 vs. session 2) but also between events that followed the experimental manipulation and events that did not (repeated simulation vs. not repeated; multiple alternative versions vs. one version).

It is important to note that this chapter is based on two published papers (De Brigard, Szpunar & Schacter, 2013; Szpunar & Schacter, 2013). The authors of these papers use some terms differently from the way I defined them in Chapter 2. In particular, whereas I suggested differentiating the process of “imagining” from the process of “simulating” depending on the sought plausibility of the event, they used these terms somewhat interchangeably. They asked participants to “imagine a future scenario” (p. 319) but in text they refer to the act of thinking about the event as “simulation”. Therefore, for clarity and continuity, I have used their terminology throughout this article, even when it might not agree with the cognitive framework I described in Chapter 2.

This chapter was prepared specifically for submission to the *Journal of Experimental Psychology: General,* as it is at the crossroad between memory, future thinking, and consciousness. Furthermore, one of the reference article we try to replicate was published in this journal (Szpunar & Schacter, 2013). The description of the journal is appended to this chapter (p.316). While this is a co-authored manuscript with my two supervisors, I was the major contributor to all aspects of the experimental design, data analysis, and preparation of the manuscripts. Each of these stages was conducted with input and advice from Amanda Barnier and John Sutton.

Perceived Plausibility in Hypothetical Simulations of Future and Counterfactual Events

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Acknowledgements

This work was supported by a Macquarie University Research Excellence Scholarship to Aline Cordonnier, by an Australian Research Council (ARC) Discovery Project and ARC Future Fellowship to Amanda Barnier, by an ARC Discovery Project to John Sutton, and by the Memory Program of the ARC Centre of Excellence in Cognition and its Disorders and the Department of Cognitive Science, Macquarie University.

Abstract

Thinking about hypothetical past and future events is an important part of daily life. Previous research has revealed that reality differentially affects how future and past hypothetical events are perceived. In this study, we examined the perceived plausibility of future and counterfactual events after repeated simulations or following the proposal of multiple alternative ways the events could occur or could have occurred. During a first session, participants generated 24 original future events or 24 original counterfactual events, and rated them on six 5-point scales phenomenological ratings, including perceived plausibility. During a second session, participants simulated half of the events three times each. Some participants were asked to repeatedly simulate identical versions of their future or counterfactual events, whereas other participants were asked to simulate alternative versions of how else their initial future or counterfactual events could occur. Finally, all participants simulated the last version they provided for all 24 future and counterfactual events, and rated them again on the six scales. Results showed no differences between the perceived plausibility of hypothetical events simulated once and hypothetical events simulated four times. However, we found that proposing multiple versions of hypothetical events maintained the perceived plausibility of the first counterfactual version but decreased the perceived plausibility of the first future version. These results support the idea that if counterfactual and future thinking rely on the same constructive processes, they are differently constrained by reality, which in turn modifies how plausible they seem.

Keywords: Future thinking, counterfactual thinking, autobiographical, plausibility, phenomenology

Perceived Plausibility in Hypothetical Simulations of Future and Counterfactual Events

A growing body of research has examined the intriguing human capacity to mentally imagine or simulate personal events that are not presently experienced (Atance & O'Neill, 2001; Suddendorf & Corballis, 1997). More specifically, researchers have compared the neural and behavioral similarities in the ability to remember and simulate personal past events with the ability to imagine and simulate personal future events (for recent reviews, see Klein, 2013; Schacter, 2012; Szpunar, 2010). This emerging line of research has suggested that common underlying processes support past and future thinking, and that both heavily rely on episodic and semantic memory to construct and reconstruct personal events (Irish & Piguet, 2013; Schacter & Addis, 2007a).

Investigations of autobiographical thinking initially focused on comparing memories and possible future events (see Chapter 1). However, recent research has started to examine and compare other ways of thinking about autobiographical events, such as autobiographical planning (Gerlach, Spreng, Madore, & Schacter, 2014; see also Chapter 3, Chapter 4, and Chapter 5) or imagining past events (Addis, Pan, Vu, Laiser, & Schacter, 2009). An interesting new line of enquiry lies in the contrast between counterfactual events and future events (Schacter, Benoit, De Brigard, & Szpunar, 2015; see also Chapter 4 and Chapter 5). Counterfactual thinking represents the act of revisiting past events to simulate how else they could have happened (Boninger, Gleicher, & Strathman, 1994; Byrne, 2002, 2016; Hoerl, McCormack, & Beck, 2011; Roese, 1997); whereas episodic future thinking represents the act of imagining and simulating events that could happen in someone's future (Atance & O'Neill, 2001; Schacter, 2012; Szpunar, 2010). Together they characterize the capacity to mentally represent hypothetical personal events set in the past or the future and they also offer complementary evidence concerning the effects of temporal orientation on the way autobiographical events are constructed (see also Chapter 2).

In previous research, we compared a range of autobiographical thinking processes – including remembering past events, imagining and planning future events, and thinking counterfactually – on the phenomenology of the simulated events and the linguistic styles used to describe them (see Chapter 4 and 5). We found that participants experienced and described remembered events differently to future events but also counterfactual events. More importantly, we found many similarities between future and counterfactual events across two experiments and two different measures. For example, while future events were experienced less clearly and with less detail than remembered events, their subjective experience was similar to counterfactual events (see Chapter 4; and also De Brigard & Giovanello, 2012). Whereas remembered events were usually described in the past tense, future and counterfactual events tended to be described in the present tense (see Chapter 5). Future and counterfactual events also contained more discrepancy and tentative terms than remembered events. In agreement with Debus (2014), we suggested that remembered events might be a "mental occurrence of a different kind" than both future and counterfactual thinking (p. 337). Remembered events are experienced and reconstructed based on memory traces, but future events and counterfactual events, although also relying on past memories, are not restricted by the past to the same extent (see Chapter 2).

Social psychology research has also shown similarities in the way participants assess the likelihood of hypothetical future or past events. Studies have demonstrated that imagining a future event increases the subjective likelihood that the event will indeed occur (for a review, see Koehler, 1991). One of the best known studies showed that before the United States presidential election in 1976, participants who imagined that Jimmy Carter would win the election felt more certain that indeed he eventually would win, and vice versa for participants who imagined that Gerald Ford would win (Carroll, 1978). Later on, these results were extended to what Garry, Manning, Loftus, and Sherman (1996) termed "counterfactual imaginings", in research on the "imagination inflation effect". After collecting confidence ratings of the likelihood that a number of childhood events happened to them, participants were asked to vividly imagine a selection of these events. Two weeks later, participants increased their likelihood ratings more for events that they earlier imagined than for events that they did not imagine; and this was also true for events that they initially rated as unlikely to have happened to them (Garry et al., 1996). The authors suggested that the accessibility and the amount of details in imagined events might make them seem more plausible, thus leading participants to be more confident that the events occurred. However, one could argue that these imagined past events are not "counterfactual events" as generally understood by psychologists, as they are not "alternative versions" to a known reality (Byrne, 2002, 2016; Epstude & Roese, 2008; Hoerl et al., 2011). An event initially rated very unlikely to have happened and then, later on, rated as likely to have happened can either be a true memory initially forgotten or a false memory, but not a counterfactual thought. Examining the perceived likelihood of counterfactual events might thus not be the most appropriate measure. Another way to investigate how we assess hypothetical events is to measure their plausibility.

Analyses of perceived plausibility have shown a different pattern of results for future and counterfactual events. Szpunar and Schacter (2013) tested how multiple simulations of future events affects their perceived plausibility. Their experiment ran over three sessions. In a first session, they asked 30 participants to generate a list of 110 familiar people, 110 familiar locations, and 110 common objects. In a second session, one week later, participants imagined 30 positive, 30 negative, and 30 neutral future events. They were cued with a person, a location, and an object they had provided in session one. This cuing method followed the recombination paradigm (Addis, Musicaro, Pan, & Schacter, 2010; Addis et al., 2009). Participants had 12.5 seconds to "imagine a future scenario that would evoke a positive/negative/neutral emotion from *[them]* in which *[they]* are interacting with the specified person, in the specified location, and that involves the specified object" (p. 324). They also provided a one-sentence summary description of the event. Finally, in a third session one day later, participants mentally simulated half of these events (45 events) three times, before simulating again the whole sample (90 events) and rating each event on its perceived plausibility as well as its ease, details, valence, and arousal. They found that participants rated emotional future events (both positive and negative) simulated four times as more plausible than future events simulated only once. Repeated emotional future events were also easier to imagine and were more detailed and more positive than future events simulated once. Another two recent studies have used the same design to investigate neural activity during emotional simulations of future events (Szpunar, Jing, Benoit, & Schacter, 2015) and future thinking in generalised anxiety disorder (Wu, Szpunar, Godovich, Schacter, & Hofmann, 2015). Both replicated Szpunar and colleagues' original findings: future events repeatedly simulated were rated as more plausible than future events simulated once.

The same paradigm was then used and adapted by De Brigard et al. (2013) in counterfactual thinking. In a first session, 30 participants generated 35 negative, 35 positive, and 35 neutral autobiographical memories. For each, they provided a title, the name of a person involved in the event, the location in which the event took place, and an object featured in the memory. In session two, one week later, participants imagined 30 upward ("imagine an alternative, better way in which the cued negative memory could have occurred"), 30 downward ("imagine an alternative, worse way in which the cued positive memory could have occurred"), and neutral ("imagine an alternative way in which the cued same event could have occurred") counterfactual events for a range of memories (p. 1330). Finally, in a third session one day later, participants mentally simulated half of these counterfactual events (45 events) three times, before simulating again the whole sample (90 events) and rating each event on its perceived plausibility as well as its valence, novelty, amount of details, and ease of simulation. The authors only kept counterfactual events that had a novel rating of 3 or more. This time, they found that participants rated counterfactual events simulated four time as less plausible than counterfactual events simulated once. Interestingly, repeated counterfactual events were also easier to imagine and were more detailed and more positive than counterfactual events simulated once, which implies that plausibility is not dependent on how detailed or easy the simulation is. The authors suggested that in this case, repeated simulations of counterfactual events provided more opportunities to find divergences from the actual memory, making the associated counterfactual events seem less plausible.

There have been a number of suggestions of how reality restricts past and future hypothetical thinking differently. Following the results of Szpunar and Schacter (2013) and De Brigard et al. (2013), as well as results from neuroimaging studies of future and counterfactual thinking, Schacter et al. (2015) proposed that future thoughts are less restricted by reality than counterfactual thoughts because counterfactual thoughts are constrained by the specific context of the related memory (Byrne, 2002, 2016; Epstude & Roese, 2008). In contrast, Ferrante, Girotto, Stragà, and Walsh (2013) argued that future thoughts were more constrained by reality than counterfactual thoughts, as a future event is seen as still realizable, whereas a counterfactual event will never occur. They showed that participants asked to reflect on past failures to solve a range of puzzles focused on uncontrollable features (e.g., having more time) when thinking about how things could have gone differently, but focused on controllable features (e.g., concentrating more) when thinking about how they would manage it in the next trial (see also Stragà & Ferrante, 2014). However, Ferrante et al.'s understanding of future thinking differed slightly from Schacter et al.'s. Whereas Schacter et al. (2015) included any future event in the realm of possibilities, plausible or highly unlikely, Ferrante et al. (2013) talked more about future events seen as personal goals by participants who thus had to think about it in a plausible way. These two types of future thinking are therefore different and serve different purposes (see also Chapter 2).

These reflections on the role of reality in our assessment of the perceived plausibility of past and future hypothetical events pose new questions. As the range of hypothetical outcomes of events is theoretically unlimited, would becoming aware of this by simulating multiple different alternative outcomes modify the perceived plausibility? As the future has not happened yet, thinking of multiple alternative versions of how a particular future event could happen might make participants more aware that the first version of the future event is only one possibility amongst many, and therefore reduce its perceived plausibility. On the other hand, following counterfactual theories suggesting that counterfactual events are compared to the “true” memory (Byrne, 1997, 2002; Epstude & Roese, 2008; Hoerl et al., 2011), multiple alternative versions of what could have happened might move away from the original memory, and therefore be perceived as less plausible compared to the very first counterfactual version, which would maintain its perceived plausibility.

The aims of this experiment were thus twofold. First, we replicated and extended Szpunar and Schacter’s (2013) and De Brigard et al.’s (2013) studies (which we will refer to as “reference studies”). In a first session, 60 participants generated 24 autobiographical memories, and provided a title, the name of a person involved in the event, the location in which the event took place, and an object featured in the memory. After a short break, 30 participants simulated 24 future events, cued with a combination of a person, a location, and an object; and 30 participants simulated 24 counterfactual events, cued with the person, location, and object of their own memories. After each simulation, all participants provided phenomenological ratings. In a second session a week later, participants mentally simulated half of these future and counterfactual events (12 events) three times, before simulating again the whole sample (24 events) and providing phenomenological ratings for each event. We expected to replicate previous findings that repeated simulation of future events increases perceived plausibility, whereas repeated simulations of counterfactual events decreases perceived plausibility. However, we compared plausibility ratings from session 1 with plausibility ratings from session 2, as well as comparing plausibility between events repeated once or four time in session 2 (see Table 1).

Table 1
Summary of Predictions on the Perceived Plausibility Between Session 1 and Session 2 for our Replications Groups

	Replication design: Identical simulations			
	Future thinking		Counterfactual thinking	
Comparison	1 repetition *M* (*SD*)	4 repetitions *M* (*SD*)	1 repetition *M* (*SD*)	4 repetitions *M* (*SD*)
Session 2 compared to session 1	Maintain plausibility	Increase plausibility	Maintain plausibility	Decrease plausibility

Second, we examined the impact of simulating multiple alternative versions of hypothetical past and future events. In a first session, 60 other participants generated 24 autobiographical memories, and provided a title, the name of a person involved in the event, the location in which the event took place, and an object featured in the memory. After a short break, 30 participants simulated 24 future events, cued with a combination of a person, a location, and an object; and 30 participants simulated 24 counterfactual events, cued with the person, location, and object of their own memories. After each simulation, all participants provided phenomenological ratings. In a second session a week later, participants simulated three alternative versions for half of these future and counterfactual events (12 events), before simulating again the last version they had generated for each event of the whole sample (24 events) and providing phenomenological ratings. With this particular design, we were less interested in the perceived plausibility of the fourth alternative version proposed, as we expected it to be lower than the first version proposed. However, we expected that proposing multiple versions of hypothetical events would decrease the perceived plausibility of the first future version proposed, but maintain the perceived plausibility of the first counterfactual version (see Table 2).

Table 2
Summary of Predictions on the Perceived Plausibility Between Session 1 and Session 2 for our Extensions Groups

	New design: Alternative simulations			
	Future thinking		Counterfactual thinking	
Comparison	1 version *M* (*SD*)	4 versions *M* (*SD*)	1 versions *M* (*SD*)	4 versions *M* (*SD*)
Session 2 compared to session 1	Maintain plausibility	Decrease plausibility	Maintain plausibility	Decrease plausibility

Method

Participants and Design

We recruited 120 undergraduate university students from Macquarie University, Australia as participants for this experiment (93 female and 27 male, mean age: 21.00 years, SD = 5.56; range, 18-52 years). Participants came twice to the laboratory for one-hour long sessions, with exactly one week between the two sessions. At the beginning of the first session, they provided informed consent prior to testing and received course credit or money (AUD $15/ hour) as compensation for their time, in accordance with procedures approved by the Macquarie University Ethics Committee.

We composed four different groups following a 2 (type of hypothetical thinking: future thinking vs. counterfactual thinking) x 2 (simulation type: identical vs. alternative) between-subjects design. Upon, arrival, participants were randomly allocated to one of these four groups: (a) identical simulations of future events; (b) alternative simulations of future events; (c) identical simulations of counterfactual events; (d) alternative simulations of counterfactual events. Therefore, we had 30 participants per group, which was the same number of participants used in the reference studies (De Brigard et al., 2013; Szpunar & Schacter, 2013).

Our predictions contained eight cells as we also added a within-subjects manipulation in session 2 for each group: half of the events were manipulated (participants repeatedly simulated the same event or participants repeatedly provided alternative versions of the event) and half of the events were not (see Table 3). Furthermore, we examined the interaction between phenomenology collected in session 1 and phenomenology collected in session 2.

Materials and Procedure

The study consisted of two sessions that were both completed on a computer in separate booths and using the presentation software E-Prime 2.0. We adapted the paradigm used in De Brigard et al. (2013) and Szpunar and Schacter (2013). However, we modified them in order to make the design for our four groups as similar as possible and run over two sessions only. We have summarized the parallel design of all our groups in Table 3.

Upon arrival, participants received the following instructions:

> During this experiment, which will run across two sessions, I will ask you to talk about personal specific events. A specific event is a unique, single event that occurs at a specific point in time, and lasts a few minutes or a few hours, but no longer than a day. These events do not have to be important or significant; they can be minor. But each event should be something that happens to you on a particular day in a particular place. You will not have to explain each event in detail so feel free to leave out what you do not want to divulge or talk about.

Table 3

Summary of the Experimental Design for the Four Groups

	FUTURE THINKING		COUNTERFACTUAL THINKING	
	Identical simulations	Alternative simulations	Identical simulations	Alternative simulations
N	30	30	30	30
Procedure day 1 (memory phase)	Generate 8 positive, 8 negative, and 8 neutral memories (5 year time frame) • Provide title, location, person, and object 5 min break (Sudoku)		Generate 8 positive, 8 negative, and 8 neutral memories (5 year time frame) • Provide title, location, person, and object 5 min break (Sudoku)	
Procedure day 1 (hypothetical events phase)	Provide 1 future version for each of the 24 events • Cue: mix of location, person, and object • Write a new title • 12.5 sec to simulate the future event • Phenomenology ratings (ease, details, plausibility, arousal, valence, novelty)		Provide 1 alternative version for each of the 24 events • Cue: title, location, person, and object • Write a new title • 12.5 sec to simulate the counterfactual event • Phenomenology ratings (ease, details, plausibility, arousal, valence, novelty)	
Procedure day 8 (manipulation phase)	For half of the future events, resimulate the same future event • Cue: title, location, person, and object • Write the old title • 12.5 sec for each simulation Repeat the whole process three times	For half of the future events, simulate an alternative version of that event • Cue: title, location, person, and object • Write the old title • 12.5 sec for each simulation Repeat the whole process three times	For half of the counterfactual events, resimulate the same counterfactual event • Cue: title, location, person, and object • Write the old title • 12.5 sec for each simulation Repeat the whole process three times	For half of the counterfactual events, simulate an alternative version of that event • Cue: title, location, person, and object • Write the old title • 12.5 sec for each simulation Repeat the whole process three times
Procedure day 8 (final phase)	5 min break Sudoku Resimulate the last version of all 24 future events • Cue: title, location, person, and object • 12.5 sec to resimulate the future event • Memory task ("Have you simulated it today or last week?") • Phenomenology ratings (ease, details, plausibility, arousal, valence, novelty)		5 min break Sudoku Resimulate the last version of all 24 counterfactual events • Cue: title, location, person, and object • 12.5 sec to resimulate the counterfactual event • Memory task ("Have you simulated it today or last week?") • Phenomenology ratings (ease, details, plausibility, arousal, valence, novelty)	

Session 1. The first session was separated into two phases: the memory phase and the hypothetical events phase (see Table 3). During the memory phase, participants were prompted to generate a total of 24 memories, made up of 8 positive, 8 negative, and 8 neutral events from the last five years. For each memory, participants typed on the computer a descriptive title, the specific location of the memory, the name or description of a person (not deceased) present during the memory or with a strong link to the event, and a common object featured in the memory. We told participants that each person, location, and object had to be different in each memory. They had a blank sheet of paper next to them if they wanted to keep track of their answers. Once they completed the 24 memories, participants had a 5-minute break while completing a Sudoku.

During the hypothetical events phase, participants generated 24 future events or 24 counterfactual events depending on which group they were in. Participants in the future thinking groups were given the following instructions:

> During this part of the experiment, you will be asked to imagine future events that could happen to you in the next five years. You will be cued with one of the locations, one of the people, and one of the objects you provided earlier on, but each cue item will be extracted from different memories. You will be requested to press the space bar as soon as you can think of a future event that could happen to you.

Once participants were ready to start, they saw the first prompt on the computer monitor showing a location, person, and object randomly extracted from different memories. In other words, the location might have come from their first memory, the person from their third memory, and the object from their sixth memory. We followed this recombination paradigm (Addis et al., 2010; Addis et al., 2009) to avoid past events being recast in the future. Participants were asked to imagine a future event that could happen to them in the next five years using this triad of cues. Whenever they had a possible future event in mind, participants typed a descriptive title for this future event on the computer and then pressed the space bar. During the next 12.5 seconds, they were asked to “mentally simulate the future event during a few seconds”. They were allowed to close their eyes and they heard a bell when the 12.5 seconds were over. This procedure is thus very similar to the procedure used by Szpunar and Schacter (2013).

Participants in the counterfactual thinking groups were given the following instructions:

> During this part of the experiment, for each event you provided before, you will be asked to imagine an alternative way in which it could have occurred. You will be cued with the title, the location, the person, and the object of the event you provided earlier on. You will be requested to press the space bar as soon as you can think of how else the event could have happened.

Once participants were ready to start, they saw the first prompt on the computer monitor showing the title, the location, the person, and the object of one of their memories. Whenever they had a possible counterfactual event in mind, participants typed a new descriptive title for this alternative event on the computer and then pressed the space bar. During the next 12.5 seconds, they were asked to “mentally simulate the counterfactual event for a few seconds”. They were allowed to close their eyes and they heard a bell when the 12.5 seconds were over.

It is worth noting that in the reference studies, participants were prompted to come up with positive, negative, or neutral future or counterfactual events. The emotional valence of the event did not impact results for counterfactual events, although it did for future events. Neutral future events did not show any difference in plausibility following repetition whereas negative and positive future events did (Szpunar & Schacter, 2013). As only neutral future events impacted their findings, and we already had a relatively complex design, we decided not to force participants to come up with positive, negative, or neutral events.

After each mental simulation, and in all groups, participants completed six 5-point phenomenological ratings, presented in a random order each time. They rated: how easy it was to simulate the event (1 = very difficult, 5 = very easy); if the simulated event contained many details (1 = few details, 5 = may details); if the simulated event was plausible (1 = very implausible, 5 = very plausible); how arousing was the simulated event (1 = very calming, 5 = very arousing); the valence of the event (1 = very negative, 5 = very positive); and how similar the simulated event was to another past event (1 = very similar, 5 = totally novel). Participants repeated the same steps (receive cue, think of counterfactual or future event, simulate it for 12.5 seconds, then rate its phenomenology on our six measures) 24 times, using all the locations, people, and objects obtained in the memory phase. At the end of their session, we thanked participants for their time and reminded them of the date and time of session 2.

Session 2. The second session took place one week later and was also divided into two phases: the manipulation phase and the final phase (see Table 3). During the manipulation phase, participants in the *identical simulations* groups were told: "You will be asked to resimulate three times half of the future/counterfactual events you generated last week."[1] They were cued with the title of the future or counterfactual events they had provided and the location, the person, and the object associated with that event. Once they recalled which event the cues related to, they pressed the space bar and typed again the title of the event. Then, they again had 12.5 seconds to resimulate the event the same way they had before. Once they had

[1] For counterfactual events, the computer randomly selected half of the counterfactual events generated after a positive memory, half of the counterfactual events generated after a negative memory, and half of the counterfactual events generated after a neutral memory. For future events, the computer simply randomly selected half of the generated future events.

gone through the 12 future or counterfactual events once, they had a small break for a few seconds then started over another two times, always simulating the exact same events but each time in a new random order. The other 12 events were not shown during this phase.

Participants in the *alternative simulations* groups were told: "You will be asked to provide and simulate three alternative versions to half of the future/counterfactual events you generated last week."[1] They were cued with the title of the future or counterfactual events they had provided, the location, the person, and the object associated with that event. When they recalled which original event the cues related to, they had to think about how else that event could happen. Once they had a new alternative version in mind, they pressed the space bar and typed a new descriptive title. Then, they again had 12.5 seconds to simulate the new future or counterfactual event. Once they had gone through the 12 events once, they had a small break for a few seconds then started over another two times, always simulating new alternative versions for these events, and each time in a new random order. The other 12 events were not shown during this phase.

Before starting the final phase, participants had another 5-minute break during which they completed a Sudoku. Then, they were given the following instructions:

> You will be asked to resimulate (the last version) of every future/counterfactual event (both from today and last week) one last time. You will be given the title, the location, the person, and the object as cues. Once more, you will be requested to press the space bar as soon as you have the event in mind. Like before, you will be given a few seconds to mentally simulate the event. Please do take the allocated time to simulate the event as best as you can.

Participants in the *alternative simulations* groups were told they would have to resimulate the last version they generated (in other words the fourth version they generated). They were cued with the correct title, location, the person, and the object associated with the event. One last time, participants simulated the event in the same way as they had before. As soon as the 12.5 seconds were over, participants were asked if they had simulated the event today or last week only. This measure was used to obscure the true purpose of the experiment. They completed again the six 5-point phenomenological ratings from session 1, presented in a random order each time. It is important to note that before the last simulation, hypothetical events cued with the same triad (location, person, and object) had been simulated either once (in the first session) or four times (once in the first session and three times in the second session). Finally, participants were debriefed on the aims of the experiment and thanked for their time.[2]

Data Analyses

In total, we collected two sets of phenomenological data. We collected phenomenological ratings during the first session when participants either generated 24 future events or 24 counterfactual events, then rated them on six phenomenological measures. At that point in time, we only had two distinct groups: future thinking or counterfactual thinking. Consequently, we first simply compared phenomenological ratings in the future and counterfactual thinking groups. As scores for different events could not be considered independent, we averaged all 24 events into single scores for each phenomenological rating and for each participant.

During the second session, participants were further separated into two more distinct groups: those asked to simulate three times the same future or counterfactual events or those asked to simulate three new alternative versions of the initial future or counterfactual events. Half of the events followed this multiple simulations procedure; the other half were not presented again at that time. At the end, participants simulated once more the last version of all 24 counterfactual or future events and completed the same phenomenological scales.

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[2] We also added a short measure of Optimism, the Life Orientation Test Revised (Scheier, Carver, & Bridges, 1994), however we did not get any significant result or correlation, so we removed it from this paper.

It is important to note that for the *identical simulations* groups, distinct sets of events were simulated twice or five times over the two sessions, but once or four times during the manipulation phase in session 2. For the *alternative simulations* groups, for distinct sets of events, participants had to provide one or four alternative versions over the two sessions, however only the last version (which could be the first and only or the fourth) was simulated a second time at the end of session two before rating the scales.

In our experiment, we were particularly interested in comparing phenomenological ratings after a single simulation vs. after four simulations. Therefore, for each phenomenological rating, we also averaged the 12 events simulated once and the 12 events simulated four times into two single scores for all participants.

In the reference studies, the authors only collected phenomenological ratings in the last session, and compared them within-subjects. As we collected data at both points in time (session 1 and session 2) and given the importance of baseline when investigating phenomenological ratings (see Chapter 4), we decided to also examine the interaction between manipulation and session to investigate changes in the perceived plausibility.

Results

Session 1

First, we compared the initial phenomenological ratings of future and counterfactual events collected during session 1. Means and standard deviations are presented in Table 4. Overall, future events were rated as more positive, $t(118) = 2.90$, $p = .004$, $d = 0.53$; and more novel, $t(118) = 2.09$, $p = .039$, $d = 0.39$ than counterfactual events. In contrast, counterfactual events were rated as more plausible, $t(118) = 6.46$, $p < .001$, $d = 1.02$; and easier to simulate, $t(118) = 2.29$, $p = .024$, $d = 0.43$ than future events. There were no other significant differences.

Together, these findings support the notion that people tend to see the future in an optimistic way (Schacter & Addis, 2007b; Sharot, 2011; Weinstein, 1980), but also the suggestion that future events are less restricted by reality than counterfactual events, as future events feel more novel whereas counterfactual events are more plausible and easier to simulate (Schacter et al., 2015).

Table 4

Means and Standard Deviations of Initial Phenomenological Ratings for Counterfactual and Future events

Measures	Future thinking *M* (*SD*)	Counterfactual thinking *M* (*SD*)
Plausibility	3.00 (0.53)	3.60 (0.48)
Ease	3.62 (0.69)	3.88 (0.51)
Details	2.92 (0.66)	2.88 (0.55)
Arousal	2.99 (0.58)	3.13 (0.48)
Valence	3.43 (0.47)	3.18 (0.48)
Novelty	3.42 (0.47)	3.24 (0.47)

Conceptual replications

As explained in the data analysis section, the reference studies only collected data in the last session and compared the phenomenological ratings between-subjects. Therefore, for our two groups replicating the references studies, we first compared the perceived plausibility rated during session 2 between events that were simulated once and events that were simulated four times.

First, we did not replicate Szpunar and Schacter's (2013) findings. Repeated measures ANOVAs did not find a significant difference for the effect of repetition on the perceived phenomenology, $F(1, 29) = 1.45$, $p = .239$. Events simulated four times were rated as plausible as events simulated once (see Table 5). Second, we also did not replicate De Brigard et al.'s (2013) findings. Repeated measures ANOVAs did not find reliable evidence of an significant difference for the effect of repetition on the perceived phenomenology, $F(1, 29) =$

1.62, $p = .213$. Events simulated four times were rated as plausible as events simulated once (see Table 5). However, as phenomenological ratings are dependent on a base rate (see Chapter 4), it is worthwhile examining the interactions between session 1 and session 2.

Interaction Between Session 1 and Session 2

To investigate changes in phenomenology – and more importantly in perceived plausibility – we ran separate ANOVAs on our four groups (*identical simulations of future events* group; *alternative simulations of future events* group; *identical counterfactual simulations of events* group; and *alternative simulations of counterfactual events* group), and this for three reasons. First, it would allow us to better compare our analyses to the reference studies (De Brigard et al., 2013; Szpunar & Schacter, 2013). Second, as we expected the *alternative simulations* manipulations to affect our phenomenological ratings more strongly, running an omnibus ANOVA and all our groups at once would have increased the risk of missing differences in the *identical simulations* groups, as these difference were quite small in the reference studies. Third, we were not interested in directly comparing phenomenological ratings across groups as our main interest differed from one group to the other. In the *identical simulations* groups, we were mostly interested in the comparison between the perceived phenomenology of events simulated four times compared to events simulated once. In the *alternative simulations* groups, we were mostly interested in the comparison between session 1 and session 2 for the first version of events (or in other words for events that were not manipulated). Therefore, comparing events repeated four times with the fourth alternative version of events would not make much sense.

Consequently, in the following four sections, we ran 2 (manipulation: one simulation vs. four simulations) x 2 (session: session 1 vs. session 2) repeated measures ANOVAs on each phenomenological measure but separately for each group. Means and standard deviations for all phenomenological ratings and in all groups are displayed in Table 5.

Table 5

Mean Phenomenological Ratings for Future and Counterfactual Events as a Function of the Number and Types of Simulations

	Future thinking				Counterfactual thinking			
	Identical simulations		Alternative simulations		Identical simulations		Alternative simulations	
	1 repetition	4 repetitions	1 version	4 versions	1 repetition	4 repetitions	1 version	4 versions
Measures	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)
Plausibility								
Session 1	3.07 (0.64)	3.03 (0.67)	3.01 (0.59)	2.89 (0.51)	3.56 (0.52)	3.53 (0.52)	3.60 (0.50)	3.71 (0.58)
Session 2	2.94 (0.71)	3.11 (0.68)	2.83 (0.61)	2.52 (0.63)	3.49 (0.49)	3.41 (0.53)	3.64 (0.44)	3.04 (0.63)
Ease								
Session 1	3.76 (0.76)	3.86 (0.80)	3.44 (0.64)	3.44 (0.63)	3.95 (0.55)	3.92 (0.51)	3.80 (0.55)	3.84 (0.57)
Session 2	3.53 (0.94)	3.92 (0.75)	3.15 (0.62)	2.96 (0.70)	3.48 (0.47)	3.68 (0.57)	3.54 (0.48)	3.48 (0.63)
Details								
Session 1	3.04 (0.73)	3.08 (0.75)	2.76 (0.64)	2.80 (0.63)	2.94 (0.81)	2.94 (0.69)	2.87 (0.38)	2.78 (0.38)
Session 2	2.83 (0.94)	3.17 (0.83)	2.83 (0.66)	2.59 (0.66)	2.88 (0.72)	2.93 (0.62)	2.79 (0.54)	2.83 (0.52)
Arousal								
Session 1	3.05 (0.71)	2.99 (0.67)	2.89 (0.51)	3.02 (0.54)	3.07 (0.55)	3.14 (0.65)	3.18 (0.44)	3.12 (0.48)
Session 2	3.12 (0.69)	3.06 (0.62)	2.97 (0.55)	2.97 (0.55)	3.16 (0.46)	3.16 (0.51)	3.27 (0.48)	3.21 (0.42)
Valence								
Session 1	3.49 (0.45)	3.48 (0.55)	3.39 (0.60)	3.36 (0.49)	3.18 (0.53)	3.22 (0.58)	3.15 (0.47)	3.17 (0.49)
Session 2	3.41 (0.53)	3.44 (0.45)	3.35 (0.47)	3.20 (0.56)	3.02 (0.47)	3.04 (0.57)	3.05 (0.51)	3.02 (0.47)
Novelty								
Session 1	3.70 (0.58)	3.43 (0.61)	3.29 (0.45)	3.26 (0.60)	3.14 (0.62)	3.38 (0.53)	3.14 (0.39)	3.30 (0.56)
Session 2	3.44 (0.56)	3.34 (0.64)	3.32 (0.55)	3.58 (0.58)	3.21 (0.72)	3.03 (0.62)	2.91 (0.39)	3.44 (0.58)

Identical simulations of future events. This group followed a similar design to Szpunar and Schacter (2013). The authors found that future events simulated four times were rated more plausible, positive, easy to simulate, detailed, and arousing than future events simulated once. In our study, results showed a main effect of session only for *novelty* ratings, $F(1, 29) = 4.46$, $p = .043$, $\eta_p^2 = 0.13$. Unsurprisingly, participants rated their future events less novel in session 2 than session 1. We also found significant interactions between session and manipulation for *ease* ratings, $F(1, 29) = 5.15$, $p = .031$, $\eta_p^2 = 0.15$; and *plausibility* ratings, $F(1, 29) = 4.46$, $p = .043$, $\eta_p^2 = 0.13$. Bonferroni adjusted contrasts indicated that in session 2, participants rated future events simulated four times easier to simulate than future events simulated once ($p = .009$), but mainly because future events simulated once were rated harder to simulate in session 2 compared to session 1 ($p = .018$). On the other hand, and as seen previously, follow-up contrasts on our *plausibility* measure did not yield any significant differences. However, even though they did not differ statistically, the raw numbers showed that plausibility in future events repeated four times increased slightly across sessions, whereas it decreased slightly in future events repeated once. Therefore, although we did not fully replicate Szpunar and Schacter's (2013) results, our results were leaning towards the same direction.

Identical simulations of counterfactual events. This group followed a similar design to De Brigard et al.'s (2013) study. The authors found that counterfactual events simulated four times were judged less plausible but more detailed, positive and easily simulated than those simulated only once. In our experiment, we found a main effect of session for *valence* ratings, $F(1, 29) = 6.62$, $p = .015$, $\eta_p^2 = 0.19$; and for *ease* ratings only, $F(1, 29) = 6.62$, $p = .015$, $\eta_p^2 = 0.19$. Participants rated all counterfactual events less positive and harder to simulate in session 2 than session 1. We also found an interaction between session and manipulation for *ease* ratings, $F(1, 29) = 4.69$, $p = .039$, $\eta_p^2 = 0.14$. Bonferroni adjusted contrasts indicated that even though participants rated counterfactual events easier to simulate in session 1 than in session 2, counterfactual events simulated 4 times in session 2 were rated easier to simulate than counterfactual events simulated once only (p = .018). Yet, of main interest here and as seen previously, plausibility ratings were similar across sessions and manipulation. Consequently, we did not replicate De Brigard et al.'s (2013) results.

Alternative simulations of future events. For half of the initial future events, this group generated three other alternative versions. Then, at the end of session 2, they simulated once more the last alternative versions they had proposed (so the fourth version of the future event). For the other half, at the end of session 2, they simulated the same version they had initially proposed in session 1 (so the first and unique version of the future event).

We found a main effect of session for *plausibility* ratings, $F(1, 29) = 9.72$, $p = .004$, $\eta_p^2 = 0.25$, but no interaction. All future events received lower ratings in session 2 than session 1. In other words, fourth alternative versions of future events were rated as less plausible than their related first version measured during session 1. It is interesting to note that future events that were not simulated during the manipulation phase were also rated less plausible in session 2 than the first time they were simulated in session 1. This result follows our prediction that the realization the future is uncertain might decrease the perceived plausibility of the first version that came to mind.

Results also yielded a main effect of session for *novelty* ratings, $F(1, 29) = 5.01$, $p = .033$, $\eta_p^2 = 0.15$; and *ease* ratings, $F(1, 29) = 11.08$, $p = .002$, $\eta_p^2 = 0.28$. Similar to the *repeated simulations* group, participants rated their future events less novel, but also less easy to simulate in session 2 than session 1. We also found a significant interaction for *details* ratings, $F(1, 29) = 5.51$, $p = .026$, $\eta_p^2 = 0.16$. Bonferroni adjusted contrasts indicated that in session 2, participants rated the fourth alternative versions of future events as less detailed than the first alternative version of future events (p = .021).

Alternative simulations of counterfactual events. For half of the initial counterfactual events, this group generated three other alternative versions. Then, at the end of session 2, they simulated once more the last alternative version they had proposed (so the fourth version of the counterfactual event). For the other half, at the end of session 2, they simulated the same version they had initially proposed in session 1 (so the first and unique version of the counterfactual event).

Results showed an interaction for the *plausibility* ratings, $F(1, 29) = 41.33$, $p < .001$, $\eta_p^2 = 0.59$. As we predicted, participants rated the fourth alternative versions of counterfactual events as less plausible than their related first version rated in session 1 ($p < .001$), but also less plausible than events that were not simulated during the manipulation phase and rated in session 2 ($p < .001$). Furthermore, counterfactual events not simulated during the manipulation phase were rated as plausible in session 2 as in session 1 ($p = .254$). As expected, the first alternative version of past event was usually the most plausible one, and thinking of multiple ways the event could have happened did not impact the first version's perceived plausibility.

Results also yielded main effects of session for *valence* ratings, $F(1, 29) = 5.22$, $p = .030$, $\eta_p^2 = 0.15$; and *ease* ratings, $F(1, 29) = 13.44$, $p = .001$, $\eta_p^2 = 0.32$. Similar to the *repeated simulations* group, participants rated all counterfactual events less positive and harder to simulate in session 2 than session 1. We also found significant interactions for the *novelty* ratings, $F(1, 29) = 9.80$, $p = .004$, $\eta_p^2 = 0.25$. Bonferroni adjusted contrasts indicated that counterfactual events simulated once during session 2 were rated as less novel in session 2 compared to session 1 ($p < .001$). On the other hand, the fourth versions of counterfactual events simulated in session 2 felt as novel than the first version of these events simulated in session 1 ($p = .105$). Therefore, in session 2, counterfactual events for which participants simulated four possible versions felt more novel than events for which participants only simulated once (*p* < .001).

Discussion

In this experiment we examined the perceived plausibility of hypothetical future and past events after repeated simulations or following the proposal of multiple alternative ways the events could occur or could have occurred. We adapted and integrated the paradigms used in Szpunar and Schacter's (2013) and De Brigard et al.'s (2013) studies. During the first session, participants generated 24 original future events or 24 original counterfactual events, and rated them on six 5-point scales phenomenological measures, including perceived plausibility. During the second session, participants simulated half of the events three times each. Some participants were asked to repeatedly simulate identical versions of their future or counterfactual events, whereas some participants were asked to simulate alternative versions of how else their initial future or counterfactual events could occur. Finally, all participants simulated the last version they provided for all 24 future and counterfactual events, and rated them again on the six scales.

Our first aim was to replicate Szpunar and Schacter's (2013) and De Brigard et al.'s (2013) results, which suggested that the perceived plausibility of future events increased with repetition, whereas the perceived plausibility of counterfactual events diminished with repetition. Unfortunately we were not able to fully replicate these findings. In our study, future events simulated once were rated as plausible as future events simulated four times. Although our results yielded an interaction between session and manipulation, and that numbers seemed to be going in the predicted direction, all contrasts were non-significant. We did not replicate the findings for counterfactual events either, as in our study counterfactual events simulated once were rated as plausible as counterfactual events rated four times.

Furthermore, we did not detect an increase in plausibility between ratings in session 1 and ratings in session 2.

There are a few possible explanations for the differences between our results and the findings from the reference studies. First, in the reference studies, participants were specifically requested to generate positive, negatives and neutral events, whereas we let participants decide what type of events they generated. However, De Brigard et al. (2013) did not find an effect of event valence for counterfactual events, so this cannot explain our results, while Szpunar and Schacter (2013) showed that neutral future events did not increase in plausibility after repetition. It is possible that we had too many neutral future events, which weakened our capacity to find an effect. However, upon inspection of the data and the relation between valence and plausibility, this does not seem to be the case.

We also had a slightly different design. This means that our replication was not technically a perfect reproduction of the original method, but that it was more a conceptual replication. We still expected to find the same pattern of results, despite the small changes in design. In the reference studies, events were rated for plausibility and other phenomenological characteristics only once, at the end of the last session; in our study, participants rated the events a first time in the first session, and once more in the last session. Szpunar and Schacter (2013, p. 325) argued that this design "helped to avoid potential biases that might have arisen had participants been asked to rate the same events across multiple simulations (e.g., under such circumstances, previous ratings of individual events might influence subsequent ratings of those same events)." However, our previous studies highlighted the need to have a baseline when using phenomenological ratings (Chapter 4). Furthermore, in order to truly measure "increase" or "decrease" in perceived plausibility following multiple simulations, we decided to collect data before and after the manipulation. This difference in design may have impacted our results, as first ratings of events could have influenced second ratings; though, we did not expect participants to recall most previous ratings as our sessions were set one week apart and consisted of many different events.

With regards to counterfactual events, De Brigard et al. (2013) selected and analyzed only events that received 3 or more on their novelty scale. We decided not to do this because Szpunar and Schacter (2013) did not select future events in this way and we wanted to keep comparability across the two studies. It is possible that keeping novel and less novel events together impacted our results. However, post hoc analyses of events rated 3 or more showed results similar to those reported above, which indicates that the novelty of the events did not seem to impact our findings.

Finally, we collected fewer events per participant compared to Szpunar and Schacter (2013). Nevertheless, for each phenomenological rating, they used an average score across all events reported by each participant, which was a process that we also followed. It is possible that the number of events generated impacted the overall results, but this is unlikely, given that we had the same number of participants and, therefore, the same degrees of freedom in our analyses. It is also worth noting that we obtained similar standard deviations to both reference studies. It is also worth noting that two recent studies from the same laboratory have replicated their finding of an increase in plausibility, although with some differences in the pattern of results (e.g., repetition also affected neutral events; Szpunar et al., 2015; Wu et al., 2015). This suggests that plausibility ratings may be sensitive to small changes in study design.

Our second aim was to examine the effect of proposing multiple alternatives of future and counterfactual events on the perceived plausibility of events. As suggested by Schacter et al. (2015), we expected that reality would not constrain future thought too much, and that thinking about multiple versions might make participants aware of the intangibility of the future. As predicted, our results showed that participants rated their first version of a future event as more plausible than their fourth alternative version. Moreover, thinking about multiple versions of future events also affected how plausible they perceived their first version, making it seem retrospectively less plausible than initially rated.

In contrast, theories of counterfactual thinking have suggested that counterfactual events are generally compared to reality and tended to be plausible versions of what could realistically have happened (Byrne, 1997, 2016; Epstude & Roese, 2008; Hoerl et al., 2011; Roese, 1997). Therefore, as proposed by Schacter et al. (2015), counterfactual thoughts should be constrained by reality of past events. As predicted, our results showed that participants rated their first counterfactual version as more plausible than their fourth version, although thinking about the multiple ways in which past events could have occurred did not affect the perceived plausibility of that first counterfactual version. These results indicate that counterfactual thinking is indeed constrained by reality and that, depending on the context, the range of plausible versions of what could have happened might be limited, with the most straightforward one coming first to mind.

Together, our findings support the idea that future and counterfactual thinking are differently constrained by reality, which in turn has implications for understanding the similarities and differences in autobiographical thinking. Cognitive scientists have argued that past and future thinking rely on similar underlying constructive processes (Klein, 2013; Schacter, 2012; Szpunar, 2010; see also Chapter 2). However, as reviewed here, one important difference between past-oriented and future-oriented events is how the reality of what happened in the past affects the way we assess and, most likely, construct these events. Memories and counterfactual thoughts are constructed while keeping in mind the “true” event and both types of representations have to maintain a certain level of plausibility imposed by reality (see also Chapter 2). In contrast, the future can be constructed more freely (see also

Chapter 3). Nonetheless, it is important to keep in mind that the differences in ratings were really small. Replications of our results would be an important step for further studies.

The way we simulate, perceive, and assess future thoughts can impact how we plan and predict the future. As discussed in the introduction, Ferrante et al. (2013) showed that future thinking in the context of problem solving is constrained by the context of the problem and the sought goal. Considering that our simulations of future events are often erroneous (Gilbert & Wilson, 2007), it can be worth considering many future alternatives when planning for a personal goal (Hayes-Roth & Hayes-Roth, 1979). Indeed, a reduced perceived plausibility after considering many alternatives, as we have shown in our study, might simply mean that the perception of plausibility has become more realistic and less optimistic (Sharot, 2011; Weinstein, 1980). Simulation of the goal, repeated or not, might increase the probability to act upon it in order to make the event happened, as shown in delayed discounting tasks (Benoit, Gilbert, & Burgess, 2011; Peters & Buchel, 2010). More generally, training participants in recollecting many details from episodic events can also enhances their performance on a problem-solving task (Madore, Addis, & Schacter, 2015; Madore & Schacter, 2014).

In conclusion, the assessment of the perceived plausibility of hypothetical events depends not only on their temporal orientation, but also on how and how often they are simulated. Counterfactual thoughts are compared to the associated memory, whereas future thoughts do not have a similarly defined “true” event. Reality thus constrains past and future thinking differently, but the extent of its effect might also depend on the function of the past or future thought.

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Journal Description (impact factor = 4.24)

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CHAPTER 7

General Discussion:

From Autobiographical Thinking

to the Future

General Discussion: From Autobiographical Thinking to the Future

"It's a poor sort of memory that only works backwards, says the White Queen to Alice" (Carroll, 1871/1954, p. 170).

Memory is usually defined and understood as the capacity to remember things of the past. Yet, researchers have now suggested that one of the main functions of memory is to imagine, simulate, or plan possible future events (Klein, 2013; Schacter, 2012; Suddendorf & Corballis, 1997). Past and future thinking can be thought of as two sides of the same coin (Dudai & Carruthers, 2005), both relying on similar underlying processes and sharing a common neural network (D'Argembeau, 2012; Schacter & Addis, 2007b; Szpunar, 2010).

Although there has been a surge of interest in better understanding past and future thinking processes in the last twenty years, the field is quite young and more research is needed to fully grasp how we create mental representations of events that happened to us, as well as mental representations of events that could, plausibly or not, have occurred to us in the past or occur to us in the future. As discussed in the Introduction (Chapter 1) and in my theoretical chapter (Chapter 2), research on what has been termed "mental time travel" has primarily focused on comparing episodic memory with episodic future thinking. However, I suggested that this focus is too narrow and that we should investigate a broader range of autobiographical thinking processes to understand the constructive process of autobiographical events, experienced or hypothetical.

Therefore, throughout this thesis I have examined how humans think autobiographically about a wide range of personal past and future events. I have asked participants to remember personal memories, but also to simulate how else they could have happened. I have asked them to imagine and plan future events, and to think about alternative versions of how they could occur. I have investigated these various processes of thinking autobiographically, their raw materials, and their products from a theoretical and empirical point of view, and across multiple levels of analyses. Throughout one theoretical and four empirical chapters, I have aimed to acquire a more comprehensive understanding of how autobiographical events are constructed, perceived, and described. I followed the design of my cognitive framework (Chapter 2), starting from the center, investigating first the raw materials of autobiographical events. I then moved to examine the various autobiographical processes from the past and future sections, comparing and contrasting their products, from the subjective experience associated with thinking about autobiographical events to the linguistic style associated with describing the narrative of autobiographical events. Finally, I considered one of the main dimensions of my framework, namely the plausibility dimension, and how plausibility can be perceived differently depending on the temporal orientation as well as the number and type of simulations.

In this final chapter, I review and integrate my findings across the studies reported in Chapters 3 to 6. I first provide an overview of my empirical findings, then, I discuss several major themes that emerged from my research. The first theme is the order effect found across multiple studies. The second theme is the role of planning as a different form of future thinking. The third theme is the role of counterfactual thinking as an interesting point of comparison with memories and future thoughts (it is hypothetical like future thoughts but oriented towards the past like memories). I will also discuss the relevance of its future counterpart, namely prefactual thinking, in autobiographical thinking research. The fourth theme is the categorization of episodic memory as a qualitatively different process from hypothetical forms of autobiographical thinking (such as counterfactual thinking or future thinking). Finally, I will review the strengths and shortcomings of my cognitive framework for understanding processes of autobiographical thinking in light of my research and my findings. I also consider some of the broader limitations of my work and possibilities for further research.

Overview of Empirical Findings

In Chapter 3, I examined the raw materials used to construct autobiographical thoughts. More specifically, I evaluated the role of episodic memories and semantic scripts in the formation of future plans in familiar or unfamiliar contexts. Inspired by the constructive episodic simulation hypothesis (Schacter & Addis, 2007a), previous studies have examined the amount of episodic details in transcripts of past and future events (Addis & Tippett, 2008), yet no study had attempted to assess the role of semantic scripts. To facilitate the analysis of semantic scripts, I asked participants to recall how they planned a past camping trip set in Australia and to describe how they would plan a future camping set either in Australia or in Antarctica. I analyzed the transcripts with a coding scheme that I specifically designed for this experiment to measure both the quantity of information units as well as the use of semantic scripts. My results showed that participants relied on relevant past memories to plan for similar future events, especially when a relevant past memory had just been recalled and thus readily accessible, as predicted by the constructive episodic simulation hypothesis (Schacter & Addis, 2007a). But this reliance on episodic memory sometimes constrained future planning. Participants also used semantic scripts to support both their remembering and planning processes. Thus, across this chapter, I showed that future thinking does rely on episodic memory and semantic scripts, and that both past and future planning processes interact with one other.

Chapter 4 and Chapter 5 can be considered companion pieces, as in both chapters I report data collected from my second and third experiments, which relied on the same participant samples. Across these two experiments, one with a between-subjects design and one with a within-subjects design, participants remembered past events, imagined future events, and planned future events. For each event, they provided phenomenological ratings on their subjective experience and described the events. Then, during the second part of the experiments, they repeated all these steps but generated alternative versions of these past and future events, which I termed counterfactual events, prefactual imagined events and prefactual planned events, respectively. In both chapters, I thus examined products of thinking autobiographically, with Chapter 4 focusing on the phenomenological experience of thinking about personal past and future events and Chapter 5 focusing on the linguistic style in the verbal descriptions of the events.

In Chapter 4, I compared phenomenological ratings across a broad range of autobiographical thinking processes. Previous research has found that imagined events, either atemporal, past, or future, were generally experienced less vividly, with less sensory details, and a less clear visuo-spatial context compared to remembered events (Addis, Pan, Vu, Laiser, & Schacter, 2009; D'Argembeau & Van der Linden, 2004; De Brigard & Giovanello, 2012; Johnson, Foley, Suengas, & Raye, 1988). However, no study had examined as many phenomenological characteristics as I did, nor had they studied them across a broad range of autobiographical thinking processes. There were two major findings from my research.

First, the phenomenological characteristics were similar across remembered past events, imagined future events, and planned future events but only when the comparison was between-subjects. In the within-subjects design, where participants were able to directly compare the remembered events with the imagined events, and the planned events, participants reported a stronger feeling of experiencing remembered events, which were also visually and spatially clearer than imagined and planned future events. This finding suggests that phenomenology is relative and not absolute. In other words, phenomenology not only varies across participants, it also varies across context and task depending on what the current subjective experience is compared to. Counterfactual events also differed from memories on a range of ratings and in a similar way to future events, whereas prefactual imagined and prefactual planned events were experienced similarly to their original versions. Together, my results revealed that participants experienced memories differently from hypothetical past and future events, which suggests that memories might be qualitatively different from hypothetical events with regards to the way they are subjectively experienced.

Second, I conducted factor analyses on all the phenomenological characteristics and across conditions, seeking correlational patterns that would indicate how various characteristics might be grouped in natural factors. I ran one factor analysis for each experiment as the two experiments followed a different design. Both factor analyses generated a four-factor solution that accounted for 53% of the variance. The factor solutions were relatively consistent across the experiments. In the first experiment, I conceptualized the first factor as representative of autonoesis. It speaks of the feeling of experiencing the events and relates to the literature on mental time travel and episodic future thinking (Atance & O'Neill, 2001; Klein, 2016; Suddendorf & Corballis, 1997; Tulving, 1985). I conceptualized the second factor as representative of scene construction. It speaks of the process of constructing the visual or spatial scene where the event takes place, as suggested by the scene construction theory (Hassabis & Maguire, 2007). I conceptualized the third factor as representative of visual perspective. This factor only combined our three measures of visual perspective, which might indicate that visual perspective depends on individual differences or on the type of events (Nigro & Neisser, 1983; Rice & Rubin, 2009; Sutin & Robins, 2008). Lastly, I conceptualized the fourth factor as representative of optimism bias. It speaks of humans' tendency to see the future in an overly optimistic way (Schacter & Addis, 2007c; Sharot, 2011; Weinstein, 1980). In the second experiment, I conceptualized the first three factors similarly, however I conceptualized the fourth factor differently as other items loaded onto that factor, which included valence and occurrence ratings. I hypothesized that this conflicting result might have been caused by differences in the designs of experiments 1 and 2.

In Chapter 5, I analyzed the linguistic style when describing past and future autobiographical narratives as words can sometimes reveal the underlying processes at play when constructing autobiographical events of different kinds (Tausczik & Pennebaker, 2010). I ran the transcripts through the Linguistic Inquiry and Word Count computer program (LIWC, Pennebaker, Booth, & Francis, 2007). Previous studies have used this software to attempt to differentiate true memories from deceptive statements (Bond & Lee, 2005; Newman, Pennebaker, Berry, & Richards, 2003), yet no study had compared true memories with imagined future events. I examined linguistic measures indicative of tense thoughts (verbs and tenses), affective processes (positive and negative terms), cognitive processes (discrepancy, tentative, certainty, inhibition, etc.), perceptual processes (hear, see, feel) and relativity (space, time, motion). It is important to note that these measures are based on the idea that certain words reflect the presence of underlying processes, such as causal thinking, considering different possibilities, or feeling certain.

First, it is worth mentioning that our results were very similar across the two experiments. As one experiment followed a between-subjects design and one experiment followed a within-subjects design, this indicates that the way events were described was not impacted by an order effect (e.g., being the first event they described or the second), or by other tasks (e.g., if remembering a past event first changed the way participants subsequently described an imagined future event; see also Chapter 3). My results showed, as expected, that remembered events were described using a different linguistic style than both imagined and planned future events. Past events were generally described in the past tense, whereas future events were described in the present tense, which might reflect the constructive process of describing a future event being done “in the moment” (Dudukovic, Marsh, & Tversky, 2004). Future events contained more discrepancy and tentative terms, indicating the hypothetical nature of future thinking. However, one of the most interesting findings was that counterfactual events were described in ways similar to future events rather than to remembered events. I suggested that what mattered was the fact that past events have been experienced whereas future and counterfactual events have not. In other words, remembering past events might involve qualitatively different processes compared to simulating hypothetical events (see also Debus, 2014).

Finally, in Chapter 6, I examined the perceived plausibility of hypothetical events depending on their temporal orientation (past, which is known and cannot be changed; and future, which is unknown), but also depending on the way they are considered: once, repeatedly or with alternative possibilities. Previous research had revealed contrary results when examining the impact of repeated simulation on the perceived plausibility of past and future hypothetical events. Szpunar and Schacter (2013) found that repeated simulation of future events increased their perceived plausibility, whereas De Brigard, Szpunar, and Schacter (2013) found that repeated simulations of counterfactual events decreased their perceived plausibility. However, no research had explored the perceived plausibility of different versions of how an event could occur. Epstude and Roese (2008) suggested that the first counterfactual version we propose should be the most plausible. Yet, I expected this would not be the case for future thoughts, as they are not restricted by reality as much. Therefore, I designed an experiment to replicate Szpunar and Schacter's (2013) and De Brigard, Szpunar, et al.'s (2013) studies, but also to examine the impact of simulating multiple different versions of hypothetical past and future events. Unexpectedly, my results did not replicate previous findings on the effect of repeated simulations. I found no differences between events simulated once and events simulated four times, yet absolute numbers were leaning in the same direction for future events (raw numbers showed that plausibility in future events repeated four times increased slightly across sessions, whereas it decreased slightly in future events repeated once). However, as predicted, I found that proposing multiple versions of hypothetical events maintained the perceived plausibility of the first counterfactual version but decreased the perceived plausibility of the first future version. Together these results support the idea that if counterfactual and future thinking rely on the same constructive processes, they are differently constrained by reality, which in turn modifies how plausible they seem.

Major Themes of my Thesis

Order Effects and Interactions

The first theme I want to discuss is that of order effects and interactions between tasks. When designing experiments, psychologists often counterbalance the order of tasks to control its potential effect without having to include it in statistical analyses. This practice is widely used and is very effective in a big sample size or with many trials. However, close examination of potential order effects can also provide valuable information on the way tasks are completed or perceived by participants. In two of my experiments, I encountered some unexpected yet informative order effects.

In my first experiment, reported in Chapter 3, I sought to investigate how people rely on past memories and semantic scripts to simulate planning a future event. To do this, I created an experiment to measure the similarities in semantic categories used between a past plan and a future plan, as well as to compare the amount of details provided. Participants completed two tasks: a past planning task and a future planning task. The future planning task was set either in a familiar or unfamiliar location. In an attempt to control for a potential order effect, I counterbalanced the order of presentation of the tasks. However, as I only had two tasks, I included their order (first or second) in my analyses, which yielded strong order effects and interactions that impacted both tasks. For the future planning task, I found that participants constructed their future plans differently depending on the accessibility of a similar and relevant memory of planning. The constructive episodic simulation hypothesis

(Schacter & Addis, 2007a) proposes that we use details from past memories to construct future events. In my experiment, and in the particular context of planning, I showed that not only do we use details from past events, we sometimes recast almost entirely specific plans if these past plans were recently brought to mind and are relevant to the future planning. In my experiment, participants who described future plans in a familiar context after remembering a similar past plan mentioned details from fewer categories than if they had not recalled that past plan first. Whereas repeating successful past plans can be an effective approach, it might not always be the case, as being innovative can lead to discovering better strategies. One way to understand why we tend to repeat successful past plans is to consider social learning strategies. Laland (2004) suggested there is a hierarchical deployment of social learning, with innovation employed as a last resort when one cannot use previously learned strategies. Therefore, remembering past plans or strategies is useful and necessary, yet as the future is unknown and, by definition, not an identical repetition of the past, it might be necessary to not only rely on one single past instance, but on many past plans as well as on semantic knowledge and semantic scripts.

I also found a surprising order effect impacting the past planning task. Participants recalled more details of their past plans if they had previously imagined a future plan. This surprising finding allowed me to propose a tentative account of this effect by calling on the concept of scripts. I suggested that semantic scripts supported both remembering and future thinking processes. Scripts used to imagine the future plan – which might have been inspired by multiple past plans but also included innovative steps – were accessible and facilitated remembering. Without analyzing the order effects, we would not have discovered this interesting influence of scripts, which shed light on how past plans are recalled as well as how future plans are imagined.

Order effect analyses also revealed valuable findings in Chapter 4. I was interested to better understand how participants experienced and perceived different types of past and future autobiographical events, so I designed an experiment to examine phenomenological ratings. To avoid the order effects I found in my first experiment (Chapter 3), I decided to first use a between-subjects design (experiment 1 of Chapter 4). To my surprise, I did not find any of the expected differences in phenomenological ratings between past and future thinking that had been found by many other researchers (Addis, Pan, et al., 2009; D'Argembeau & Van der Linden, 2004; De Brigard & Giovanello, 2012). I ran a second similar experiment, but this time with a within-subjects design (experiment 2 of Chapter 4), as generally used in previous studies. Participants completed two out of the three conditions (remembering, imagining, or planning). I decided against requesting all three conditions from each participant to avoid complicating the analyses in case of order effect and interactions between tasks. As anticipated, I did find an order effect, which shed light on the lack of differences in the previous between-subjects experiment (experiment 1 of Chapter 4). Indeed, first events were rated similarly across all conditions (in experiment 2 of Chapter 4), replicating the result from experiment 1 (Chapter 4). In contrast, second events showed the expected differences described in the literature. Therefore, results from the between-subjects experiment combined with the order effect in the within-subjects experiment provided evidence that phenomenological ratings are relative and not absolute. For example, if someone remembers a vivid and highly emotional past memory, and then imagines a possible but not highly plausible minor future event, this future event might be given relatively low phenomenological ratings than if it was compared to a distant memory of an unimportant past event. Thus, analyses should be conducted in light of the “base rate” that participants compare their experience to. In conclusion, investigating order effects and interactions between tasks has value beyond verifying that counterbalancing has been applied successfully. Whereas studies containing many trials are often a necessity in psychology and cognitive science, examining tasks and conditions separately and with regards to their presentation order can also provide a deeper understanding of some of the mechanisms involved.

Planning as Another Type of Future Thinking Process

The second theme I want to discuss is that of planning. From my very first experiment, I have been interested in measuring planning in the context of future thinking. When researching and reading the literature on future thinking at the beginning of my PhD, I started to reflect on the difference between tasks requesting participants to imagine a future event and how future thinking takes form in everyday life. As discussed in Chapter 1, studies had generally examined the capacity to mentally time travel by comparing the way participants remember past events and imagine future events. However, I felt that in some experiments, future thinking capacities as measured by imagined events represented more the capacity to construct fictional events than the capacity to think about personal future events. For example, when using the recombination paradigm (Addis, Musicaro, Pan, & Schacter, 2010), the combination of idiosyncratic cues of a person, a location, and an object could sometimes result in very implausible prompts, forcing participants to imagine future events that will most likely never occur. This was particularly true when the three cues came from different social spheres, as the original authors themselves showed later (van Mulukom, Schacter, Corballis, & Addis, 2016). On the other hand, studies using common words such as “dog” or “summer” might result in very banal events that could happen in the future, but also could have happened countless times in the past. Therefore, it would be difficult to ensure that the future event imagined or simulated was indeed future-oriented and not just a recall of the past. Therefore, I was trying to find a way to ensure the future orientation of an event as well as a relative level of plausibility. I was also aware of the importance of future planning in everyday life as shown by studies recording the number of times people thought of the future during the course of one day and the functions of these future thoughts (Baird, Smallwood, & Schooler, 2011; D'Argembeau, Renaud, & Van der Linden, 2011).

In deciding to include future planning in my research, I reflected on the differences between planning and imagining, and this reflection led me to the cognitive framework described in Chapter 2. It is by considering the concept of planning as another type of future thinking that I started thinking outside the “mental time travel box” and identifying different ways to think in an autobiographical manner. In turn, this paved the way for my entire PhD project. First, I used planning as the content of a past and a future planning task in order to examine the raw materials, including semantic scripts, used to construct past and future thoughts (Chapter 3). In the introduction to that paper, I provided three reasons as to why using planning as the content of the past and future thoughts was advantageous. Briefly, the first reason was to make the task a bit more ecologically valid by providing a task that slightly resembled everyday life conditions, as future planning is a major aspect of future thinking. The second reason was that future planning is goal-directed, and therefore strives to create a plausible plan in order to research the sought goal, which would allow us to examine how future thoughts are constructed when constrained by plausibility. The third reason was that future planning should rely more heavily on scripts than imagined implausible events, which would allow us to examine these scripts in more detail. The experiment thus successfully captured the use of semantic scripts in past and future planning, as previously described in the overview of my empirical findings.

For the same reasons as the first two listed above, but also because I wanted to compare a broad range of autobiographical thinking processes, I added planning as a third process to remembering past events and imagining future events in the experiments reported in Chapters 4 and 5. I designed these two experiments in order to apply the three processes I was interested in (remembering, imagining, and planning) and compare their products on how events were subjectively experienced and narrated. I was particularly interested in using planning as a different type of future thinking to compare against remembering past events.

In the paper presented in Chapter 4, I investigated phenomenological ratings of past and future events across two experiments, as described previously. Interestingly, the expected differences between the phenomenology of past and future events (D'Argembeau & Van der Linden, 2004) were more apparent when comparing remembered past events with planned future events than when comparing remembered past events with imagined future events. For example, remembered events were experienced more fully, their location was clearer and the storyline more coherent than planned events, whereas imagined events received ratings in-between the two. Consequently, in terms of differences in subjective experience, planned events seemed to provide a stronger comparison to remembered events than imagined events.

In the paper presented in Chapter 5, I analyzed the linguistic style across narratives of past and future autobiographical events. Once more, most of the differences we found between remembered and imagined events were also found between remembered and planned events, and often to a higher degree. For example, in experiment 1, participants used the future tense more often for planned than imagined events and remembered events. Negative terms were also very rare in planned events compared to other conditions (remembered events, imagined events, counterfactual events, or prefactual imagined events). However, for most other categories measured, imagined and planned events contained similar amount of terms relative to the category. Therefore, with regards to their linguistic styles, narratives of planned events provided a stronger comparison to remembered events than imagined events. Together, these results show that in my studies, if the products of planning and imagining future events were very similar, both processes were different from remembering, and this difference seemed stronger when the comparison was between remembered events and planned events.

However, I had expected to find more phenomenological and linguistic differences between imagined and planned events. In my cognitive framework (Chapter 2), I hypothesized that imagining and planning were different autobiographical processes, as there are no requirements to make imagined events plausible, whereas plans to reach a goal have to be. I defined planning as the action of thinking of and simulating the different steps in a plausible way to reach a personal goal or event, as suggested by Hayes-Roth and Hayes-Roth (1979). One possible explanation for the lack of differences between imagined and planned events is that plausibility does not affect the way we experience future events or the way we describe them. Another possible explanation lies in the fact that we did not require imagined events to be plausible. However, this does not rule out that participants may have mostly imagined plausible events. Finally, it is worth noting that participants in the imagining and planning conditions all had to describe how the future event they imagined or planned would occur. Therefore, the instructions given and the process applied to the event (imagining it or planning for it) might not have impacted the way these future events were constructed. Future research could test these possibilities, for example by giving specific instructions to participants to think about plausible or implausible future events, or simply by asking participants to rate the perceived plausibility of the events.

In summary, including planning in future thinking research can be useful to expand knowledge of how future events are constructed, as demonstrated in Chapter 3. Furthermore, planning seems to provide a strong comparison to the process of remembering, as it might be more clearly future-oriented than imagined events. Finally, bearing in mind the important role of future planning in daily life (D'Argembeau et al., 2011), but also in investigating future thinking in animals and children (Clayton, Bussey, & Dickinson, 2003; McCormack & Atance, 2011), more research is still needed to fully understand the mechanisms at play when planning for future events as well as their impact on the way the future is perceived.

The Relevance of Counterfactual Thinking for Future Thinking Research

The third theme I want to discuss is the relevance of examining counterfactual thinking in a future thinking research context. Counterfactual thinking has a long research history, especially with regards to the functions of thinking about how else past events could occur and how such thoughts impact regret, remorse, and coping strategies (Boninger, Gleicher, & Strathman, 1994; Byrne, 2002; Roese, 1997). Cognitive researchers have also suggested that one of the main reasons to think counterfactually is to learn from our mistakes so we do not repeat them in the future, but also to exercise causal thinking and test possible consequences that can be useful for future purposes (De Brigard, 2013; De Brigard, Addis, Ford, Schacter, & Giovanello, 2013; Hoerl, McCormack, & Beck, 2011; Schacter, Benoit, De Brigard, & Szpunar, 2015; Van Hoeck et al., 2013). Thus, counterfactual thinking can have a future-oriented function.

As discussed in Chapter 1, studying counterfactual thinking as another form of hypothetical thinking has value for future thinking research. Future thoughts about personal events are often compared to memories (Addis, Wong, & Schacter, 2007; D'Argembeau & Van der Linden, 2004; Suddendorf & Corballis, 1997). However, there are two important aspects that differentiate them. First, memories and future thoughts have a different temporal orientation, as one is set in the past and the other is set in the future. Second, one can only be experientially aware of remembered events, as they have happened and were experienced (Debus, 2014), which is not the case for future events. Thus, when studies highlight differences between remembered past events and imagined future events, whether it be related to phenomenology (D'Argembeau & Van der Linden, 2004) or neural activation (Addis et al., 2007), researchers can never be sure whether the findings are caused by a difference in temporal orientation or by a qualitative difference in processes (recalling a past event that was experienced or constructing a hypothetical future event). Counterfactual thinking is therefore an interesting point of comparison as it shares the past orientation of memories but the hypothetical nature of future thoughts.

In Chapters 4 and 5, as described in the overview of my findings, I first compared remembered past events with imagined future events and imagined planned events. As a second step, I asked participants to provide alternative versions for all of these events; in my terminology, they generated counterfactual events, prefactual imagined events, and prefactual planned events. This second step allowed me to compare counterfactual events with memories, and prefactual events with future events, imagined or planned. It also allowed me to compare counterfactual events with prefactual events. Interestingly, the pattern of results was similar for both types of products examined, phenomenological ratings and linguistic styles. First, counterfactual events were different to memories, both in terms of phenomenological ratings and linguistic style. Participants indicated that they did not feel as though they were mentally experiencing counterfactual events as strongly as they felt they were experiencing remembered events. Counterfactual events were also less vivid and contained less visual or spatial details. Furthermore, counterfactual narratives contained more verbs, mostly used the present tense, and included more discrepancy and tentative terms than narratives of remembered events. Second, prefactual events were the same as their original versions, both in terms of phenomenological ratings and linguistic styles. Participants indicated that alternative changes to future events, imagined or planned, did not really modify the way the events were subjectively experienced or described. Finally, counterfactual events were very similar to prefactual events. In experiment 2 of Chapter 4, which allowed a direct comparison of the phenomenology across conditions, participants reported that they experienced counterfactual and prefactual events in a similar way. Furthermore, counterfactual and prefactual events were all described mainly in the present tense and using terms that suggested uncertainty and inconsistency.

Together, results from Chapters 4 and 5 highlight that the temporal orientation does not strongly impact the way hypothetical events are perceived and described. This suggests that hypothetical events, whether counterfactual, prefactual imagined, or prefactual planned, might be constructed and experienced in a similar way, and reinforces the links between counterfactual and future thinking (De Brigard, Addis, et al., 2013; Hoerl et al., 2011; Schacter et al., 2015; Van Hoeck et al., 2013). It is also worth noting than across both experiments, asking participants to provide alternative versions of imagined or planned events did not modify their subjective experience of the events, or the terms they used to describe them. The concept of "prefactual" might thus be superfluous and more a concept than an actual phenomenon. Thinking about a possible future event as happening one way or another is still future thinking. I used the term as a parallel to counterfactual thinking, yet the results emphasize one of the main differences between past and future thinking: that the past has already happened in a specific way. Chapter 6 provides more insight into this.

Because of its relation to a "true event", counterfactual thinking is constrained to a certain degree by the reality of what did happen (Epstude & Roese, 2008; Schacter et al., 2015). But the future is infinite in its possibilities, and thus might not be constrained by reality as much. This assumption was proposed by Schacter et al. (2015) to explain the difference between Szpunar and Schacter's finding (2013) that repeated simulation of future events increased their perceived plausibility, and De Brigard, Szpunar, et al.'s finding (2013) that repeated simulation of counterfactual events decreased their perceived plausibility.

This explanation also supports the findings reported in Chapter 6, where I investigated if thinking about multiple ways an event could occur modifies its perceived plausibility. Counterfactual theories have proposed that the first counterfactual event generated tends to be a highly plausible one, as it is based on what did happen (Byrne, 2002, 2016; Epstude & Roese, 2008; Hoerl et al., 2011). However, proposing multiple different alternatives might compel participants to drift further away from the reality of the initial event, and therefore reduce the perceived plausibility, which is what I found in my experiment. Future events, on the other hand, cannot be compared to a specific future event that will occur in a precise way, and so are not constrained by reality as much. Proposing multiple versions of how a future event could occur might lead to the realization that the future is uncertain, and that the first version proposed might not be as plausible as perceived at first.

To conclude, I believe that examining counterfactual thinking in a future thinking context has great value. It provides another type of comparison, which maintains the constructive nature of hypothetical thinking but differs in its temporal direction, and thus, its relation with reality. Counterfactual thinking also provides a tool for future thinking, as we can learn from our mistakes or remember what we did to avoid them. Finally, it broadens our research to include various forms of autobiographical thinking in addition to episodic memory and future thinking.

Is Episodic Memory a Qualitatively Different Process to Hypothetical Thinking?

Across Chapters 4 and 5, and as discussed in the section above and in the overview of my findings, I highlighted the interesting discovery that participants reported a similar subjective experience when thinking about counterfactual events and when thinking about future events. Participants also described these events using similar terms and even using a similar tense (the present tense) despite the different temporal orientations. I suggested that one of the reasons why counterfactual and future thoughts were so similar, whereas memories were experienced and described differently, is that they are “mental occurrences of two different kinds” as suggested by (Debus, 2014, p. 337). The idea of separating episodic memory from other types of autobiographical thinking is a fascinating and particularly current debate. In an upcoming chapter from a book on mental time travel, Perrin (2016, as cited in

Michaelian, 2016)[1] distinguishes between two views on the relation between episodic memory and other forms of mental time travel (counterfactual thinking and future thinking). From one point of view, there are fundamental qualitative differences between episodic memory and other forms of mental time travel (Perrin calls this view “discontinuism”). From the other point of view, they are qualitatively continuous (Perrin therefore calls this view “continuism”). In his own chapter, (Michaelian, 2016a) defends the continuism view. I will not review this complex philosophical debate here, but this promises to be a live new debate in the philosophy of memory for a while. Hopefully it will benefit from the empirical evidence provided by this thesis and inspire new empirical research. However, I will note that my results can be considered in light of these questions. My work suggests that counterfactual and future thinking share similarities that are not shared with episodic memory, and therefore provide some support to what Michaelian calls “narrow discontinuism”, which “maintains that, in addition to their distinct temporal orientations, there are further qualitative differences between future mental time travel and episodic memory” (p. 4). Nevertheless, as argued by Michaelian, there is a possibility that all types of mental time travel rely on qualitatively similar constructive processes. In my cognitive framework (Chapter 2), based on previous literatures on the similarities in past and future thinking, I suggest that all forms of autobiographical thinking appear to rely on similar constructive processes. Furthermore, results from my factor analyses (Chapter 4) suggest that the different components, such as autonoesis and scene construction, can be found across remembering, imagining, and planning to some degree. Thus, this is a current and important issue that requires future research.

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[1] This forthcoming chapter is not yet accessible but described and commented on in Michaelian (2016a)

Strengths and Shortcomings of my Integrated Cognitive Framework

I developed and modified my integrated cognitive framework for understanding processes of autobiographical thinking (Chapter 2) during the course of my PhD. It has been a difficult but enriching reflective process, which has broadened my understanding of autobiographical thinking but has also led me to new questions. Since the beginning of my research four years ago, the field of mental time travel and future thinking has evolved considerably, with hundreds of articles published. And in 2016 alone, we will see published a Special Issue on Episodic Future Thinking by the *Quarterly Journal of Experimental Psychology* (Szpunar & Radvansky, 2016), a book on *Seeing the Future* (Michaelian, Klein, & Szpunar, 2016), as well as a book on *Mental Time Travel* (Michaelian, 2016b). As the field grows and advances at a fast rate, it is unsurprising that some ideas proposed in my cognitive framework have also been put forward by other researchers. For example, Szpunar, Spreng, and Schacter's (2014) organizational framework was created and published at the same time as I was designing mine. I was pleased to see that we agreed on the importance of broadening the concept of future thinking to include, amongst others, future planning. However, my framework had a different emphasis to theirs as I included past and atemporal thinking, but I only focused on autobiographical thinking, whereas Szpunar et al. (2014) examined future thinking in a wider context (including non-autobiographical future thinking).

The integration of both past and future autobiographical thinking processes is, from my perspective, one of my framework's major strengths. Integrating all processes of past, future, and atemporal autobiographical thinking together emphasizes the idea that they rely on similar underlying processes, as suggested by an overwhelming amount of empirical and philosophical literature (Conway & Loveday, 2015; D'Argembeau, 2012; Michaelian, 2016a; Schacter & Addis, 2007a), but also that they interact with one another (De Brigard, 2013; Irish, Addis, Hodges, & Piguet, 2012; Schacter & Addis, 2009). Throughout my empirical studies, I searched for similarities across all autobiographical processes and also looked for interactions

Proposing dimensions to differentiate the various autobiographical thinking processes was another major goal of the framework and I believe another of its strengths. In my empirical studies, I showed that, to a certain extent, the temporal orientation of events affected the raw materials used to construct the events (Chapter 3), the way the events were perceived (Chapter 4), and how they were described (Chapter 5). In Chapter 6, I showed that temporal orientation influenced plausibility, the second dimension of my framework. However, as suggested previously, one question remains: is episodic memory qualitatively different from other autobiographical thinking processes? Further development of the framework, as well as empirical research, could consider the role of reality in impacting the way plausible past events (hypothetical or experienced) are constructed.

Finally, one of the weaknesses of my framework relates to my objective of clarifying some of the terms often found in the future thinking literature. In agreement with Szpunar et al. (2014), future thinking can encompass many processes that are used in different contexts and to attain different goals, such as future planning, simulating, or remembering intention. However, some suggested differences, although theoretically interesting, were difficult to apply in an experimental context. Specifically, the distinction between imagining and simulating processes is particularly hard to implement in research, and this is due to two principal reasons. The first relates to the terms as understood by the general population, and therefore by participants. The words “simulating” and “imagining” are both common terms and carry multiple meanings. “Imagining” can describe the act of creating a mental picture, but also to make suppositions or to guess. “Simulating” can either mean faking or mentally enacting how certain actions will play out. Therefore, in a testing context, a clear description of what the task intends to measure is necessary. The second reason lies within the existing future thinking literature itself and how these terms have been used. For example, the constructive episodic *simulation* hypothesis contains the word “simulation”, yet the authors also use the word “imagine” in the instructions of their recombination paradigm (Addis et al., 2010). Similarly, Szpunar and Schacter (2013) talk about the effects of repeated simulation, yet described their instructions as asking participants to “imagine a future scenario” (p. 324). These words have been used so often in an interchangeable way in the current literature that it is now hard to separate their meanings. Nonetheless, I still believe that it is necessary to find a way to separate events that are constructed in a plausible way (e.g., in order to plan, predict or anticipate potential future events) from events that are constructed without being restricted by plausibility or likelihood (e.g., as when we day-dream and fantasize).

In conclusion, my cognitive framework takes place alongside other recent work in seeking to provide a good starting point in mapping the domain of autobiographical thinking. It successfully integrates the many autobiographical processes, whilst suggesting dimensions for differentiating them.

Limitations and Future Research

I approached this thesis by investigating a range of autobiographical processes across many levels of analysis and using a variety of methods and measures. This approach allowed me to test various parts of my framework and examine autobiographical thinking from different directions. In the discussion section of each of the individual empirical chapters, I identified some specific limitations and directions for future research. I will now propose a more general discussion of these issues.

In Chapter 3, I investigated the raw materials used in past and future thinking, and in the specific context of planning. This particular design, combined with a tailored coding scheme, gave me the opportunity to code for semantic scripts, which had not been done previously. My results provided complementary evidence that semantic knowledge has an important role to play in future thinking (Irish & Piguet, 2013; Martin-Ordas, Atance, & Louw, 2012). However, more research is needed to examine the raw materials used in other types of autobiographical events, and my coding scheme was limited to my specific design and might be difficult to replicate with a different task. The Autobiographical Interview coding scheme has been shown to be a useful technique (e.g., Addis, Sacchetti, Ally, Budson, & Schacter, 2009; Cole, Gill, Conway, & Morrison, 2012; Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002), but it has its own limitations as discussed previously (Chapter 2 and Chapter 3). Therefore, future research should seek new ways to code for and examine raw materials.

Another interesting extension of my research would be to use plausibility as an independent variable. For example, participants could be asked to imagine plausible and implausible events, so that their content could be compared. I would expect that participants might rely more on scripts and similar episodic memories in the construction of plausible events than implausible events. Similarly, phenomenology and linguistic style could also be analyzed in light of events that are highly plausible or not. This could be done in parallel to the large body of literature on the link between false memory and perceived plausibility (e.g., Garry, Manning, Loftus, & Sherman, 1996; Mazzoni, Loftus, & Kirsch, 2001; Pezdek, Blandon-Gitlin, & Gabbay, 2006; Pezdek, Finger, & Hodge, 1997)

In Chapter 4, I argued that my results showed that phenomenological ratings of events depended on the type of event participants used as their base rate, which created difficulties and limitations for my analyses. An interesting research question would be to examine the phenomenology of events when participants are required to make direct comparisons. For example, participants could be asked to first imagine a simple everyday life event (such as walking around a mall) and rate their subjective experience. This would serve as their base rate. Then, they could be asked to remember past events, imagine future ones, or plan for them. To provide their phenomenological ratings, participants would receive the ratings they had previously given and be asked to make a direct comparison. Another interesting comparison could be between remembered events and their counterfactual versions, with remember events' ratings provided as comparison points to participants. This technique is similar to the Q-sort method, which requires participants to order the Q-items into a designated number of categories (Block, 1961).

In Chapter 5, the LIWC (Pennebaker et al., 2007) revealed itself as an interesting and valuable tool. However, as suggested in the discussion to that chapter, it remains quite blunt in some cases; it can be very dependent on context but also on narrative style. One way to control for this would be to compare narratives of past and future events with narratives of non-personal stories told by the same participant. I also tried to use the autobiographical narratives coding scheme developed by Habermas and colleagues, which seeks to measure the richness of details as well as the emotions and evaluations present in personal narratives (Habermas, Diel, & Heberer, 2009; Habermas, Diel, Mahmoudi, & Streck, 2009). Unfortunatelly, this tool did not reveal any differences across our different autobiographical events. Furthermore, it was not fully adapted to the analysis of future events. Therefore, it would be worth trying different coding schemes and looking for converging evidence.

In Chapter 6, I adapted and integrated two existing methods to investigate the perceived plausibility of hypothetical events. In order to create a single design that included both experiments as well as my own extensions, I had to modify some of the original designs. One of the major changes was my decision not to use emotional cues to reduce the number of experimental cells. Future research could therefore test the effect of emotional valence on the new condition I added to the design (asking for multiple versions of each event), as it has not been done before. Another possible future experiment could test the same questions but using a different cuing method for the future thinking task, as the recombination paradigm has advantages but also disadvantages, specifically with regards to plausibility (see Chapter 2 and 3). For example, participants could be asked to come up with their own novel events in response to noun cues.

Another major issue that I have not gone into is the issue of individual differences. Research has indicated that individual characteristics can affect episodic memory (McIlwain, 2006; Nelson, 2003), but also future thinking (D'Argembeau, Ortoleva, Jumentier, & Van der Linden, 2010; D'Argembeau & Van der Linden, 2006; Ely & Mercurio, 2011). In my own research, there were some important variations in the way participants rated their subjective experience (Chapter 4) or described the events (Chapter 5). Anecdotally, some participants were very good at describing future events in detail, making the story interesting, emotionally vivid, and full of twists, whereas others had a more practical style. Furthermore, D'Argembeau and Van der Linden (2006) showed that participants with a higher capacity for visual imagery experienced more visual and other sensory details both in past and future thinking. It would be interesting to see if these participants would also describe their events in a more vivid and visual way. Future research could thus investigate the impact of individual differences on the different components of autobiographical thinking.

More generally, the focus of future research could be expanded by running more ecologically valid experiments. We often think about the future in our everyday life, and this is for a range of reasons (see Chapter 1 and Chapter 2). Analysis of these “real life” future thoughts would be valuable for a better understanding of how future thoughts are constructed, experienced, and described. This research could thus follow previous studies that have used diaries to record future thoughts (e.g., Barsics, Van der Linden, & D'Argembeau, 2016; Berntsen & Jacobsen, 2008; D'Argembeau et al., 2011) Researchers could also collect narratives and phenomenological measures of events across time. For example, they could ask participants to think about a future event that is very likely to happen (for example their future holiday that they have already booked), and ask them to simulate and plan it (as described in my theoretical framework in Chapter 2). Then, once the event has occurred, participants could come back to the lab and remember how it happened, as well as propose alternative versions. This way, the content, phenomenological ratings, and linguistic styles would be specific to a single event and a single person.

Finally, future research could examine collaborative and collective future thinking. Research on collective memory has argued that we often use our memories in a social context (Barnier & Sutton, 2008; Sutton, Harris, Keil, & Barnier, 2010). A similar case can be made for future thinking. In a romantic relationship, in families or at work, we are often required to think and plan the future collaboratively. Couples plan for their wedding, families discuss holidays and weekends, or employers propose new techniques to their manager. As each individual relies on a different set of raw materials to construct these future events and might seek different goals, analysis of the processes and products of collective future thinking would most likely be challenging but very rewarding. In the laboratory, collaborative memory studies involving two strangers remembering together have shown collaborative inhibition; that they remember less together than than if they had remembered alone and pooled their answers (Basden, Basden, Bryner, & Thomas, 1997; Weldon & Bellinger, 1997). Would two strangers planning and problem-solving together show a similar pattern? However, field studies involving real world groups such as older couples have shown collaborative facilitation when they worked together remembering more meaningful material (Harris, Barnier, & Sutton, 2013; Harris, Keil, Sutton, & Barnier, 2010; Harris, Keil, Sutton, Barnier, & McIlwain, 2011). Therefore, we could also find such facilitation in meaningful groups working on every day future thinking and future planning tasks.

Concluding Thoughts

In this thesis, I aimed to broaden research on episodic memory and episodic future thinking to a wide range of autobiographical thinking processes. Across one theoretical chapter and four empirical chapters, I showed the advantages of using different autobiographical processes to investigate the raw materials used to construct personal events; the role of temporal orientation, goal-directed thinking or hypothetical thinking on phenomenology and linguistic styles; and the role of reality on the perceived plausibility of hypothetical past and future events. Across analyses of the many similarities and differences, I have demonstrated the importance of expanding research from mental time travel to autobiographical thinking.

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APPENDIX A

Appendix A removed from Open Access version as they may contain sensitive/confidential content .

APPENDIX B

Appendix B of this thesis have been removed as they contain published material. Please refer to the following citation for details of the article contained in these pages.

Cordonnier, A., Barnier, A. J., & Sutton, J. (2016). Scripts and information units in future planning: Interactions between a past and a future planning task. *Quarterly Journal of Experimental Psychology*, 69(2), 324–338.

DOI: 10.1080/17470218.2015.1085587