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Self-reflection and the temporal focus of the wandering mind

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ABSTRACT

Current accounts suggest that self-referential thought serves a pivotal function in the human ability to simulate the future during mind-wandering. Using experience sampling, this hypothesis was tested in two studies that explored the extent to which self-reflection impacts both retrospection and prospection during mind-wandering. Study 1 demonstrated that a brief period of self-reflection yielded a prospective bias during mind-wandering such that participants' engaged more frequently in spontaneous future than past thought. In Study 2, individual differences in the strength of self-referential thought — as indexed by the memorial advantage for self rather than other-encoded items — was shown to vary with future thinking during mind-wandering. Together these results confirm that self-reflection is a core component of future thinking during mind-wandering and provide novel evidence that a key function of the autobiographical memory system may be to mentally simulate events in the future.

1. Introduction

In the bestselling novel *The Time Traveler's Wife* (Niffenberg, 2003), the male protagonist — *Henry DeTamble* — has a genetic disorder that causes him to travel physically through time to periods of the past or future with personal significance (e.g., the childhood home of his wife). While the laws of physics currently prohibit time travel, we are nevertheless able to revisit the past or simulate the future using a quite straightforward ability — imagination. Such prospective thinking involves a constellation of brain regions including the hippocampus and areas of frontal cortex (Buckner, 2010; Schacter & Addis, 2007b; Schacter, Addis, & Buckner, 2008) and is adaptive because it permits the imaginer to "pre-experience" situations that have yet to occur and alter subsequent behavior if necessary (Bar, 2009; Boyer, 2008; Gilbert & Wilson, 2007; Wheeler, Stuss, & Tulving, 1997). In addition, the ability to locate autobiographical events in their correct temporal context enables a coherent and stable personal identity to be developed (Tulving, 1985).

While past and present events are represented by a combination of perceptual and memorial details, several lines of evidence suggest that the ability to simulate future outcomes is a construction based on previous autobiographical (i.e., personal) knowledge (Buckner, 2010; Gilbert & Wilson, 2007; Schacter & Addis, 2007a). First, both autobiographical memory and prospection emerge at around the same age (Suddendorf & Busby, 2003). Second, patients with problems remembering events from their personal past also have difficulties in imagining what they are likely to do in the future (e.g., Klein, Rozendal, & Cosmides, 2002). Finally, neuroimaging studies show overlapping brain activation when individuals remember events from the past and imagine experiences that have yet to occur (Addis, Pan, Vu, Laiser, & Schacter, 2009).

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It is commonly argued that the primary purpose of mental time travel (Suddendorf & Corballis, 1997, 2007) and indeed the memorial system (e.g. Bar, 2007, Gilbert & Wilson, 2007; Schacter & Addis, 2007a) is to ensure the continued existence of the organism by using imagination to look forward rather than backwards in time. Consistent with this hypothesis, participants spend significant time engaged in future related thought under laboratory conditions (Smallwood, Nind & O'Connor 2009; Smallwood & O'Connor, in press) and in daily life (D'Argeambeau, Renaud, & Van der Linden, 2009). If the primary function of the autobiographical memory system is to mentally simulate the future, it is possible that the process of self reflection would be more strongly associated with the engagement of prospective thought during mind-wandering than it would with thoughts of the past.

The current set of studies examined two issues regarding the hypothesized role of self-memory in prospective thought. If the self is especially important to thoughts of the future, then making self-memories salient (e.g., by asking participants to answer self-referential autobiographical questions) should increase the frequency that prospective thoughts arise during mind-wandering. To this end, Study 1 required participants to rate whether a set of trait adjectives applied to one of several referents (i.e., self, best friend and the UK prime minister, see Rogers, Kuiper, & Kirker, 1977), thereby creating a task context that varied the applicability of self-reflection (Kelley et al., 2002; Rogers et al., 1977; Symons & Johnson, 1997). Following this procedure, we examined whether those individuals who engaged in self-reflection reported more future than past-oriented thoughts during periods of spontaneous mind-wandering than those who did not. In Study 2, we considered whether individual differences in the memorial advantage to self-relevant information (known as the self-reference effect (SRE) (Rogers et al., 1977) moderated the emergence of this effect (i.e., larger SRE = greater prospection). In both experiments, experience sampling was used to assess the momentary occurrence of future and past thought during mind-wandering.

2. Study 1

In Phase 1, undergraduate students from a UK university were told that they were going to perform a brief personality test ('Self' condition, $n = 15$), a survey of social networks ('Best Friend' condition, $n = 15$) or a political survey ('Gordon Brown' condition, $n = 15$).[1] All participants in the Gordon Brown condition were familiar with his identity as he was the UK prime minister at the time of testing. One person from each referent condition was excluded for performing below chance on one or other task. Participants in all three conditions were then shown a sequence of 32 trait adjectives (from Anderson, 1968) on a computer screen and asked to decide whether these adjectives did or did not apply to the condition-specific referent (i.e., self, best friend or Gordon Brown). The identity of the referent was displayed on the computer screen throughout the task and the specific instructions for each condition were identical. Each word list contained an equal number of positive and negative adjectives and the lists were rotated across conditions. Order of adjectives within each list was randomized. Stimulus presentation was self-paced. An additional control group ($n = 13$) did not perform any personality survey, only Phase 2 of the experiment. The mean age of the sample was 20.3 ($SE = .7$) and seventeen participants were male.

The second phase of the experiment required participants to complete two tasks that have previously been shown to vary in their propensity for future thinking (Smallwood, Nind et al., 2009). One was a Working Memory (WM) task that required individuals to monitor a stream of numbers (the digits 1–8), presented in black ink and appearing at fixation. Randomly interspersed with the number presentation were targets (a colored '?') that cued participants to report whether the previous digit was odd or even by means of a mouse click. Stimulus presentation rate was 1 item every 1000 ms (followed by 1500 ms fixation cross) and the stimuli were presented in five blocks each with a quasi-random order of presentation. The second task was a Choice Reaction Time (CRT) task in which participants viewed a similar stream of black digits appearing on screen, this time monitoring for the presence of a colored digit. On presentation of a colored digit, they were asked to report whether the presented stimulus was odd or even. All features of stimulus presentation were identical to the WM task. In both tasks a total of 156 non-targets and 25 targets were presented. Previous work demonstrated that future thinking was more prevalent in the CRT than in the WM task (Smallwood, Nind et al., 2009) a finding that Study 1 sought to replicate.

Participants' mind-wandering was assessed by presentation of ten experience sampling probes (five in each task). These probes were presented visually on a computer screen and prompted participants to report whether their current thoughts pertained to the task/here and now, a personal event in the future or a personal event in the past. Participants responded with the keyboard using the first letter of each experience. Participants were explicitly instructed to reserve the category of future/past thoughts for personal events unrelated to the current task. Following completion of these tasks, participants were thanked, debriefed and dismissed.

2.1. Results

Analysis of variance (ANOVA) yielded no significant effect of Referent [$F(2, 36) = 1.88$, $p = .169$, $\eta^2 = .09$] showing that participants did not differ in their assignment of character traits to the three referents (*Self*, *Best Friend*, or *Gordon Brown*). A mixed-model ANOVA conducted on the accuracy data, with Referent included as a between-participants factor and Task

[1] It is possible that different introductory screens for the three conditions may have subtly influenced the mind set of individuals as they performed the task. While this bias may have enhanced the effectiveness of the manipulations, as the adjectives and the specific instructions were identical across conditions, it would not alter the conclusion that self-memories are central to prospective thought.