Thinking about the Past and Future in Daily Life: An Experience Sampling Study of Individual Differences in Mental Time Travel

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Abstract

Remembering the past and imagining the future are hallmarks of mental time travel. We provide evidence that such experiences are influenced by individual differences in temporal and affective biases in cognitive style, particularly brooding rumination (a negative past-oriented bias) and optimism (a positive future-oriented bias). Participants completed a seven-day, cellphone-based experience-sampling study of temporal orientation and mental imagery. Multilevel models showed that individual differences in brooding rumination predicted less vivid and positive past- and future-oriented thoughts, even after controlling for depressed mood. People high in brooding rumination were also more likely to report thinking about a past experience when probed at random during the day. Conversely, optimists were more likely to report more vivid and positive future-oriented, but not past-oriented thoughts, although they did not report thinking more or less often about the past and future. The results suggest that temporal and affective biases in cognitive style influence how people think about the past and future in daily life.

Keywords

future thinking; memory; mind wandering; optimism; rumination

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Mentally revisiting the past and projecting to the future are defining features of mental time travel. Remembering past experiences is undoubtedly important for normal functioning as it allows us to learn from our experiences and to develop a temporally stable sense of self (i.e., autonoetic consciousness; Tulving, 1985). Likewise, imagining the future serves several adaptive functions (Schacter, 2012). For instance, it allows us to plan future events and to engage in important decision-making processes that influence our future lives (e.g., Baird, Smallwood, & Schooler, 2011; D'Argembeau, Renaud, & Van der Linden, 2011; Stawarczyk, Cassol, & D'Argembeau, 2013; Stawarczyk & D'Argembeau, 2015). A notable

theme in the literature on mental time travel is that future thinking, like episodic memory, is a reconstructive process that draws upon prior knowledge and experiences to form mental representations that support our ability to simulate both past and future events (e.g., Schacter & Addis, 2007; Schacter, Benoit, & Szpunar, 2017).

Numerous studies have documented striking cognitive and neural similarities between remembered past experience and imagined future experiences (for reviews, see Szpunar, 2010; Schacter et al., 2012). For example, studies using functional magnetic resonance imaging (fMRI) have shown remarkably similar patterns of brain activation when people recall an event from their past and when they imagine an event in their future (e.g., Addis, Wong, & Schacter, 2007; Szpunar, Watson, & McDermott, 2007; Schacter, Addis, & Buckner, 2007; for a recent meta-analysis, see Benoit & Schacter, 2015). Other experimental work has documented overlap among the underlying cognitive processes and phenomenological characteristics associated with imagining the future and remembering the past (e.g., D'Argembeau & Mathy, 2011; McDermott, Wooldridge, Rice, Berg, & Szpunar, 2016; Schacter & Madore, 2016; Szpunar & McDermott, 2008).

Several recent studies have examined past- and future-oriented cognition in the context of mind-wandering, or thoughts that arise independently of external stimulation (for a review, see Seli et al., in press). Such work has used experience-sampling methods to probe temporal orientation and other phenomenological characteristics during laboratory tasks and in daily life by periodically interrupting participants with thought probes (Kane et al., 2007; Poerio et al., 2013; Song & Wang, 2012; Spronken, Holland, Figner & Dijksterhuis, 2016). Spronken et al. (2016) found that future-oriented thoughts are rated as more positive than past-oriented thoughts in the lab and in daily life, consistent with the optimism bias of future-oriented cognition (Weinstein, 1980). Moreover, Poerio et al. (2013) assessed mood before and after mind-wandering episodes in daily life and found that sad mood often preceded mind-wandering (contrary to prior work suggesting that sad mood is a consequence of mind-wandering; Killingsworth & Gilbert, 2010), and that sad mood prior to mind-wandering episodes was more frequently past-oriented.

Contemporary mind-wandering research emphasizes the distinction between spontaneous (unintentional) and deliberate (intentional) mind-wandering (Seli, Risko, Smilek, & Schacter, 2016). In terms of temporal orientation, deliberate future-oriented thoughts may involve strategic and deliberate planning of an upcoming event (e.g., thinking about what items to buy at the grocery store). Spontaneous future thoughts, on the other hand, occur without conscious initiation and may arise during an ongoing task (i.e., task-unrelated thoughts), despite one's best intention to focus attention on the task at hand (Seli, Risko, & Smilek, 2016). According to Christoff and colleagues, the "default state" of mind-wandering is spontaneous—freely moving from one topic to another—but various emotional and cognitive factors can impact the content and variability of thoughts via constraints (Christoff, Irving, Fox, Spreng, & Andrews-Hanna, 2016). Negative emotion, for example, can constrain the spontaneous variability of thoughts by inducing a past-oriented, perseverative cognitive style.

Despite considerable experimental work on past- and future-oriented cognition, relatively less is known about how and why people differ in these abilities. Research with clinical populations, however, suggests that an over-general memory bias—describing the past and future in broad, categorical terms—contributes to deficits in both remembering and imagining (e.g., Brown et al., 2014; D'Argembeau, Rafford, & Van der Linden, 2008; Williams, Ellis, Tyers, & Healy, 1996). When recalling specific life events, depressed patients tend to offer a summary of related past experiences that are comprised of minimal episodic detail (Watkins & Teasdale, 2001; but see Kvavilashvili & Schlagman, 2011). Past work has found that this overgeneral memory bias extends to rumination, a tendency to perseverate on negative past-oriented information, which has been attributed to deficits in executive control during retrieval and to attentional capture to negatively-valenced mnemonic information (Williams et al., 2007). Studies have likewise reported reduced specificity of episodic memories and future simulations in people suffering from anxiety disorders (Brown et al., 2014; McNally, Litz, Prassas, Shin, & Weathers, 1994; Wu, Szpunar, Godvich, Schacter, & Hofmann, 2015; for review, see Miloyan, Bulley, & Suddendorf, 2016).

Research with nonclinical populations has also shown considerable variability in the extent to which people can construct detailed mental representations about the future (e.g., D'Argembeau & Van der Linden, 2006). Moreover, individual variation in executive functioning is predictive of the quantity and quality of episodic detail in future simulations (Addis, Wong, & Schacter, 2008; D'Argembeau, Ortoeleva, Jumentier, & Van der Linden, 2010; Hill & Emery, 2013), pointing to the potential importance of cognitive flexibility. Indeed, a recent functional brain imaging study found that activity within neural systems engaged during more flexible constructions of future scenarios (i.e., incongruent with past events) correlated with individual differences in divergent creative thinking, or the ability to generate a range of possible solutions to open-ended problems (Roberts et al., 2017). Taken together, this growing body of research suggests that individual differences in cognitive and affective processes influence how people remember the past and project the future.

Although future thinking relies on past experience (Schacter & Addis, 2007), projecting into the future also requires a partial break from the past to successfully construct new simulations of what one has yet to experience. This process may therefore be disrupted by an inability to move beyond past experience—in other words, getting "stuck" in a recursive loop of past-oriented thought (e.g., ruminating) should yield greater challenges in shifting attention towards the future. On the other hand, a tendency to focus on future-related experiences might impact the constructive process by biasing attention toward the future. In the present research, we examined the role of cognitive styles characterized by past- and future-oriented thought in mental time travel. Specifically, we explored whether brooding rumination, a tendency to perseverate on negative past experiences, is related to decreases in people's ability to vividly and positively imagine the future. We also explored whether optimism, a tendency to expect positive future events, is related to enhanced imagery for the future. Critically, although rumination and optimism have been linked to past- and future-oriented cognition, respectively, in a lab context, it remains unclear whether these traits similarly correspond to past- and future-oriented thoughts in daily life, which are more likely to be spontaneous than lab-based assessments of past and future thinking.

Using an experience-sampling design, we examined temporal orientation and mental imagery by calling people on their cellphones at random times throughout the day for one week and asking if they were thinking about the past, present, or future; we also asked them to rate the vividness, valence, and temporal distance of their thoughts. This approach allowed us to explore how temporal, cognitive, and affective biases in thinking style impact people's momentary conscious experiences of the past, present, and future. Previous research suggests that autobiographical and future thinking deficits are related to an over-general memory bias (e.g., Dickson & Bates 2005; Kremers et al., 2006; MacLeod et al. 1993; Williams et al., 1996); however, it remains unclear whether this effect is driven by negative mood or perseverative thinking, as negative mood and rumination are highly correlated constructs (Nolen-Hoeksema, 1991). To address this issue, we also measured depressive symptoms.

We hypothesized that people high in brooding rumination would not only report more past-oriented thought in daily life, but also show reductions in the *vividness* of future-oriented thought—a phenomenological dimension related to the specificity with which people recall the past and imagine the future (Sheldon & El-Asmar, 2017). Conversely, we expected that people high in optimism would report more vivid future-related thoughts in daily life. Previous laboratory research suggests that optimism is characterized by the ability to generate vivid and positive mental imagery for the future (Blackwell et al., 2013). It is unknown, however, whether people high in optimism spontaneously generate positive and vivid future-oriented thoughts outside of the lab, and whether they show a similar profile for past-oriented thoughts. The present research thus offers a first look at the extent to which optimists experience a bias towards the future in everyday life. We hypothesized that people high in optimism would report more frequent episodes of future-oriented thought, and that such episodes would be characterized by increased vividness and positive valence.

Method

Participants

Seventy-nine students from the University of North Carolina at Greensboro participated in the study (mean age = 20.06, SD = 2.54; 61 women, 18 men). Students received credit toward a course option or up to $20 for their participation. Partial compensation was awarded during the first phase of the study and, if students completed at least 60% of the phone surveys, they were again compensated.

Procedure

The first phase of the study involved a tutorial of the phone survey system and a series of computerized questionnaires. Students filled out consent forms, and then provided their cell phone numbers and a convenient 12-hour period of time to receive survey calls (e.g., 10am – 10pm). An interactive voice response (IVR) system administered the automated surveys (Burgin, Silvia, Eddington, & Kwapil, 2013). The system (Telesage, 2009) generated eight survey calls per day, at quasi-random times, within each participant's 12-hour window of availability. Participants responded to survey items using the keypad of their phones.

The survey began by asking participants if they were thinking about the past, present, or future. The "present" option was endorsed if participants were not immediately concerned with an aspect of their past or future. The "past" and "future" options branched to items regarding vividness ("How vivid is this thought?"), positive valence ("How positive is this thought?"), and temporal distance (e.g., if future, then "Is this thought about the near or distant future?").

A seven-point scale was used for the vividness and valence items (1 = *not at all*, 7 = *very much*), and a dichotomous scale was used for the temporal distance item (1 = *recent past*, 2 = *distant past*, 1 = *near future*, 2 = *distant future*). The three phenomenological items (temporal distance, positive valence, and vividness) afforded a detailed assessment of when mental episodes had occurred in time (temporal distance), as well as the extent to which episodes were characterized by positive emotion (valence) and contextually rich (vividness) mental imagery.

Lab questionnaires.—We administered the abbreviated Ruminative Response Scale (RRS), a 10-item measure of cognitive style that excludes items confounded with other depressive symptoms (Treynor, Gonzalez, & Nolen-Hoeksema, 2003). The short RSS has two subscales—brooding and self-reflection—each measured with five items. The brooding subscale assesses how often people engage in negative self-focused thoughts (e.g., "I think about a recent situation, wishing it had gone better"; "Why do I always react this way?"), whereas the reflection subscale assesses neutral pondering about the self (e.g., "I write down what I am thinking and analyze it"; "go someplace alone to think about your feelings"). Participants also completed the depression subscale of the Depression Anxiety Stress Scales (DASS; Lovibond & Lovibond, 1995), a seven-item scale that assesses depressive symptoms (e.g., dysphoria; "I felt downhearted and blue"). Finally, we administered the revised Life Orientation Test (LOT-R; Scheier, Carver, & Bridges, 1994), a 10-item scale of dispositional optimism (e.g., "I'm always optimistic about my future").

Results

Model Specification

The data were analyzed using multilevel structural equation modeling (SEM) with maximum likelihood estimation in Mplus 7. We modeled items from each questionnaire as indicators of latent variables; for example, "brooding" was specified as a latent variable, indicated by the five items of its subscale. The same procedure was applied to the other measures (self-reflection, depression, and optimism). For model identification, the latent variables' variances were fixed to one (Kline, 2011).

A multilevel approach allowed us to accommodate the hierarchical structure of the nested survey data. Responses to the phone surveys were group-mean centered at the within-person level (i.e., Level 1), and responses to the lab questionnaires were grand-mean centered at the between-person level (i.e., Level 2; Enders & Tofighi, 2007). We report logistic regression coefficients for analyses with categorical variables (e.g., the likelihood of thinking about the past, present, or future) and unstandardized regression coefficients for continuous variables (e.g., the vividness of future-oriented thoughts).

Descriptive Statistics

Participants completed a total of 2,483 phone surveys. The survey completion rate (57%) was comparable to other cellphone-based experience sampling studies (e.g., Beaty et al., 2013; Burgin et al., 2013), and consistent with the required level of compliance for receiving additional compensation at the end of the study (i.e., 60%). Before reporting the individual differences analyses, we first explore baseline levels of temporal orientation within the entire sample. This descriptive analysis provides a closer look at how often people think about the past, present, and future in daily life, in addition to the extent to which past- and future-oriented thoughts are characterized by vivid mental imagery, positive emotional content, and greater temporal distance.

Overall, the sample was more likely to be thinking about the present moment when called at random by the phone survey system: participants reported thinking about the present more than two-thirds of their waking hours (68%). It is important to note that the "present" category likely includes both clearly-defined present thoughts and a range of other thoughts with no discernable temporal orientation. Future-oriented thought was reported on 19% of the survey calls, and past-oriented thought was reported on 13% of the calls—a nominal difference that did not reach conventional statistical significance ($t = 1.87$, $p = .06$). Thus, people spent most of their days engaged in present-oriented or atemporal thought, but they also spent a considerable amount of time engaged in past- and future-oriented thought.

For past-oriented thought, participants reported a relatively low degree of positive valence ($M = 2.19$; $SD = 1.81$; using a seven-point scale). The vividness of past-oriented thought was moderate ($M = 3.07$; $SD = 2.34$), suggesting an overall neutral level of valence and imagery of past-oriented imagery within the sample. Regarding temporal distance, participants reported thinking more often about events in the recent past (77%) than in the distant past (23%).

For future-oriented thought, participants also reported a moderate degree of positive valence ($M = 3.05$; $SD = 2.28$), which was significantly greater than the mean level of past-oriented thought reported above (i.e., $M = 2.19$; $t = 5.25$, $p < .001$). Interestingly, the vividness of future-oriented imagery was quite high ($M = 4.69$; $SD = 2.05$) and significantly greater than the mean level of vividness for past-oriented thought (i.e., $M = 3.07$; $t = 6.17$, $p < .001$). For temporal distance, participants reported thinking more often about events in the near future (78%) than in the distant future (22%). Thus, like past-oriented thoughts, future-oriented thoughts were mostly restricted to events close in time, suggesting a relatively narrow window of mental time travel in daily life.

Rumination and Past-Oriented Thought

Our first multilevel analysis examined the effects of brooding and self-reflection on the likelihood of thinking about the past in daily life. Although they were strongly correlated ($r = .75$), brooding, but not self-reflection, significantly predicted the likelihood of thinking about the past in daily life ($b = -.68$, $p = .04$): consistent with our hypothesis, people high in brooding were more likely to report thinking about the past when probed by the survey system at random times of the day.

We then added the depression variable to a model with brooding and self-reflection predicting the likelihood of thinking about the past (see Figure 1 and Table 1). Brooding remained a robust predictor of past-oriented thought (brooding $b = -.89$, $p = .02$), suggesting that, when controlling for depressed mood, a perseverative cognitive style is related to an increased frequency of past-oriented thoughts.

Next, we examined the extent to which rumination and depressed mood were related to the phenomenology of past-oriented thoughts. Vividness, valence, and temporal distance were modeled as multivariate outcomes, predicted by brooding and self-reflection. Brooding negatively predicted the vividness of past-oriented thought ($b = -.90$, $p = .01$)—as levels of brooding increased, people recalled less vivid thoughts about their personal pasts. Importantly, the effect of brooding remained significant when the depression variable was added to the model (see Table 1); brooding, self-reflection, and depression were unrelated to valence and temporal distance. Taken together, although people high in brooding rumination were more likely to be thinking about the past in daily life, their experiences for past-oriented episodes were less vivid.

We then examined the effects of rumination and depressed mood on the likelihood of thinking about the present. Brooding, self-reflection, and depression were modeled as predictors of the likelihood of thinking about the present. No significant effects emerged, suggesting that rumination and depressed mood were unrelated to a present-oriented focus in daily life.

Rumination and Future-Oriented Thought

Our next set of analyses examined the frequency and phenomenology of future thinking as a function of brooding and self-reflection. A model with brooding, self-reflection, and depressed mood predicting the likelihood of engaging in future thought revealed no significant effects ($ps > .30$), suggesting that subclinical levels of rumination and depressed mood are largely unrelated to how often people imagine the future in daily life.

Next, brooding and self-reflection were modeled as predictors of the vividness, valence, and temporal distance of future-oriented thoughts. Brooding negatively predicted imagery ($b = -.53$, $p = .02$) and it showed a marginal effect on valence ($b = -.54$, $p = .13$); no effects of temporal distance emerged. Thus, people high in brooding rumination generated less vivid mental images of the future.

We then assessed the role of depressed mood in future-oriented thought. Because rumination is a common symptom of depression (Nolen-Hoeksema, 1991) and future thinking deficits have been related to dysphoria in laboratory studies (e.g., Holmes, Lang, Moulds, & Steele, 2008; Williams et al., 1996), we could not yet rule out an influence of depressed mood in future thought. Modeled as the lone predictor of imagery vividness and valence, depressive symptoms negatively predicted valence ($b = -.41$, $p = .02$), but not vividness or temporal distance (see Table 2). In the full model, however, with brooding, self-reflection, and depressive symptoms predicting vividness, valence, and temporal distance, only brooding negatively predicted vividness ($b = -.70$, $p = .03$); no effects of depressive symptoms emerged.[1]

Optimism and Past-Oriented Thought

We next tested whether optimism, a trait associated with a positive future outlook, was related to enhanced imagery for past and future-oriented thoughts in daily life. Optimism was modeled as a predictor of the likelihood of engaging in past-oriented thought. The effect of optimism was not significant ($p = .58$), suggesting that people high in optimism were not more likely to be thinking about the past in daily life. Next, we explored whether optimism was related to the phenomenology of past-oriented thoughts. Vividness, valence, and temporal distance of past-oriented thoughts were modeled as multivariate outcomes. Optimism showed nonsignificant effects on all dependent variables (see Table 1). Thus, people high in optimism were not more likely to be thinking of the past, nor were their past-oriented thoughts more likely to be characterized by greater vividness and positive valence.

Optimism and Future-Oriented Thought

We then examined whether optimists were more likely to report thinking about the future in daily life. The effect of optimism on the likelihood of engaging in future-oriented thought, however, was not significant ($p = .60$), indicating that optimism is not characterized by thinking more or less about the future.

Finally, we examined the phenomenology of future-oriented thoughts as a function of optimism. Vividness, valence, and temporal orientation were modeled as multivariate outcomes, predicted by the latent optimism variable. Optimism predicted both vividness ($b = .55$, $p = .01$) and valence ($b = .54$, $p = .01$), but not temporal distance (see Table 2). Thus, although optimists did not spend more time thinking about the future, their future-oriented thoughts were more likely to contain vivid and positive mental imagery.

Discussion

The present research suggests that temporal and affective biases in cognitive style influence mental time travel in everyday life. Using an experience sampling design, we found that brooding rumination (a negative past-oriented bias) and optimism (a positive future-oriented bias) predicted a distinct pattern of decreases and increases in past- and future-oriented mental imagery. Not only did people high in brooding rumination report less vivid imagery for the past and future, they also spent more time dwelling in past-oriented thought. In contrast, people high in optimism reported enhanced imagery for the future, but they did not spend more or less time in the past or the future. Taken together, these results suggest that individual differences in cognitive style influence how people think about the past and future in daily life.

Overall, participants reported more present or atemporal thoughts (68%) than past (13%) and future (19%) thoughts. It is important to note that the prevalence of future-oriented thought reported in the current study was greater than previous experience sampling studies on temporal orientation and mental imagery (e.g., 12%; Klinger & Cox, 1987), potentially due to methodological differences across studies, such as thought sampling procedure.

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[1]We also assessed the role of gender. Past research suggests that women ruminate more than men (Nolen-Hoeksema, 1991), and our sample was approximately two-thirds female; however, gender did not decrease the effect of brooding on vividness.

Regarding temporal distance, participants reported thinking more about events in the recent past and near future, which suggests a relatively narrow window of mental time travel in daily life. Moreover, the phenomenological quality of past and future thoughts was notably different across temporal dimensions: participants reported a greater degree of positive valence for future-oriented thoughts, pointing to an enhanced conscious experience of the future in daily life.

Notably, we found that vividness ratings were higher for future- than past-oriented thoughts. Previous work on episodic memory and future simulation has reported higher vividness ratings for memory compared to simulation (e.g., D'Argembeau & Van der Linden, 2004, 2006). However, because this study did not assess thought content, we cannot know whether thought reports about the past were related to actual episodic memories, simulations of imagined past events (e.g., counterfactual simulations; Schacter, Benoit, De Brigard, & Szpunar, 2015), or other forms of self-generated thought. Moreover, our thought probes did not assess intentionality, and past work has shown that vividness can vary as a function of intentionality, with involuntary past and future thoughts rated as similarly vivid (Bernsten & Jacobsen, 2008). Subsequent work should consider thought content and intentionality to determine how these variables relate to the vividness and valence of past and future thoughts in daily life.

Mental Time Travel and Cognitive Style

Our results extend previous research on deficits in past- and future-oriented thinking. Specifically, we found that brooding rumination was related to reductions in past- and future-oriented mental imagery, even when controlling for levels of depressed mood. This finding builds on past work by suggesting that future thinking decreases stem from a perseverative, past-oriented cognitive style (i.e., rumination), rather than a depressed mood per se. Although depressed participants reported less positively valenced future thoughts, this effect was no longer significant once levels of rumination were taken into account. Furthermore, people high in brooding did not report significantly less positive valence in their thoughts about the future. They were, however, less likely to report vivid imagery for the future. Thus, although people high in brooding reported thinking about the past more often, their thoughts were actually characterized by *less* mental imagery for both the past and the future.

This observation points to a possible dissociation between the frequency and phenomenology of mental imagery in people high in brooding rumination. One explanation for this pattern of effects is that brooders' thought content may be comprised of verbal rather than visual-spatial imagery; for example, they may experience more frequent episodes of perseverative inner speech related to negative past events. Future work should further explore the past-oriented thought content associated with high levels of brooding rumination, and determine the extent to which this cognitive style is characterized by deficits in verbal or visual-spatial imagery in daily life.

Regarding changes in future thinking reported by people high in brooding, one plausible explanation is that a perseverative, past-oriented thinking style disrupts future thinking via

cognitive inflexibility. In other words, a fixation on past experiences may prevent attention from being reoriented toward the future. According to the impaired disengagement hypothesis (Koster, De Lissnyder, Derakshan, & De Raedt, 2011), a chronic perseverative focus on negative self-referential events can lead to an overall difficulty in withdrawing attention from negative thoughts. In this context, it could be that brooders become "stuck" in a recursive loop of past-oriented thought, thereby preventing attention from disengaging from the past and reorienting toward the future. On the other hand, brooding was not associated with a global reduction of future-oriented thought in daily (the effect was specific to vividness) so the extent to which future thinking deficits in rumination are a function of impaired past engagement requires further investigation. Moreover, brooding rumination is associated with an abstract cognitive style (Watkins, 2008)—or a tendency to think about past and future experiences with minimal concrete detail—which may in part explain the link between rumination and decreased vividness of past and future thoughts in the current study.

However, if brooders indeed experience difficulty disengaging from past experience, they may rely more on recasting those experiences, rather than constructing novel ones, when imagining possible future events, which might further impact the *novelty* of future-oriented thought. People high in brooding may therefore oversample from past experience when imagining the future because their attention is chronically biased towards past-oriented thought. Indeed, recasting past experience when imagining novel future episodes is a symptom of cognitive impairment in neuropsychological disorders such as semantic dementia (Irish & Piguet, 2013). An interesting question for future work to consider is whether impaired cognitive flexibility affects the novelty of future-oriented thought, or the extent to which future thought content deviates from past experience. In this context, the ability to construct novel future thoughts can be construed as a type of creative thought process.

Recent behavioral and neuroimaging research points to a tight coupling in the cognitive and neural mechanisms involved in episodic future thinking and creative cognition (Addis, Pan, Musicaro, & Schacter, 2016; Beaty & Schacter, in press; Roberts et al., 2017; Schacter & Madore, 2016). Research on creative thought suggests that executive control contributes to people's ability to generate novel, useful, and uncommon ideas (Beaty, Benedek, Silvia, & Schacter, 2016; Gilhooly et al., 2007). The ability to freely direct attention thus may influence how much people tend to recast past experiences when constructing novel thoughts about the future. Subsequent research should explore the extent to which cognitive flexibility and creative thought contribute to the novelty of episodic future thinking.

Another fruitful direction for future research is to extend the existing literature on individual differences in mental time travel, including related research on time perspective, which has established that people vary in their biases toward past- and future-oriented thinking (Zimbardo & Boyd, 2015). For example, D'Argembeau et al. (2010) reported a positive correlation between future orientation and the amount sensory details reported when participants imagined future events; the authors also found that self-consciousness (a factor linked to self-reflection in rumination) correlated positively with subjective reports of experiencing future-oriented events. An interesting direction for future research would be to

examine whether temporally-relevant cognitive styles such as rumination and optimism predict aspects of past- and future-oriented thought, beyond what can be explained by variation in time perspective and other established biases in cognitive style.

Another goal of the present work was to determine whether optimism is related to enhanced future thinking in daily life. We found that people high in optimism reported an active imagination for the future. To our knowledge, this study is the first to provide evidence that optimism is characterized by greater vividness and positive valence for future-oriented thought in everyday life, therefore validating a widely used self-report measure of optimism (i.e., the LOT-R; Scheier et al., 1994). Past research has shown that optimists report more vivid mental imagery than pessimists when imagining plausible future episodes (Blackwell et al., 2013). Our study extends this work by demonstrating that optimists report enhanced vividness ratings for future-oriented thoughts, but not for past. Regarding temporal distance, people high in optimism were not more likely to be thinking about the near or distant future, which suggests that their thought content showed variability across time.

We also found that, contrary to our hypothesis, optimists did not show a bias toward future-oriented thought in daily life. In hindsight, however, it may be reasonable to assume that optimists would not report spending more time in the future. Optimism is a positive psychological trait characterized by the tendency to expect positive future outcomes (Carver et al., 1994)—not necessarily a tendency to perseverate on, or think more often about, such outcomes. Indeed, a high degree of future-oriented thought may be indicative of psychological disorder (e.g., worry or anxiety). Unlike the past-oriented focus of brooders, then, optimists may engage in a more adaptive cognitive style that allows attention to freely shift among past, present, and future-oriented thoughts in daily life.

It is important to note that worry is strongly correlated with rumination in clinical populations: people who tend to ruminate about past events also tend to worry about future events, pointing to a general tendency toward repetitive thinking in people with clinical conditions (Watkins, 2008). Because we did not assess worry in the current study, the extent to which the observed effects of rumination on past- and future-oriented thought in daily life reflects a global bias to engage in negative, repetitive thought is unclear. Future work might therefore assess common and unique effects of rumination and worry on past- and future-oriented thought in daily life using a bi-factor approach, which can assess global or high-order effects of a latent construct (e.g., negative/repetitive thinking) and specific or lower-order effects indicating that construct (e.g., rumination and worry).

Optimism is also associated with an ability to cope with stressful life events (Brissette, Scheier, & Carver, 2002). To what extent do optimists rely on their ability to vividly imagine the future in the face of stressors in daily life? One possibility is that people high in optimism are successful in managing stressful events because they can more easily disengage from the present and mentally project positive and vivid future experiences. This capacity may provide an adaptive, self-regulatory buffer, whereby further negative affect is prevented by the ability to disengage from adverse physical and psychological conditions and mentally simulate positive future experiences. Subsequent research should explore whether optimists show enhanced future-oriented mental imagery when confronted with

stressful events in daily life, and determine the extent to which enhanced future thinking aids in self-regulation.

Our results may also have implications for debates about the role of temporal factors in studies of remembering the past and imagining the future. As discussed by Schacter et al. (2012; see also Addis, Pan, Vu, Laiser, and Schacter, 2009), references to ''past events'' and ''future events'' in these studies are often confounded with the distinction between ''remembering'' and ''imagining.'' Remembered events, of course, necessarily refer to the past.

However, cognitive or neural characteristics attributed to ''future events'' could potentially also be attributed to ''imagined events,'' regardless of whether such events refer to the future, the past, or the present. For example, studies of atemporal scene construction (e.g., Hassabis, Kumaran, & Maguire, 2007) reveal many of the same cognitive and neural features documented for remembered past and imagined future experiences (for review, see Mullally & Maguire, 2014), even though no mental time travel is involved. Thus, it is not always clear whether studies of the relation between remembering the past and imagining the future specifically address the relation between past and future, or whether they address the relation between memory and imagination, regardless of the involvement of mental time travel.

With respect to our study, we cannot know for certain whether the differences documented here between brooding ruminators and optimists are entirely accounted for by differences in temporal orientation (i.e., past vs. future); it is conceivable that the effects we observed are attributable to differences between memory (past) and imagination (future) that would *not* be observed if participants were imagining (as opposed to remembering) past events. Because we did not obtain the content of the past and future events reported by participants, we do not know whether past events reported by participants were imagined, as opposed to remembered. This issue may merit exploration in future research. Nonetheless, given that the individual difference variable we examined was defined in terms of temporal orientation, we think that our data most likely do reveal differences that are specifically related to mental time travel.

Another important caveat of the study is that the thought probes did not distinguish between spontaneous and deliberate cognition. This distinction is particularly relevant for the topic of the special issue in Psychology Research, and it has been increasingly emphasized in the mind-wandering literature. Although some work has examined intentionality and spontaneity of past- and future-oriented thoughts in a laboratory context (Seli, Ralph, Konishi, Smilek, & Schacter, 2017), to our knowledge, no research has explored these dimensions in daily life. Because mind-wandering varies across lab and daily-life contexts (Kane et al., 2017), an interesting direction for future research would be to compare temporality and spontaneity in lab and life. In our study, we suspect that many thought probes captured task-unrelated cognitions or daydreams, while others may have captured some deliberate aspects of planning. Future work could assess whether intentionality and temporality interact with cognitive style: it is possible that rumination is associated with more spontaneous and negative past-oriented thought, whereas optimism is related to more

deliberate future-oriented thought. We encourage researchers to examine temporality and spontaneity in the context of individual differences in cognitive style.

A final methodological limitation of the current work worth noting concerns the response rate of daily-life surveys. On average, people responded to about 57% of the surveys over the course of the week. Although consistent with past work using IVR systems (Burgin et al., 2013; 58%), other experience-sampling methods that do not require participants to respond to phone calls (e.g., personal digital assistants, PDA; app-based methods) may be preferred in future studies. Indeed, Burgin and colleagues found that survey completion rates were higher in a PDA condition compared to an IVR condition, although the daily-life ratings provided in this study were comparable (Burgin et al., 2013). We suggest future daily-life experience-sampling studies consider employing one of the many app-based methods currently available (e.g., MetricWire; www.metricwire.com) which may be more conducive to higher survey completion rates.

Summary and Future Directions

The present research examined the role of cognitive style in everyday mental time travel, which is more likely to be spontaneous than the kind of cue-elicited mental time travel typically studied in the lab. We found that although people high in brooding rumination spent more time engaged in past-oriented thought, they experienced *less* vivid mental imagery for their past- and future-oriented thoughts. In addition, we found that people high in optimism were not more or less likely to be thinking about the past or future, but they reported enhanced mental imagery and positive valence for future-oriented thoughts. Our results suggest that certain temporal biases in cognitive style affect the frequency and phenomenology of past- and future-oriented cognition. Future work could extend this correlational study with experimental manipulations that induce the temporal direction of spontaneous cognition (cf., Cole, Staugaard, & Bernsten, 2016). Moreover, because we did not ask people to report what they were thinking about, our conclusions concerning the content of such thoughts are necessarily limited. Subsequent research should explore additional subjective and objective criteria by exploring past- and future-oriented cognition in individuals with cognitive, affective, and temporal biases, and further examine future-thinking deficits in clinical populations.

Acknowledgments

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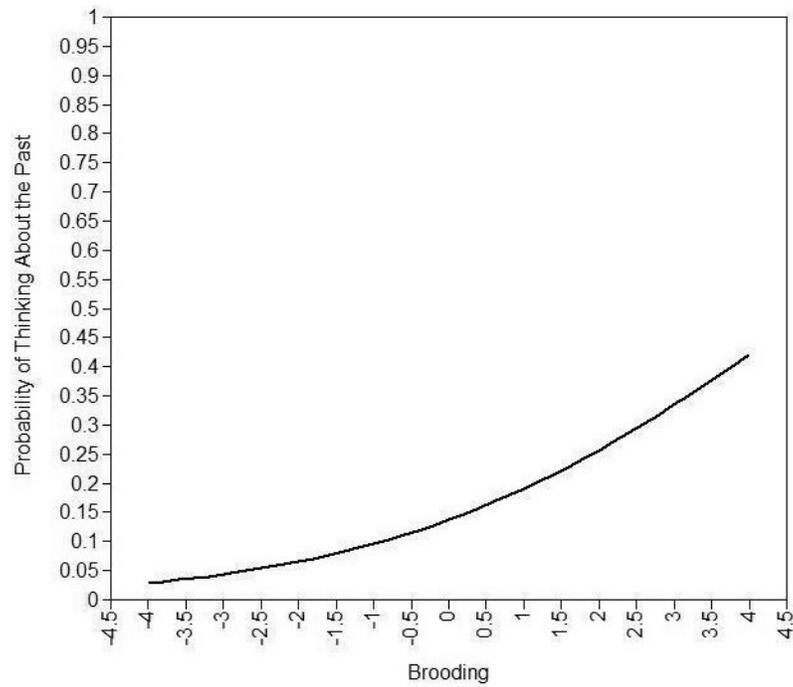
Figure 1.

The Probability of Thinking About the Past as a Function of Brooding

Note. $n = 79$. The brooding variable on the x-axis was derived from summing and z-transforming the five items of the brooding subscale. The full model included brooding, self-reflection, and depression, so the above graph represents the probability of thinking about the past as a function of brooding, adjusted for levels of self-reflection and depressed mood. Z-transformed observed variables were used instead of latent variables for the sake of illustration.

Table 1

Unstandardized Effects of the RRS, DASS-D, and LOT-R on Past-oriented Thought

	Past: Vivid		Past: Positive		Past: Distance	
Model	**b**	**p**	**b**	**p**	**b**	**p**
1. RRS						
Brooding	−.90	.01	−.09	.67	−.22	.48
Self-Reflection	.49	.18	.16	.50	.48	.16
2. DASS-D						
DASS-D	−.15	.53	.04	.77	.31	.16
3. RRS & DASS-D						
Brooding	−.96	.01	−.09	.69	−.25	.43
Self-Reflection	.38	.35	.14	.59	.33	.38
DASD-D	.23	.53	.01	.94	.24	.46
4. LOT-R						
LOT-R	.27	.29	−.13	.44	−.11	.67

Note. n = 79. RRS = Ruminative Response Scale; DASS-D = Depression Anxiety Stress Scale-Depression; LOT-R = Life Orientation Test-Revised.

Table 2

Unstandardized Effects of the RRS, DASS-D, and LOT-R on Future-oriented Thought

	Future: Vivid		Future: Positive		Future: Distance	
Model	***b***	***p***	***b***	***p***	***b***	***p***
1. RRS						
Brooding	−.53	.02	−.32	.18	.05	.89
Self-Reflection	.33	.17	.09	.70	.12	.75
2. DASSD						
DASSD	−.11	.53	−.41	.02	−.02	.87
3. RRS & DASSD						
Brooding	−.70	.03	−.22	.49	.11	.69
Self-Reflection	.37	.26	.27	.40	.17	.58
DASSD	.10	.71	−.44	.13	−.20	.43
4. LOT-R						
LOT-R	.45	.01	.47	.01	.12	.49

Note. n = 79. RRS = Ruminative Response Scale; DASSD = Depression Anxiety Stress Scale-Depression; LOT-R = Life Orientation Test-Revised.