



# Individual differences in the frequency of voluntary & involuntary episodic memories, future thoughts, and counterfactual thoughts

Jared G. Branch<sup>1</sup>

Received: 22 August 2022 / Accepted: 4 February 2023 / Published online: 13 February 2023  
© The Author(s), under exclusive licence to Springer-Verlag GmbH Germany, part of Springer Nature 2023

## Abstract

Voluntary and involuntary mental time travel can take the form of episodic memory, episodic future thinking, and episodic counterfactual thinking. This study uses an individual-differences approach to understand why people engage in these forms of mental time travel. The individual-differences variables include trait-level personality, boredom proneness, depression, anxiety, stress, emotion regulation, mindfulness, mind-wandering, positive and negative affect, rumination, optimism, thinking styles, and time perspective. Across two studies, our results indicate that individual differences underlie these forms of mental time travel. The most unique, episodic counterfactual thinking, was alone positively correlated with negative emotionality and negatively correlated with optimism. We also observe differences as a function of voluntariness and discuss these findings in relation to the cognitively demanding nature of constructing future and counterfactual thoughts. We discuss the importance of distinguishing voluntary from involuntary thinking and assessing episodic counterfactual thinking in relation to episodic memory and episodic future thinking.

## Introduction

Our ability not only to remember and imagine but mentally to travel backward and forward through personal time is known as *mental time travel* (Suddendorf & Corballis, 2007; Tulving, 2002). In addition to remembering our past and imagining our future, we can also imagine how our past could have been different, that is, entertain a counterfactual thought (De Brigard & Parikh, 2019). Why do people differentially engage in these forms of mental time travel? For instance, what personality traits are more likely to be seen in someone who engages more frequently in episodic counterfactual thinking than episodic future thinking?

The main research question in this study focuses on individual differences underlying the frequency of mental time travel. We use an individual-differences approach to understand why people engage in these forms of mental time travel. The individual-differences variables—trait-level personality, boredom proneness, depression, anxiety, stress, emotion regulation, mindfulness, mind-wandering, positive and negative affect, rumination, optimism, thinking styles,

and time perspective—were selected based on a review of the literature. For instance, mind-wandering is negatively correlated with conscientiousness and positively correlated with neuroticism (Carciofo & Jiang, 2021; Kane et al., 2017; Nicosia & Balota, 2021; Robison et al., 2017, 2020), depression (Chaieb et al., 2022; Deng et al., 2014; Seli et al., 2019; Webb et al., 2021), anxiety (Seli et al., 2019), and boredom (Danckert et al., 2018).

Episodic memory and episodic future thinking share many commonalities. They are both used for planning and goal-directed purposes (Baumeister et al., 2016; Biderman et al., 2020; Cole et al., 2021; Kvavilashvili & Rummel, 2020; Ozdes, 2021) and function to regulate mood and reduce boredom (Branch & Zickar, 2021; Hallford & D'Argembeau, 2022). Underlying the behavioral similarities between memory and imagination is a core network consisting of the hippocampus and other areas (e.g., Benoit & Schacter, 2015).

Episodic memory and episodic future thinking are also involved in mental health. The ability to envisage a positive future is associated with positive mental health (see MacLeod, 2016 for a discussion), and deficits in future thinking are seen with anxiety (Wu et al., 2015), depression (Hallford et al., 2020), and other mental health conditions (Brunette & Schacter, 2021). Past mental time travel can also be maladaptive given that it is predicted by brooding (Beaty

✉ Jared G. Branch  
Jared.Branch@avila.edu

<sup>1</sup> School of Psychology & Cognitive Science, Avila University, Kansas, MO 64145, USA

et al., 2019) and thought suppression (del Palacio-Gonzalez & Berntsen, 2019).

Mental time travel can occur voluntarily or involuntarily (e.g., Berntsen, 2021). Individuals with anxiety are more likely to experience involuntary mind-wandering (Arch et al., 2021) and involuntary thoughts are more anxiety provoking and emotionally intense (Cole et al., 2016; del Palacio-Gonzalez & Berntsen, 2020). In daily life, involuntary memories are experienced more frequently than voluntary memories (Rasmussen & Berntsen, 2011). Interestingly, more differences in phenomenological details are observed between voluntary and involuntary mental time travel than between future and past temporal orientations (Cole et al., 2016).

Several theoretical frameworks have been offered to explain this phenomenological (e.g., Spreng & Levine, 2006) and neural (e.g., Addis et al., 2008) overlap. One prominent theory offers that future thinking is the result of a constructive memory system that allows for episodic memories to be modified to imagine potential episodic future events (Schacter & Addis, 2007). Other theories hold that episodic memory is built on future thinking (Schulz & Robins, 2022), while some take the continuist view that memory and imagination (e.g., future thinking) are both part of a common simulation process (Addis, 2018; De Brigard, 2014; Michaelian et al., 2020).

In addition to studying the remembered personal past and imagined personal future, the present research also examined a comparatively less-studied phenomenon: the counterfactual personal past, i.e., thoughts about how past events could have turned out differently. Episodic counterfactual thoughts are conceptually similar to episodic memories, given that they are about the past, and episodic future thoughts, given that they are imagined. Özbek et al. (2017) provide a framework for thinking of counterfactual thoughts in relationship to memories and future thoughts, in that they each hold a unique temporal direction (past or future) and reality (real or imagined) (see De Brigard & Parikh, 2019, for a similar framework). Memories are past thoughts that are real, future thoughts are future thoughts that are imagined, and counterfactual thoughts are past thoughts that are imagined.

Like episodic memories and episodic future thoughts, episodic counterfactual thoughts are thought to play a role in goal-directed purposes (Markman & McMullen, 2003; Roesse & Epstude, 2017) and are used for emotion regulation (Branch & Zickar, 2021). Episodic counterfactual thinking also plays a role in mental health conditions, including depression (Feng et al., 2015) and PTSD (Hoppen et al., 2020). Blix et al. (2018) assessed the relationship of both PTSD and counterfactual thinking in survivors of the 1990 Scandinavian Star tragedy. As counterfactual thoughts became more frequent and vivid, the severity of PTSD symptoms increased. Likewise, Mitchell et al. (2016)

observed that counterfactual thinking was a significant predictor of PTSD symptomology in patients engaged in mental health treatment.

Several studies have demonstrated that episodic memories, episodic future thoughts, and episodic counterfactual thoughts show neural (e.g., Addis et al., 2009; De Brigard et al., 2013a; Van Hoeck et al., 2013) and phenomenological overlap. De Brigard and Giovanello (2012), for instance, compared episodic memories, episodic future thinking, and episodic counterfactual thinking by asking participants to recall a memory, imagine something similar happening in future, or construct a counterfactual thought by imagining the opposite emotional valence had occurred in the past. Compared to future and counterfactual thoughts, memories were rated as being perceived more clearly and with more sensory details and, compared to memories and future thoughts, counterfactual thoughts contained lower emotion ratings. However, on several other phenomenological characteristics, including emotional intensity and perspective, no differences between memories, future thoughts, and counterfactual thoughts were observed. Rather than creating counterfactual and future events from memories, Özbek et al., (2017) asked participants to provide and rate the phenomenological characteristics of an important memory, potential future event, and an imagined event that could have but did not happen. That their findings largely but not completely replicated those of De Brigard and Giovanello suggests that this overlap is at least partially mediated by cueing method.

Despite the conceptual, neural, and phenomenological overlap, episodic counterfactual thinking is distinct from episodic memory and episodic future thinking (De Brigard & Parikh, 2019). For instance, repeatedly simulating future events increases plausibility (Szpunar & Schacter, 2013) while repeatedly simulating counterfactual events decreases plausibility (De Brigard et al., 2013b). Counterfactual thinking is positively correlated with neuroticism and negatively correlated with agreeableness, whereas future thinking is negatively correlated with neuroticism and positively correlated with agreeableness (Bacon et al., 2020).

In this study, we use an individual differences approach to understand why people engage in these forms of mental time travel. In addition to hypothesizing that we will confirm past findings discussed in the literature review, we make several hypotheses about novel variables. The first novel variable is optimism. Beatty et al. (2019) used a dispositional measure of optimism and found no relationship between it and the frequency of past or future mental time travel. We used this same measure to assess the relationship between optimism and counterfactual mental time travel. Given findings related to mental health and personality, and plausibility decreasing with repeated simulation, we predicted that optimism would be negatively correlated with counterfactual thinking.

Second, we assessed thinking styles. Past research has found that being prone to fantasy positively correlates with the generation of counterfactual thoughts (Bacon et al., 2013). We used thinking styles as a measure to conceptually replicate this finding and predicted that counterfactual and future thoughts would be positively correlated with imaginative thinking styles.

Finally, we included a measure of time perspective. We predicted that episodic future thinking would be correlated with future time perspectives and episodic memories would be correlated with past-time perspectives. However, this variable also allowed us to make predictions about counterfactual thoughts. As we discuss above, counterfactual thoughts are similar to both episodic future thoughts and episodic memories yet are a distinct form of mental time travel (e.g., De Brigard & Parikh, 2019). If counterfactual thoughts most closely align with imagined future thoughts, we would expect to see a positive correlation between future time perspectives and counterfactual thinking. Alternatively, if counterfactual thoughts are more closely aligned with remembered past thoughts, we would expect to see a positive correlation between past-time perspectives and counterfactual thinking. Finally, if counterfactual thoughts exist as a distinct category of mental time travel, they would be neither correlated with future- nor past-time perspectives.

We investigated these questions in two studies. In both studies, participants responded to questionnaires to assess the frequency of their mental time travel. In the first study, in addition to responding to questionnaires, participants were asked to track their episodic memories, episodic future thoughts, and episodic counterfactual thoughts as they went about their day. Our aim was to obtain a measure of mental time travel frequency in daily life and analyze this finding in relation to our individual-differences variables.

## Study 1

### Method

#### Participants

A total of 143 participants (48 male, 92 female, 3 other; mean age = 25.2,  $SD = 8.20$ , range = 18 to 57) enrolled at a large university in the western United States completed the questionnaire portion of the study in exchange for course credit. The questionnaires were presented via SurveyMonkey, and each questionnaire was presented on a separate page. The presentation of questionnaires was randomized. Participants completed the questionnaires online and took, on average, 23 min to complete this portion of the study. After completing the questionnaire portion, participants were invited to record their thoughts in daily life for

additional course credit. A total of 88 participants (32 male, 53 female, 3 other; mean age = 26.1,  $SD = 9.06$ , range = 18 to 57) chose to do, completing both the questionnaires and recording their thoughts as they went about their daily lives. The participants who recorded their thoughts in daily life ( $N = 88$ ) did not significantly differ from those who did not ( $N = 55$ ) on any questionnaire measure (all  $ps > 0.05$ ). Sample size determinations were made via G\*Power, indicating a sample size of 84 is sufficiently powered (80%) to detect medium effect sizes (Faul et al., 2009).

### Procedure

Informed consent was obtained for experimentation with human subjects. Participants first completed the questionnaire portion, responding to the questionnaires listed below in the materials section. After completing the questionnaire portion of the study, participants completed the daily life portion. First, they scheduled and attended an informational session via Zoom, in which a research assistant explained that we were interested in the frequency of personal memories, personal future thoughts, and personal counterfactual thoughts that the participant experienced in daily life. Participants were informed that they should “focus on how many personal thoughts come to mind naturally” without willfully trying to conjure a certain type of thought more or less frequently than they normally do. An episodic memory was defined as follows.

“Personal past thoughts are simply memories. If you think about how your past actually occurred, then you have had a thought about the past. However, our focus in this study is with personal memories. For example, if you think back to the election in November, and you think about Trump and Biden, this is a past memory, but it’s not a personal memory. If your thought was about when you voted for one of those candidates, then it’s a personal memory, because it’s a past memory and you are in that thought.”

Next, participants were informed about episodic future thoughts as follows.

“Personal future thoughts concern things like upcoming events. But remember, it’s personal, so it’s not just thoughts about future things, but things that might happen to you in the future. They could be thoughts about goals you hope to attain, and your future actions toward those goals. So, a personal future thought could be a thought about something you hope happens to you, or expect to happen to you, or even something involving you in the future. Any of these would be counted as a personal future thought. It could be what you will eat for dinner, or the grade you will get on an

assignment. Again, it's personal; so, it is not tomorrow's weather, or the future of the country, but a thought about you in the future."

Finally, participants were informed about episodic counterfactual thoughts.

"Finally, the last kind of thought we want to track is personal counterfactual past thoughts. A counterfactual thought is what it sounds like—imagining a scenario that is counter to the facts. For example, perhaps you have a thought about a past scenario where something embarrassing happened to you, and then you imagine how the event could've played out in a less embarrassing way. This would be a personal counterfactual thought. Basically, if you think about how a scenario could have been different than it was, you are having a counterfactual thought. You may imagine how a bad event could've played out better. For instance, you might imagine how leaving 5 minutes early could've caused you to avoid getting into a car accident. Alternatively, you could imagine how a good event could've been worse. For instance, you imagine an event when you barely missed another car in traffic, but this time you think about the event as if you weren't paying attention and you hit the other car. Or you could've done poorly on a test and imagined doing better if you had spent more time studying. All personal counterfactual thoughts have in common that they occurred in the past, they could have played out differently, and they involved you.

After each type of thought was defined, the participant was asked to give a corresponding example. If their example fit within that category, then the research assistant moved on and described the next type of thought. If their example did not fit within that category, then the research assistant identified why that thought did not fit within that category and asked the participant to provide a different example. Participants were asked to set aside three hours in a single day in 1-h increments during which they were relatively free, for instance, not attending class, working, or driving.

Participants were asked to record, during three separate hours, the number of memories, future thoughts, and counterfactual thoughts, respectively, they experienced during that specific hour. That is, only one of the three types of thought was to be recorded during each hour. Participants were asked to download a tally counter app of their choosing to their phone and increase, by one, the tally each time a particular thought, as described above, was experienced. The order of category of thought the participant tracked and reported was randomly assigned. The participant was contacted before each hour that they had set aside to remind them to record their thoughts and identify which

type of thought the participant was to record within that hour. The participant was contacted at the end of the hour and asked to provide the total number of thoughts of the specific type that they had.

## Materials

**Involuntary mental time travel** The Involuntary Autobiographical Memory Inventory (IAMI; Berntsen et al., 2015) is a 20-item measure that separates involuntary past (e.g., "When I am relaxing or doing routine work, memories of past events come to my mind by themselves—without me consciously trying to remember") from involuntary future (e.g., "When I am relaxing or doing routine work, imaginary future events come to my mind by themselves—without me consciously trying to evoke them") mental time travel. Participants respond using a 4-point scale ranging from never (0) to once an hour or more (4).

**Personality** Big Five Personality was measured using the Ten-Item Personality Inventory (TIPI; Gosling et al., 2003) which uses 10 items (2 per domain) to assess the five factors of personality. Participants respond using a 7-point Likert-type scale ranging from disagree strongly (1) to agree strongly (7).

**Boredom proneness** Boredom proneness was measured using the Boredom Proneness (BP; Vodanovich & Kass, 1990) scale, a 28-item measure with a 7-point Likert-type response scale.

**Depression, anxiety, and stress** Depression, anxiety, and stress were measured using the Depression Anxiety Stress Scales (DASS; Lovibond & Lovibond, 1995).

**Emotion regulation** Participant ability to regulate emotion was measured using the Emotion Regulation Questionnaire (ERQ; Gross & John, 2003), which separates reappraisal (e.g., "I control my emotions by changing the way I think about the situation I'm in.") from suppression (e.g., "I keep my emotions to myself."). Participants respond using a 7-point Likert-type response scale.

**Mindfulness** The Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003) assessed participant mindfulness, using a 6-point scale ranging from almost always (1) to almost never (7).

**Mind-wandering** Mind-wandering was measured using the Mind-Wandering Questionnaire (MWQ; Mrazek et al., 2013). The MWQ uses 5 items and a 6-point response scale ranging from almost never (1) to almost always (6).

**Affect** The International Positive and Negative Affect Schedule Short Form (I-PANAS-SF; Thompson, 2007) is a 10-item measure with a 5-point response scale in which participants indicate the frequency they experience positive and negative affective states.

**Rumination** Rumination was measured via the Ruminative Responses Scale (RRS; Treynor et al., 2003), which separates reflection (e.g., “Analyze recent events to try to understand why you are depressed), brooding (e.g., “Think ‘What am I doing to deserve this?’”), and depression-related (e.g., “Think about how alone you feel”) rumination styles.

## Results

We first conducted a repeated-measures ANOVA using the tally of episodic thoughts experienced in daily life (memories, future thoughts, and counterfactual thoughts) as a within-subjects factor. The analysis was significant,  $F(2, 174) = 11.5, p < 0.001, \eta^2 p = 0.116$ , showing that participants experienced fewer counterfactual thoughts ( $M = 6.68, SD = 6.57$ ) than future thoughts ( $M = 10.8, SD = 9.95$ ); Tukey’s  $p < 0.001$ ; or memories ( $M = 10.4, SD = 12.2$ ); Tukey’s  $p = 0.003$ . There was no significant effect of gender ( $p > 0.05$ ). None of the questionnaire measures correlated with participant reports of thoughts experienced in daily life (all  $ps > 0.05$ ). Participants reported experiencing

significantly more memories ( $M = 2.36, SD = 0.81$ ) than future thoughts ( $M = 2.21, SD = 0.85$ ) in the IAMI ( $p = 0.001$ ).

Our main variables of interest were the correlation coefficients shown in Table 1. Given the number of predictors (18), we used a Bonferroni-corrected  $p$  value of 0.003. Personality, boredom proneness, depression, emotion regulation (reappraisal and suppression), mind-wandering, mindfulness, and positive affect did not correlate with involuntary memories or involuntary future thoughts. Involuntary memories were positively correlated with anxiety, stress, negative affect, reflection, brooding, and depression-related rumination. Involuntary future thoughts were positively correlated with stress, negative affect, reflection, and brooding. The correlation coefficients shared by memories and future thoughts tended to be stronger for involuntary memories than involuntary future thoughts (i.e., negative affect, reflection, and brooding).

## Discussion

We did not observe the expected correlations among our variables of interest and participant-reported tallies of memories, future thoughts, and counterfactual thoughts in daily life. We gave minimal instruction of what the participants should be doing during this time in the hope that they would go about their daily lives and not try to construct more or

**Table 1** Means, standard deviations, and correlation coefficients for involuntary memory and future mental time travel as measured by the IAMI

Variable	N	Mean	SD	Involuntary memory	Involuntary future
Extraversion	143	4.37	1.64	0.101	0.158
Agreeableness	143	5.29	1.16	0.106	0.058
Conscientiousness	143	5.52	1.16	0.017	0.033
Emotional stability	143	4.45	1.42	−0.205	−0.094
Openness to experience	143	4.29	1.03	0.068	0.093
Boredom proneness	143	3.83	0.49	0.011	0.005
Depression	143	0.68	0.70	0.177	0.073
Anxiety	143	0.51	0.53	0.285*	0.177
Stress	143	0.71	0.66	0.279*	0.282*
ERQ: Reappraisal	143	5.14	1.19	−0.021	0.116
ERQ: Suppression	143	3.86	1.60	0.056	0.009
Mind-wandering	143	3.99	0.95	0.222	0.227
Mindfulness	142	33.6	24.9	0.119	0.178
Positive affect	143	3.63	0.58	0.093	0.147
Negative affect	143	2.63	0.72	0.307*	0.229*
RRS: Reflection	143	2.31	0.77	0.441*	0.359*
RRS: Brooding	143	2.38	0.76	0.353*	0.279*
RRS: Depression	143	2.37	0.75	0.317*	0.241

Note. \* $p = / < .003$ . The variable means, standard deviations, and correlation coefficients are for the full sample ( $N = 143$ )



fewer thoughts than they normally experience. However, it is important to note that the predicted correlations were observed when thought frequency was measured via the IAMI questionnaire. As such, we suggest that the nature of the task caused participants to report a state frequency inconsistent with their underlying trait frequency.

Both memories and future thoughts were correlated with stress, negative affect, reflection, and brooding, whereas memories were also correlated with anxiety and depression-related rumination. No individual-differences correlations were unique for future thoughts. While the findings for brooding and self-reflection were predicted by prior findings, past research also predicts that future thinking would correlate with personality (neuroticism and agreeableness) and anxiety, and memories would correlate with depression and suppression.

## Study 2

Given that we did not observe some of the predicted correlations, and that our measure of counterfactual thinking was ineffective, in Study 2, we used a novel measure of counterfactual thinking and increased our sample size to detect smaller effects. We also used different measures of several of the individual-differences variables. Given that study 2 took participants longer to complete than study 1 (study 2 took participants, on average, 51 min), attention checks were included, and participant data were excluded if participants did not successfully complete three out of five attention checks.

## Method

### Participants

A total of 373 participants (116 male, 252 female, 5 other; mean age = 22.5,  $SD = 7.14$ , range = 18 to 77) enrolled at a large university in the western United States completed the study in exchange for course credit. Sample size determinations, made via G\*Power (Faul et al., 2009), showed a sample size of 346 was sufficiently powered (80%) to detect small (0.15) effect sizes.

### Procedure

Participants responded to a battery of questionnaires. The presentation of the questionnaires was random. Informed consent was obtained from all individual participants included in the study.

## Materials

**Involuntary mental time travel** We again used the Involuntary Autobiographical Memory Inventory (IAM; Berntsen et al., 2015) to measure involuntary future and past mental time travel. In addition to the existing future and past questionnaires, the tense and grammar were modified to create a measure of counterfactual thinking (see Appendix A). This newly created measure of involuntary counterfactual past mental time travel had good reliability (McDonald's  $\omega = 0.930$ ) that did not improve if any items were dropped.

**Voluntary mental time travel** To compare involuntary to voluntary mental time travel, we used the voluntary control questions from the IAM (Berntsen et al., 2015), a 10-item measure that assesses the frequency of voluntary past and future mental time travel. Similar to the IAM, we created a counterfactual version to assess voluntary counterfactual mental time travel (see Appendix B). This measure also had good reliability (McDonald's  $\omega = 0.899$ ) that did not improve if any items were dropped.

**Personality** Big Five Personality was measured using the Big Five Inventory-2 (BFI-2; Soto & John, 2017) which uses 60 items (12 per domain) and a 5-point response scale to assess the five factors of personality.

**Boredom proneness** Boredom proneness was measured using the Boredom Proneness Scale-Short Form (BPS-SR; Struk et al., 2017), an 8-item measure with a 7-point Likert-type response scale.

**Depression, anxiety, and stress** Depression, anxiety, and stress were again measured using the Depression Anxiety Stress Scales (DASS; Lovibond & Lovibond, 1995).

**Emotion regulation** Participant ability to regulate emotion was again measured using the Emotion Regulation Questionnaire (ERQ; Gross & John, 2003), which separates reappraisal (e.g., "I control my emotions by changing the way I think about the situation I'm in.") from suppression (e.g., "I keep my emotions to myself."). Participants respond using a 7-point Likert-type response scale.

**Mindfulness** The Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003) was again used to assess participant mindfulness, using a 6-point scale ranging from almost always (1) to almost never (7).

**Mind-wandering** Mind-wandering was measured using the Mind-Wandering: Deliberate and Mind Wandering: Spontaneous Questionnaire (Carriere et al., 2013), which uses 8 items (4 for each domain) and a 6-point response

scale to assess deliberate and spontaneous mind-wandering.

**Affect** The International Positive and Negative Affect Schedule Short Form (I-PANAS-SF; Thompson, 2007) is a 10-item measure with a 5-point response scale in which participants indicate the frequency they experience positive and negative affective states.

**Rumination** Rumination was again measured via the Ruminative Responses Scale (RRS; Treynor et al., 2003), which separates reflection (e.g., “Analyze recent events to try to understand why you are depressed”), brooding (e.g., “Think ‘What am I doing to deserve this?’”), and depression-related (e.g., “Think about how alone you feel”) rumination styles.

**Optimism** The Revised Life Orientation Test (LOT-R; Scheier et al., 1994) is a 6-item measure of dispositional optimism, using a 5-point response scale.

**Thinking styles** The Rational/Experiential Multimodal Inventory (REIm; Norris & Epstein, 2011) is a 42-item measure of thinking styles, including rational (e.g., “I enjoy problems that require hard thinking”), imaginative (e.g., “I enjoy imagining things”), emotional (e.g., “When I’m sad, it’s often a very strong feeling”), and intuitive (e.g., “I often go by my instincts when deciding on a course of action”) thinking styles.

**Time perspective** The Balanced Time Perspective Scale (BTPS; Vowinckel et al., 2017) is a measure of future, past, and present time perspective. Respondents use a 6-point response scale.

**ART** The Autobiographical Recollection Test (ART; Berntsen et al., 2019) is a measure of individual differences in the phenomenological experience of autobiographical memories. The ART is not the focus of the current research and we do not discuss it further.

## Results

The means, standard deviations, and correlation coefficients of our individual-differences variables for (in)voluntary memories, future thoughts, and counterfactual thoughts are shown in Table 2. Given the number of predictors (27), we used a Bonferroni-corrected  $p$  value of 0.002. For involuntary thoughts, participants reported experiencing more involuntary memories ( $M=2.26$ ,  $SD=0.78$ ) than involuntary future thoughts ( $M=2.15$ ,  $SD=0.82$ ;  $p<0.001$ ) or involuntary counterfactual thoughts ( $M=2.11$ ,  $SD=0.89$ ;  $p<0.001$ ). For voluntary thoughts, participants also

reported experiencing more voluntary memories ( $M=2.12$ ,  $SD=0.91$ ) than voluntary future thoughts ( $M=2.28$ ,  $SD=0.91$ ;  $p<0.001$ ) and more voluntary future thoughts than voluntary counterfactual thoughts ( $M=2.07$ ,  $SD=0.98$ ;  $p<0.001$ ). Comparing voluntary to involuntary thoughts, participants reported experiencing more involuntary than voluntary memories ( $p=0.007$ ), more voluntary than involuntary future thoughts ( $p=0.004$ ), and no differences between voluntary and involuntary counterfactual thoughts ( $p>0.05$ ).

Many individual-differences measures showed no significant correlations with either voluntary or involuntary memories, future thoughts, or counterfactual thoughts, including several personality traits (i.e., extraversion, agreeableness, conscientiousness, and open-mindedness), emotion regulation (both reappraisal and suppression), positive affect, rational and intuitive thinking styles, and present time perspectives.

However, other variables showed correlations with all the dependent variables, including anxiety, stress, negative affect, mindfulness and all types of rumination (reflection, brooding, depression). As well, deliberate mind-wandering more strongly correlated with voluntary mental time travel and spontaneous mind-wandering more strongly correlated with involuntary mental time travel.

Involuntary memories were correlated with boredom proneness, depression, and imaginative and emotional thinking styles, whereas voluntary memories were correlated with past-time perspectives. Voluntary and involuntary future thinking were both further correlated with imaginative time perspectives, and involuntary future thinking was also correlated with boredom proneness. Voluntary and involuntary counterfactual thinking were both correlated with negative emotionality, boredom proneness, depression, and emotional thinking styles. Voluntary counterfactual thoughts were also negatively correlated with optimism and involuntary counterfactual thoughts positively correlated with imaginative thinking styles.

## Discussion

The results of Study 2 largely replicated the results of Study 1: Stress, negative affect, and reflective and brooding rumination correlated with involuntary memories and future thoughts in both studies. However, correlations for boredom proneness, depression, anxiety, mind-wandering, mindfulness, and ruminative depression were observed in Study 2 but not in Study 1. We would suggest that this is an effect of a larger sample size, and the resulting ability to detect smaller effect sizes, rather than the different measures employed between the two studies: Study 1 was adequately powered to detect medium effect sizes, whereas Study 2 was

**Table 2** Means, standard deviations, and correlation coefficients for (in)voluntary memory, future, and counterfactual mental time travel

Variable	N	Mean	SD	Involuntary mental time travel			Voluntary mental time travel		
				Memory	Future	Counterfactual	Memory	Future	Counterfactual
Extraversion	373	3.18	0.75	0.04	0.06	0.07	0.06	0.09	0.06
Agreeableness	373	3.82	0.59	0.06	0.02	0.00	0.02	0.01	–0.00
Conscientiousness	373	3.56	0.67	–0.02	–0.05	–0.02	0.02	0.03	0.02
Negative emotionality	373	3.12	0.85	0.15	0.14	0.21*	0.07	0.12	0.21*
Open-mindedness	373	3.73	0.68	0.13	0.13	0.06	0.04	0.11	0.02
Boredom proneness	373	3.56	1.27	0.17*	0.17*	0.21*	0.14	0.12	0.22*
Depression	373	0.72	0.70	0.19*	0.16	0.19*	0.16	0.14	0.23*
Anxiety	373	0.65	0.62	0.29*	0.25*	0.28*	0.19*	0.23*	0.28*
Stress	373	0.91	0.71	0.29*	0.26*	0.29*	0.17*	0.22*	0.28*
ERQ: Reappraisal	373	5.06	1.20	0.02	–0.03	0.06	0.01	–0.01	0.02
ERQ: Suppression	373	3.88	1.57	0.02	0.06	0.09	0.08	0.06	0.08
D Mind-wandering	373	4.15	1.07	0.16*	0.24*	0.09	0.23*	0.32*	0.16*
S Mind-Wandering	373	4.24	1.05	0.31*	0.29*	0.27*	0.15	0.21*	0.21*
Mindfulness	373	3.38	0.79	–0.29*	–0.31*	–0.34*	–0.23*	–0.31*	–0.33*
Positive affect	373	3.63	0.59	0.00	0.03	0.05	0.06	0.04	0.03
Negative affect	373	2.74	0.65	0.23*	0.23*	0.26*	0.17*	0.19*	0.25*
RRS: Reflection	373	2.41	0.76	0.23*	0.22*	0.20*	0.19*	0.24*	0.19*
RRS: Brooding	373	2.50	0.78	0.24*	0.29*	0.34*	0.21*	0.28*	0.36*
RRS: Depression	373	2.53	0.71	0.19*	0.21*	0.25*	0.17*	0.21*	0.28*
Optimism	373	19.1	5.00	–0.10	–0.10	–0.15	–0.11	–0.10	–0.19*
REIm: Rational	373	4.81	1.02	0.02	–0.03	–0.02	0.01	0.02	–0.02
REIm: Imaginative	373	4.90	0.86	0.21*	0.21*	0.16*	0.15	0.22*	0.13
REIm: Emotional	373	4.68	0.83	0.17*	0.15	0.18*	0.08	0.15	0.16*
REIm: Intuitive	373	4.73	0.79	0.05	0.03	0.10	0.04	0.08	0.10
BTPS: Future	373	4.69	0.90	0.06	0.14	0.14	0.06	0.19*	0.12
BTPS: Past	373	3.86	1.01	0.05	0.02	0.07	0.23*	0.15	0.16
BTPS: Present	373	4.27	0.98	–0.04	–0.02	–0.02	0.03	0.09	0.03

Note. \* $p < .002$

adequately powered to detect small effect sizes. Notably, our measures for depression, anxiety, stress, mindfulness, and rumination were consistent across both studies.

## General discussion

In daily life, episodic counterfactual thoughts were experienced significantly less frequently than episodic memories or episodic future thoughts. This finding partially replicates past findings in which counterfactual thoughts were experienced less frequently than memories, which were experienced less frequently than future thoughts (Branch & Zickar, 2021). While our participants experienced a similar number of future and past thoughts, it should be noted that the number of thoughts reported was well above the number of thoughts participants report experiencing in experience-sampling (Baumeister et al., 2020;

Kane et al., 2017) and diary studies (D'Argembeau et al., 2011). Although there is evidence that people may not effectively self-report behavior in questionnaires (e.g., Clark & Maguire, 2020), the predicted correlations were observed when self-reporting frequency using the involuntary autobiographical memory inventory (IAMI) questionnaire (Berntsen et al., 2015). These findings would suggest that our method of daily life thought collection was ineffective.

Turning to the counterfactual-modified involuntary autobiographical memory inventory (IAMI) in study 2, participants reported experiencing more involuntary memories than involuntary future thoughts or involuntary counterfactual thoughts. As well, they experienced more voluntary memories than voluntary future thoughts, which were experienced more than voluntary counterfactual thoughts. Participants reported experiencing more involuntary than voluntary memories, more voluntary than involuntary future



thoughts, and no differences between voluntary and involuntary counterfactual thoughts.

In line with our findings, Özbek et al., (2017) observed that memories were easier to remember relative to future or counterfactual thoughts. Taken together, these findings could be explained, in part, by the cognitively demanding nature of future (Mazzoni, 2019) and counterfactual thinking. Remembering how an event occurred and imagining how it could have been different (see Espino & Byrne, 2021) are arguably more cognitively demanding than simply remembering. That counterfactual thinking was experienced the least, and that future thinking was also experienced less frequently than memories, suggests that because these types of thoughts are cognitively demanding they are experienced less in daily life. Our finding that future thinking was experienced more frequently as voluntary than involuntary provides further evidence for this cognitive-demand framework (e.g., Barzykowski & Niedźwieńska, 2018) but is directly opposed to theoretical accounts (Cole & Kvavilashvili, 2021; Kvavilashvili & Rummel, 2020). However, we did not directly test this assumption and future research should seek to do so.

Episodic memories, episodic future thinking, and episodic counterfactual thinking were closely related as defined by our individual-differences measures. Whether voluntary or involuntary, anxiety, stress, negative affect, and rumination positively correlated, and mindfulness negatively correlated, with mental time travel. This finding is predicted given a framework in which imagination is related to memory.

Although we observed significant overlap between these forms of mental time travel, our results indicate that individual differences underlie the frequency with which these forms of mental time travel are experienced. For instance, depression and emotional thinking styles were correlated with involuntary memories and involuntary and voluntary counterfactual thoughts. As such, these forms of mental time travel are experienced with differing frequencies by different individuals, and that frequency is correlated with different cognitive styles.

The most unique form of mental time travel was counterfactual thinking. Involuntary counterfactual thinking was uniquely positively correlated with the personality trait of negative emotionality while voluntary counterfactual thinking was likewise positively correlated with negative emotionality, boredom, depression, and emotional thinking styles and negatively correlated with optimism. Taken together, these findings suggest that individuals who frequently have episodic counterfactual thoughts have a cognitive style distinct from those who think frequently of episodic memories or episodic future thoughts. Episodic counterfactual thinking was uniquely positively correlated with negative emotionality and depression, and negatively correlated with optimism. As such, an increased frequency of episodic counterfactual

thinking may be associated with poorer mental health outcomes, more so than episodic future thinking or episodic memory.

We had predicted that we would confirm past research findings and largely did: counterfactual thinking correlated positively with anxiety, depression, and neuroticism; however, we did not observe the negative correlation with agreeableness that was observed by Bacon et al., (2020). We also observed the predicted correlations between counterfactual thinking and imaginative thinking styles and optimism, but not with past or future time perspectives. These findings provide evidence that, although episodic counterfactual thinking shares similarities with episodic memories and episodic future thinking, it is not easily classifiable as a remembered past event or an imagined future event. Rather, it exists as a distinct category of mental time travel.

We also observed differences as a function of voluntariness. For instance, boredom proneness was more strongly correlated with involuntary than voluntary mental time travel, as would be predicted by past research on spontaneous mind-wandering (Isacescu et al., 2017; Martarelli et al., 2021). We observed stronger correlations for involuntary mental time travel with spontaneous mind-wandering and voluntary mental time travel with deliberate mind-wandering. However, we did not observe, as would be suggested by past findings, that involuntary relative to voluntary mental time travel was more strongly correlated with anxiety and depression (Arch et al., 2021; Seli et al., 2019). As well, we observed that imaginative thinking styles were correlated with all involuntary mental time travel but only voluntary counterfactual mental time travel. These findings demonstrate the importance of distinguishing between thoughts that occur deliberately or arise spontaneously. Studying involuntary thoughts in the absence of voluntary thoughts provides only a piece of the mental time travel picture.

## Limitations and future research

Our participants were young and mostly female. Although we did not observe a significant effect of gender, the extent to which our findings generalize to a larger population is unknown. However, given that past findings have noted an effect of age on mind-wandering (e.g., Maillet et al., 2018) future research should assess the extent to which our findings hold for older adults. De Brigard et al., (2017), for instance, compared episodic memories, future thinking, and counterfactual thinking in younger and older Colombian adults and observed similarities—e.g., memories contained more sensory details relative to future and counterfactual thoughts—and differences—e.g., higher phenomenological ratings and the use of more external and fewer internal details for older adults compared to younger adults—as a function of age. Özbek et al. (2020) also tested for age effects across two

studies, with an effect of age emerging in one but not the other. However, these effects were confounded with culture given that the researchers utilized a Turkish sample in study 1 and an American sample in study 2. Given that, relative to younger adults, older adults differentially construct episodic thoughts, it is likely that individual differences vary as a function of age.

Finally, we did not distinguish upward from downward counterfactual thinking. Upward counterfactual thinking is an imagined alternative that is better than reality, whereas downward counterfactual thinking is an imagined alternative worse than reality (Byrne, 2016). A different cognitive profile would almost certainly exist for someone who engages more frequently in downward relative to upward counterfactual thinking. Future studies should assess the degree to which differences exist not only in frequency but phenomenology of upward and downward counterfactual thought.

In summary, we provide a novel assessment of voluntary and involuntary episodic memory, episodic future thinking, and episodic counterfactual thinking. Although we observed, as predicted, many similarities between these forms of mental time travel, we also observed several measures unique to each type of thinking, especially when considering whether these thoughts were experienced voluntarily or involuntarily. The most dissimilar form of mental time travel was episodic counterfactual thinking, and it was correlated with several unique measures including negative emotionality and optimism. These findings lend themselves to much further research and demonstrate the importance of separating voluntary from involuntary mental time travel as well as assessing episodic counterfactual thinking in relation to episodic memories and episodic future thinking.

**Supplementary Information** The online version contains supplementary material available at <https://doi.org/10.1007/s00426-023-01802-2>.

**Author contributions** JGB is the sole author of this manuscript.

**Funding** The author did not receive support from any organization for the submitted work.

**Availability of data and materials** The author has no relevant financial or non-financial interests to disclose. The datasets generated during and/or analyzed during the current study are available in the OSF repository, <https://osf.io/73ce5/>.

## Declarations

**Conflict of interest** The author has no relevant financial or non-financial interests to disclose.

## References

- Addis, D. R. (2018). Are episodic memories special? On the sameness of remembered and imagined event simulation. *Journal of the Royal Society of New Zealand*, 48(2–3), 64–88.
- Addis, D. R., Wong, A. T., & Schacter, D. L. (2008). Age-related changes in the episodic simulation of future events. *Psychological Science*, 19(1), 33–41.
- Addis, D. R., Pan, L., Vu, M. A., Laiser, N., & Schacter, D. L. (2009). Constructive episodic simulation of the future and the past: Distinct subsystems of a core brain network mediate imagining and remembering. *Neuropsychologia*, 47(11), 2222–2238.
- Arch, J. J., Wilcox, R. R., Ives, L. T., Sroloff, A., & Andrews-Hanna, J. R. (2021). Off-task thinking among adults with and without social anxiety disorder: An ecological momentary assessment study. *Cognition and Emotion*, 35(2), 269–281.
- Bacon, A. M., Walsh, C. R., & Martin, L. (2013). Fantasy proneness and counterfactual thinking. *Personality and Individual Differences*, 54(4), 469–473.
- Bacon, A. M., Walsh, C. R., Briazu, A., & R. (2020). Looking behind and looking ahead: Personality differences in counterfactual and prefactual thinking. *Imagination, Cognition and Personality*, 40(2), 111–125.
- Barzykowski, K., & Niedźwieńska, A. (2018). Involuntary autobiographical memories are relatively more often reported during high cognitive load tasks. *Acta Psychologica*, 182, 119–128.
- Baumeister, R. F., Vohs, K. D., & Oettingen, G. (2016). Pragmatic prospection: How and why people think about the future. *Review of General Psychology*, 20(1), 3–16.
- Baumeister, R. F., Hofmann, W., Summerville, A., Reiss, P. T., & Vohs, K. D. (2020). Everyday thoughts in time: Experience sampling studies of mental time travel. *Personality and Social Psychology Bulletin*, 46(12), 1631–1648.
- Beatty, R. E., Seli, P., & Schacter, D. L. (2019). Thinking about the past and future in daily life: An experience sampling study of individual differences in mental time travel. *Psychological Research Psychologische Forschung*, 83(4), 805–816.
- Benoit, R. G., & Schacter, D. L. (2015). Specifying the core network supporting episodic simulation and episodic memory by activation likelihood estimation. *Neuropsychologia*, 75, 450–457.
- Berntsen, D. (2021). Involuntary autobiographical memories and their relation to other forms of spontaneous thoughts. *Philosophical Transactions of the Royal Society B*, 376(1817), 20190693.
- Berntsen, D., Rubin, D. C., & Salgado, S. (2015). The frequency of involuntary autobiographical memories and future thoughts in relation to daydreaming, emotional distress, and age. *Consciousness and Cognition*, 36, 352–372.
- Berntsen, D., Hoyle, R. H., & Rubin, D. C. (2019). The Autobiographical Recollection Test (ART): A measure of individual differences in autobiographical memory. *Journal of Applied Research in Memory and Cognition*, 8(3), 305–318.
- Biderman, N., Bakkour, A., & Shohamy, D. (2020). What are memories for? The hippocampus bridges past experience with future decisions. *Trends in Cognitive Sciences*, 24(7), 542–556.
- Blix, I., Kanten, A. B., Birkeland, M. S., & Thoresen, S. (2018). Imagining what could have happened: Types and vividness of counterfactual thoughts and the relationship with post-traumatic stress reactions. *Frontiers in Psychology*, 9, 515.
- Branch, J. G., & Zickar, M. J. (2021). Mental time travel into the episodic future, episodic past, and episodic counterfactual past in everyday life. *Applied Cognitive Psychology*, 35(1), 293–299.
- Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: Mindfulness and its role in psychological well-being. *Journal of Personality and Social Psychology*, 84(4), 822.
- Brunette, A. M., & Schacter, D. L. (2021). Cognitive mechanisms of episodic simulation in psychiatric populations. *Behaviour Research and Therapy*, 136, 103778.
- Byrne, R. M. (2016). Counterfactual thought. *Annual Review of Psychology*, 67(1), 135–157.
- Carciofo, R., & Jiang, P. (2021). Deliberate and spontaneous mind wandering in Chinese students: Associations with mindfulness,

- affect, personality, and life satisfaction. *Personality and Individual Differences*, 180, 110982.
- Carriere, J. S., Seli, P., & Smilek, D. (2013). Wandering in both mind and body: Individual differences in mind wandering and inattention predict fidgeting. *Canadian Journal of Experimental Psychology/revue Canadienne De Psychologie Expérimentale*, 67(1), 19.
- Chaieb, L., Hoppe, C., & Fell, J. (2022). Mind wandering and depression: a status report. *Neuroscience & Biobehavioral Reviews*, 133, 104505.
- Clark, I. A., & Maguire, E. A. (2020). Do questionnaires reflect their purported cognitive functions? *Cognition*, 195, 104114.
- Cole, S., & Kvavilashvili, L. (2021). Spontaneous and deliberate future thinking: A dual process account. *Psychological Research Psychologische Forschung*, 85(2), 464–479.
- Cole, S. N., Staugaard, S. R., & Berntsen, D. (2016). Inducing involuntary and voluntary mental time travel using a laboratory paradigm. *Memory & Cognition*, 44(3), 376–389.
- Cole, S. N., Smith, D. M., Ragan, K., Suurmond, R., & Armitage, C. J. (2021). Synthesizing the effects of mental simulation on behavior change: Systematic review and multilevel meta-analysis. *Psychonomic Bulletin & Review*, 28(5), 1514–1537.
- Danckert, J., Hammerschmidt, T., Marty-Dugas, J., & Smilek, D. (2018). Boredom: Under-aroused and restless. *Consciousness and Cognition*, 61, 24–37.
- D'Argembeau, A., Renaud, O., & Van der Linden, M. (2011). Frequency, characteristics and functions of future-oriented thoughts in daily life. *Applied Cognitive Psychology*, 25(1), 96–103.
- De Brigard, F. (2014). Is memory for remembering? Recollection as a form of episodic hypothetical thinking. *Synthese*, 191(2), 155–185.
- De Brigard, F., & Giovanello, K. S. (2012). Influence of outcome valence in the subjective experience of episodic past, future, and counterfactual thinking. *Consciousness and Cognition*, 21(3), 1085–1096.
- De Brigard, F., & Parikh, N. (2019). Episodic counterfactual thinking. *Current Directions in Psychological Science*, 28(1), 59–66.
- De Brigard, F., Addis, D. R., Ford, J. H., Schacter, D. L., & Giovanello, K. S. (2013a). Remembering what could have happened: Neural correlates of episodic counterfactual thinking. *Neuropsychologia*, 51(12), 2401–2414.
- De Brigard, F., Szpunar, K. K., & Schacter, D. L. (2013b). Coming to grips with the past: Effect of repeated simulation on the perceived plausibility of episodic counterfactual thoughts. *Psychological Science*, 24(7), 1329–1334.
- De Brigard, F., Rodriguez, D. C., & Montañés, P. (2017). Exploring the experience of episodic past, future, and counterfactual thinking in younger and older adults: A study of a Colombian sample. *Consciousness and Cognition*, 51, 258–267.
- del Palacio-Gonzalez, A., & Berntsen, D. (2019). The tendency for experiencing involuntary future and past mental time travel is robustly related to thought suppression: An exploratory study. *Psychological Research Psychologische Forschung*, 83(4), 788–804.
- del Palacio-Gonzalez, A., & Berntsen, D. (2020). Involuntary autobiographical memories and future projections in social anxiety. *Memory*, 28(4), 516–527.
- Deng, Y. Q., Li, S., & Tang, Y. Y. (2014). The relationship between wandering mind, depression and mindfulness. *Mindfulness*, 5(2), 124–128.
- Espino, O., & Byrne, R. M. (2021). How people keep track of what is real and what is imagined: The epistemic status of counterfactual alternatives to reality. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 47(4), 547.
- Faul, F., Erdfelder, E., Buchner, A., & Lang, A. G. (2009). Statistical power analyses using G\* Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, 41(4), 1149–1160.
- Feng, X., Gu, R., Liang, F., Broster, L. S., Liu, Y., Zhang, D., & Luo, Y. J. (2015). Depressive states amplify both upward and downward counterfactual thinking. *International Journal of Psychophysiology*, 97(2), 93–98.
- Gosling, S. D., Rentfrow, P. J., & Swann, W. B., Jr. (2003). A very brief measure of the big-five personality domains. *Journal of Research in Personality*, 37(6), 504–528.
- Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology*, 85(2), 348.
- Hallford, D. J., & D'Argembeau, A. (2022). Why we imagine our future: Introducing the Functions of Future Thinking Scale (FoFTS). *Journal of Psychopathology and Behavioral Assessment*, 44(2), 376–395.
- Hallford, D. J., Barry, T. J., Austin, D. W., Raes, F., Takano, K., & Klein, B. (2020). Impairments in episodic future thinking for positive events and anticipatory pleasure in major depression. *Journal of Affective Disorders*, 260, 536–543.
- Hoppen, T. H., Heinz-Fischer, I., & Morina, N. (2020). If only... a systematic review and meta-analysis of social, temporal and counterfactual comparative thinking in PTSD. *European Journal of Psychotraumatology*, 11(1), 1737453.
- Isacescu, J., Struk, A. A., & Danckert, J. (2017). Cognitive and affective predictors of boredom proneness. *Cognition and Emotion*, 31(8), 1741–1748.
- Kane, M. J., Gross, G. M., Chun, C. A., Smeekens, B. A., Meier, M. E., Silvia, P. J., & Kwapil, T. R. (2017). For whom the mind wanders, and when, varies across laboratory and daily-life settings. *Psychological Science*, 28(9), 1271–1289.
- Kvavilashvili, L., & Rummel, J. (2020). On the nature of everyday prospection: A review and theoretical integration of research on mind-wandering, future thinking, and prospective memory. *Review of General Psychology*, 24(3), 210–237.
- Lovibond, P. F., & Lovibond, S. H. (1995). The structure of negative emotional states: Comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories. *Behaviour Research and Therapy*, 33(3), 335–343.
- MacLeod, A. K. (2016). Prospection, well-being and memory. *Memory Studies*, 9(3), 266–274.
- Maillet, D., Beaty, R. E., Jordano, M. L., Touron, D. R., Adnan, A., Silvia, P. J., Kwapil, T. R., Turner, G. R., Spreng, R. N., & Kane, M. J. (2018). Age-related differences in mind-wandering in daily life. *Psychology and Aging*, 33(4), 643.
- Markman, K. D., & McMullen, M. N. (2003). A reflection and evaluation model of comparative thinking. *Personality and Social Psychology Review*, 7(3), 244–267.
- Martarelli, C. S., Bertrams, A., & Wolff, W. (2021). A personality trait-based network of boredom, spontaneous and deliberate mind-wandering. *Assessment*, 28(8), 1915–1931.
- Mazzoni, G. (2019). Involuntary memories and involuntary future thinking differently tax cognitive resources. *Psychological Research Psychologische Forschung*, 83(4), 684–697.
- Michaelian, K., Perrin, D., & Sant'Anna, A. (2020). Continuities and discontinuities between imagination and memory: The view from philosophy. *The Cambridge Handbook of the Imagination*, 293, 293–310.
- Mitchell, M. A., Contractor, A. A., Dranger, P., & Shea, M. T. (2016). Unique relations between counterfactual thinking and DSM-5 PTSD symptom clusters. *Psychological Trauma: Theory, Research, Practice, and Policy*, 8(3), 293.
- Mrazek, M. D., Phillips, D. T., Franklin, M. S., Broadway, J. M., & Schooler, J. W. (2013). Young and restless: Validation of the

- Mind-Wandering Questionnaire (MWQ) reveals disruptive impact of mind-wandering for youth. *Frontiers in Psychology*, 4, 560.
- Nicosia, J., & Balota, D. (2021). Dispositional factors account for age differences in self-reported mind-wandering. *Psychology and Aging*, 4, 421.
- Norris, P., & Epstein, S. (2011). An experiential thinking style: Its facets and relations with objective and subjective criterion measures. *Journal of Personality*, 79(5), 1043–1080.
- Özbek, M., Bohn, A., & Berntsen, D. (2017). Imagining the personal past: Episodic counterfactuals compared to episodic memories and episodic future projections. *Memory & Cognition*, 45(3), 375–389.
- Özbek, M., Bohn, A., & Berntsen, D. (2020). Characteristics of personally important episodic memories, counterfactual thoughts, and future projections across age and culture. *Applied Cognitive Psychology*, 34(5), 1020–1033.
- Ozdes, A. (2021). How did I do it then? How will I do it later? A theoretical review of the impact of mental time travel on decision-making processes. *New Ideas in Psychology*, 62, 100869.
- Rasmussen, A. S., & Berntsen, D. (2011). The unpredictable past: Spontaneous autobiographical memories outnumber autobiographical memories retrieved strategically. *Consciousness and Cognition*, 20(4), 1842–1846.
- Robison, M. K., Gath, K. I., & Unsworth, N. (2017). The neurotic wandering mind: An individual differences investigation of neuroticism, mind-wandering, and executive control. *The Quarterly Journal of Experimental Psychology*, 70(4), 649–663.
- Robison, M. K., Miller, A. L., & Unsworth, N. (2020). A multi-faceted approach to understanding individual differences in mind-wandering. *Cognition*, 198, 104078.
- Roese, N. J., & Epstude, K. (2017). *The functional theory of counterfactual thinking: New evidence, new challenges, new insights*. Academic Press.
- Schacter, D. L., & Addis, D. R. (2007). The cognitive neuroscience of constructive memory: Remembering the past and imagining the future. *Philosophical Transactions of the Royal Society b: Biological Sciences*, 362(1481), 773–786.
- Scheier, M. F., Carver, C. S., & Bridges, M. W. (1994). Distinguishing optimism from neuroticism (and trait anxiety, self-mastery, and self-esteem): A reevaluation of the Life Orientation Test. *Journal of Personality and Social Psychology*, 67(6), 1063.
- Schulz, A. W., & Robins, S. (2022). Episodic memory, simulated future planning, and their evolution. *Review of Philosophy and Psychology*. <https://doi.org/10.1007/s13164-021-00601-1>
- Seli, P., Beaty, R. E., Marty-Dugas, J., & Smilek, D. (2019). Depression, anxiety, and stress and the distinction between intentional and unintentional mind wandering. *Psychology of Consciousness: Theory, Research, and Practice*, 6(2), 163.
- Soto, C. J., & John, O. P. (2017). The next Big Five Inventory (BFI-2): Developing and assessing a hierarchical model with 15 facets to enhance bandwidth, fidelity, and predictive power. *Journal of Personality and Social Psychology*, 113(1), 117.
- Spreng, R. N., & Levine, B. (2006). The temporal distribution of past and future autobiographical events across the lifespan. *Memory & Cognition*, 34(8), 1644–1651.
- Struk, A. A., Carriere, J. S., Cheyne, J. A., & Danckert, J. (2017). A short boredom proneness scale: Development and psychometric properties. *Assessment*, 24(3), 346–359.
- Suddendorf, T., & Corballis, M. C. (2007). The evolution of foresight: What is mental time travel, and is it unique to humans? *Behavioral and Brain Sciences*, 30(3), 299–313.
- Szpunar, K. K., & Schacter, D. L. (2013). Get real: Effects of repeated simulation and emotion on the perceived plausibility of future experiences. *Journal of Experimental Psychology: General*, 142(2), 323.
- Thompson, E. R. (2007). Development and validation of an internationally reliable short-form of the positive and negative affect schedule (PANAS). *Journal of Cross-Cultural Psychology*, 38(2), 227–242.
- Treynor, W., Gonzalez, R., & Nolen-Hoeksema, S. (2003). Rumination reconsidered: A psychometric analysis. *Cognitive Therapy and Research*, 27(3), 247–259.
- Tulving, E. (2002). Episodic memory: From mind to brain. *Annual Review of Psychology*, 53(1), 1–25.
- Van Hoeck, N., Ma, N., Ampe, L., Baetens, K., Vandekerckhove, M., & Van Overwalle, F. (2013). Counterfactual thinking: An fMRI study on changing the past for a better future. *Social Cognitive and Affective Neuroscience*, 8(5), 556–564.
- Vodanovich, S. J., & Kass, S. J. (1990). A factor analytic study of the boredom proneness scale. *Journal of Personality Assessment*, 55(1–2), 115–123.
- Vowinckel, J. C., Westerhof, G. J., Bohlmeijer, E. T., & Webster, J. D. (2017). Flourishing in the now: Initial validation of a present-eudaimonic time perspective scale. *Time & Society*, 26(2), 203–226.
- Webb, C. A., Israel, E. S., Belleau, E., Appleman, L., Forbes, E. E., & Pizzagalli, D. A. (2021). Mind-wandering in adolescents predicts worse affect and is linked to aberrant default mode network–salience network connectivity. *Journal of the American Academy of Child & Adolescent Psychiatry*, 60(3), 377–387.
- Wu, J. Q., Szpunar, K. K., Godovich, S. A., Schacter, D. L., & Hofmann, S. G. (2015). Episodic future thinking in generalized anxiety disorder. *Journal of Anxiety Disorders*, 36, 1–8.

**Publisher's Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Springer Nature or its licensor (e.g. a society or other partner) holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.