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ORIGINAL ARTICLE

The tendency for experiencing involuntary future and past mental time travel is robustly related to thought suppression: an exploratory study

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Abstract
Involuntary mental time travel (MTT) refers to projecting oneself into the past or into the future without prior conscious effort. The previous studies have shown high inter-individual variability in the frequency of involuntary MTT, but a few systematic studies exist. In three exploratory studies, we investigated the relation between individual differences in experiencing involuntary past and future MTT, and selected emotional and cognitive processes, with a special focus on thought suppression. Across all three studies, thought suppression emerged as a robust predictor of involuntary MTT above and beyond emotion-related variables, mind-wandering, daydreaming styles, and demographic variables. Findings from Studies 1 and 2 showed that higher thought suppression consistently predicted both more frequent involuntary past and future MTT across an American and a Danish sample, whereas rumination and emotion regulation were less consistently related to involuntary MTT. In Study 3, thought suppression reliably predicted more frequent involuntary MTT, even when controlling for mind-wandering, as well as for positive and negative daydreaming styles, which were all related to greater involuntary MTT. Overall, the individual differences assessed showed similar relationships to the tendency for having past and future involuntary MTT, with the possible exception of daydreaming styles, which appeared more strongly related to future-directed involuntary MTT.

> "I imagine leaving the classroom after having Biology exam. After a few minutes, my friend will come out too, holding a cup of tea. I will ask her how it went, and after taking a sip, she will say that the exam went well."

(Involuntary future projection of a 22 year-old woman; del Palacio-Gonzalez & Berntsen, 2018a).

Introduction

Mentally traveling in time happens many times during everyday life and often in ways that are beyond conscious control. Involuntary memories have been investigated over the past 20 years (Berntsen, 2009; Mace, 2007 for reviews). However, more recently, both experimental and naturalistic studies have shown that involuntary mental time travel (MTT) can also take place towards the future (Berntsen & Jacobsen, 2008; Cole, Staugaard, & Berntsen, 2016; Finnbogadoottir & Berntsen, 2011, 2013). Involuntary future MTT refers to imagining possible future events with no preceding conscious attempt (Berntsen, 2018), as the example presented above. Similar to involuntary memories of past events (Berntsen, 1996), involuntary future MTT is characterized by a sense of "living" (or "pre-experiencing"), such that the person has a feeling of being mentally transported into his or her personal future to the imagined event. As is the case with involuntary memories, involuntary future MTT often comes to mind in response to features of the ongoing situation (Berntsen & Jacobsen, 2008; Cole et al., 2016; Finnbogadoottir & Berntsen, 2011).

Thus far, the frequency of non-intrusive involuntary MTT has been examined primarily in experimental (e.g., Cole et al., 2016; Kamiya, 2014; Plimpton, Patel, & Kvavilashvilli, 2015) and naturalistic studies (e.g., Berntsen & Jacobsen, 2008; Finnbogadottir & Berntsen, 2013). Such studies show that, on average, people experience about 20

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involuntary future projections on a daily basis (e.g., Finnbogadoottir & Berntsen, 2013), which is roughly the same as the average number of involuntary memories recorded on a daily basis, when recording demands are kept as simple as possible (Rasmussen & Berntsen, 2011; Rasmussen et al., 2015). However, these means are associated with substantial inter-individual variance, suggesting that the frequency of involuntary MTT should not only be analyzed as a function of conditions and situational factors—abstracting from individual variability—but also as a dispositional factor that varies between individuals.

In line with this notion, Berntsen et al. (2015) introduced the Involuntary Autobiographical Memory Inventory (IAMI) to assess the self-reported tendency for experiencing involuntary past and future MTT. To the best of our knowledge, Berntsen et al.'s (2015) study was the first systematic empirical approach to understanding dispositional involuntary MTT. In relation to the present study, the following findings are of particular relevance. First, Berntsen et al. (2015) found that the frequency of involuntary memories and future MTT were highly correlated with each other. Confirmatory factor analyses, nonetheless, supported a two-factor solution—corresponding to a past and future subscale—better than a one-factor solution. A high correlation in the frequency of past and future MTT was also found in a naturalistic study assessing the frequency of MTT (Finnbogadoottir & Berntsen, 2013). The converging findings obtained through these two methodologies are consistent with the previous work, showing that several measures of individual dispositions, such as visual imagery, correlate similarly with phenomenological characteristics for both voluntary past and future MTT, suggesting shared underlying processes (D'Argembeau & van der Linden, 2006).

Second, Berntsen et al. (2015) found that involuntary future MTT was less frequent among older compared with younger adults, but no age-related variations were found for involuntary memories. Third, future involuntary MTT was consistently rated as less frequent than past involuntary MTT. Fourth, both the tendency for experiencing future and past involuntary MTT correlated positively with the measures of negative thinking style, such as rumination and worry, as well as with measures of emotional distress, such as depression and anxiety symptoms. Fifth, both the tendency for experiencing future and past involuntary MTT were related to cognitive processes indicative of poor attentional and mental control, such as daydreaming and chronic thought suppression. In sum, the tendency for experiencing past and future involuntary MTT related very similarly to other emotional and cognitive processes, although they showed different effects of aging, and involuntary memories were reported to be more frequent. It should be noted that most of these correlations were paralleled by similar correlations with voluntary MTT.

Here, we aim to replicate and extend the findings reported by Berntsen et al. (2015). First, we investigate the relation between various individual differences in cognitive and affective processing and involuntary MTT across different studies, involving different populations. Second, many of the variables originally assessed by Berntsen et al. (2015) were correlated to each other (e.g., rumination with thought suppression; emotional distress with negative daydreaming). The study did not resolve whether any of the significant correlates were particularly robust predictors of involuntary MTT, when controlling for other variables, and whether this differed for past versus future MTT. Therefore, in the present study, we undertook the examination with a different analytical strategy that allowed us to examine the uniqueness of selected emotional and cognitive processes in relation to involuntary MTT (past, future, and together). In the following, we motivate our selection of key variables.

Involuntary mental time travel and mental control

Involuntary MTT may be viewed as a subcategory of a broader category of spontaneous cognition (Berntsen et al., 2015; Krans, de Bree, & Moulds, 2015; Marchetti, Loster, Klinger, & Alloy, 2016). Spontaneous cognition is an umbrella term employed for various thought processes, which share at least one key feature: lack of deliberate intention for bringing the cognition to mind (Berntsen, 2018; Marchetti et al., 2016). Since involuntary MTT is not purposefully initiated, it follows that it is uncontrollable at least at the moment of retrieval. Because involuntary MTT may occur in any situation of our daily lives, individuals who experience more frequent involuntary MTT would likely be more inclined to respond with a strategy to mentally control such involuntary cognitions, consistent with previous findings (Berntsen et al., 2015).

Thought suppression is a strategy for mental control. Thought suppression was initially examined in a series of experimental studies in which both non-distressing and unwanted (i.e., distressing) thoughts were target of suppression (Lavy & van den Hout, 1990; Salkovskis & Campbell, 1994; Salkovskis & Reynolds, 1994; Wegner, Schneider, Carter, & White, 1987). These studies showed that conscious efforts to suppress spontaneous thoughts led to more intrusions of the targeted thought (Wegner & Zanakos, 1994 for a review). Therefore, although thought suppression is a way to control one's mind, it may also lead to more intrusions of the kind of thoughts that one wishes to suppress (i.e., a bidirectional relationship).

Thought suppression has also been established as a dispositional, trait-like construct in relation to various forms of spontaneous cognition implicated in emotional disorders,

such as obsessions, intrusive memories, and worries (Aldao & Nolen-Hoeksema, 2010; Clark & Beck, 2010; Muris, Merckelbach, & Horselenberg, 1996). This is not surprising as, in their initial model, Wegner and Zanakos (1994) had proposed that thought suppression may be targeting distressing thoughts. Therefore, the links between dispositional thought suppression and non-pathological spontaneous cognition, in general, and involuntary MTT in particular, have received little attention.

However, emerging findings suggest that thought suppression is a strategy employed for a wider spectrum of spontaneous cognition, including innocuous involuntary MTT (Alle, Berna, & Berntsen, 2018; Berntsen et al., 2015; Hyman et al., 2015). In one study, Hyman et al. (2015) found that individuals with a higher tendency for suppressing thoughts reported experiencing more involuntary thought contents overall, including involuntary memories and involuntary future thoughts. Two other recent studies found a moderate correlation between dispositional thought suppression and a tendency for experiencing both past and future involuntary MTT (Alle et al., 2018; Berntsen et al., 2015). These relationships may be partly due to the fact that a chronic tendency to actively suppress thoughts by necessity requires monitoring one's own thoughts more frequently (Wegner & Zankos, 1994). In addition, it could also point to a greater meta-awareness of one's mental activity (Meyer, Otgaar, & Smeets, 2015).

Other dispositional factors: mind-wandering, rumination, and emotion

We consider other potential correlates of both involuntary MTT and thought suppression relevant for examining the extent to which thought suppression and involuntary MTT are related. Specifically, we consider mind-wandering and daydreaming, rumination, and emotion-related measures.

Mind-wandering and daydreaming

Involuntary MTT differs from a current conceptualization of mind-wandering and daydreaming, in which these phenomena are defined as the mental contents that occur when attention shifts away from a primary task and turns inwards into private and internal thought processes (e.g., Antrobus, Singer, Goldstein, & Fortgang, 1970; Giambra, 1993; Singer, 1974; Smallwood & Schooler, 2006; see McMillan, Kaufmann, & Singer, 2013, for a review). Mind-wandering and daydreaming can be deliberate (Seli, Risko, Smilek, & Schacter, 2016; McMillan et al., 2013), whereas involuntary MTT by definition is unintentional. Furthermore, according to the above definition, daydreaming and mind-wandering are unrelated to the ongoing task (for a different view on how mind-wandering mental contents are connected to an ongoing task, see Miles, Karpinska, Lumsden, & Macrae, 2010), whereas involuntary autobiographical memories can be triggered by, and serve important functions for, an ongoing task (Hintzman, 2011; Rasmussen & Berntsen, 2009; Schank, 1982). Berntsen et al. (2015) discussed a number of other important empirical and conceptual differences between involuntary MTT and mind-wandering (see also Berntsen, 2018).

Similarly, thought suppression is a mental control strategy that goes beyond the poor attentional control associated with mind-wandering (Singer, 1974; Smallwood & Schooler, 2006). Because thought suppression is a more general strategy of mental control, it may not necessarily be employed to re-gain attentional control during a task when the mind wanders. At least it is unlikely to be its only, or even primary, function. Instead, it may be employed simply as a means to push away involuntary thoughts in various contexts, including during the absence of competing tasks.

In other words, thought suppression may index a greater tendency to experiencing involuntary MTT than mind-wandering tendencies. If this idea is correct, then thought suppression would be related to the tendency for experiencing involuntary MTT beyond mind-wandering tendencies. Here, we explore this question by examining the role of thought suppression, when accounting for mind-wandering and other competing processes.

Rumination

Rumination is conceived as a negative repetitive thinking style (Watkins, 2008) and is linked to both involuntary MTT (Berntsen et al., 2015; Smets, Wessel, Schreurs, & Raes, 2012) and thought suppression (Aldao & Nolen-Hoeksema, 2010; Erskine, Kvavilashvili, & Kornbrot, 2007) in various ways. First, all these cognitive processes reflect to some extent problems with thought control (Berntsen, 2018; Watkins, 2008). In addition, involuntary MTT (or at least memories) may lead to rumination and vice versa (Smets et al., 2012), in the same way that thought suppression and rumination may reinforce each other (Erskine et al., 2007). Finally, both involuntary MTT and rumination are by definition self-focused (Berntsen & Jacobsen, 2008; Plimpton et al., 2015; Watkins, 2008). Therefore, we here examined whether thought suppression was related to the tendency for involuntary MTT beyond rumination. In doing so, we distinguished between the two facets of rumination, brooding and reflection (Treynor, Gonzalez, & Nolen-Hoeksema, 2003), which, under certain circumstances, hold different relationships to both intrusive cognitions (Jones & Fernyhough, 2009), and non-intrusive MTT (Beaty, Seli, & Schacter, 2018).

Emotion-related variables

Emotion regulation refers to the process by which certain strategies are employed to prevent, launch, increase, and decrease both positive and negative emotions (Gross & John, 2003). D'Argembeau and van der Linden (2006) found significant negative correlations between emotion suppression and a number of phenomenological characteristics of mental representations of both past and future events, when generated voluntarily. When studied in diary and experimental studies, involuntary MTT is related to greater mood and emotional impact at the time of retrieval (Berntsen & Jacobsen, 2008; Cole et al., 2016; Finnbogadottir & Berntsen, 2011; Rubin, Dennis, & Beckham, 2011), as well as greater emotion regulation efforts (del Palacio-Gonzalez, Berntsen, & Watson, 2017) than voluntary retrieval. However, because these findings derive from naturalistic and experimental studies using factorial designs abstracting from individual differences, it is unknown to what extent emotional intensity and regulation are relevant for dispositional involuntary MTT.

The findings for dispositional involuntary MTT, although scarce, show a related pattern with regard to emotional intensity. Berntsen et al. (2015) and Allé et al. (2018) found that a tendency for experiencing involuntary MTT was associated with a higher emotional intensity of the MTT. However, neither study showed significant correlations between the propensity for experiencing involuntary MTT and the overall emotional valence of the events retrieved. The relationship between the frequency and intensity of involuntary MTT could suggest that a higher tendency for experiencing involuntary MTT is related to greater efforts for emotion regulation, a question we examine in the present study. We also examine if thought suppression shows a unique relationship with involuntary MTT, beyond such processes.

Present studies

We conducted three studies exploring how a theoretically motivated selection of psychological processes, namely thought suppression, rumination, mind-wandering, and daydreaming, were related to the dispositional tendency for experiencing involuntary MTT, as assessed by the IAMI (Berntsen et al., 2015). In addition, across the three studies, we sought to replicate two key findings from Berntsen et al.'s (2015) study. The first concerned the high correlation between the past and future dimensions of the IAMI. The second concerned the higher frequency of past MTT relative to involuntary future MTT. We extended Berntsen et al.'s (2015) study by conducting exploratory analyses examining the relationship between the IAMI and a range of other individual differences measures. Briefly, in Studies 1 and 2, we examined whether thought suppression was a unique predictor of both past and future involuntary MTT, when controlling for a selection of cognitive and emotion-related variables. In Study 3, we expanded the range of cognitive processes by including mind-wandering and daydreaming. Throughout the three studies, we systematically compared the relationships of these cognitive and emotional processes with future versus past involuntary MTT.

Furthermore, to our knowledge, this is the first examination of the relationship between dispositional involuntary MTT and emotion regulation, for which we included the measures of emotional suppression and reappraisal, two important emotion-regulation strategies (Aldao & Nolen-Hoeksema, 2010; Gross & John, 2003). Note that while thought suppression refers to a tendency for pushing away thoughts from consciousness, emotional suppression targets the behavioral expression of the emotions, whether positive (e.g., smiling) or negative (e.g., crying and yelling).

Study 1

We had two primary aims in Study 1. First, we wanted to replicate two key findings from Berntsen et al. (2015) as outlined above. Second, we sought to examine the role of thought suppression relative to emotion regulation and rumination in relation to the self-reported frequencies of involuntary MTT.

Method

Participants Participants were 428 Amazon MTurk workers residing in the United States of America. Fifty-seven percent ($n = 244$) were men, and forty-three percent ($n = 184$) were women. Their mean age was 27.5 years ($SD = 3.5$, range 19–35 years). Seventy-five percent ($n = 320$) described themselves as white, 11% ($n = 46$) of Asian ethnicity, 6.5% ($n = 28$) as Latin, 5.4% ($n = 23$) African–American, and 2.3% ($n = 10$) of mixed-race origin. Their mean number years of education were 15.0 ($SD = 2.3$, range 4–25 years)[1].

[1] The following steps were taken to increase the reliability of the data collection process. First, the entire survey consisted of 275 single items, and thus, it was determined that spending a minimum of 8 min answering the survey was a mandatory inclusion criterion (1.5 s per item plus instructions). Note that some of the questionnaires in the survey were not analyzed for the present study; however, the 8-min rule was based on the entire set of questionnaires completed by participants. Second, an attention check was inserted in the IAMI collected via Amazon MTurk ("If you are reading this item attentively, select the last option 'Once an hour or more'"). Of the original 510 participants, 42 (8.2%) completed the survey in less than 8 min. Forty additional participants (7.8% of the 510) did not pass the attention check, thus resulting in $N = 428$.

Table 1 Means (*M*s), standard deviations (*SD*s), and bivariate correlations between the IAMI and other cognitive and emotion variables in Study 1 and Study 2

		2	3	4	5	6	7	8	*M*	*SD*	*α*
Study 1: American sample ($n = 428$)											
1	IAMI future	0.84**	0.96**	0.09	0.03	0.38**	0.46**	0.51**	1.75	0.85	0.93
2	IAMI past		0.96**	0.09*	0.05	0.42**	0.48**	0.45**	1.93	0.78	0.92
3	IAMI total			0.10*	0.04	0.41**	0.49**	0.50**	1.84	0.78	0.96
4	ERQ-ES				−0.06	0.11*	0.18**	0.18**	15.70	5.75	0.90
5	ERQ-Rea					−0.05	−0.22**	−0.11*	30.01	7.48	0.80
6	RRS-Ref						0.65**	0.39**	10.14	3.68	0.84
7	RRS-Bro							0.61**	10.24	3.78	0.84
8	WBSI							–	46.26	14.57	0.95
Study 2: Danish sample ($n = 481$)											
1	IAMI future	0.69**	0.92**	−0.05	0.13**	0.14**	0.13**	0.25**	1.90	0.67	0.88
2	IAMI past		0.92**	0.01	0.04	0.22**	0.17**	0.28**	2.18	0.64	0.88
3	IAMI total			−0.02	0.09*	0.20**	0.16**	0.29**	2.04	0.61	0.92
4	ERQ-ES				−0.09*	0.13**	0.22**	0.24**	12.53	5.08	0.74
5	ERQ-Rea					0.03	−0.15**	−0.05	29.51	6.08	0.81
6	RRS-Ref						0.49**	0.30**	10.02	3.36	0.74
7	RRS-Bro							0.47**	9.95	3.27	0.74
8	WBSI							–	49.60	11.62	0.89

IAMI Involuntary Autobiographical Memory Inventory, *ERQ-ES* Emotion Regulation Questionnaire-Emotional suppression, *ERQ-Rea* Emotion Regulation Questionnaire-Reappraisal, *RRS-Ref* Ruminative Responses Styles-Reflection, *RRS-Bro* Ruminative Responses Styles-Brooding, *WBSI* White Bear Suppression Inventory

*$p \leq .05$

**$p \leq .01$

Materials The internal consistencies of the included psychometric measures listed are presented in Table 1.

Emotion Regulation Questionnaire (ERQ; Gross & John, 2003). The ERQ is a widely employed ten-item self-report questionnaire assessing a general tendency to engage in two emotion-regulation strategies, cognitive reappraisal (e.g., "When I'm faced with a stressful situation, I make myself think about it in a way that helps me stay calm") and emotional suppression (e.g., "I control my emotions by not expressing them") when experiencing both positive and negative emotions. Each item is rated on a seven-point Likert scale going from 1 = Strongly Disagree to 7 = Strongly Agree.

The White Bear Suppression Inventory (WBSI; Wegner & Zanakos, 1994). The WBSI consists of 15 items assessing individual differences in the tendency to suppress thoughts (e.g., "There are things that I try not to think about"). Item responses are on a five-point Likert scale ranging from 1 = Strongly Disagree to 5 = Strongly Agree.

Involuntary Autobiographical Memory Inventory (IAMI; Berntsen, et al., 2015). The IAMI consists of 20 items assessing the frequency of neutral tendencies for involuntary mental time travel. Specifically, ten items assess the frequency of involuntary autobiographical memories (e.g., "Some locations or places bring memories of past events to mind—without me consciously trying to remember them"), and ten items assess the frequency of involuntary future MTT (e.g., "Imaginary future events pop into my mind by themselves—without me consciously trying to evoke them"). The items are rated on a scale ranging from 0 (Never) to 4 (Once an hour or more). The frequencies of involuntary memories (IAMI past) and involuntary future MTT (IAMI future) were scored separately, in addition to the scale's total score (IAMI total).

The Ruminative Response Scale (RRS; Nolen-Hoeksema, Larson, Grayson, 1999). The RRS assesses dispositional tendencies to engage in rumination when experiencing low mood. The 22-item version of this questionnaire was employed; however, only the 10 items assessing reflection and brooding subscales were employed for the analyses (five items for each subscale). The reflection subscale focuses on analyzing situations and feelings, the same as problem-solving, (e.g., "Go away by yourself and think about why you feel this way"), whereas brooding refers to a tendency for self-blame and dwelling on negative situations (e.g., "Think 'Why can't I get going?'") (Treynor et al., 2003). Response options are given in a four-point Likert scale ranging from 1 = Almost Never to 4 = Almost Always.

Procedure Participants were recruited between August 2015 and September 2016 via Amazon MTurk. Previous studies support the reliability of employing Amazon

Table 2 Study 1: prediction of the tendency for future and past involuntary MTT in an American sample ($N = 428$)

	IAMI future				IAMI past				IAMI total			
	ΔR^2	β	t	sr^2	ΔR^2	β	t	sr^2	ΔR^2	β	t	sr^2
Step 1	< 0.01				< 0.01				< 0.01			
Sex[a]		0.01	0.31	< 0.01		0.08	1.59	< 0.01		0.05	0.96	< 0.01
Step 2	0.01				0.02*				0.01*			
ERQ-ES		0.10	2.08	0.01		0.12	2.47*	0.01		0.12	2.36*	0.01
ERQ-Reap		0.04	0.74	< 0.01		0.06	1.26	< 0.01		0.05	1.03	< 0.01
Step 3	0.22***				0.25***				0.26***			
RRS-Ref		0.12	2.11*	< 0.01		0.16	2.84**	0.01		0.14	2.59**	0.01
RRS-Bro		0.41	6.93***	0.09		0.40	7.06****	0.08		0.42	7.39***	0.09
Step 4	0.08***				0.04***				0.06***			
WBSI		0.36	7.09***	0.08		0.25	4.87****	0.04		0.32	6.39***	0.06

ERQ-ES Emotion Regulation Questionnaire-Emotional suppression, *ERQ-Rea* Emotion Regulation Questionnaire-Reappraisal, *RRS-Ref* Ruminative Responses Styles-Reflection, *RRS-Bro* Ruminative Responses Styles-Brooding, *WBSI* White Bear Suppression Inventory

*$p < .05$; **$p < .01$; ***$p < .001$

[a]Men = 1, Women = 2

MTurk workers for research on autobiographical memory (e.g., Buhrmester, Talaifar, & Gosling, 2018; Grysman, 2015). The project was described as an online study about how adults think about and react to their life experiences and their overall psychological well-being. Participants accessed a secure link with the questionnaires, which were completed in the order listed above. Informed consent was obtained electronically. The average completion time was 16.1 min (SD = 20.1). All participants were compensated with USD 1.4.

Results

Frequency of involuntary past and future MTT Consistent with previous findings (Berntsen et al., 2015), involuntary future MTT was less frequent than involuntary memories, $t(427) = 8.00$, $p < .001$. Table 1 shows the means and SDs.

Bivariate correlations Consistent with the previous findings (Berntsen et al., 2015), the frequency of involuntary future MTT correlated strongly with the frequency of involuntary memories (see Table 1). Both involuntary future and past MTT were correlated to higher thought suppression, brooding, and reflection. Involuntary future MTT did not correlate with either reappraisal or emotional suppression (emotion regulation). However, involuntary past MTT correlated with higher emotional suppression, but not reappraisal.

Hierarchical multiple regression models To determine whether any of the correlates had a unique relationship with either the tendency for experiencing involuntary past MTT, future MTT, or both, we conducted three primary multiple hierarchical regression analyses with different dependent variables: IAMI future, IAMI past, and IAMI total. For the three models, sex was controlled in Step 1. Step 2 consisted of the emotion regulation strategies. Step 3 consisted of the two facets of rumination. Our primary interest was to explore the robustness of the relationships between thought suppression and involuntary MTT, and thus, thought suppression was entered last in Step 3. However, given the exploratory nature of our analyses, we considered alternative models entering rumination in the last step. Such models are described only briefly for sake of simplicity (see Table 2 for the full primary models).

Involuntary future MTT The final model was significant and explained 32% of the variance in the tendency for experiencing involuntary future MTT, $F(421, 6) = 32.41$, $p < .001$. Step 1 (sex) and Step 2 (emotion regulation) were not significant. Step 3 (rumination) significantly added variance to the model, and both higher reflection and brooding were related to more involuntary future MTT. Step 4 was significant and showed that higher thought suppression predicted more involuntary future MTT.

Involuntary past MTT The final model was significant and explained 31% of the variance of the tendency for experiencing involuntary past MTT, $F(421, 6) = 31.67$, $p < .001$. Step 1 (sex) was not significant. Step 2 (emotion regulation) explained additional variance, and indicated that higher emotional suppression was related to higher involuntary past MTT. Step 3 (rumination) was significant, and both brooding and reflection predicted higher involuntary past MTT. Finally, in Step 4, higher thought suppression also predicted higher involuntary past MTT, over and beyond the other variables included (See Table 2 for the full model).

Total involuntary MTT The final model for the total score of involuntary MTT was a combination of the results for past

and future involuntary MTT, $F(421, 6) = 35.67$, $R^2 = 0.34$, $p < .001$. Briefly, higher emotional suppression, brooding, reflection, and thought suppression were unique predictors of a greater tendency for involuntary MTT.

Alternative models To examine if rumination would explain variance beyond the variance explained by thought suppression, we conducted regression analyses entering rumination in the last step (Step 4), after thought suppression (Step 3). Thought suppression added to the amount of variance explained for the IAMI past, future, and total, ΔR^2s = 0.19–25, βs = 0.48–0.52, $p < .001$. In Step 4, reflection and brooding together added to the amount of explained variance, ΔR^2s = 0.05–0.09, βs = 0.13–0.25, $p < .05$. In general, both rumination and thought suppression consistently predicted IAMI scores; however, the effect sizes were larger for thought suppression and brooding compared to reflection.

Summary and discussion

Study 1 findings replicated those of Berntsen et al.'s study (2015) concerning the high correlation between past and future involuntary MTT, as well as involuntary future MTT being rated as less frequent than involuntary past MTT. In simple correlations, we also replicated the relationship between involuntary MTT and rumination (both brooding and reflection), as well as thought suppression. In the primary regression analyses, we found that there was a unique, but small relationship between higher emotional suppression and greater involuntary past MTT, but not with future MTT. Regarding rumination, both greater brooding and reflection were uniquely related to both involuntary past and future MTT, thus suggesting that higher rumination is related to a greater tendency for involuntary MTT, in general. Importantly, we found that thought suppression was related to more frequent involuntary past and future involuntary MTT, above and beyond rumination and emotion regulation, thus suggesting that a tendency for mental control of unwanted thoughts goes hand in hand with frequent involuntary MTT.

Study 2

The objective of Study 2 was to conduct a conceptual replication of Study 1 with a different population consisting of Danish bachelor and master students. We employed the same self-report inventories as those of Study 1. We were particularly interested in replicating the findings regarding thought suppression as a robust unique predictor of involuntary MTT with a different population.

Method

Participants

Participants were 481 Danish undergraduate and master-level students. Seventy-seven percent ($n = 371$) were women, 22.5% ($n = 108$) men, and 0.2% ($n = 1$) of other gender. Their mean age was 22.8 years of age ($SD = 2.1$; range 18–30). Eighty-seven percent ($n = 419$) described themselves as Caucasian, 9% ($n = 43$) as of "other" ethnic origin, 1.2% ($n = 6$) as middle eastern, 1% ($n = 5$) as Asian, and 0.4% ($n = 2$) as of African ethnicity.

Materials We employed the same self-report questionnaires as in Study 1. The internal consistency for each questionnaire in the present sample is reported in the bottom panel of Table 1.

Procedure Participants were recruited from December 2014 to September 2017 through a participant pool, social media, posters, and in-class announcements in the university. Interested participants contacted the researchers via e-mail to obtain a secure link to the online questionnaires. For about half of the participants, the order of the questionnaires was: IAMI, WBSI, ERQ, and RRS, whereas the order for the other half was: IAMI, ERQ, RRS, and WBSI. Informed consent was obtained electronically. The average completion time was 44.4 min ($SD = 28.8$).[2] Participants were compensated with a gift card for 100 DKK (15 USD).

Results

Frequency of involuntary MTT Involuntary future MTT was less frequent than involuntary memories, $t(480) = 11.61$, $p < .001$ (see Table 1 for means and *SD*s).

Bivariate correlations Replicating Study 1, the tendencies for future and past involuntary MTT were highly correlated (see Table 1). In addition, both involuntary future and past MTT were correlated to higher thought suppression, brooding, and reflection in the present sample. Moreover, involuntary future MTT correlated with higher reappraisal, but the relationship with emotional suppression was not significant.

[2] The entire survey consisted of 275 single items. All Danish participants took 8 min or more in the survey ($N = 481$); thus, we did not eliminate anybody because of speed. We did not employ an attention check for the Danish participants; thus, data from all 481 Danish participants were analyzed. The data from this sample derived from two other larger projects and, thus, the questionnaires were given in two different orders. (Analyses not overlapping with the present study are published in del Palacio-Gonzalez & Berntsen, 2018b.)

Table 3 Study 2: prediction of the tendency for experiencing future and past involuntary mental time travel in a Danish sample ($N = 481$)

	IAMI future				IAMI past				IAMI total			
	ΔR^2	β	t	sr^2	ΔR^2	β	t	sr^2	ΔR^2	β	t	sr^2
Step 1	< 0.01				< 0.01				< 0.01			
Order		− 0.03	− 0.70	< 0.01		− 0.02	− 0.47	< 0.01		− 0.03	− 0.64	< 0.01
Step 2	< 0.01				< 0.01				< 0.01			
Sex[a]		0.02	0.38	< 0.01		− 0.02	− 0.52	< 0.01		< 0.01	− 0.07	< 0.01
Step 3	0.02*				< 0.01				< 0.01			
ERQ-ES		− 0.05	− 1.01	< 0.01		< 0.01	0.09	< 0.01		− 0.02	− 0.51	< 0.01
ERQ-Reap		0.12	2.56*	0.01		0.04	0.80	< 0.01		0.08	1.84	< 0.01
Step 4	0.03***				0.06***				0.05***			
RRS-Ref		0.09	1.79	< 0.01		0.19	3.61***	0.03		0.15	2.92**	0.02
RRS-Bro		0.12	2.33**	0.01		0.09	1.77	< 0.01		0.12	2.23**	0.01
Step 5	0.05***				0.05***				0.06***			
WBSI		0.25	4.93***	0.04		0.25	5.00***	0.05		0.27	5.44***	0.05

ERQ-ES Emotion Regulation Questionnaire-Emotional suppression, *ERQ-Rea* Emotion Regulation Questionnaire-Reappraisal, *RRS-Ref* Ruminative Responses Styles-Reflection, *RRS-Bro* Ruminative Responses Styles-Brooding, *WBSI* White Bear Suppression Inventory

*$p < .05$; **$p < .01$; ***$p < .001$

[a]Men = 1, Women = 2

Involuntary past MTT was not significantly correlated with either reappraisal or emotional suppression.

Hierarchical multiple regression models We followed the same analytical strategy as in Study 1, including the alternative analyses. The only variation was controlling for the two different orders for completing the questionnaires in Step 1. The remaining predictor variables were entered in subsequent steps in the same order as in Study 1 (see Table 3 for primary analyses).

Involuntary future MTT The final model was significant and explained 10% of the variance for the tendency for experiencing involuntary future MTT, $F(468, 7) = 3.04$, $p < .001$. The first two steps, order of questionnaires and sex, were not significant. Step 3 (emotion regulation) significantly added variance to the model, in which higher reappraisal was related to more involuntary future MTT. Step 4 (rumination) was significant and showed that higher brooding uniquely predicted more involuntary future MTT. Finally, thought suppression predicted variance over and beyond these variables in Step 5 (Table 3).

Involuntary past MTT The final model was significant and explained 11% of the variance in the tendency for experiencing involuntary past MTT, $F(468, 7) = 3.11$, $p < .001$. Steps 1–3 were not significant, meaning that the order of questionnaires, sex, and emotion-regulation strategies were not significantly related to the IAMI past. Step 4 (rumination) was significant, but only higher reflection predicted higher involuntary past MTT. Finally, in Step 5, higher thought suppression predicted higher involuntary past MTT (see Table 3 for the full model).

Total involuntary MTT The final model for the IAMI total score was a combination of the results for past and future involuntary MTT, $F(468,7) = 8.85$, $R^2 = 0.12$, $p < .001$. Briefly, higher brooding, reflection, and thought suppression were unique predictors of a greater tendency for involuntary MTT.

Alternative models To examine if rumination would explain variance beyond the variance explained by thought suppression, we conducted regression analyses entering rumination in the last step (Step 5), after thought suppression (Step 4). Thought suppression added significantly to the amount of variance explained in the IAMI past, future, and total score, ΔR^2s = 0.07–0.09, βs = 0.28–0.31, $p < .001$. The rumination step did not add significantly to the amount of explained variance in IAMI future, $\Delta R^2 < 0.01$, $p = .19$. The rumination step added significantly the amount of explained variance in IAMI past, $\Delta R^2 = 0.02$, $p = .002$, and IAMI total score, $\Delta R^2 = 0.02$, $p = .015$. However, only higher reflection was a significant predictor of these dependent variables with small effect sizes (βs < 0.17, $p < .05$). Therefore, with this sample, the relationship between rumination and involuntary MTT (particularly involuntary future MTT) was weak and inconsistent.

Summary and discussion

Study 2 replicated key findings from Study: we found again more frequent involuntary past MTT than future MTT and high correlations between past and future MTT. In addition, higher thought suppression consistently predicted higher involuntary past and future MTT, above and beyond

emotion regulation and rumination. However, there were some inconsistencies between Study 1 and Study. First, all models tested in Study 2 explained less involuntary MTT variance in compared with Study 1 involving a more diverse sample of Americans. Second, rumination behaved differently in predicting past and future involuntary MTT in the two studies. In Study 1, both rumination (brooding and reflection) and thought suppression predicted involuntary past MTT, future MTT, and the IAMI total. In contrast, in Study 2 (primary analyses), brooding predicted more frequent involuntary future MTT, whereas reflection predicted more frequent involuntary past MTT. However, in an alternative model giving priority to thought suppression, rumination did not predict involuntary future MTT in Study 2 (while reflection remained significant for past MTT). These differences suggested weaker and inconsistent relationship between rumination and the IAMI, and more robust associations between thought suppression and the IAMI. Emotion regulation was not a robust predictor of the tendency for experiencing involuntary MTT in either sample.

In sum, thought suppression was a robust predictor of both involuntary past and future MTT in both Study 1 and Study 2, whereas there were inconsistencies regarding rumination and emotion regulation between the two studies, possibly reflecting differences between the two populations from which the participants were sampled.

Study 3

To build upon the findings regarding thought suppression, we extended the examination of its relationship with involuntary MTT, when also considering mind-wandering and daydreaming styles. We speculated that daydreaming styles might show a differential pattern for past versus future involuntary MTT. This idea is consistent with a diary study (Finnbogadottir & Berntsen, 2013), in which three daydreaming styles conceptualized by Huba et al. (1977, 1982); each had a different association with the proportion of negative and positive involuntary MTT experienced. The three styles of daydreaming were (1) positive and constructive daydreaming, (2) guilt and fear of failure daydreaming, and (3) poor attention control (Huba et al., 1977, 1982; Singer, 1974, 1975). The positive and constructive style, and the guilt and fear of failure style are content-defined daydreaming styles (Singer, 1974, 1975). The former is oriented towards generating pleasant thoughts, planning, and problem-solving, whereas the latter is directed towards negative content and unpleasant scenarios.

While MTT to the past and to the future hold many similarities (e.g., Berntsen & Bohn, 2010; Finnbogadottir & Berntsen, 2011; Schacter, Addis, & Buckner, 2007; for reviews see D'Argembeau, 2012; Szpunar, 2010), one difference is that the positive bias is more marked in future MTT relative to past MTT (e.g., Berntsen & Jacobsen, 2008; Cole et al., 2016). In addition, there appears to be a greater goal-directed component in future than in past MTT (Cole & Berntsen, 2016; Plimpton et al., 2015). These aspects of future MTT suggest commonalities with Huba et al.'s (1977, 1982) conceptualization of positive-constructive daydreaming.

Huba and colleagues' third style of daydreaming was not distinguished on the basis of daydreaming content, but rather on the basis of a cognitive process tapping into poor attentional control and distractibility. This construct resembles the dominant conceptualization of mind-wandering centering on having attention drifting away from an ongoing task (e.g., Smallwood & Schooler, 2006, 2015). We expected that poor attentional control and mind-wandering would be highly correlated with one another, and would relate similarly to both involuntary past and future MTT. We explored again whether thought suppression would explain additional variance beyond these factors. Finally, Study 3 also extended the previous two studies by including the trait measures of affect. In Studies 1 and 2, we assessed how emotions are typically handled, but not what type of affect is more typical to be experienced by the individual. This was an important issue to address, because prior research suggests that emotional distress is related to various cognitive processes such as involuntary MTT and mind-wandering.

Method

Participants Participants were 490 Amazon MTurk workers residing in the United States of America.[3] The mean age was 37.8 years ($SD = 11.6$; range 18–73 years; note the wider age range relative to Studies 1 and 2). Forty-six percent ($n = 228$) were men, 53% ($n = 261$) were women, and one participant was of 'other' gender. Seventy-six percent ($n = 372$) described themselves as white, 10.4% ($n = 51$) as African American, 6.1% ($n = 30$) as Asian, 5% ($n = 24$) as Latin, 2.2% ($n = 11$) of mixed-race origin, 0.2% ($n = 1$) as Middle Eastern, and 0.2% ($n = 1$) as of 'other' ethnic origin. The average year of education was 15.1 years ($SD = 2.2$; range 4–30).

Materials We included the same self-report questionnaires employed in Studies 1 and 2, and added the inventories

[3] The data preparation for Study 3 followed the same steps as Study 1. With 127 items, we estimated that the minimum time required to answer the survey was 4 min. Note that the entire survey was shorter than that of Studies 1 and 2, and we analyzed data from all questionnaires. Initially, 567 participants accessed the survey, of which 7.9% ($n = 45$) were too fast. An additional 5.6 % of the original ($n = 32$) did not pass the attention check, thus leaving a final sample of 490 participants for analysis.

listed below. Table 4 presents the internal consistency of each inventory for this sample.

Short Imaginal Process Inventory (SIPI; Huba, et al., 1982). The SIPI is a 45-item self-report on daydreaming. The inventory assesses three aspects of daydreaming and inner experience style, namely positive and constructive daydreaming (SIPI-p), guilt and fear of failure daydreaming (SIPI-n), and poor attentional control (mind-wandering and drifting thoughts; SIPI-PAC). Item examples for each scale include, respectively: "My dreams are often stimulating and rewarding", "In my daydreams, I fear meeting new responsibilities in life", and "I find it hard to read when someone is on the telephone in a neighboring room". Each scale consists of 15 items that are rated on a five-point scale with the following response options: 1 = definitely untrue or strongly uncharacteristic of me, 2 = moderately untrue or uncharacteristic of me, 3 = neither characteristic of uncharacteristic of me, 4 = moderately true or characteristic of me, and 5 = very true or strong or characteristic of me. See Huba et al. (1982) for psychometric properties.

Mind-wandering Questionnaire (MWQ; Mrazek et al., 2013). The MWQ is a self-report measure consisting of five items with high face validity assessing mind-wandering (e.g., I do things without paying full attention; I have difficulty maintaining focus on simple or repetitive work). Items are answered on a six-point rating scale ranging from 1 = Almost never to 6 = Almost always. The psychometric properties of the MWQ are reported in Mrazek et al. (2013).

Positive and Negative Affect Scale-Short version (PANAS; Thompson, 2007). We assessed trait or general affect with the PANAS short version validated by Thompson (2007), which includes five descriptors of positive affect (alert, inspired, determined, attentive, and active), and five of negative affect (upset, hostile, ashamed, nervous, and afraid). Items were answered in a five-point Likert scale ranging from 1 = Very slightly or not at all to 5 = Extremely.

Procedure The procedure was the same as in Study 1, except that the order of the questionnaires was as follows: WBSI, ERQ, MWQ, IAMI, RRS, SIPI, and PANAS. The average completion time was 17.7 min (*SD* = 19.5).

Results

Frequency of involuntary past and future MTT Involuntary future MTT was rated as less frequent than involuntary memories, $t(487) = 12.13$, $p < .001$. Table 4 shows the means and *SD*s.

Bivariate correlations The tendencies for past and future involuntary MTT were highly correlated. Both showed essentially the same correlational pattern with the other measures. Both correlated positively with reflection, brooding, thought suppression, mind-wandering, all of SIPI's subscales (positive, negative, and poor attentional control), negative affect, and emotional suppression. Both the IAMI future and past correlated negatively with positive affect and had a non-significant relationship to reappraisal. Table 4 shows the correlations for all variables included in Study 3.

Other correlations of interest were those between daydreaming styles and mind-wandering. The positive-constructive daydreaming and guilt and fear of failure daydreaming were virtually orthogonal, $r = .08$. As expected, the SIPI-PAC and the MWQ were strongly correlated with each other, $r = .66$. Likewise, these two measures had a remarkably similar correlational pattern with the vast majority of other psychological processes. Both held positive correlations in the moderate range with the IAMI past and future, brooding, reflection, and thought suppression. Both were related to lower positive affect and to higher negative affect. Finally, both had a small or no significant correlation with the SIPI's positive-constructive daydreaming. Therefore, the SIPI-PAC and MWQ tapped into other cognitive and emotional variables in very much the same way.

Hierarchical multiple regression models Step 1 consisted of demographic control variables (age and gender). Step 2 included emotion-related variables, for which we added trait positive and negative affect to better account for the potential role of emotionality in the cognitive processes assessed. Step 3 included rumination. Steps 4 and 5 were the main interest in the present study. Step 4 included the new cognitive variables, namely, mind-wandering and daydreaming styles, and they were entered after emotion and rumination to explore whether they would explain an additional variance to that accounted for by such variables, as shown in Studies 1 and 2. Finally, in Step 5, we examined whether thought suppression would still contribute to the variance in the tendency for involuntary MTT beyond mind-wandering and/or daydreaming. Because of the high correlations between the MWQ and the SIPI-PAC, we employed the MWQ for our main analyses (Table 5), and the SIPI-PAC for alternative analyses, which are briefly discussed below.

Involuntary future MTT The final model was significant and explained 46% of the variance in the frequency of involuntary future MTT $F(472, 12) = 33.78$, $p < .001$. Step 1 (sex and age) was significant, but only age was significant, so that younger participants reported higher involuntary future MTT. Step 2 (emotion variables) was significant, and indicated that greater negative affect, and higher emotional suppression uniquely predicted a greater tendency for experiencing involuntary future MTT. In Step 3, both greater brooding and reflection predicted higher IAMI future scores. These results largely replicated Study 1. However, beyond these findings, in Step 4, additional variance was explained by mind-wandering, positive daydreaming, and guilt and

Table 4 Study 3: means, standard deviations, internal consistencies, and bivariate correlations between the IAMI and other cognitive and emotion variables ($N = 490$)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	IAMI future	–													
2	IAMI past	0.76**													
3	IAMI total	0.95**	0.93**												
4	ERQ-ES	0.16**	0.10*	0.14**											
5	ERQ-Rea	−0.08	−0.07	−0.08	−0.04										
6	RRS-Ref	0.37**	0.43**	0.42**	0.12**	−0.05									
7	RRS-Bro	0.45**	0.49**	0.50**	0.20**	−0.24**	0.60**								
8	WBSI	0.52**	0.51**	0.55**	0.32**	−0.15**	0.40**	0.63**							
9	MWQ	0.39**	0.40**	0.42**	0.21**	−0.26**	0.30**	0.51**	0.54**						
10	SIPI-p	0.39**	0.27**	0.35**	−0.02	0.23**	0.16**	0.05	0.13**	0.03					
11	SIPI-n	0.48**	0.38**	0.46**	0.28**	−0.26**	0.40**	0.57**	0.53**	0.42**	0.08				
12	SIPI-PAC	0.38**	0.39**	0.41**	0.16**	−0.17**	0.25**	0.46**	0.53**	0.66**	0.10*	0.38**			
13	PANAS-p	−0.10*	−0.10*	−0.11*	−0.19**	0.31**	−0.09	−0.22**	−0.22**	−0.39**	0.20**	−0.20**	−0.29**		
14	PANAS-n	0.32**	0.33**	0.34**	0.18**	−0.17**	0.38**	0.49**	0.42**	0.45**	0.01	0.42**	0.36**	−0.12*	–
	M	1.55	1.89	1.72	14.08	30.9	9.35	9.47	43.07	2.81	45.04	29.78	36.72	16.74	7.23
	SD	0.93	0.79	0.81	5.68	7.13	3.53	3.66	14.61	1.11	10.87	9.93	11.33	4.37	3.39
	α	0.88	0.92	0.96	0.82	0.88	0.83	0.86	0.95	0.89	0.86	0.84	0.86	0.83	0.86

ERQ-ES Emotion Regulation Questionnaire-Emotional suppression, *ERQ-Rea* Emotion Regulation Questionnaire-Reappraisal, *MWQ* Mind-wandering questionnaire, *PANAS-p* positive affect, *PANAS-n* negative affect, RRS-*Bro* ruminative responses styles-brooding, *RRS-Ref* ruminative responses styles-reflection, *SIPI-p* positive daydreaming, *SIPI-n* guilt and fear of failure daydreaming, *WBSI* White Bear Suppression Inventory (thought suppression)

*$p < .05$; **$p < .01$

Table 5 Study 3: prediction of the tendency for future and past involuntary MTT including mind-wandering and daydreaming ($N = 490$)

	IAMI future				IAMI past				IAMI total			
	ΔR^2	β	t	sr^2	ΔR^2	β	t	sr^2	ΔR^2	β	t	sr^2
Step 1	0.06***				0.02**				0.03***			
Sex		0.03	0.67	< 0.01		0.13	2.92**	0.02		0.08	1.82	0.01
Age		− 0.24	− 5.51***	0.06		− 0.06	− 1.27	< 0.01		− 0.17	− 3.77***	0.03
Step 2	0.09***				0.11***				0.11***			
PANAS-n		0.27	6.26***	0.07		0.31	2.28***	0.09		0.31	7.08***	0.09
PANAS-p		− 0.02	− 0.46	< 0.01		− 0.05	− 0.35	< 0.01		− 0.04	− 0.78	< 0.01
ERQ-ES		0.09	2.02*	0.01		0.05	0.17	< 0.01		0.08	1.74	0.01
ERQ- Reap		− 0.01	-0.26	< 0.01		− 0.02	0.60	< 0.01		− 0.01	− 0.33	< 0.01
Step 3	0.10***				0.15***				0.14***			
RRS-Ref		0.13	2.50*	0.01		0.19	3.89***	0.02		0.17	3.38***	0.02
RRS-Bro		0.29	5.10***	0.04		0.33	5.99***	0.05		0.33	5.95****	0.05
Step 4	0.18***				0.08***				0.15***			
MWQ		0.16	3.54***	0.01		0.17	3.47***	0.02		0.17	3.84***	0.02
SIPI-p		0.35	9.47***	0.11		0.21	5.35***	0.04		0.31	8.24***	0.08
SIPI-n		0.24	5.16***	0.03		0.13	2.74**	0.01		0.20	4.40***	0.02
Step 5	0.03***				0.03***				0.03***			
WBSI		0.25	5.03***	0.03		0.24	4.66***	0.04		0.26	5.34***	0.03

ERQ-ES Emotion Regulation Questionnaire-Emotional suppression, *ERQ-Rea* Emotion Regulation Questionnaire-Reappraisal, *MWQ* Mind-wandering questionnaire; *PANAS-p* Positive Affect, *PANAS-n* Negative Affect, *RRS-Bro* Ruminative Responses Styles-Brooding, *RRS-Ref* Ruminative responses Styles-Reflection, *SIPI-p* Positive daydreaming, *SIPI-n* Guilt and fear of failure daydreaming, *WBSI* White Bear Suppression Inventory (thought suppression)

*$p < .05$, **$p < .01$, ***$p < .001$

[a]Men = 1, Women = 2

fear of failure daydreaming, all with positive relationships. Finally, thought suppression in Step 5 significantly predicted involuntary future MTT (see Table 5 for the full model).

Involuntary past MTT The final model was significant and explained 39% of the variance in the tendency for experiencing involuntary past MTT, $F(472, 12) = 25.34$, $p < .001$. Step 1 was significant and indicated that women reported more frequent involuntary memories. Unlike with involuntary future MTT, age did not predict IAMI past. Step 2 was also significant and indicated that greater negative affect was related to higher involuntary past MTT. Step 3 significantly added variance to the model, and both higher reflection and brooding predicted involuntary past MTT. Similarly to the IAMI future model, higher mind-wandering, positive daydreaming, and guilt and fear of failure daydreaming all uniquely predicted more frequent involuntary past MTT in Step 4. Finally, greater thought suppression was uniquely related to greater involuntary past MTT in Step 5.

Daydreaming styles and involuntary MTT SIPI-p uniquely predicted both involuntary past ($\beta = 0.21$) and future MTT ($\beta = 0.35$). However, we had hypothesized that positive daydreaming would have a stronger relationship to involuntary future MTT than to past MTT. Therefore, we estimated 95% *CI*s [lower limit, upper limit] for the SIPI-p's βs in relation to involuntary future MTT [0.280, 0.425], and in relation to involuntary past MTT [0.134, 0.289] to verify that these βs were significantly different. The CIs overlapped by 0.05% ($p < .001$). An overlap of less than 50% between CIs indicates a significant difference between coefficients, but of decreasing magnitude as they approach the 50% overlap (Cummings, 2009). The small overlap confirmed that the SIPI-p had a significantly stronger relationship to involuntary future MTT than to involuntary past MTT. As a means of comparison, the βs for the relationship between the SIPI-n and the IAMI past [0.038, 0.229] and IAMI future [0.142, 0.327] overlapped by 43% ($p < .05$). Therefore, while both the SIPI-p and SIPI-n were related to both involuntary future MTT than to past MTT, the relationship was stronger for the SIPI-p in connection to involuntary future MTT, than the SIPI-p and past MTT.

Total involuntary MTT The final model for the total scale on involuntary MTT was a combination of the results for past and future involuntary MTT, $F(472,12) = 34.22$, $R^2 = 0.46$, $p < .001$. Briefly, younger age, more negative affect, higher brooding and reflection, higher mind-wandering, and higher tendency for daydreaming were all uniquely related to a greater tendency for involuntary MTT. Higher

thought suppression explained additional variance beyond these predictors.

Alternative models We repeated the primary analyses (Table 5) with the SIPI-PAC as a measure of mind-wandering instead of the MWQ to compare potentially different relationship patterns. The results were remarkably similar. The total amount of variance explained employing the SIPI-PAC (39–43%) was similar to that of the models reported in Table 5 using the MWQ. In the alternative models, the SIPI-PAC was a unique predictor of both higher involuntary future MTT, $\beta = 0.13$, $p = .002$, and past MTT, $\beta = 0.16$, $p < .001$. Thus, the MWQ and the SIPI-PAC behaved in very much the same way in relation to the tendency for experiencing involuntary MTT (see βs for the MWQ in Table 5).

Summary and discussion

Following the primary regression analyses, there were few differences between the correlates for experiencing past and future involuntary MTT as follows. Younger age was related to more frequent involuntary future MTT, whereas sex (being women) was related to (more) involuntary past MTT. The age effect is consistent with findings by Berntsen et al. (2015), although they had a wider age range. For its part, the gender effect seems specific to this sample as it was not found in the previous two studies, and, therefore, should be considered with caution. Consistent with expectations, a positive and constructive daydreaming style had a stronger relation to involuntary future MTT, than to involuntary past MTT. Such effect was smaller for the relationship between the guilt and fear of failure daydreaming and involuntary future MTT.

Reflection, brooding, mind-wandering, guilt and fear of failure daydreaming, and thought suppression all had unique positive relationships with both past and future involuntary MTT. Importantly, consistent with expectations, individual differences for engaging in more thought suppression significantly predicted involuntary future and past MTT, when controlling for other correlating factors.

General discussion

The examination of the frequency of involuntary mental time travel (MTT) in the context of individual differences is an emerging approach in the field of MTT. In three exploratory studies, we investigated a range of emotional and cognitive measures that the literature suggests as likely correlates for experiencing involuntary past and future MTT. We were particularly interested in the relationship between thought suppression and involuntary MTT. Across the three studies, we found that a greater tendency to suppress unwanted thoughts was consistently and robustly related to a higher tendency for experiencing involuntary MTT, even after taking into account a variety of measures of emotion-related and cognitive dispositions, such as trait affect, emotion regulation, rumination, mind-wandering, and daydreaming styles.

Wegner and Zanakos (1994) conceptualized thought suppression as a chronic tendency to monitor and attempt to suppress target thoughts. These target thoughts were hypothesized to be unwanted, unpleasant, distressing, or obsessive-like, and indeed, their experimental studies supported that notion. More recent studies continue to show that thought suppression is related to various forms of distress symptoms (e.g., Aldao & Nolen-Hoeksema, 2010). However, recent evidence also suggests that thought suppression is related to everyday and innocuous involuntary MTT in bivariate correlations (Alle et al., 2018; Berntsen et al., 2015; Hyman et al., 2015). Extending these findings, we examined the relative contribution of thought suppression when considering two other groups of important correlates and potentially intervening variables. First, we controlled for various forms of negative cognition and affect, such as brooding (Studies 1–3) and guilt and fear of failure daydreaming as well as trait negative affect (Study 3). Thought suppression emerged as a unique predictor in relation to MTT after accounting for these variables.

Second, we examined cognitive processes often investigated in relation to MTT, such as mind-wandering and poor attentional control, and compared their relationship to involuntary MTT relative to that of thought suppression. Thought suppression, mind-wandering, and attentional control were all moderately related to each other (Study 3), thus indicating that they share common underlying mechanisms. Although not assessed directly, we presume that one of such mechanisms is executive functioning (Smallwood & Schooler, 2006). However, the direction of the relationships between executive functioning and spontaneous cognition (Christoff et al., 2016), as well as thought suppression (Koster, Soetens, Braet, & De Raedt, 2008) is not fully understood. We also found that the operationalizations of mind-wandering (Mrazek et al., 2013) and poor attentional control (Huba et al., 1982) were highly correlated with one another and yield a highly similar relationship pattern with involuntary MTT. In any case, the regression analyses indicated that even when considering the shared variance among mind-wandering, poor attentional control, and thought suppression, thought suppression continued to be a robust predictor of involuntary MTT.

Given that the relationship between thought suppression and involuntary MTT was maintained, even when controlling for negative psychological processes and mind-wandering, we propose that an important contributing factor to such relationship is the uncontrollability of involuntary MTT. That is, involuntary MTT—because of its uncontrollability—may be followed by attempts to control one's mind, and

this, in turn, may reinforce involuntary MTT for both past and future (Erskine et al., 2007; Wegner & Zanakos, 1994).

Other individual differences that were examined showed similar relationships with involuntary past and future MTT. Specifically, guilt and fear of failure daydreaming, brooding, and negative affect (but not positive affect) were all uniquely and positively related to both involuntary past and future MTT, suggesting that more frequent involuntary MTT is, indeed, related to emotionally negative psychological processes. These findings are in line with findings by Berntsen et al., (2015) in which involuntary MTT was related to emotional distress. In contrast, reflection and the two emotion-regulation strategies assessed in the present studies were weakly and inconsistently related to involuntary MTT across the present studies. Both reflection and emotion regulation represent relatively benign or normative psychological processes, at least in non-clinical populations. For instance, emotion regulation may be employed in relation to both positive and negative emotions (Gross & John, 2003), and reflection is sometimes prospectively related to positive psychological outcomes (e.g., Palacio-Gonzalez, Clark, & O'Sullivan, 2017; Treynor et al., 2003). We did not find a clear pattern in which the greater use of any of the emotion regulation strategies was related to more frequent involuntary MTT.

The inconsistent relationship between emotion regulation and involuntary MTT may seem at odds with recent diary studies, indicating that involuntary retrieval of both memories (del Palacio-Gonzalez, Berntsen, & Watson, 2017) and future thoughts (del Palacio-Gonzalez & Berntsen, 2018a) is related to greater emotion regulation efforts compared with voluntary MTT. However, findings derived from such factorial designs do not necessarily speak to individual differences, since the latter are treated as error variance in such analyses (Cronbach, 1957). In other words, although involuntary memories have been found to involve more emotional regulation processes than voluntary memories at the time of retrieval, the frequency with which individuals experience involuntary MTT may still be unrelated to their dispositional emotion-regulation tendencies.

Another finding worth of attention was that both the positive-constructive, and the guilt and fear of failure daydreaming styles emerged as strong predictors of involuntary future MTT. Together, the two styles explained about 14% of the variance in involuntary future MTT compared to about 5% variance in involuntary past MTT (see sr^2s in Table 5). The amount of variance explained by daydreaming styles was also greater than the variance explained by mind-wandering. In an additional follow-up analysis, we found that, after accounting for daydreaming styles, mind-wandering explained only 1.5% of the variance in involuntary future MTT, and 1.6% for involuntary past MTT.[4] Importantly, while both daydreaming styles were related to both future and past involuntary MTT, the positive-constructive daydreaming style in particular was more strongly related to involuntary future MTT, than to involuntary past MTT. This stronger relationship may be reflective of the overlapping content and functions of the positive-constructive daydreaming style with involuntary future MTT. Positive-constructive daydreaming has adaptive functions, including planning and problem-solving, and may also serve as a creativity incubator (McMillan et al., 2013). Similarly, the content of future MTT often refers to personal goals (e.g., Plimpton et al., 2015) and serves directive functions, such as problem-solving (see Berntsen, 2018 for a review), further underscoring the possible adaptive value of these two processes.

Finally, across the three studies, we replicated two key findings initially reported by Berntsen et al., (2015). Specifically, the two temporal dimensions of involuntary MTT were highly correlated with each other, and the tendency for experiencing involuntary future MTT was lower than the tendency for involuntary past MTT. In addition, in Study 3, we replicated the finding that younger age is related to more frequent involuntary future MTT (but not past involuntary MTT).

Our study had a number of limitations. First, the specified models fitted better the two American populations (Studies 1 and 3) as reflected by the larger variance explained and the stronger bivariate correlations, when compared to the models in the Danish sample (Study 2). This and other differences between studies (e.g., inconsistent relationship between rumination and MTT) may not only be due to the country of residence, but also to other differences between populations (i.e., the Danish sample was more homogenous than the two Amazon MTurk samples). This further suggests that the generalizability of some of our findings may be limited. Second, the measures that we employed for mind-wandering and daydreaming styles did not exclusively assess spontaneous mind-wandering and daydreaming. Since both of these processes may be volitional at times (Seli et al., 2016), the findings may underrepresent the strength of the relationships with other more pure forms of spontaneous cognition. Third, although we controlled for emotion-related variables, in light of previous findings (e.g., Berntsen et al., 2015), an important control for future research regarding the frequency of involuntary MTT is the emotional intensity associated with such MTT. Fourth, our examination of the

[4] The variance corresponds to the ΔR^2 and sr^2 explained by the MWQ in an additional model in which the MWQ was entered alone after the SIPI subscales. The model is not reported in the manuscript, but is available upon request.

role of thought suppression relative to other possible predictors of involuntary MTT was exploratory. Our primary analyses showed that a tendency for thought suppression was robustly associated with involuntary MTT. This interpretation was further strengthened when testing alternative models. However, the findings do not rule out that other measures (including measures not included here) may play even greater roles. The present findings may serve as the basis for a hypothesis-driven approach in future research. Finally, because our findings were based on individual differences assessed via self-report, they may not generalize to experimental studies or studies employing other assessment methods.

All in all, when assessing the frequency of involuntary future and past MTT as a disposition varying between individuals, we found that employing thought suppression as a strategy to control one's mind was a robust predictor of experiencing involuntary MTT, even when controlling for emotional variables, rumination, mind-wandering, and daydreaming. Most of the variables we examined here related similarly to past and future MTT, with some indication that positive-constructive daydreaming was more strongly related to involuntary future MTT, a finding that may underscore the adaptive value of involuntary future MTT.

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Data availability The data sets during and/or analyzed during the current study are available from the corresponding author upon request.

Compliance with ethical standards

Conflict of interest The author declares that there is no competing interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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