Involuntary Future Projections are as Frequent as Involuntary Memories, but More Positive

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Abstract

Mental time travel (MTT) is the ability to mentally project oneself into one's personal past or future, in terms of memories of past events or projections of possible future events. We investigated the frequency and valence of involuntary (spontaneously arising) MTT in the context of trait worry. High ($N=18$) and low ($N=16$) worriers recorded the frequency and valence of involuntary memories and future projections using a structured notebook and completed measures probing individual differences related to negative affectivity. Involuntary future projections were as frequent as involuntary memories. We found a positivity bias for both past and future MTT, in that fewer negative events were reported than positive or neutral ones. This positivity bias was greater for future than for past events. Individual differences related to negative affectivity were positively associated with the proportion of negative events, indicating a reduced positivity bias in individuals with a general tendency to experience negative affect.

Keywords: mental time travel; involuntary memories; frequency; positivity bias; negative affect; attentional control; daydreaming; worry

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1. Introduction

Mental Time Travel (MTT) is defined as the ability to travel mentally through time, to relive events in one's personal past through autobiographical memories or to prelive possible events in one's personal future through future projections (Tulving, 2002; Wheeler, Stuss, & Tulving, 1997). MTT can be either initiated voluntarily or arise spontaneously or involuntarily (Berntsen & Jacobsen, 2008). According to an emerging view in the literature, past and future MTTs are constructive processes based on the same memory system (Suddendorf & Corballis, 2007), and it is suggested that autobiographical memory may have evolved primarily because it enables us to envision our future (e.g., Schacter, Addis, & Buckner, 2007; Schacter & Addis, 2007). This view has been supported by both neuroimaging and behavioural studies showing that remembering past events and imagining future events is largely based on the same neural networks (e.g., Addis, Wong, & Schacter, 2007), is affected in similar ways in response to a variety of experimental manipulations (e.g., D'Argembeau & Van der Linden, 2004; Larsen, 1998) and shows similar deficits in mental disorders (e.g., D'Argembeau, Raffard, & Van der Linden, 2004; Williams et al., 1996). Based on this, we could expect past and future MTT to show many similarities and to be affected similarly by experimental manipulations as well as everyday conditions.

The present study examines the frequency and emotional valence of spontaneously arising MTT, past and future. Below, we describe the phenomenon of involuntary MTT and related thought processes, such as mind wandering and daydreaming. We review research that has examined the frequency and valence of these thought processes and relate this to individual differences measures, such as personality and trait worry, before making predictions for the present study.

1.1. Frequency of Involuntary MTT

Involuntary memories and future projections belong to a category of spontaneous thought processes, such as daydreaming, task irrelevant thought, mind wandering, fantasy or stimulus independent mentation, that arise in the absence of specific situational demands (Johannessen & Berntsen, 2010). In contrast to voluntary MTT, involuntary MTT is an associative and direct retrieval process, relying less on executive and attentional processes and more often occurring when a person is not concentrating on a certain task (Berntsen, 2009; Heeren, Van Broeck, & Philippot, 2009; Conway, 2005; Williams et al., 2006). Studies on involuntary memories indicate that they are common in everyday life (e.g., Berntsen, 1996; Rubin & Berntsen, 2009) with individuals experiencing on average around 20 a day, but with great individual variability (Rasmussen & Berntsen, 2011). Little is known about the frequency of involuntary future projections. Observations reported by Berntsen and Jacobsen (2008) suggest that they are as common in everyday life as involuntary memories. However, in that study, participants assessed the frequency of involuntary MTT retrospectively and quite casually as part of an interview following a diary study. D'Argembeau, Renaud, and Van Der Linden (2011) examined the frequency of future-oriented thoughts on a given day and found that participants experienced on average 59 future-oriented thoughts, although there was high individual variability in the numbers reported. However, as participants in that study did not separate recordings for involuntary versus voluntary thought, the frequency of involuntary future projections compared to involuntary memories is still unknown. In line with the view that past and future MTT are constructive processes, based on the same memory system, we expect future projections to be at least as common as their memory counterparts. On the other hand, studies on mind wandering indicate that the mind wanders more to the impending future than to the past (Smallwood, Nind, & O'Connor, 2009). Therefore, it is possible that future involuntary MTT is more frequent than past involuntary MTT. The primary

purpose of the present study was to examine the frequency of future involuntary MTT compared with past involuntary MTT.

1.2. Positivity bias in MTT

Studies have consistently found a positivity bias in autobiographical memory recall, in that when asked to retrieve personal events, 50% or more of them tend to be positive, whereas much fewer tend to be negative or neutral. This positivity bias applies to both voluntary and involuntary recall (see Walker, Skowronski, & Thompson, 2003 for review). Studies also find mind wandering and daydreaming to show a positivity bias. For instance with regards to mind wandering, one study found that in daily life people's minds tend to wander more to pleasant topics than to neutral or negative ones (Killingsworth & Gilbert, 2010), and in the general population, self-report measures of daydreaming style suggest that having a more positive daydreaming style is the norm (Huba, Aneshensel, & Singer, 1981). This positivity bias may reflect a basic motivational tendency for people to seek out positive experiences and avoid negative ones, to maintain or enhance a positive view of oneself, and to protect the self against threatening information (Walker & Skowronski, 2009; Walker, Skowronski, & Thompson, 2003). Related to this is the notion of "positivity offset," that at very low levels of input into the affective system, the affective output of positivity is greater than the output of negativity. Therefore, at low levels of activation (e.g., when confronted with neutral stimuli) individuals show a consistent tendency to respond in a mildly positive fashion, with the result that the motivation to approach is stronger than the motivation to avoid (Cacioppo & Gardner, 1999). The positivity bias in autobiographical memory recall has been found to be even stronger for future projections than for memories, which may be because of more uncorrected positive illusions for the future than for the past (Berntsen & Bohn, 2010). That is, at the same time our affective system is characterized by positivity offset, the affective system also shows heightened sensitivity to negative information, in that there is a propensity to react more strongly to negative

than to positive stimuli, as this increases chances of survival (Cacioppo & Gardner, 1999). Thus, highly negative events are very well remembered (see e.g., McGaugh, 2003 for review), which corrects or balances the positivity illusion. However, as the future is unknown, there are no negative events to correct the positivity illusion for the future, and therefore there are more uncorrected positive illusions for the future than for the past. Indeed, according to Cacioppo and Gardner (1999), the evolutionary tendency of positivity offset manifests itself in the tendency to expect generally positive outcomes for unknown future events.

The positivity bias in MTT is often found to be reduced in the context of negative affect. For instance, the positivity bias in MTT has been found to be reduced in individuals with anxiety, depression or dysphoria, or individuals that generally feel affectively low (e.g., Burke & Mathews, 1992; MacLeod & Byrne, 1996; Ritchie et al., 2009; Walker et al., 2003), as well as for the tendency to engage in thought suppression (Neufeind, Dritschel, Astell, & MacLeod, 2009) and the personality trait neuroticism (Rasmussen & Berntsen, 2010; Rubin, Boals, & Berntsen, 2008). In addition, low attentional control in the in the context of trait anxiety appears to be associated with a reduced ability to ignore negative and threatening information (Reinholdt-Dunne, Mogg, & Bradley, 2009).

Whereas the personality trait neuroticism has been found to be associated with a reduced positivity bias, the personality traits openness to experience and extraversion have been found to be positively associated with positive emotion in autobiographical memory (Berntsen, Rubin, & Siegler, 2011; Rubin et al., 2008; Rubin & Siegler, 2004; but see Rasmussen & Berntsen, 2010). Thus, it seems that measures related to negative affect (e.g., neuroticism) are related to less positive emotion during past MTT, whereas measures related to positive affect (e.g., extraversion) are related to more positive emotion during past voluntary MTT. Similarly, a more positive daydreaming style has been found to be related to the personality trait openness to experience

(Zhiyan & Singer, 1996-1997), whereas a more negative daydreaming style characterizes individuals with depression or a trait like tendency to worry, or neurotic individuals (Giambra & Traynor, 1978; Pruzinsky & Borkovec, 1990; Starker & Singer, 1975; Zhiyan & Singer, 1996-1997).

Trait worry is a person's general tendency to become worried and is seen as an aspect of the personality trait neuroticism. A key feature of the worry process is that it "...is primarily anticipatory in nature, relating mainly to future possibilities and the threats they pose" (Mathews & Funke, 2006, p. 51). Thus, high worriers experience negative thoughts about future scenarios on a regular basis in relation to their frequent worrying. Furthermore, high worriers might be more likely to experience negative involuntary thoughts, as one study (Borkovec, Robinson, Pruzinsky, & DePree, 1983) found that high worriers, compared to low worriers, reported less task-focused attention and more negative thoughts during a breathing task. High worriers also report having a more negative daydreaming style compared to low worriers (Pruzinsky & Borkovec, 1990). In light of this it seems plausible to expect high worriers to show a reduced positivity bias in involuntary MTT.

To summarize, there is a positivity bias in MTT, mind wandering, and daydreaming that can become reduced in the presence of negative affect, such as neuroticism and depressive symptoms. The personality factors openness to experience and extraversion, on the other hand, have been found to be related to more positive MTT and daydreaming. However, the frequency of involuntary future oriented MTT relative to involuntary past MTT is still unknown.

1.3. The present study

The purpose of the study was threefold: First, to examine the on-line frequency and valence of involuntary future projections compared to involuntary memories; second, to examine the valence of MTT in relation to individual differences measures sensitive to negative affect; and third, to

examine the on-line frequency and valence of involuntary memories and future projections in the context of trait worry. In order to examine these issues, we utilized data from a previous diary study (Finnbogadottir & Berntsen, 2011), in which participants selected as either high or low worriers recorded memories and future projections and rated them on various memory characteristics, as well as answered questionnaires sensitive to negative affect. The present study reports data on the on-line frequency and valence of involuntary MTT, past and future, which have not been previously published. The present study also utilizes data from psychometric scales, of which only two (BDI-II, PSWQ) were reported in the previous study.

In line with previous research as well as the notion that past and future MTT is based on the same memory system, we expect involuntary future projections to be about as frequent as involuntary autobiographical memories. Furthermore, we expect to find a positivity bias in MTT, in that positive events will be more frequent than neutral or negative events. We expect this effect to be stronger for future MTT than for past MTT. We expect individual differences measures related to negative affect to correlate with the frequency and proportion of negatively valenced involuntary MTT, indicating a reduced positivity bias, whereas we expect individual differences measures related to positive affect to correlate with the frequency and proportion of positively valenced involuntary MTT. Finally, as worry is a negative future oriented state involving rehearsal of negative future events, we expect the frequency and proportions of negative involuntary future projections to be greater in high worriers compared to low worriers, indicating a reduced positivity bias.

2. Method

2.1. Participants

Thirty-four Danish undergraduates (26 females, mean age 23.62 years, range 19-45) participated in the study as a part of a more extensive diary study (Finnbogadottir & Berntsen,

2011). Initially all 37 participants from the study by Finnbogadottir and Berntsen (2011) were invited to participate in the present study, but three declined. Of the 34 participants, 18 were high worriers (3 males) and 16 were low worriers (5 males). Each participant was compensated with a book gift with a value of roughly €40.

2.2. Design

The study examines involuntary MTT in high and low worriers. The design is a 2 (trait worry: high, low) x 2 (time: past, future) x 3 (valence: positive, neutral, negative) mixed design, with one between-subjects factor, trait worry, and two within-subjects factors, time and valence. The dependent variable was the number of events recorded in each of the within-subjects cells of the design.

2.3. Materials

2.3.1. Trait Worry¹.

The Penn State Worry Questionnaire (PSWQ; Meyer, Miller, Metzger & Borkovec, 1990) was used to identify individuals with high or low levels of trait worry. The PSWQ is a 16 item self-report questionnaire that measures individual differences in intensity and excessiveness of worry; total scores range from 16 to 80. The PSWQ has excellent psychometric properties in both non-clinical and clinical populations (Molina & Borkovec, 1994). Individuals with PSWQ scores 60 and above were selected as high worriers, corresponding to the upper twenty scores on the scale (60-80) and roughly to the top 20% of the screening sample. The criteria for low worriers mirrored the criteria for high worriers, by defining low worriers as being the bottom twenty scores on the scale (16-36) corresponding roughly to the bottom 20% of the sample (see Delgado et al., 2009 and Moulds, Kandris & Williams, 2007 for a similar procedure). The PSWQ was administered both before and after the study and demonstrated high test-retest reliability ($r = .90$), and internal consistency

(Cronbach's $\alpha = .96x$ for the pre measure, $\alpha = .96x$ for the post measure). However, participants generally had lower scores on the PSWQ at the end of the study, $t(33) = 3.23$, $p < .01$, with seven of the high worriers no longer reaching the cut-off score for a high worrier. All the low worriers, however, were still low worriers at the end of the study. We compared the group of high worriers, who remained high, to the group of high worriers, who dropped in worry score, on the measures of frequency and the two groups did not differ on any of the frequency measures. Furthermore, a second and third set of the analyses were conducted by first, excluding the remitted high worriers from the analysis, and second, by treating trait worry as a between-subjects factor with three levels (true high worriers, remitted high worriers, true low worriers). Because these analyses yielded results that were identical to results from analyses using the full sample, only results using the full sample are reported below.

2.3.2. Other measures.²

Participants also answered the Beck Depression Inventory (BDI-II; Beck, Steer, & Brown, 1996), the White Bear Suppression Inventory (WBSI; Wegner & Zanakos, 1994), which assesses people's tendency for chronic thought suppression, the Big Five Inventory (BFI; John, Donahue, & Kentle, 1991), and the Short Imaginal Processes Inventory (SIPI; Huba, Singer, Aneshensel, & Antrobus, 1982), which assesses daydreaming style and content, mental content, and general inner experience. The SIPI contains three second-order underlying factors, Positive-Constructive Daydreaming, Guilt-Fear of Failure Daydreaming, and Poor Attentional Control.

2.4. Procedure

The current study was conducted as a part of a more extensive diary study (Finnbogadottir & Berntsen, 2011) in which the current participants also participated in³. In

one part participants recorded involuntary and voluntary autobiographical memories and answered questionnaires to each memory, whereas in the other part participants recorded future projections. Each part of the study took on average four weeks to complete. Participants began either with the future or the past condition. As there were no differences between these two groups of participants on the main variables of interest, the data are collapsed across the two order conditions. At the end of each part of that study, participants recorded for an entire day the frequency and valence of involuntary autobiographical memories or future projections, depending on which part of the study it was. Participants recorded an event by putting a mark in a small notebook. Each mark represented one involuntary MTT event (see D'Argembeau, Renaud, & Van der Linden, 2011 and Rasmussen & Berntsen, 2011, for a similar procedure). They indicated whether the event was positive, neutral or negative by putting their mark in a corresponding column. The recording sheet was divided into different time slots, to help participants organize their recording. The frequency of involuntary events for the different time slots was summarized to create total scores for the entire day of positive, neutral and negative involuntary memories or future projections. The recording sheets for memories and future projections were identical, except for temporal reference. The recording sheet for future projections is presented in the Appendix. Participants received both verbal and written instructions for each part of the study and were instructed individually. Participants completed the PSWQ at screening and the end of the study. The BDI-II and the WBSI were administered at the beginning of the diary. The BFI and the IPI-short form were administered at the end of the diary study. At the end of the study, each participant was interviewed individually and asked for feedback.

3. Results

First, we provide descriptive statistics for the frequency of past and future MTTs, as well as differentially valenced MTTs. Second, we analyze the frequency of MTT in terms of temporal orientation, valence and trait worry. Third, we describe the sample of high and low worriers in terms of individual differences measures. Fourth, we examine the associations between the frequency of MTT and the individual differences measures.

3.1. Frequency and valence of involuntary mental time travel

Table 1 presents the mean number of memories and future projections reported by the participants, broken down by valence and worry status. On average participants experienced 22.61 ($SD = 27.80$, range = 132) involuntary memories and 21.50 ($SD = 28.11$, range = 147) future projections. Thus, on average, participants experienced 44-45 ($M = 44.64$, $SD = 55.61$, range = 278, skewness = 2.91, kurtosis = 9.91) involuntary MTTs per day. There was a high correlation between the frequency of past and future MTTs, $r = .96$, $p < .001$ ($N = 33$). In terms of valence, participants experienced on average 21.52 ($SD = 31.60$, range = 156, skewness = 3.21, kurtosis = 11.45) involuntary positive MTT events (past and future) per day, 14.48 ($SD = 16.48$, range = 81, skewness = 2.47, kurtosis = 7.49) neutral events, and 8.64 ($SD = 9.61$, range = 41, skewness = 1.71, kurtosis = 3.16) negative events. High worriers ($N = 18$) experienced on average 30.33 ($SD = 26.68$) involuntary MTTs, and low worriers ($N = 15$) experienced 61.80 ($SD = 75.00$) per day⁴.

As can be seen from the descriptive statistics, there was high individual variability in the frequency of involuntary memories and future projections reported. In order to reduce this variability, we transformed the frequency data by conducting a square root transformation before analyzing the data. We analyzed the transformed frequency data using a series of repeated measures ANOVAs, with two within-subjects factors, valence (positive, neutral,

negative) and time (memory vs. future projection) and one between-subjects factors, trait worry (high vs. low). One participant was not included in the ANOVAs, as he recorded only future projections.

Involuntary future projections were as common as involuntary autobiographical memories in terms of frequency, $F(1, 31) = 1.11, p = .30, \eta_p^2 = .03$. There was no difference between high and low worriers in the reported frequency of involuntary MTTs, $F(1,31) = 1.86, p = .18, \eta_p^2 = .06^5$. There was a main effect for valence on the frequency of involuntary MTT, $F(2,62) = 21.46, p < .001, \eta_p^2 = .41$. Pairwise comparisons revealed that negative events were less common than both positive ($p < .001$) and neutral events ($p < .001$), and that the neutral events were less common than positive events ($p = .05$). Finally, there was a significant interaction between time and valence $F(1.6,50)^6 = 3.99, p = .02, \eta_p^2 = .11$. We examined this interaction with a series of paired samples t-tests. Although for both the past and the future condition, significant differences were found between positive and negative events and between negative and neutral events (all $ps < .01$), these differences were greater in the future condition (positive: $M = 2.83$, negative: $M = 1.44$, neutral: $M = 2.23$) than in the past condition (positive: $M = 2.63$, negative: $M = 1.83$, neutral: $M = 2.37$)⁷. Furthermore, for the past condition the number of positive events was not significantly greater than the number of neutral events ($p = .22$), whereas in the future condition, the number of positive events was significantly greater than the number of neutral events ($p < .01$). There was no interaction between worry and valence, $F(2,62) = 1.07, p = .35, \eta_p^2 = .03$, nor between worry and time $F(1,31) = 0.02, p = .88, \eta_p^2 = .001$. The three-way interaction between valence, time and worry was not significant, $F(2,62) = 0.26, p = .77, \eta_p^2 = .01$.

In order to examine the relative frequency of positive and negative events, we calculated the percentages of positive and negative memories from the total number of memories

reported by each participant. The same was done for future projections. Thereafter, we analyzed the data using repeated measures ANOVA, with one between subjects factor, trait worry, and two within-subjects factors, time (past, future) and valence (positive, negative).⁸ The results are presented in Figure 1. On average, 41.69% of past events were positive and 21.79% were negative, whereas 51.30% of future events were positive and 15.66% were negative. There was a main effect of valence, $F(1,29) = 32.98, p < .001, \eta_p^2 = .53$, in that the proportion of positive events was greater than the proportion of negative events (Mean Difference = 27.84, $p < .001$). The analysis also revealed a significant interaction between valence and time, $F(1,29) = 5.88, p = .02, \eta_p^2 = .17$. Examining this interaction with a series of paired samples t-tests, we found that although for both the past and the future condition, significant differences were found between positive and negative events ($ps < .01$), these differences were greater in the future condition (positive: $M = 51.30$, negative: $M = 15.66$) than in the past condition (positive: $M = 41.69$, negative: $M = 21.79$). Finally, there was no interaction between worry and valence, $F(1,29) = 0.01, p = .92, \eta_p^2 = .00$, or worry and time, $F(1,29) = 0.99, p = .33, \eta_p^2 = .03$. The three-way interaction between valence, time and worry was not significant, $F(1,29) = 0.58, p = .46, \eta_p^2 = .02$.

-----Figure 1 about here-----

3.2. Correlations with measures of negative affect, attention control and personality traits

Means and standard deviations for individual differences measures are presented in Table 2, broken up by high and low worriers. Compared to low worriers, high worriers reported a greater tendency to engage in thought suppression (WBSI), had higher scores on neuroticism, and they were less extraverted. Furthermore, there was a trend for high worriers

to report more depressive symptoms, to have a more negative daydreaming style and to score higher on the poor attentional control subscale of the SIPI.

Table 3 shows how individual difference measures correlated with the proportion of positive and negative involuntary memories and future projections. As can be seen from the table, scales and measures sensitive to the presence of negative affect (e.g., depressive symptoms, neuroticism and negative daydreaming) and poor attentional control tended to be correlated negatively with the proportion of positive events, but correlated positively with the proportion of negative events, irrespective of temporal direction. Scales and measures assessing characteristics such as openness and approach (e.g., openness, extraversion and agreeableness) tended to correlate positively with the proportion of positive events, and negatively with the proportion of negative events (Table 3). We also examined the correlations between individual differences measures and the raw frequency data (square root transformed). Negative daydreaming style correlated positively with the raw frequency of negative future projections ($r = .46, p < .01, N = 31$), whereas positive daydreaming style correlated positively with the raw frequency of positive memories ($r = .47, p < .01, N = 31$), while the poor attentional control subscale correlated positively with both the raw frequency of negative memories ($r = .38, p < .05, N = 31$) and negative future projections ($r = .49, p < .01, N = 31$). None of the other correlations for raw frequency were significant..

4. Discussion

The main finding of the study was, as predicted, that involuntary future projections were as frequent as involuntary autobiographical memories. This is consistent with the findings Berntsen and Jacobsen (2008) obtained by interviewing their participants subsequent to completing a diary study. However, unlike the retrospective and rather casual assessments obtained in this previous

study, the present study used a systematic, on-line recording procedure. This allows records to be taken immediately and thus relies little on retrospection to avoid contaminating the self-reports with guessing and personal beliefs (Ericsson & Simon, 1980; Nisbett & Wilson, 1977). Importantly, the mean number of involuntary memories reported in the present study is very similar to the numbers reported in the study by Rasmussen and Berntsen (2011), which used a mechanical counter to assess frequency.

In accordance with our predictions, both past and future involuntary MTT was generally positive. Furthermore, we found that the positivity bias was even stronger for future projections, which is in accordance with previous findings. In line with our predictions, we found systematic associations between individual differences measures related to negative and positive affectivity and the proportions of differently valenced events. The correlations revealed that characteristics such as openness and approach tended to correlate positively with the proportion of positive events, and negatively with the proportion of negative events. On the other hand, measures related to negative affect and poor attentional control correlated positively with the proportion of negative events, and tended to correlate negatively with the proportion of positive events. In this regard, the daydreaming subscales “negative daydreaming” and “poor attentional control” showed especially strong correlations with both the proportion and the frequency of negatively valenced events. The finding for the poor attentional control subscale - which measures tendency for mind wandering and distractibility as well as boredom proneness – suggest that individuals, who report having a wandering mind and being easily distracted, are especially prone to experiencing negative involuntary memories and future projections. These individuals might benefit from interventions that aim to increase attentional control or modify biases towards negative material in disorders involving high negative affect, such as in mindfulness training (e.g., Teasdale, 1999) or attention bias modification (e.g., Hirsch, Hayes, & Mathews, 2009). In mindfulness training, for instance,

participants practice redirecting their attention from depressive or anxious thoughts back to the present moment (Teasdale, 1999; Teasdale, Segal, & Williams, 1995).

Contrary to our expectations, we did not find evidence of reduced positivity bias in high worriers for involuntary future projections. This could be taken to indicate that, despite the focus on negative future scenarios evident in high worriers during worry, high worriers show a normal positivity bias for involuntary MTT in daily life. However, the results for trait worry need to be taken with caution, as trait worry was found to be unstable during the study, with seven of the high worriers no longer reaching the cut-off score for high worriers at the end of the study. Furthermore, it could also be that by asking participants to register anxiety provoking memories and future projections, instead of negative ones, we would have found more anxiety provoking future projections in the high worrier group, as asking that question might be more sensitive to the pathology in high worriers, namely rehearsal of feared future scenarios. Future research should examine these possibilities.

The present study has a number of limitations. First, the participants in the study were a highly selective group of high and low worriers, corresponding to the upper and lower twenty percent of the screening population. Therefore, the findings regarding the frequency of past versus future involuntary MTT need to be replicated in a sample representing a broader range of trait worry before any strong conclusions can be made. Second, the small sample size in this study makes it difficult to draw firm conclusions, as it could have been too small to detect differences between high and low worriers. However, the sample size in the current study is similar to the sample sizes used in previous studies on involuntary MTT (e.g., Rasmussen & Berntsen, 2011; Berntsen & Jacobsen, 2008; Johannesen & Berntsen, 2010), and clear effects of time on valence were seen indicating that the study had enough statistical power to identify strong effects. Still, more subtle effects may have been overlooked due to sample size. Another limitation is that as the

sample is taken from a population of university students and not from a clinical population, which limits the generalizability of the findings to clinical populations, such as patients with generalized anxiety disorder. Furthermore, using a notebook to record the frequency of involuntary memories and future projections might not be an ideal way to assess true frequency, as participants reported in the final interview that using the notebook was inconvenient at times, and that they had chosen not to record at certain times, such as in the cinema. Future studies should opt for a more convenient instrument to report frequency, such as using social media (e.g., Facebook, Twitter) or using a smartphone application (e.g., Killingsworth & Gilbert, 2010). However, in the study by Rasmussen and Berntsen (2011), a mechanical counter was used to record memories and the same number of involuntary memories was found as in the present study. Finally, it should be noted that the poor attentional control subscale of the SIPI, which measures a tendency for mind wandering and distractibility (conceived as a trait, or general tendency) is based on self-report and therefore may not be an ideal way to assess such involuntary processes as distractibility and mind wandering. Thus, the results for the poor attentional control subscale need to be taken with caution.

Despite limitations, the findings indicate that involuntary future projections are as common in everyday life as involuntary autobiographical memories, and show an even stronger positivity bias than memories for past events. The findings also show that this positivity bias varies as a function of individual differences related to negative affectivity and poor attentional control.

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Figure 1. The Figure displays the proportion of positive and negative events from the total events reported by participants, as a function of temporal direction. Error bars display Standard Error of the Mean for each condition.

Table 1.

Mean Number of Memories and Future Projections, as a Function of Valence and Worry Status.

	Positive				Neutral				Negative			
	High worriers		Low worriers		High worriers		Low worriers		High worriers		Low worriers	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
AMs	6.17	5.89	14.87	20.08	5.61	5.03	9.27	9.57	3.78	4.26	6.93	9.18
FPS	7.06	6.53	15.63	24.27	5.17	5.93	9.25	11.54	2.56	2.45	4.19	4.83

Note: AMs = Autobiographical Memories; FPS = Future Projections

Table 2.

Means and Standard Deviations on Individual Differences Measures, Broken Down by Worry Status.

	High worriers		Low worriers		<i>t</i>	df	<i>p</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
BDI-II	7.18	5.17	4.14	2.91	-1.95	31	.06
WBSI	54.72	11.42	36.75	10.33	-4.79	32	< .01
Extraversion	3.03	.64	3.73	.79	2.66	28	.01
Agreeableness	3.63	.54	3.90	.65	1.25	28	.22
Conscientiousness	3.86	.72	3.67	.73	-.74	28	.47
Neuroticism	3.23	.58	1.88	.42	-7.32	28	< .01
Openness	3.63	.64	3.71	.40	.44	28	.66
Pos. daydreaming	53.47	6.72	54.43	6.32	.41	29	.69
Neg. daydreaming	38.59	9.47	32.92	7.73	-1.79	29	.08
Poor attentional control	52.69	9.28	46.29	8.31	-2.00	29	.06

Note. BDI-II = Beck Depression Inventory (2nd ed.); WBSI = White Bear Suppression Inventory. Higher scores on the WBSI means greater tendency for thought suppression. Higher scores on the poor attentional control subscale of the SIPI means greater tendency for mind wandering, distractibility and boredom.

Table 3.

Correlations Between Individual Differences Measures and the Proportion of Positive and Negative Involuntary Memories and Future Projections.

	Pos. past %	Pos. future %	Neg. past %	Neg. future %
BDI-II	.00	-.12	.41*	.32
WBSI	-.23	-.17	.10	.23
Extraversion	.25	.42*	-.26	-.30
Agreeableness	.24	.34	-.45*	-.43*
Conscientiousness	.38*	.27	-.42*	-.32
Neuroticism	-.33	-.24	.34	.30
Openness	.13	.37	.00	-.19
Positive constr. daydreaming	.24	-.04	.12	.20
Negative daydreaming	-.16	-.58**	.33	.61***
Poor attentional control	-.41*	-.35	.70***	.69***
PSWQ1	.01	.11	.09	-.03
PSWQ2	-.01	.02	.15	.11

Note. BDI-II = Beck Depression Inventory (2nd ed.); WBSI = White Bear Suppression Inventory; PSWQ = Penn State Worry Questionnaire. Higher scores on the WBSI means greater tendency for thought suppression. Higher scores on the poor attentional control subscale of the SIPI means greater tendency for mind wandering, distractibility and boredom.

N (range) = 28-31.

Spearman correlation.

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

Appendix

Recording sheet for recording of involuntary future projections during the morning period.

<h1 style="margin: 0;">Notebook</h1> <p style="margin: 5px 0;">page 1: morning</p> <p style="margin: 5px 0;">page 2: afternoon</p> <p style="margin: 5px 0;">page 3: evening</p> <p style="margin: 20px 0;">Record in this notebook the number and valence of the involuntary future projections you experience today, from the moment you wake up until the moment you go to sleep.</p> <p style="margin: 5px 0;">Put one mark in the notebook, in the appropriate time and valence slot, each time you experience an involuntary future projection.</p>																															
<h2 style="margin: 0;">Morning</h2> <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"><thead><tr><th style="width: 25%;"></th><th style="width: 25%;">Positive</th><th style="width: 25%;">Neutral</th><th style="width: 25%;">Negative</th></tr></thead><tbody><tr><td>6:00-7:00</td><td></td><td></td><td></td></tr><tr><td>7:00-8:00</td><td></td><td></td><td></td></tr><tr><td>8:00-9:00</td><td></td><td></td><td></td></tr><tr><td>9:00-10:00</td><td></td><td></td><td></td></tr><tr><td>10:00-11:00</td><td></td><td></td><td></td></tr><tr><td>11:00-12:00</td><td></td><td></td><td></td></tr></tbody></table>					Positive	Neutral	Negative	6:00-7:00				7:00-8:00				8:00-9:00				9:00-10:00				10:00-11:00				11:00-12:00			
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Footnotes

¹ More information on the PSWQ can be found in the supplementary material on the journal's website.

² Information on these measures can be found in the supplementary material on the journal's website.

³ The frequency findings reported here were not reported in the Finnbogadottir and Berntsen (2011) study. The results for the PSWQ and the BDI-II for this sample were reported in Finnbogadottir & Berntsen (2011), as they are necessary to define the groups of high and low worriers. Data for the remaining self-report measures (SIPI; BFI; WBSI) were not reported.

⁴ The large difference in the mean frequency reported by high and low worriers is due to two outliers in the low worrier group reporting frequency that corresponded to two or more standard deviations above the mean for the entire sample. When the two outliers in the low worrier group are removed, the mean frequency in the low worrier group becomes very similar to the mean frequency in the high worrier group.

⁵ Examining the distribution more closely revealed that two low worriers reported frequency that corresponded to two or more standard deviations above the mean for the entire sample. Reanalyzing the data without these two outliers did not change the results.

⁶ As assumptions for sphericity were violated for the interaction between time and valence, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\epsilon = 0.81$).

⁷ As the numbers reported here represent square root transformed frequency data, they differ from the numbers reported in the descriptive statistics.

⁸ Two participants were not included in the ANOVA, as they had reported having either no memories or future projections.