



# The frequency of involuntary autobiographical memories and future thoughts in relation to daydreaming, emotional distress, and age

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## ABSTRACT

We introduce a new scale, the *Involuntary Autobiographical Memory Inventory (IAM)*, for measuring the frequency of involuntary autobiographical memories and involuntary future thoughts. Using the scale in relation to other psychometric and demographic measures provided three important, novel findings. First, the frequency of involuntary and voluntary memories and future thoughts are similarly related to general measures of emotional distress. This challenges the idea that the involuntary mode is uniquely associated with emotional distress. Second, the frequency of involuntary autobiographical remembering does not decline with age, whereas measures of daydreaming, suppression of unwanted thoughts and dissociative experiences all do. Thus, involuntary autobiographical remembering relates differently to aging than daydreaming and other forms of spontaneous and uncontrollable thoughts. Third, unlike involuntary autobiographical remembering, the frequency of future thoughts does decrease with age. This finding underscores the need for examining past and future mental time travel in relation to aging and life span development.

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“I can only describe it as the inside of my head being like a darkened room with a large TV set in the corner. On the screen are images and events from my entire life back to about four or five years old. These images are constantly running” (Male, 58 years).

## 1. Introduction

Humans have an extraordinary ability to recollect our personal past and imagine our potential future. Sometimes this happens as a result of a deliberate and consciously initiated process. However, just as frequently, memories of past events and images of possible future events arise involuntarily, that is, with no preceding attempt to produce them (Berntsen, 1996). The quote in the beginning of this paper derives from a person, who contacted the first author with his unusual experiences. He has no psychiatric diagnoses and appears to be a completely normal person, who just extraordinarily frequently

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experiences involuntary memories. But exactly how remarkable is his case? At the present, we know little about the frequency of involuntary memories and involuntary future thoughts in daily life and how this varies among individuals. Here we begin to fill this gap in the literature. We first introduce a new scale, *The Involuntary Autobiographical Memory Inventory* (IAMI), to measure such individual differences. We next examine the relation between this new measure and daydreaming, emotional distress, and age.

Historically, most memory research has focused on voluntary (intentionally retrieved) memories examined in a laboratory context. More recently, a number of studies have examined involuntary autobiographical memories as they occur in daily life (e.g., Ball & Little, 2006; Berntsen, 1996, 1998; Berntsen & Hall, 2004; Berntsen & Rubin, 2008; Kvavilashvili & Mandler, 2004; Mace, 2004, 2005, 2007; Rubin, Boals, & Berntsen, 2008; Schlagman, Kliegel, Schulz, & Kvavilashvili, 2009; Schlagman & Kvavilashvili, 2008). However, these studies have largely focused on the characteristics of the memories and their retrieval mechanisms, and only rarely examined individual differences in their prevalence. Nonetheless, this research has provided a number of converging findings (see Berntsen, 2009, 2012, for reviews) that should be taken into account when attempting to measure individual differences. First, involuntary autobiographical memories are common in everyday life and (like voluntary memories) are predominantly emotionally positive (Walker, Skowronski, & Thompson, 2003) – in contrast to the stressful and negative involuntary memories observed in clinical settings (e.g., Ehlers, Hackmann, & Michael, 2004; Van der Kolk & Fisler, 1995). Second, the retrieval of most involuntary memories is facilitated by cues in the present context, either in terms of external features in the environment, or (less frequently) thoughts and feelings (see Berntsen, 2009, for a review). Third, involuntary memories most frequently come to mind in situations with diffuse attention, that is, during dull tasks or in situations that otherwise require little concentration (e.g., Berntsen, 1998; Schlagman et al., 2009). Fourth, in addition to cues in the immediate situation, more long-term concerns (e.g., Johannessen & Berntsen, 2010) or recent, stirring events in the personal past (e.g., Berntsen, 2001) also affect the content of the involuntary memories, suggesting an interaction between immediately present contextual cues and longer lasting constraints imposed by the life-situation of the individual (Berntsen, 2007). Fifth, compared with voluntary autobiographical memories, involuntary memories are more frequently about specific episodes and they tend to have more mood impact at the time of retrieval (e.g., Berntsen & Hall, 2004). They are also often rated as less central to the life story and identity (Berntsen, 2009, 2012, for reviews). Most likely, these differences are caused by the fact that the retrieval of the involuntary memories generally needs a distinct cue-item match (Berntsen, Staugaard & Sørensen, 2012) that may favor specific episodes over more abstract event knowledge as well as the fact that the rapid and uncontrollable retrieval of involuntary memories leaves little room for antecedent emotion regulation (see Berntsen, 2009, 2012, for extended discussions).

In summary, involuntary autobiographical memories are common in daily life, their activation is facilitated by situational cues and they typically arise in situations with diffuse attention. They share many characteristics with voluntary autobiographical memories, such as a dominance of emotionally positive events, but are the result of a more associative and context-sensitive form of retrieval that requires less effort.

Imaginations of possible future events, often called episodic future thoughts (Atance & O'Neill, 2001; Szpunar, 2010), also come to mind involuntarily during everyday activities (Berntsen & Jacobsen, 2008; Finnbogadottir & Berntsen, 2011). They appear to take place as frequently as involuntary memories (Finnbogadottir & Berntsen, 2013) and their occurrence seems strikingly similar to the involuntary memories. As with memories, they typically arise in response to situational features that overlap with features of their content (such as imagining receiving a speeding ticket, while speeding on the motorway) and in situations that require less concentration. Berntsen and Jacobsen (2008) found that their phenomenological characteristics differ from the characteristics of voluntary future thoughts in ways that parallel differences observed between involuntary and voluntary autobiographical memories in that the involuntarily generated future and past events more frequently referred to specific episodes and involved more (negative) mood impact than the voluntary counterparts. This agrees with research showing that episodic remembering and future thinking are affected similarly by at least some retrieval manipulations (see D'Armentau, 2012; Szpunar, 2010, for reviews).

### 1.1. Frequency of involuntary memories and future thoughts

Involuntary autobiographical memories are at least as frequent in daily life as autobiographical memories that are deliberately (voluntarily) retrieved (e.g., Rasmussen & Berntsen, 2011; Rasmussen, Ramsgaard, Berntsen, 2015; Rubin & Berntsen, 2009), although measures of their frequencies tend to vary with the amount of effort imposed by the recording task (Rasmussen et al., 2015). Importantly, substantial individual variability is seen, both when involuntary memories are recorded in real time in diary studies and retrospectively in survey studies (see Rasmussen et al., 2015, for a review). Only few studies have analyzed dispositional and demographic correlates of this variability.

In a diary study, Schlagman et al. (2009) found that older compared with younger participants reported fewer voluntary memories, but not fewer fully recorded involuntary memories. Yet, when taking into account uncompleted involuntary memory records (marked off with a tick), the older adults had significantly fewer involuntary memories. However, the older participants also had fewer years of education than the younger participants (who all were psychology students), which may have affected the results. In a survey study involving representative samples of more than 1000 Danes between the ages of 15 and 96 years, no effects of age was seen on the reported frequencies of involuntary and voluntary remembering of a specific recent and remote personal event. In a similar study, Berntsen and Rubin (2002) observed a general trend toward

a decrease in the reported frequency of involuntary memories across age caused by slightly higher scores among participants in their 20s and 30s. They did not observe an aging effect in terms of a decline in older adults.

In terms of factors other than age, [Mace, Bernas, and Clevinger \(2014\)](#) found that undergraduates reported fewer involuntary memories than graduate students in a diary study, and that the groups differed regarding the nature of the reported cues. [Kamiya \(2014\)](#) found that frequencies of involuntary memories reported during a walk across campus correlated with measures probing cognitive failure and everyday forgetting. In a recent survey study, [Hyman et al. \(2015\)](#) reported weak positive correlations between the frequency of experiencing spontaneous musical imagery and the frequency of experiencing involuntary future events and memories.

In a diary study of involuntary memories of previously presented emotionally negative pictures, [Hall and Berntsen \(2008\)](#) found a positive correlation between trait dissociation and the frequency of involuntary picture memories. A similar relation with trait dissociation and negative memories was reported by [Brewin and Soni \(2011\)](#) in a study of involuntary autobiographical memories activated during an association task. [Finnbogadottir and Berntsen \(2013\)](#) examined the relation between the frequency of involuntary autobiographical memories and future thoughts reported in a diary study and several measures of negative affectivity and personality. None of these measures correlated with the overall frequencies of memories or future thoughts. Measures of poor attentional control and negative daydreaming (i.e., two subscales of the Short Imaginal Processes Inventory; [Huba, Singer, Aneshensel, & Antrobus, 1982](#)) correlated with the raw frequencies of memories and future thoughts that were rated as negative. In addition, the proportions of memories and future thoughts that were rated as negative correlated positively with measures of depression and poor attentional control, and negatively with agreeableness and conscientiousness.

In short, findings regarding correlates of individual differences in the frequency of involuntary autobiographical memories are sparse and mixed. Possible reasons are the usage of different sampling methods as well as the reliance on methods that are too time-consuming to allow the inclusion of large participant samples.

### 1.2. Daydreaming and mind wandering

Involuntary autobiographical memories and future thoughts can be seen as related to the notions of mind wandering (e.g., [Smallwood & Schooler, 2006](#)), daydreaming (e.g., [Singer, 1966](#)) and task-unrelated images and thought (e.g., [Giambra, 1993](#)), which all refer to thought processes that arise in the absence of specific situational demands. The notions of daydreaming, mind wandering and task-unrelated thoughts are conceptually and empirically highly similar in that they are all broadly defined as the mental contents that occur when attention shifts away from a primary task and the person instead engages in private and internal thought processes (e.g., [Antrobus, Singer, Goldstein, & Fortgang, 1970](#); [Giambra, 1993](#); [Singer, 1966](#); [Smallwood & Schooler, 2006](#); see [McMillan, Kaufman, & Singer, 2013](#), for a recent review). However, these notions differ from the concepts of involuntary autobiographical memories and involuntary future thoughts in several important ways.

First, the mental contents of daydreaming or mind wandering need not be episodic or autobiographical (e.g., [Singer, 1966](#)). In contrast, involuntary autobiographical memories and involuntary future thoughts by definition involve a mental experience of a personal event. Second, daydreaming and mind wandering can be volitional in that the person can intentionally choose to disengage from an external task in order to pursue an internal stream of thought (e.g., [McMillan et al., 2013](#)), whereas involuntary autobiographical memories and involuntary future thoughts by definition are unintentional. Third, sustained mind wandering involves the recruitment of a frontal–parietal control network ([Smallwood, Brown, Baird, & Schooler, 2012](#)), whereas involuntary episodic memories take place with little neural activation associated with strategic control ([Hall et al., 2014](#)). Fourth, daydreaming episodes are often prolonged. Indeed there is converging evidence that we spend about a third of our waking hours daydreaming ([Kane et al., 2007](#); [Klinger, 1978](#)). In contrast, involuntary memories and involuntary future thoughts are typically short-lived mental manifestations that last a few seconds and need to be recorded immediately in order to prevent forgetting ([Berntsen, 2009](#)). Fifth, by definition, daydreaming and mind wandering are unrelated to the ongoing task. In contrast, involuntary autobiographical memories can be triggered by, and serve important functions for, an ongoing task ([Hintzman, 2011](#); [Rasmussen & Berntsen, 2009](#); [Schanck, 1982](#)).

The propensity for daydreaming is robustly and positively related to a tendency for experiencing negative affect ([Giambra & Traynor, 1978](#); [Killingsworth & Gilbert, 2010](#); [Stawarczyk, Majerus, Van der Linden & D'Argembeau, 2012](#)) although the causal relationship between negative affect and daydreaming is unclear (e.g., [Poterio, Totterdell, & Miles, 2013](#); [Smallwood, Fitzgerald, Miles, & Phillips, 2009](#)). Furthermore, a robust negative relation is seen between age and the frequency of task-unrelated thoughts and images ([Giambra, 1989, 1993](#)). However, it is unclear whether these relationships generalize to involuntary autobiographical memories and involuntary future thoughts because of the conceptual and empirical differences delineated above.

## 2. Overview of the present studies

The development of a reliable inventory for the frequency of involuntary memories and involuntary future thoughts will help to address problems left unresolved by previous research by allowing more systematic and robust measurements with larger participant samples. In addition, it will help to clarify the relation of involuntary autobiographical memories and involuntary future thoughts to other forms of thought processes that arise without specific situational demands.

In Study 1 we describe the development of the IAMI. We show that the IAMI has good psychometric properties. Factor analyses show two highly correlated factors corresponding to the past versus future dimensions of the scale. In Study 2 we examine the relation between the IAMI and measures of daydreaming, posttraumatic stress disorder (PTSD), trait dissociation, suppression of unwanted thoughts as well as its relation with voluntary (deliberate) remembering and future thinking. We show that the IAMI is positively related to these measures, and that involuntary and voluntary remembering and imagining show a similar correlational pattern to these measures. In Study 3 we examine the relations between the IAMI and measures of emotional distress and negative thinking style (i.e., rumination, worry, depression and anxiety). We show that the frequency with which people engage in remembering their past or imagining their future are related to emotional distress and negative thinking style, irrespective of whether remembering and imagining are initiated involuntarily or involuntarily. This finding challenges the view that engaging in autobiographical remembering and future thinking generally are adaptive as well as the view that involuntary remembering (and involuntary imagining) is uniquely associated with emotional distress. In Study 4 we examine the relation between the IAMI and aging. We show that involuntary autobiographical remembering forms an exception from other forms of spontaneous thoughts, such as daydreaming, by not showing a decline with age. Furthermore, in contrast to involuntary autobiographical remembering, the frequency of future thoughts decreases with age, which underscores the importance of examining past and future mental time travel in a life span perspective.

The present series of studies all used on-line survey data from participants recruited through Amazon's Mechanical Turk. This facility provides an easy and low cost access to a large, stable and diverse subject pool in the USA. Subjects themselves create a profile as workers and have access to a variety of tasks created and advertised by different individuals, companies or institutions. Subjects willing to engage in tasks posted in Amazon's Mechanical Turk are paid according to the time they use (the calculated rate, for the time these studies were conducted was of USD \$ 2.4 per hour according to the forums for requesters in the website); however, requesters might decide on other sums. An increasing amount of research, also in autobiographical memory (e.g. Grysman, 2014; Grysman, Prabhakar, Anglin, & Hudson, 2014), supports the quality of data obtained through Amazon's Mechanical Turk by showing that it is as high as the quality of data obtained through more conventional means (see Mason & Suri, 2012 for a review) and by showing that Amazon's Mechanical Turk respondents are generally highly motivated participants (Buhrmester, Kwang, & Gosling, 2011; Ipeirotis, 2010). In the present series of studies, the validity of our findings is supported by the fact that we replicate many previous findings in the literature and that our findings replicate across the four studies, when the same measures are used.

### 3. Study 1

#### 3.1. Methods

##### 3.1.1. Scale development

We developed the IAMI from well-established findings on the retrieval of involuntary autobiographical memories and future thoughts in daily life. As reviewed in the introduction, involuntary memories and the future thoughts both typically come to mind in response to identifiable cues and in situations with diffuse attention. In addition, they may be affected by recent salient personal events or current concerns. We first generated 34 questions based on these characteristics, 17 for involuntary memories of past events and 17 for involuntary future thoughts. The questions for the memories and the future thoughts were exactly the same, except for the temporal references of whether the target was a memory of a past event or an event imagined to take place in the future. Of the 17 past–future question pairs, four pairs (8 items) reflected states of diffuse attention that typically precede involuntary memories or involuntary future thoughts, seven pairs described situations with different, but common, types of cueing, three pairs described ways in which involuntary remembering or future thinking may relate to recent salient events, and three pairs were of a general nature. This variety of items allowed us to probe for the involuntary memories and future thoughts along a number of domains with empirically well-established relevance for the phenomenon (e.g., Berntsen, 2012). Each question was rated on a five point scale indicating its frequency. We piloted this version of the inventory on a sample of 96 Amazon's Mechanical Turk participants and found excellent internal consistencies, Cronbach's Alpha = .98. We therefore reasoned that it was possible to reduce the inventory from 34 items to 20 items (10 past–future pairs) with no serious loss of reliability or information. This reduced version reflected the range of domains described above: Three past–future pairs described situations with diffuse attention, four pairs described situations with different kinds of cueing, two pairs described ways in which involuntary remembering or imagining may relate to recent salient events, and one pair was of general nature. The final 20 item inventory is presented in Table 1. Each question is rated on the following scale: Never (0), Once a month or more (1), Once a week or more (2), Once a day or more (3), Once an hour or more (4). This rating scale was selected to represent easy to conceptualize time markers of colloquial language that in pilot testing produced near normal distributions.

##### 3.1.2. Participants

Based on pilot work, we decided to limit our participants to those under 65 years of age and to those who took less than 10 min to complete the task, because there were few observations outside of these values. Advance settings prevented participants who had participated in the pilot study to see the advertised task and thus also prevented them to take the survey

**Table 1**The Involuntary Autobiographical Memory Inventory<sup>a</sup> (correlations with scale total).**Instructions:**

The following questions address how frequently memories and imagined future events come to your mind by themselves (without trying) during daily life. For each question, please use the response option that best fit your experience of the frequency

## Questions (1–20)

1. When I am relaxing or doing routine work, imaginary future events come to my mind by themselves—without me consciously trying to evoke them (0.74)
2. Memories of personal events pop into my mind by themselves—without me consciously trying to remember them (0.69)
3. Some locations or places bring imaginary future events to mind—without me consciously trying to evoke them (0.71)
4. After something surprising has happened, I spontaneously remember it, without consciously trying. It just comes to me (0.65)
5. Imaginary future events pop into my mind by themselves—without me consciously trying to evoke them (0.78)
6. Some emotions, moods or thoughts bring imaginary future events to mind—without me consciously trying to evoke them (0.77)
7. When I am bored, imaginary future events come to my mind by themselves—without me consciously trying to evoke them (0.70)
8. After I have experienced something that made a strong impression, I spontaneously remember it, without consciously trying. It just comes to me (0.62)
9. Some emotions, moods or thoughts bring memories of past events to mind—without me consciously trying to remember them (0.69)
10. When I am physically active, for example walking, bicycling, or running, imaginary future event come to my mind by themselves—without me consciously trying to evoke them (0.70)
11. Listening to some music or songs bring memories of past events to mind—without me consciously trying to remember them (0.59)
12. After something surprising has happened, I spontaneously imagine related events in the future, without consciously trying. It just comes to me (0.75)
13. When I am relaxing or doing routine work, memories of past events come to my mind by themselves—without me consciously trying to remember them (0.74)
14. When I am bored, memories of past events come to my mind by themselves—without me consciously trying to remember them (0.68)
15. Some sensory experiences, such as certain odors or tastes, bring imaginary future events to mind—without me consciously trying to evoke them (0.67)
16. After I have experienced something that made a strong impression, I spontaneously imagine related events in the future, without consciously trying. It just comes to me (0.75)
17. When I am physically active, for example walking, bicycling, or running, memories of past events come to my mind by themselves—without me consciously trying to remember them (0.71)
18. Listening to some music or songs bring imaginary future events to mind—without me consciously trying to evoke them (0.70)
19. Some locations or places bring memories of past events to mind—without me consciously trying to remember them (0.64)
20. Some sensory experiences, such as some odors or tastes, bring memories of past events to mind—without me consciously trying to remember them (0.66)

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Each question is rated on the following (0–4) scale: Never (0), Once a month or more (1), Once a week or more (2), Once a day or more (3), Once an hour or more (4).

<sup>a</sup> The copyright for the scale is held by the authors (© 2015, Berntsen, Rubin & Salgado). Permission is given to use the scale for research purposes.

again. We recruited from those who had computer addresses indicating they were in the USA, and excluded any participants who reported their nationality as other than U.S. American or native language as other than English, or who answered all 20 questions with the same rating. We enrolled participants until we had 200 who met these requirements and completed the task. In doing this we excluded four people based on nationality and language, three who were older than 65, ten who took longer than ten minutes, and four people who answered all 20 items with the same rating. The mean age of our 200 participants (79 female) was 33.73 (median: 31, standard deviation: 10.88, range: 19–64). They took an average of 3.61 min to complete the task (median: 3.16, standard deviation: 1.79, range: 1.05–9.78).

### 3.1.3. Procedure

A task was created and advertised in Mechanical Turk. It briefly described to the potential participants the details about the task, what was expected to be done, the approximate time that it might take and the expected compensation that they would receive if they completed the task. Subjects who wanted to take part in the study were directed to an external website (Survey Monkey) to complete the on-line survey. After agreeing with a consent form and providing demographic information, participants were instructed to read carefully each of the questions to be presented and to respond using the option that best fitted their experience of their frequency of memories or imagined future events, respectively. They then were presented with the 20 items of the IAMI, one item at a time. Upon completion, participants were given a code that they provided in Mechanical Turk so we could validate they had completed the task and, hence, only pay workers who had completed it. This also functioned as a first filter to exclude participants from the data to be analyzed. Participants who provided a valid code were paid 1.00 USD.

## 3.2. Results

### 3.2.1. Basic statistics and reliability

The IAMI was designed as a single scale measuring the overall frequency of future and past involuntary events, with clearly defined and closely matched future and past subscales. The mean, standard deviation, and range for the full 20 item scale and the 10 item future and past scales are: Full:  $M = 1.92$ ,  $SD = 0.69$ , range = 0.05–3.95; Future:  $M = 1.80$ ,  $SD = 0.79$ ,



range = 0.00–3.90; and Past:  $M = 2.04$ ,  $SD = 0.66$ , range = 1.00–4.00, respectively. The ratings of the past items were higher than the future items,  $t(199) = 6.89$ ,  $p < .0001$ ,  $d = 0.49$ .

Cronbach's Alphas for the full 20 item scale and the 10 item future and past scales were 0.95, 0.94 and 0.92, respectively. The two scales correlated,  $r = .78$ ,  $p < .0001$ . The time taken to complete the scale varied widely; to check that it was not a factor in our results, we divided the 200 participant into 10 groups of 20 based on how long they took, and computed Cronbach's Alpha for each group. This showed no trend based on time taken; the alphas for the shortest to longest duration groups were: .94, .90, .96, .96, .95, .96, .96, .97, .95, and .96.

The first panel of Fig. 1 provides the distribution of all 2000 responses (10 items by 200 participants) across the five possible rating scale categories to both the future and past items. Both the future and past distribution appear approximately normal with some, but not many, 'never' and 'about once an hour' responses. Thus, the standard time terms of English provide a reasonable way for participants to code their responses. The second panel of Fig. 1 provides the distribution for the 200 participants' means for the future and past scales, divided into eight bins (e.g., the frequency of means between 0 and 0.5 are represented in the first bin). Again the distribution appears near normal with a good range of responses.

### 3.2.2. Confirmatory factor analysis

We examined the latent structure of the 20 items using confirmatory factor analysis (CFA) with maximum likelihood estimation. We evaluated goodness of fit using the comparative fit index (CFI; Bentler, 1990), for which values greater than .90 indicate acceptable fit, and the standardized root mean-square residual (SRMR), for which values less than .06 indicate acceptable fit (Hu & Bentler, 1999). We compared nested models using chi-square difference tests.

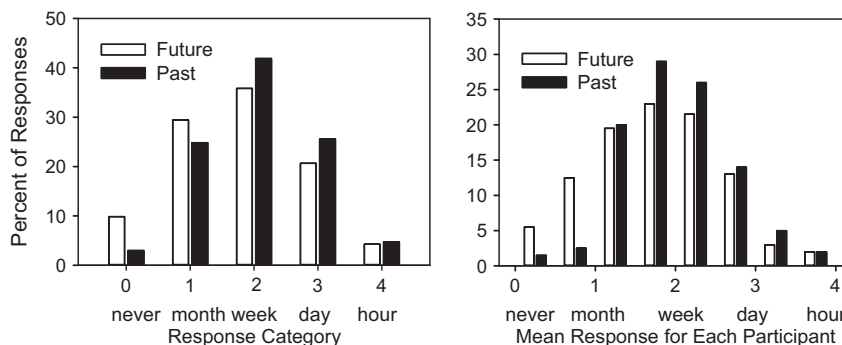
The focal model includes two correlated factors representing reports of past and future items; each item loads only on the relevant factor (i.e., no cross loadings). Because the wording of pairs of items is identical except for the reference to past or future, we would expect any systematic variance not accounted for by the factors to be correlated. As such, the focal model includes 10 covariances between the uniquenesses associated with pairs of indicators that differ only with reference to past or future. We compared the focal model to two nested models, one with no correlated uniquenesses and one with a single factor.

The focal model offered an acceptable account of the data,  $\chi^2(159, N = 200) = 383.97$ ,  $p < .001$ , CFI = .924, SRMR = .055. All loadings were significant and comparable between factors, ranging from .65 to .84. The correlation between factors was  $r = .82$ . Eight of the 10 covariances between uniquenesses associated with item pairs were significant. A comparison between the focal model and one in which these covariances were fixed at zero resulted in a highly significant difference,  $\Delta\chi^2(10, N = 200) = 305.96$ ,  $p < .001$ , favoring the focal model. Similarly, a model with only one factor (retaining the 10 covariances between uniquenesses), fit more poorly than the focal model,  $\Delta\chi^2(1, N = 200) = 303.04$ ,  $p < .001$ . Neither of these two alternatives offered an acceptable fit to the data in an absolute sense (CFIs were .82).

### 3.3. Summary and discussion

The internal consistencies of the overall IAMI as well as of the two subscales for past and future temporal direction were high. Confirmatory factor analyses revealed two correlated factors, corresponding to the past versus future dimensions of the scale. These two factors were strongly correlated with one another, consistent with research showing that remembering the personal past and imagining the personal future are highly related processes (see Szpunar, 2010, for a review).

The mean ratings of items probing the frequency of involuntary memories of past events were slightly, but reliably, higher than those probing future thoughts. This is partly inconsistent with Finnbogadottir and Berntsen (2013) who found no reliable differences between involuntary memories and future thoughts in a diary study. This discrepancy may reflect the use of different measurements as well as the fact that the sample in Finnbogadottir and Berntsen (2013) consisted of students, whereas



**Fig. 1.** The distribution of responses. The left panel shows the distribution of the 2000 future and 2000 past individual responses on the 0–4 scales. The right panel shows the distribution of the mean response of the 200 participants to the future and past scales. Cutoffs for the 8 categories were <.5, <1.0, <1.5, <2.0, <2.5, <3.0, <3.5, and >3.5.

the present sample was a community sample with a more mixed age distribution and a higher mean age, and it is possible that the tendency to having involuntary future thoughts decreases with age (a question we pursue in Study 4).

In sum, the IAMI has excellent psychometric properties. In Studies 2–4 we use the scale to examine how the frequency of involuntary autobiographical memories and involuntary future thoughts correlate with theoretically related phenomena.

## 4. Study 2

Study 2 was undertaken to examine the relation between the IAMI and daydreaming and other forms of unprompted or uncontrollable thoughts. Because daydreaming and mind wandering are highly similar concepts, and because systematic research on daydreaming predates the more recent explorations of mind wandering (McMillan et al., 2013) we use the term daydreaming in the following as a referent to thoughts and images that occur when attention drifts away from an immediate task. In addition to a measure of daydreaming frequency (Giambra, 1993), we include a set of measures that all probe unwanted or uncontrollable aspects of thinking. First, we include a measure of the propensity of having unwanted thoughts and exerting thought suppression (Wegner & Zanakos, 1994). Having unwanted thoughts and attempting to suppress them likely involves a shift in attention from an ongoing external situation toward a private stream of thought as is the case with daydreaming. In addition, it involves thoughts and images that are unwanted and thus, by definition, involuntary. Second, we also include a measure of the frequency of having dissociative experiences in everyday life (Carlson & Putnam, 1993) because this phenomenon too involves thought processes that are uncontrollable and because mild forms of dissociative experiences may be viewed as episodes of daydreaming (Waller, Putnam, & Carlson, 1996). Third, because involuntary autobiographical memories historically have been associated with PTSD and have been ascribed a key role in the processing of negative, stressful events (e.g., Horowitz, 1975, 1976, see Berntsen, 2009, for a review) and because a key symptom of PTSD is intrusive, involuntary memories of the trauma, we also included a measure of PTSD symptoms in our battery of inventories in Study 2.

We expected these measures to have positive correlations with the IAMI. If so, this would be open to different interpretations. First, such correlations could reflect that these other measures along with the IAMI probe thought processes that are involuntary and uncontrollable. Second, and alternatively, they might reflect that both the IAMI and these other thought processes deal with autobiographical events. If so, positive correlations between these measures and the IAMI would reflect a general tendency to think about the personal past and future, irrespective of the involuntary nature of the retrieval process. To resolve this ambiguity we included a set of voluntary control questions probing the same autobiographical contents as the IAMI, but through voluntary retrieval. Third, daydreaming, PTSD symptoms, dissociation and thought suppression are all associated with emotional distress (e.g., Carlson & Putnam, 1993; Giambra & Traynor, 1978; Killingsworth & Gilbert, 2010; Purdon, 1999; Rubin, Boals, & Hoyle, 2014; Stawarczyk, Majerus, Van der Linden & D'Argembeau, 2012) for which reason correlations with the IAMI might reflect that it too is associated with emotional distress. If so, this would agree with a long tradition for viewing involuntary remembering as a response to negative emotional events, such as observed in the case of intrusive involuntary memories of traumatic events in PTSD (Berntsen & Rubin, 2014). In order to explore this possibility, we included questions that probed the emotional contents of the remembered and imagined events.

### 4.1. Methods

#### 4.1.1. Participants

As in Study 1, participants were recruited through Amazon's Mechanical Turk. The task was available only to participants in the USA and to those who had not participated in the pilot studies or in Study 1. We excluded participants who reported their native nationality as other than U.S. American or their native language as other than English, or who answered all questions of either IAMI or its voluntary counterparts with the same ratings. Also, participants above 65 years of age were excluded, yielding a final sample of 200 participants (103 females) with a mean age of 34.50, median: 32, standard deviation: 10.01, range: 21–63.

#### 4.1.2. Materials

In addition to the IAMI, the following instruments were included. Their internal consistencies (Cronbach's Alpha) are presented in Table 3.

*Daydreaming Frequency Scale* (DDFS, Giambra, 1993, adapted from Singer & Antrobus, 1970) is a 12 item questionnaire addressing the frequency of daydreaming in everyday life, such as "I lose myself in active daydreaming". Each item is answered on a five point scale (0–4) indicating frequency. The sum score can range from 0 to 48.

The *PTSD Checklist for DSM-5* (PCL-5; Weathers et al., 2013) is a 20-item self-report measure that assesses the 20 DSM-5 symptoms of PTSD. The participants are asked to assess how much they were bothered by the symptom over the last month, such as having "repeated, disturbing, and unwanted memories of the stressful experience". Each item is assessed on a severity scale ranging from 0 ('not at all') to 4 ('extremely'). The sum score ranges from 0 to 80.

The *White Bear Suppression Inventory* (WBSI; Wegner & Zanakos, 1994) is a 15-item self-report measure that assesses the tendency to exert chronic thought suppression. The participants are asked to rate questions, such as "there are thoughts that keep jumping into my head" on a 5-point scale, from strongly disagree (1) to strongly agree (5). The sum score ranges from 15 to 75.

The *Revised Dissociative Experiences Scale* (DES II; Carlson & Putnam, 1993) is a 28 item scale measuring the frequency of dissociative experiences in everyday life. Each item describes a situation indicating an experience of dissociation, such as “Some people have the experience of finding themselves in a place and having no idea how they got there”. Each item is rated on a scale from 0% to 100%, indicating the percentage of time the person experiences the dissociative experience in question. The score is the mean of the 28 items.

The *Voluntary Control Questions* were 10 questions generated for the purpose of the present study in order to provide a comparison between the IAMI and measures of voluntary (deliberate) remembering and imagining of past and future events. As in the IAMI, half of the questions were directed toward the past and the other half toward the future. The questions for past and future were formulated similarly except for the temporal reference. The questions were generated to be as close as possible to formulations in the IAMI, except for the emphasis on voluntary deliberate retrieval. We constructed the questions to probe the same domains as the IAMI. The 10 questions are presented in Table 2. Each question was rated on the same (0–4) frequency scale as the items in the IAMI. We report the means to allow comparisons with the IAMI.

The *Emotional Valence and Emotional Intensity* of the involuntary memories and future thoughts were addressed using four items. These four single item scales were answered immediately after completing the IAMI and the following instructions: “You have just answered a series of questions about how frequently past and future events come to your mind by themselves—without you trying to have them. Half of the items were about past events and half about possible future events. We now ask about the past and future events separately”. The four questions were as follows: “1. For the spontaneously arising memories of past events, in general how positive or negative were the memories?” (Scale: –2 extremely negative, –1 somewhat negative, 0 neutral, +1 somewhat positive, +2 extremely positive.) “2. For the spontaneously arising memories of past events, in general how emotionally intense were the memories?” (Scale: 0 not at all intense, 1 mildly intense, 2 moderately intense, 3 very intense, 4 extremely intense). “3. For the spontaneously arising imaginations of possible future events, in general how positive or negative were the imaginations?” (to be rated on the same scale as the past directed valence question). “4. For the spontaneously arising imaginations of future events, in general how emotionally intense were the imaginations?” (to be rated on the same scale as the past directed intensity question).

#### 4.1.3. Procedure

As in Study 1, the task was advertised on Amazon’s Mechanical Turk and participants were directed to an external website to complete the survey. After agreeing with a consent form and providing demographic information, participants proceeded to answer the batteries of scales. The scales were presented in the following order: IAMI, emotional valence and intensity of the IAMI items for past, emotional valence and intensity of the IAMI items for future, the DDFS, the PCL-5, the WBSI, the DES II, and, finally, the voluntary control questions. A brief instruction preceded the presentation of each scale. All questions in all scales were presented one at the time, except for the questions related to the emotional valence and intensity of the IAMI, which were presented on the same screen to provide a contrast of what was being asked in each item. The participants who completed the task were paid 1.70 USD for their participation, following the same procedure as described in Study 1.

#### 4.2. Results

We first examine the correlations between the IAMI and the included measures of daydreaming, thought suppression and PTSD symptoms. Second, we examine whether similar correlations are seen for the voluntary control questions, in order to decide whether they are specific for involuntary retrieval. Third, we examine correlations between the emotion ratings for the events and the IAMI in order to examine if individuals with more frequent involuntarily remembered and imagined

**Table 2**

The voluntary control questions.<sup>a</sup>

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**Instructions:**  
The following questions address how frequently memories and imagined events come to your mind when purposely trying to generate them during daily life. For each question, please use the response option that best fit your experience of the frequency

Questions (1–10)

1. When I am bored or doing dull work, I willfully and deliberately think ahead to possible events in my future and try to imagine them
2. After an event has happened, I willfully and deliberately think back to it in my mind and try to remember it
3. When I am bored or doing dull work, I willfully and deliberately think back to past experiences and try to remember them
4. After something surprising has happened, I willfully and deliberately think ahead and try to imagine related events in the future
5. When I am relaxing or doing routine work, I willfully and deliberately think ahead to possible events in my future and try to imagine them
6. Before an event has happened, I willfully and deliberately think ahead to it in my mind and try to imagine it
7. When I am listening to some music or songs, I willfully and deliberately think ahead to possible events in my future and try to imagine them
8. After something surprising has happened, I willfully and deliberately think back to it in my mind and try to remember it
9. When I am listening to some music or songs, I willfully and deliberately think back to past experiences and try to remember them
10. When I am relaxing or doing routine work, I willfully and deliberately think back to past experiences and try to remember them

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Each questions is rated on the following (0–4) scale: Never (0), Once a month or more (1), Once a week or more (2), Once a day or more (3), Once an hour or more (4).

<sup>a</sup> The copyright for the scale is held by the authors (© 2015, Berntsen, Rubin & Salgado). Permission is given to use the scale for research purposes.



events also rate these events as more negative, which would agree with the view that involuntary mental time travel is a response to negative, stressful events (e.g., Horowitz, 1976), but is counter to our prediction based on previous work (e.g., Berntsen & Rubin, 2014; Hall & Berntsen, 2008; Rubin et al., 2008). Fourth, we compare the future and past directed parts of the scale to examine if involuntary memories are rated as more frequent than involuntary future events, consistent with Study 1. We also compare the emotion ratings for the future and past events in order to examine if the future events are rated as more positive, consistent with previous research (e.g., Berntsen & Jacobsen, 2008; Berntsen & Bohn, 2010).

The correlations between the IAMI, its past and future directed subscales and the included psychometric measures are shown in Table 3 (additional correlations are reported in the text). All correlations are either significant at least at the  $p < .001$  level or are not significant at the  $p < .05$  level suggesting a clear distinction between effects we observe and those we do not, and not a continuum of significance aided by a large sample size. Strong positive correlations were found between the DDFS and the IAMI, including its future and past subscales. The IAMI also correlated strongly with the voluntary control questions. Moderate sized correlations were found between the IAMI and the PCL5, the WBSI, and the DES II (see Table 3). Importantly, the correlations between the voluntary control questions and these measures were comparable to the ones of the IAMI (coefficients not shown in Table 3: DDFS: .52; PCL5: .31; WBSI: .28; DES II: .35, all  $ps < .0001$ ). This is consistent with the view that involuntary and voluntary remembering operate on the same underlying memory system and thus respond similarly to dispositions affecting this system (Berntsen, 2009).

The IAMI did not correlate significantly with the emotional valence of either the past or future events, and only modestly with the emotional intensity of the events (Table 3). However, as expected, both the past ( $-.36, p < .0001$ ) and the future ( $-.26, p < .0001$ ) valence correlated negatively with the PCL5. Valence also correlated negatively with the WBSI, but only significantly for the past ( $-.36, p < .0001$ ), not for the future ( $-.08, p > .2$ ).

As in Study 1, the mean scores for the past directed IAMI were higher than the corresponding score for the future directed IAMI,  $t(199) = 6.92, p < .0001, d = 0.49$  (see Table 3 for means and standard deviations). Thus, people more frequently experience involuntary memories than involuntary future thoughts, according to their own ratings. The emotion ratings showed that the future directed IAMI was associated with more positive events than the past directed IAMI,  $t(199) = 8.00, p < .0001, d = 0.57$  (see Table 3 for means and standard deviations). This is consistent with previous research showing a general positivity bias for future episodic thinking compared with autobiographical remembering of the past (e.g., Berntsen & Bohn, 2010). Keeping with previous research (Berntsen & Bohn, 2010), the ratings of intensity were higher for the past than for the future,  $t(199) = 3.72, p < .0005, d = 0.26$  (see Table 3).

#### 4.3. Summary and discussion

As expected we found positive correlations between the IAMI and the measures of daydreaming, thought suppression, dissociation and PTSD symptoms. Also consistent with our predictions, the voluntary control questions correlated highly with the IAMI and showed the same pattern of correlations with the other measures as the IAMI, consistent with the view that involuntary and voluntary remembering operate on the same underlying memory system (Berntsen, 2009).

Only measures of PTSD symptoms and thought suppression were associated with the emotional valence of the involuntary memories and future thoughts. PTSD symptoms were negatively correlated with valence of both memories and future thoughts, whereas thought suppression showed this relation only for the memories.

Also, consistent with previous work, valence was rated as more positive for future thoughts than for memories, whereas a difference in the opposite direction was found for emotional intensity. As in Study 1, involuntary memories were rated as more frequent on the IAMI than the involuntary future thoughts.

The correlations between the measure of daydreaming and both the IAMI and the voluntary control questions were especially strong. This raises the question as to how the IAMI and the voluntary control questions relate to well-established correlates of daydreaming. One robust finding is a positive correlation between the frequency of daydreaming and general measures of negative affect, such as depression (Giambra & Traynor, 1978; Killingsworth & Gilbert, 2010; Stawarczyk et al., 2012). If the IAMI, but not the voluntary control questions, showed a similar pattern, this would be consistent with a long history for associating involuntary (but not voluntary) autobiographical memories with emotional distress and unresolved personal concerns so that individuals with higher levels of emotional distress or unresolved problems would be likely to more frequently experience involuntary memories and involuntary future thoughts, but not their voluntary counterparts (see Berntsen, 2009, for a review). In contrast, if voluntary and involuntary memories (and their future counterparts) are both more frequent among individuals with higher levels of emotional distress, this would be consistent with the alternative view that voluntary and involuntary retrieval operate on the same underlying structures and therefore may be affected similarly by a disposition to experience negative affect (e.g., Berntsen, 2009; Berntsen & Rubin, 2014). Study 3 was conducted to clarify these issues.

### 5. Study 3

The goal of the present study was to examine the relation between the IAMI and measures of emotional distress and negative thinking style. On the basis of well-established positive associations between negative affect and daydreaming (Giambra & Traynor, 1978; Killingsworth & Gilbert, 2010; Stawarczyk et al., 2012), we expected to find positive correlations

**Table 3**

Means, standard deviations, and Cronbach Alphas of measures included in Study 2 and their correlations with the total IAMI and the past- and future directed IAMI subscales.

Measures	<i>M</i>	<i>SD</i>	$\alpha$	Total	Past	Future
IAMI	1.86	0.71	.95	–	–	–
Past IAMI	1.99	0.68	.90	.93 <sup>****</sup>	–	–
Future IAMI	1.74	0.82	.93	.95 <sup>****</sup>	.78 <sup>****</sup>	–
DDFS	22.61	10.26	.94	.54 <sup>****</sup>	.45 <sup>****</sup>	.55 <sup>****</sup>
PCL5	19.49	14.06	.94	.34 <sup>****</sup>	.31 <sup>****</sup>	.33 <sup>****</sup>
WBSI	44.08	13.62	.93	.33 <sup>****</sup>	.30 <sup>****</sup>	.32 <sup>****</sup>
DES II	13.03	13.17	.95	.35 <sup>****</sup>	.27 <sup>****</sup>	.38 <sup>****</sup>
Voluntary total	1.66	0.73	.92	.66 <sup>****</sup>	.61 <sup>****</sup>	.61 <sup>****</sup>
Voluntary Past	1.63	0.75	.87	.58 <sup>****</sup>	.59 <sup>****</sup>	.52 <sup>****</sup>
Voluntary Future	1.69	0.81	.86	.62 <sup>****</sup>	.55 <sup>****</sup>	.62 <sup>****</sup>
Valence past	0.04	1.03	N/A	–.03	–.03	–.04
Intensity past	1.87	0.91	N/A	.25 <sup>****</sup>	.25 <sup>****</sup>	.23 <sup>****</sup>
Valence Future	0.78	0.89	N/A	.05	–.03	.09
Intensity Future	1.59	1.01	N/A	.28 <sup>****</sup>	.21 <sup>****</sup>	.32 <sup>****</sup>

Note: *N* = 200; DDFS: Daydreaming Frequency Scale; PCL5: PTSD Checklist for DSM-5; WBSI: White Bear Suppression Inventory; DES II: Revised Dissociative Experiences Scale.

\*\*\*  $p < .001$ .

\*\*\*\*  $p < .0001$ .

between the IAMI and such measures. However, we did not expect these correlations to be unique for the involuntary memories. We expected to find correlations in the same range between our voluntary control questions and these measures, based on the theoretical assumption that involuntary and voluntary autobiographical memory sample from the same underlying memory system and are similarly affected by individual dispositions, unless these have marked effects on executive processes (Berntsen, 2010).

## 5.1. Methods

### 5.1.1. Participants

Participants were recruited through Amazon's Mechanical Turk. The task was available only to participants in the USA and to those who had not participated in any of the previous studies. The inclusion criteria were the same as the ones in Study 2, yielding a final sample of 200 participants (90 females) with a mean age of 33.72, median: 30, standard deviation: 9.44, range: 20–62.

### 5.1.2. Materials

In addition to the IAMI, the voluntary control questions, and the four individual items addressing the emotional valence and intensity of the involuntary memories and future thoughts, which were all included in Study 2, the following instruments were included. Their Cronbach's Alphas are presented in Table 4.

*The Rumination-Reflection Questionnaire* (RRQ; Trapnell & Campbell, 1999) consists of two subscales, rumination and reflection, both measuring heightened attention to the self, and both consisting of 12 items rated on a 5 point scale (with 1 = strongly disagree and 5 = strongly agree). The rumination subscale addresses "self-attentiveness motivated by perceived threats, losses, or injustices to the self" whereas the reflection subscale addresses "self-attentiveness motivated by curiosity or epistemic interest in the self" (Trapnell & Campbell, 1999, p. 297). Rumination includes items such as "My attention is often focused on aspects of myself I wish I'd stop thinking about" whereas reflection includes items such as "I love exploring my "inner" self". Sum scores range from 12 to 60.

*The Penn State Worry Questionnaire* (PSWQ; Meyer, Miller, Metzger, & Borkovec, 1990) consists of 16 items that measure intensity and excessiveness of worry, such as "My worries overwhelm me". Each item is rated on a 5 point scale (1 = 'not at all typical of me' to 5 = 'very typical of me'). Sum scores range from 16 to 80.

*Center for Epidemiologic Studies Depression Scale* (CES-D; Sawyer-Radloff, 1977). The CES-D is a 20-item self-report scale designed to assess symptoms of depression in the general population. The items of the scale describe well-established symptoms associated with depression and the participant is asked to rate how frequently this has happened within the last week, e.g., "I was bothered by things that usually don't bother me". Each item is rated on a 4 point scale (0–3) addressing how frequently the symptom has been experienced over the last week, sum scores range from 0 to 60.

*A Brief Measure for Assessing Generalized Anxiety Disorder* (GAD-7; Spitzer, Kroenke, Williams, & Lowe, 2006) is a 7 item measure used for screening for Generalized Anxiety Disorder (GAD) and assessing its severity in clinical practice as well as in research (Spitzer et al., 2006). The seven items of the scale probe the frequency of symptoms indicative of GAD (e.g., "feeling nervous, anxious or on edge") each to be rated on a 4 point scale from "not at all" (0) to "nearly every day" (3), with sum scores ranging from 0 to 21.

*Centrality of Event Scale* (CES; Berntsen & Rubin, 2006) measures the extent to which a traumatic or stressful memory forms a central component of personal identity, a turning point in the life story and a reference point for everyday inferences.

**Table 4**

Means, standard deviations and Cronbach Alphas of measures included in Study 3 and their correlations with the total IAMI and the past- and future directed IAMI subscales.

Measures	<i>M</i>	<i>SD</i>	$\alpha$	Total	Past	Future
IAMI	1.92	0.63	.94	–	–	–
Past IAMI	2.04	0.60	.88	.91****	–	–
Future IAMI	1.82	0.75	.92	.94****	.73****	–
RRQ-RUM	41.50	9.98	.94	.42****	.39****	.38****
RRQ-REF	40.72	10.14	.94	.27****	.26****	.24****
PSWQ	51.81	15.90	.96	.31****	.26****	.32****
CES-D	15.88	12.34	.95	.21**	.13	.25****
GAD-7	5.91	5.22	.92	.27****	.19**	.30****
CES	3.15	1.12	.94	.26****	.24****	.24****
Voluntary total	1.87	0.67	.89	.65****	.56****	.64****
Voluntary Past	1.86	0.70	.82	.57****	.57****	.50****
Voluntary Future	1.88	0.74	.83	.64****	.48****	.69****
Valence Past	0.49	0.97	N/A	–.14	–.08	–.16*
Intensity past	1.81	0.82	N/A	.31****	.36****	.23****
Valence Future	0.73	0.92	N/A	.07	–.03	.09
Intensity Future	1.78	0.92	N/A	.36****	.21**	.43****

Note: *N* = 200; RRQ-RUM: The Rumination-Reflection Questionnaire: Rumination subscale; RRQ-REF: The Rumination-Reflection Questionnaire: Reflection subscale; PSWQ: The Penn State Worry Questionnaire; CES-D: Center for Epidemiologic Studies Depression Scale; GAD-7: A Brief Measure for Assessing Generalized Anxiety Disorder; CES: Centrality of Event Scale.

\*  $p < .05$ .

\*\*  $p < .01$ .

\*\*\*  $p < .001$ .

\*\*\*\*  $p < .0001$ .

We here use the short version of the CES consisting of 7 items (e.g., “I feel that this event has become part of my identity”) rated on 5 point scales (1 = totally disagree; 5 = totally agree) in relation to the most stressful or traumatic event in the person’s life. We report the average scores.

### 5.1.3. Procedure

The task was advertised on Amazon’s Mechanical Turk and the procedure for data collection and compensation of the participants were the same as in Study 2. The scales were presented in the following order: IAMI, emotional valence and intensity of the IAMI items for past, emotional valence and intensity of the IAMI items for future, the RRQ, the PSWQ, the CES-D, the GAD-7, the CES, and, finally, the voluntary control questions for the IAMI.

### 5.2. Results

We first examine the correlations between the IAMI and the included measures of emotional distress and negative thinking style. Second, as in Study 2, we next examine whether similar correlations are seen for the voluntary control questions, in order to decide whether they are specific for involuntary processes. Third, we examine correlations between the IAMI and the emotion ratings for the remembered and imagined events in order to examine if individuals with more frequent involuntary past and future events also rate these events as more negative. Following Study 2 and the view that involuntary memories are a basic mode of remembering (e.g., Berntsen, 2009; Berntsen, 2010) we do not predict this to be the case. However, we expect the emotion ratings of the events to correlate negatively with the included measures of emotional distress and negative thinking style. Fourth, we compare the future and past directed parts of the scale to examine if involuntary memories are rated as more frequent than involuntary future events, consistent with Studies 1 and 2. We also compare the emotion ratings for the future and past events and expect the future events to be rated as more positive, as found in Study 2 as well as in previous work (e.g., Berntsen & Jacobsen, 2008; Berntsen & Bohn, 2010).

Moderate to strong positive correlations were found between the IAMI and the included measures of emotional distress and negative thinking style (Table 4). As expected, a largely similar pattern of correlations was observed between these measures and the voluntary control questions, with correlation coefficients in the same range as for the IAMI (RRQ-RUM: .34; RRQ-REF: .29; PSWQ: .23; GAD-7: .20; CES: .17, all  $ps < .05$ ). There was only one deviation from this pattern: The correlation between the voluntary control questions and the CES-D ( $r = .10$ ) was low and not significant ( $p > .1$ ), while a weak, but significant, correlation was seen between the IAMI and the CES-D (see Table 4).

The emotional valence of the remembered events (‘Valence Past’ in Table 4) did not correlate with the overall IAMI score, although a weak, but significant, negative correlation was found for the future directed IAMI (see Table 4). In contrast, systematic negative correlations were found between valence of past events and all measures of emotional distress and negative thinking style ( $rs$  range  $-.25$  to  $-.42$ , all  $ps < .01$ ). The reflection subscale of the RRQ showed no association with valence of the past events ( $r = .04$ ), consistent with the idea that the reflection subscale is not associated with negative stressful events (Trapnell & Campbell, 1999). Valence for the future events (‘Valence Future’) did not correlate with the IAMI, but correlated significantly with the CES-D ( $r = -.28$ ,  $p < .0001$ ) and the GAD-7 ( $r = -.18$ ,  $p < .01$ ).

As in Studies 1 and 2, the mean score for the past directed IAMI was higher than the corresponding score for the future directed IAMI,  $t(199) = 5.95, p < .0001, d = .42$  (see Table 4 for means and standard deviations). Thus, people more frequently experience involuntary memories than involuntary future thoughts, according to these ratings. We also replicated the finding from Study 2 that the future directed IAMI was rated as more emotionally positive than the past directed IAMI,  $t(199) = 2.57, p < .05, d = .18$  (cf. Table 4). However, we did not replicate the finding from Study 2 of the past events being rated as more intense than the future events ( $p > .70$ , cf. Table 4).

### 5.3. Summary and discussion

As expected, we found positive correlations between the IAMI and the measures of emotional distress and negative thinking style. Similar correlations were found between these measures and the voluntary control question. At the same time, the IAMI did not correlate systematically with ratings of the emotional valence of the remembered events. This suggests that it is not the involuntary nature of the remembering and imagining processes that is central for the association with negative affectivity, nor is it the emotional characteristics of the mental contents. Instead it appears to be the inclination to (involuntarily or voluntarily) mentally time travel into the past or future and thus be less attentive to, and aware of, the present. This can be seen as consistent with research on mindfulness, commonly defined as “the state of being attentive to, and aware of, what is taking place in the present” (Brown & Ryan, 2003, p. 822). Previous research has shown positive associations between mindfulness and well-being, beneficial effects of mindfulness training on mental health (e.g., see Brown & Ryan, 2003, for a review), and negative correlations between mindfulness and thought suppression (e.g., Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006; Erskine, Rawaf, Grice, & Ussher, 2015; Erskine et al., 2012).

The finding that the both the IAMI and the voluntary control questions correlated with measures of emotional distress and negative thinking style appears inconsistent with theories assuming a special role to involuntary memories and images in relation to emotional distress and emotional disorders (e.g., Brewin, Gregory, Lipton, & Burgess, 2010; Horowitz, 1976). The present findings do not support such dissociation between involuntary and voluntary modes of remembering and imagining (see also Berntsen & Rubin, 2014).

Study 2 showed a strong correlation between the IAMI and the measure of daydreaming frequency. Since there is robust evidence that frequency of daydreaming is related to negative affect (Giambra & Traynor, 1978; Killingsworth & Gilbert, 2010; Stawarczyk et al., 2012), the moderate to strong correlations between the IAMI and measures of negative affect in the present study were expected and can be seen to support the validity of the scale. However, at the same time, it raises the important question as to whether anything clearly differentiates the IAMI from measures of daydreaming as well as from measures of other spontaneous thought processes. One theoretically meaningful candidate might be the age of the individual. In addition to negative affect, previous research has demonstrated consistent negative associations between age and frequency of daydreaming (Giambra, 1989, 1993), thought suppression (Erskine, Kvavilashvili, & Kornbrot, 2007; Lambert, Smyth, Beadel, & Teachman, 2013) and trait dissociation (e.g., Ross, Joshi & Currie, 1990). In contrast, we should not expect an age-related decline for the past dimension of the IAMI following the theoretical position that involuntary autobiographical memories form a basic mode of remembering that requires less executive processes and therefore may show less age-related impairments (Berntsen, 2009, 2012; Hall et al., 2014). This would also be consistent with research suggesting that older individuals show less decrement in performance on memory tasks that are assumed to involve less cognitive effort, although findings are mixed (see Ward, Berry, & Shanks, 2013, for review and discussion). Study 4 was undertaken to examine this issue.

## 6. Study 4

The goal of Study 4 was to examine the relation between the IAMI and age. In addition to the IAMI and the voluntary control questions, we also included the DDFS, WBSI, and the DES II (used in Study 2). We expected to replicate previous work showing an age related decline for daydreaming frequency (Giambra, 1989, 1993), thought suppression (Erskine et al., 2007; Lambert et al., 2013) and trait dissociation (e.g., Ross et al., 1990). However, we expected involuntary autobiographical memories (the past directed IAMI) to form an exception from this pattern, on the basis of work suggesting involuntary episodic remembering to be less cognitively demanding than voluntary episodic remembering (e.g., Berntsen, Staugaard, & Sørensen, 2013; Hall et al., 2014) and therefore less effected by a general cognitive decline in older adulthood.

We limit the latter hypothesis to the past dimension of the IAMI in that there may be age related reductions in the frequency of future thoughts that reflect other factors than cognitive decline, given that older individuals are likely to perceive their futures as being shorter than younger people and therefore may have less needs and reasons to think ahead (Carstensen, Isaacowitz, & Charles, 1999). Unfortunately, at this point, the scarce literature on age related differences in episodic future thinking has mostly concentrated on the phenomenological characteristics of the imagined events and their level of episodic details and not examined their prevalence in different age groups. There is some evidence that older people do not imagine events as far into the future as younger people do (Spreng & Levine, 2006), still, the frequency of engaging in future episodic thinking has not been examined. Although there is some recent experimental evidence (Lyons, Henry, Rendell, Corballis, & Suddendorf, 2014) that older relative to younger individuals are less likely to think ahead in relation to solving a future task, it is unclear whether this age related reduction in episodic foresight can be generalized to the personal future as imagined in naturalistic contexts.

## 6.1. Methods

### 6.1.1. Participants

As in the three previous studies, participants were recruited through Amazon's Mechanical Turk, following the same procedures as in Studies 1 and 2. Based on the age distribution in Studies 1–3, we increased the sample size to ensure at least 100 participants aged 50 and older. Our final sample was 732 individuals (361 females), with a mean age of 34.80, median: 31, standard deviation: 11.93, range: 18–82. The distribution across age groups is shown in Table 5.

### 6.1.2. Materials

The present study included a selection of the inventories that were included in Study 2: We included the IAMI, the voluntary control questions and the four individual items addressing the emotional valence and intensity of the involuntary memories and future thoughts. In addition we included the DDFS, WBSI and the DES II, which previously have shown negative associations with age (Erskine et al., 2007; Giambra, 1989, 1993; Lambert et al., 2013; Ross et al., 1990).

### 6.1.3. Procedure

The task was advertised on Amazon's Mechanical Turk and the procedure for data collection and compensation of the participants was the same as in Studies 1 and 2. Subjects who completed the study were compensated with 1.50 USD. The scales were presented in the following order: IAMI, emotional valence and intensity of the IAMI items for past, emotional valence and intensity of the IAMI items for future, the DDFS, the WBSI, the DES II, and, finally, the voluntary control questions.

## 6.2. Results

The descriptive statistics of the included measures and their correlations with the IAMI are shown in Table 6. We first present the scores of the included key measures across the five age groups shown in Table 5. We next contrast the scores of the younger versus the older participants on the past versus future dimensions of the IAMI and voluntary control questions. These analyses are illustrated by Figs. 2–4 (note that the IAMI scores are labelled 'involuntary' in the figures to keep conceptual consistency with the voluntary control questions).

**Table 5**  
The distribution of participants across age groups in Study 4.

Age range	N	Women	Age
20–29	306	123	24.96
30–39	226	112	33.45
40–49	97	59	43.97
50–59	61	44	54.20
60+	42	23	64.50

**Table 6**

Means, standard deviations, and Cronbach Alphas of measures included in Study 4 and their correlations with the total IAMI and the past- and future directed IAMI subscales.

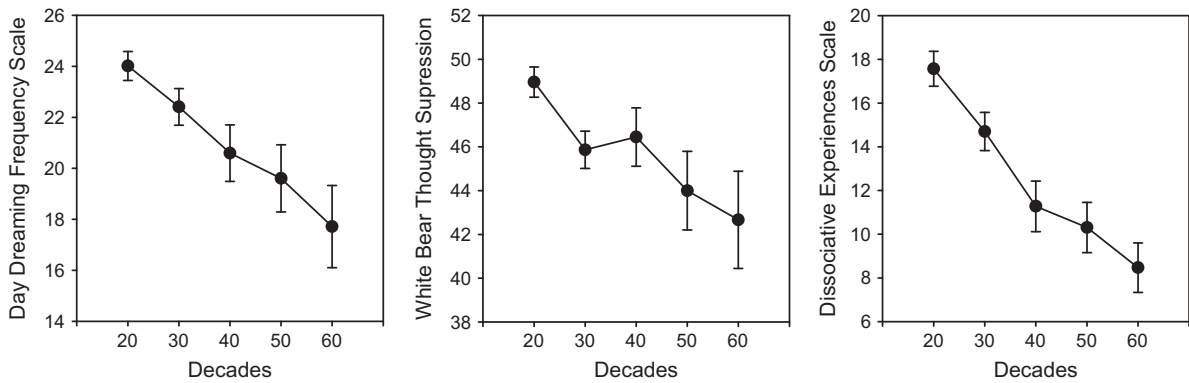
Measures	M	SD	$\alpha$	Total	Past	Future
IAMI	1.86	0.66	.94	–	–	–
Past IAMI	1.97	0.65	.89	.92****	–	–
Future IAMI	1.74	0.79	.92	.94****	.73****	–
DDFS	22.34	10.51	.95	.62****	.52****	.63****
WBSI	46.90	12.86	.93	.36****	.35****	.32****
DES II	14.72	13.04	.95	.31****	.24****	.33****
Voluntary total	1.70	0.72	.91	.67****	.60****	.65****
Voluntary Past	1.67	0.74	.87	.60****	.60****	.53****
Voluntary Future	1.72	0.80	.86	.65****	.51****	.68****
Valence Past	0.26	1.01	N/A	–.03	–.03	–.02
Intensity past	1.82	0.90	N/A	.31****	.32****	.25****
Valence Future	0.80	0.89	N/A	.09	–.03	.13
Intensity Future	1.63	0.97	N/A	.38****	.25****	.43****

Note: N = 732; DDFS: Daydreaming Frequency Scale; PCL5: PTSD Checklist for DSM-5; WBSI: White Bear Suppression Inventory; DES II: Revised Dissociative Experiences Scale.

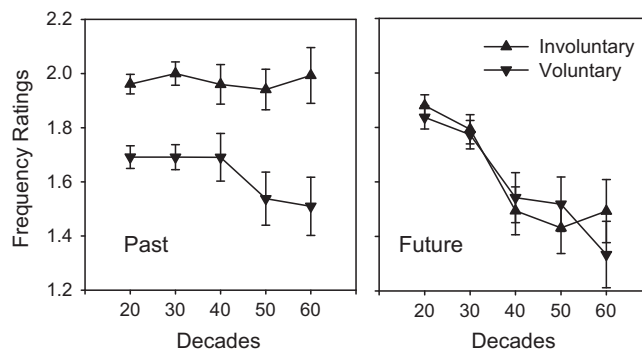
\*  $p < .05$ .

\*\*\*\*  $p < .0001$ .

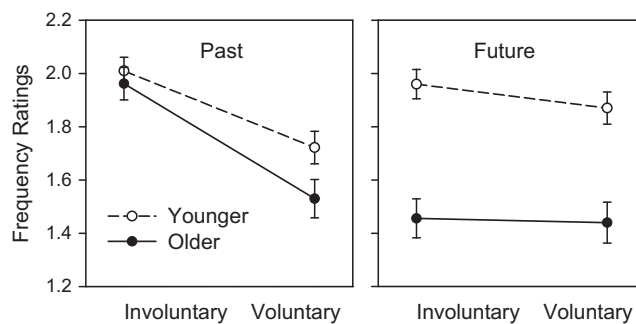




**Fig. 2.** The scores for the Daydreaming Frequency Scale, White Bear Suppression Inventory and the Revised Dissociative Experiences Scale by the age of the participants.



**Fig. 3.** The mean frequency ratings for involuntary and voluntary past versus future events by age of the participants. The involuntary ratings derive from the past and future directed subscales of the IAMI. The voluntary ratings derive from the past versus future directed items of the voluntary control questions.



**Fig. 4.** The mean frequency ratings for involuntary and voluntary past versus future events among the older (50+ years) versus younger (<25 years) participants. The involuntary ratings derive from the past and future directed subscales of the IAMI. The voluntary ratings derive from the past versus future directed items of the voluntary control questions.

### 6.2.1. Comparisons across the five age groups

As predicted and consistent with previous research, a marked age related decline was found for the scores of daydreaming frequency, thought suppression and dissociative experience, respectively (see Fig. 2 for illustrations). For all three measures, a significant group effect was seen: Daydreaming frequency,  $F(1,727) = 5.83, p < .001, \eta_p^2 = .03$ ; thought suppression,  $F(1,727) = 4.35, p < .005, \eta_p^2 = .02$ ; dissociative experience,  $F(1,727) = 9.96, p < .0001, \eta_p^2 = .05$ . For each of these three analyses, we followed up by conducting a planned comparison to test our prediction of a linear decline with the age of participants. In each case, this was confirmed: Daydreaming frequency,  $F(1,727) = 17.08, p < .0001$ ; thought suppression,  $F(1,727) = 9.97, p < .005$ ; dissociative experience,  $F(1,727) = 24.38, p < .0001$ .

We next conducted the same analyses for the future and past directed subscales of the IAMI, and the voluntary control questions (see Fig. 3). For the two future directed scales, clear age effects were found: future directed IAMI,  $F(4, 727) = 9.00$ ,  $p < .0001$ ,  $\eta_p^2 = .05$ ; future directed voluntary questions,  $F(4, 727) = 6.74$ ,  $p < .0001$ ,  $\eta_p^2 = .04$ . We then conducted a planned comparison for each of the two variables to test our prediction of a linear decline across age groups. This was confirmed in both cases: Future directed IAMI,  $F(1, 727) = 17.23$ ,  $p < .0001$ ; future directed voluntary questions,  $F(1, 727) = 19.97$ ,  $p < .0001$ .

The two past directed subscales showed no significant group differences ( $ps > .3$ ). For the past directed IAMI, planned comparison across age groups showed no indication of a linear decrease ( $F < .01$ ). However, for the voluntary control questions, a planned comparison showed a trend of a linear decrease, bordering on significance,  $F(1, 727) = 3.77$ ,  $p = .052$ . Thus, the past directed subscale of the IAMI was a clear exception from an age related decline (although the decline for voluntary past directed items only bordered on significance). It should be noted that these findings were replicated when the same analyses were conducted with the subset of the IAMI items that mapped onto the 10 voluntary control questions (cf. Tables 1 and 2).

### 6.2.2. Older versus younger participants

In order to further examine age related differences related to the future and past directed items of the IAMI as well as the future and past directed voluntary control questions, we compared the youngest participants (25 years and younger,  $n = 165$ ) with the oldest participants (50 years and older,  $n = 103$ ). We chose these groups to be of nearly equal size and to approximate those commonly selected in the cognitive aging literature to provide comparable results to this literature. We combined all participants age 50 and older, given the results in Fig. 3 showing very similar scores in the two oldest bins. We conducted a 2 (Group: younger versus older)  $\times$  2 (Time: past versus future)  $\times$  2 (Scale: involuntary versus voluntary control questions) repeated measures ANOVA, with Time and Scale as repeated measures factors, each with two levels, and older versus younger as a between subjects variable. The main findings are illustrated in Fig. 4. There was a main effect of Group with the younger group overall having higher scores,  $F(1, 266) = 14.99$ ,  $p < .001$ ,  $\eta_p^2 = .05$ . Consistent with Studies 1, 2 and 3, there was a main effect of Time with past being rated higher than future,  $F(1, 266) = 16.98$ ,  $p < .0001$ ,  $\eta_p^2 = .06$ . Consistent with previous research (Rasmussen & Berntsen, 2011), there was a main effect of Scale with the involuntary (IAMIs) having higher mean scores than the voluntary control questions  $F(1, 266) = 32.94$ ,  $p < .0001$ ,  $\eta_p^2 = .11$ . However, these main effects were qualified by a number of interactions:

There was a two-way interaction between Time and Group,  $F(1, 266) = 34.41$ ,  $p < .0001$ ,  $\eta_p^2 = .11$ , reflecting that the older group had considerably lower frequency ratings on the future directed subscale of both the IAMI,  $t(266) = 5.63$ ,  $p < .0001$ , Cohen's  $d = 0.69$ , and the voluntary control questions,  $t(266) = 4.39$ ,  $p < .0001$ , Cohen's  $d = 0.55$ . They also scored lower than the younger group on the past directed items for the voluntary control questions,  $t(266) = 2.04$ ,  $p < .05$ , Cohen's  $d = 0.26$ , although the effect size was small, but, as expected, no age effect was found for the past directed items of the IAMI ( $t < .1$ ).

A two way interaction was found between Scale and Time,  $F(1, 266) = 66.90$ ,  $p < .0001$ ,  $\eta_p^2 = .20$ , which reflected that the means of the IAMI items were higher than the voluntary control questions for the past directed items,  $t(267) = 8.25$ ,  $p < .0001$ , Cohen's  $d = 0.50$ , whereas the two scales did not differ for the future directed items,  $t(267) = 1.62$ ,  $p > .11$ .

Importantly, there was an interaction between all three factors,  $F(1, 266) = 8.79$ ,  $p < .01$ ,  $\eta_p^2 = .03$ , which reflected that the past directed items of the IAMI showed no age difference, whereas the remaining three measures (voluntary past, voluntary future and involuntary future) all did (as evidenced by the previously presented  $t$ -tests).

Again, we note that all of these findings were replicated when the same analyses were conducted with the subset of the IAMI items that mapped onto the 10 voluntary control questions.

### 6.2.3. Emotional contents

The future and past directed items of the IAMI were rated for valence as in Studies 2 and 3. Consistent with these studies, we also here found that the future directed items were rated as more positive than the past directed items,  $t(731) = 11.77$ ,  $p < .0001$ , Cohen's  $d = 0.43$ , when analyzed within the full sample (see Table 6 for  $M$ s and  $SD$ s).

In order to examine whether this interacted with the age of the participants, we conducted a 2 (Group: Younger versus Older)  $\times$  2 (Time: Past versus Future) repeated measures ANOVA with the valence ratings as the dependent variable, and with the older and younger groups defined as in the previous analyses. In addition to a main effect of Time,  $F(1, 266) = 57.13$ ,  $p < .0001$ ,  $\eta_p^2 = .18$ ), we found a significant interaction with age group,  $F(1, 266) = 4.92$ ,  $p < .05$ ,  $\eta_p^2 = .02$ . This reflected that the older group tended to have more positive ratings of the involuntary memories of past events ( $M = .30$ ,  $SD = 1.16$ ), when compared with the younger group ( $M = .07$ ,  $SD = 1.00$ ),  $t(266) = 1.75$ ,  $p = .08$ , whereas a numerical, but non-significant, group difference in the opposite direction was found for the future directed questions (old:  $M = .74$ ,  $SD = .94$ ; young:  $M = .87$ ,  $SD = .90$ ),  $t(266) = 1.12$ ,  $p = .26$ .

Consistent with Study 2, the ratings of the emotional intensity of the contents also differed with the past being rated as more emotionally intense than the future,  $t(731) = 4.95$ ,  $p < .0001$ , Cohen's  $d = .18$ , in the full sample (see Table 6 for  $M$ s and  $SD$ s).

Again we conducted a 2 (Group: Younger versus Older)  $\times$  2 (Time: Past versus Future) repeated measures ANOVA with the intensity ratings as the dependent variable. The main effect of time  $F(1, 266) = 24.2$ ,  $p < .0001$ ,  $\eta_p^2 = .08$ , was qualified by an interaction with age group,  $F(1, 266) = 12.48$ ,  $p < .001$ ,  $\eta_p^2 = .05$ , which reflected that the future directed items were rated as significantly less intense than the past directed items in the older group ( $M$ s = 1.38 versus 1.93, respectively),

$t(102) = 5.42, p < .0001$ , Cohen's  $d = .53$ , but not in the younger group, ( $M_s = 1.78$  versus  $1.87$ , respectively),  $t(164) = 1.22, p > .2$ .

### 6.3. Summary and discussion

Study 4 had two main findings. First, the past directed subscale of the IAMI – measuring involuntary memories of past events – showed no age related decline. In contrast, clear age related declines were seen for the measures of daydreaming frequency, thought suppression and dissociative experience. The voluntary control questions for past events showed a marginally significant linear decline across all age groups and a modest, but significant, decline from the youngest to the oldest participants. The fact that the frequencies of involuntary memories formed an exception from an age related decrease is an important novel finding. It is especially striking given the fact that the IAMI scores showed consistent correlations with measures of spontaneous thought processes and measures of negative affectivity (Studies 2–4) which are known to decline with age. The fact that frequency of involuntary remembering followed a different pattern agrees with the idea that involuntary autobiographical memories are a basic mode of remembering that serves important functions throughout life and is less cognitively demanding than strategic recall and therefore less affected by age related reductions in executive control functions (Berntsen, 2009; Berntsen, 2010). Second, the future directed subscale of the IAMI, as well as the future directed subscale of the voluntary control questions, showed a marked decrease with age. Thus, as people grow older they less frequently imagine possible events in their future. Such age related decrease in the daily frequency of future thinking has not been demonstrated before, but it is important for a more complete understanding of the interplay between autobiographical memory and future episodic thought. Although these two processes appear to operate on the same underlying neurocognitive structures (e.g., Buckner & Carroll, 2007; D'Argembeau, 2012; Szpunar, 2010), the frequency with which they are recruited and their roles in daily life interact with the age of the person.

In addition, as in Studies 2 and 3, we found that the contents of involuntary future thoughts were rated as more positive than the contents of involuntary memories. However, we also found that this interacted with the age of the participants, in that the older participants tended to have more positive ratings of past events and less positive ratings of future events, compared with the younger participants. The fact that older participants rated the contents of their memories as more positive agrees with previous work showing that older compared with younger individuals recall more positive items, when presented with stimuli that vary on positive versus negative valence (Charles, Mather, & Carstensen, 2003; Mather & Carstensen, 2005).

This has been seen to suggest that emotion regulation through selective encoding and remembering is more common among older than among younger adults (e.g., Kennedy, Mather, & Carstensen, 2004; Mather & Knight, 2005; Schlagman, Schulz & Kvavilashvili, 2006). The present findings add to this literature by showing that this positive bias in older individuals does not extend to imagined future events. Relatedly, we found intensity ratings in the older group to be less intense for the future compared with the past, whereas this difference was absent in the younger group. However, although these findings were statistically significant they accounted for relatively little variance.

In summary, Study 4 showed that the past dimension of the IAMI relates differently to age compared with daydreaming, thought suppression and dissociative experience. Study 4 also showed that the past and future directed subscales of the IAMI are affected differently by age.

## 7. General discussion

Autobiographical memories and future thoughts often come to mind with no preceding attempt to produce them. Naturalistic studies have demonstrated that such unplanned and spontaneously arising memories and future thoughts are at least as frequent as autobiographical memories and future thoughts that are produced deliberately. However, naturalistic studies and anecdotal evidence also suggest substantial individual variability in their frequency. In previous research, systematic analyses of dispositional and demographic correlates of this variability have been hampered by small sample sizes and different sampling methods.

In order to remedy these shortcomings, we here introduced a new scale, the *Involuntary Autobiographical Memory Inventory* (IAMI), to measure the frequency of involuntary autobiographical memories and involuntary future thoughts. Study 1 showed excellent psychometric properties for the IAMI. Factor analyses revealed two highly correlated factors corresponding to the past versus future dimensions of the scale. The internal consistencies of both the full scale and the two subscales were high. Studies 2–4 demonstrated good convergent and discriminant validity of the IAMI, including of its past and future subscales.

Using the scale in relation to other psychometric measures and demographic assessments has provided three important, novel findings. First, the frequency of involuntary and voluntary remembering (and future thinking) both are related to emotional distress and negative thinking style. This finding challenges common beliefs in the literatures on emotional distress and autobiographical memory. Second, the frequency of involuntary autobiographical remembering does not decline with age. Hereby it forms an important exception from other forms of spontaneous thought processes, such as daydreaming, that all show a robust age related decline. Third, unlike involuntary autobiographical remembering, the frequency of future

thoughts decreases with age. This finding underscores the relevance of examining past and future mental time travel in a life span perspective. These findings are elaborated and discussed in the following.

### *7.1. Involuntary and voluntary autobiographical remembering and future thinking are both related to emotional distress*

Studies 2 and 3 showed that involuntary and voluntary forms of autobiographical remembering and future thinking both are related to emotional distress and negative thinking styles, such as symptoms of PTSD, anxiety, worry, depression, and rumination. This finding challenges two prevalent beliefs. First, it contradicts a long history of associating involuntary, but not voluntary, remembering (and imagining) with negative affectivity and emotional distress. This view was introduced in Horowitz's (1976) theory on stress response syndromes and has been repeated in many modern conceptions of reactions to traumatic or stressful events (e.g., Brewin, 2014; Brewin et al., 2010; Halligan, Michael, Clark, & Ehlers, 2003, see Berntsen & Rubin, 2014, for review and discussion). The fact that the frequency of both involuntary and voluntary autobiographical remembering and future thinking correlated with emotional distress contradicts such a dissociation. Instead it is consistent with the view that both types of retrieval sample from the same underlying mental structures and thus are similarly affected by many individual dispositions (Berntsen, 2009, 2012).

Second, the finding that the frequency of (involuntary and voluntary) autobiographical memories and future thoughts is correlated with measures of emotional distress and negative thinking style is counter to the prevalent assumption that autobiographical remembering as well as episodic future thinking necessarily are adaptive processes that serve important functions in daily life, for example by facilitating problem solving, supporting social relationships, our sense of identity and the pursuit of goals and plans (e.g., Bluck, Alea, Habermas, & Rubin, 2005; D'Argembeau, Lardi, & Van der Linden, 2012; D'Argembeau, Renaud, & Van der Linden, 2011). Following this view, and contrary to the present results, we should not expect the frequency of remembering the personal past and imagining the personal future to be associated with emotional distress and anxiety.

This finding cannot be explained in terms of the emotional valence associated with the past and future events since the frequency of having involuntary and voluntary memories and future projections did not correlate with the valence of the events. Across Studies 2–4 the reported valence consistently was found to show no significant correlation with the overall IAMI. Furthermore, on the average, the valence ratings of both future and past events were positive. Thus, involuntary (and voluntary) autobiographical memories and future projections do not preferentially access emotionally negative events. Given these findings, the valence of the remembered and imagined events cannot account for the correlations between the IAMI and measures of general emotional distress, such as anxiety and PTSD.

One possibility is that a dispositional tendency for often having autobiographical memories and future thoughts is a risk factor for developing prolonged negative emotional states after exposure to stressful experiences, because emotionally stressful experiences stay highly accessible in memory until they are resolved and therefore are likely to be a continuous focus for remembering and future thinking (Berntsen & Rubin, 2006). Following this explanation, autobiographical remembering and future thinking is normally adaptive and normally do not favor negative events (e.g., Berntsen, 2009), but if one or more negative events become salient in memory (e.g., after a traumatic experience), a general inclination to often remember the past and often think ahead to future events may increase the risk of developing prolonged emotional distress. In addition, individuals experiencing prolonged states of emotional distress may use autobiographical remembering and future thinking as a means of mood repair by selectively engaging in remembering and imagining events that are happier than their current situation.

Although seemingly counter to the accepted view that autobiographical remembering and future thinking are necessarily adaptive, the association between emotional distress and frequency of autobiographical memories and future thoughts is consistent with previous work showing robust correlations between daydreaming frequency and negative mood (e.g., Giambra & Traynor, 1978; Killingsworth & Gilbert, 2010) as well as with the budding literature on mindfulness and well-being, suggesting that the state of being attentive to, and aware of, the present – instead of mentally escaping into the past or future – is associated with positive emotional states (Brown & Ryan, 2003).

### *7.2. Involuntary autobiographical remembering does not decline with age*

In Study 4 we found that the past directed subscale of the IAMI – measuring the frequency of involuntary memories of past events – showed no age related decline, whereas measures of daydreaming frequency, thought suppression, dissociative experiences and involuntary and voluntary future thoughts all did. The past directed items of the voluntary control questions also tended to decline with age and differed significantly between younger and older participants, although the effect was smaller. The fact that involuntary autobiographical remembering formed an exception from this overall pattern is remarkable in the context of previous research suggesting that the frequency of task-unrelated thoughts generally decreases with age, irrespective of whether this is measured through self-reports (Giambra, 1993) or through experimental procedures (Giambra, 1989).

The present findings support the idea that involuntary autobiographical memories are a basic mode of remembering that serves important functions throughout life. It is a context-dependent and highly cue sensitive type of retrieval that is less cognitively demanding than strategic recall (e.g., Berntsen, 2009; Hall et al., 2014) and therefore may be less affected by age related reductions in cognitive abilities (Berntsen, 2009; Berntsen, 2010; Schlagman et al., 2009). For older people

who live in relatively stable environments it may play a central role for regulating behavior and automatically reviewing and updating knowledge about oneself and others. Although speculative, this may help to explain why younger people outperform older people in laboratory memory tests, but often not when studies take place in everyday life settings (see [Ross & Schryer, 2014](#), for a review). The latter context may be more likely than the former to facilitate involuntary remembering through situational cueing. Empirically, the absence of an age-related decline in the reported frequency of involuntary memories agrees with [Rubin and Berntsen \(2009\)](#) who found no age differences in the self-reported frequencies of involuntary memories of a recent and a remote past event in large stratified samples. In contrast, our finding can be seen to disagree with [Schlagman et al. \(2009\)](#) who found that older participants in a diary study indicated having fewer involuntary autobiographical memories than younger participants. However, the older participants in [Schlagman et al. \(2009\)](#) had fewer years of education than the younger participants, which may have influenced the results. Also, they registered the same amount of fully reported involuntary memories, but in contrast to the younger group, they had very few memories marked off with a tick, which was used to indicate that a memory had occurred, but recoding could not be completed right away. Thus, one potential explanation for the age difference in [Schlagman et al. \(2009\)](#) may be that the older participants found the sustained monitoring of conscious experience needed to continuously detect involuntary memories more demanding, than did the younger participants, and therefore truncated the monitoring periods and, as a consequence, reported fewer memories overall.

### 7.3. *The frequency of future thoughts decreases with age*

In contrast to the past directed subscale of the IAMI, the future directed subscale showed a clear decline with age. The same applied to the future directed items of the voluntary control questions. This dissociation between autobiographical remembering and future thinking in relation to aging has gone largely unnoticed in the literature on future and past mental time travel. Yet it has important implications for our understanding of these processes. It is commonly assumed that autobiographical remembering and future thinking recruit the same underlying neurocognitive structures (e.g., [Schacter & Addis, 2007](#)). While substantial evidence supports this position by showing that the characteristics of the two processes tend to be similarly affected by a range of experimental manipulations as well as by demographic and dispositional factors (see [D'Argembeau, 2012](#); [Szpunar, 2010](#), for reviews), the present findings suggest that the frequency with which these processes are recruited interacts with the age of the individual. This suggests that important factors are in play in relation to regulating the amount of cognitive resources that are allocated to remembering the past versus imagining the future.

One relevant theoretical framework to be considered in this context is the socioemotional selectivity theory ([Carstensen et al., 1999](#); [Mather & Carstensen, 2005](#)), which holds that the open-ended time horizon of young adults allows them to pursue preparatory goals and therefore makes them more inclined to seek out new information, whereas older adults to a greater extent focus on information that is likely to support a positive emotional state and enhance well-being, which might be positive memories of past events. This also agrees with the additional findings from Study 4 that older participants tended to rate the emotional content of the past dimension of the IAMI as more positive than did the younger participants, whereas a numerical difference in the opposite direction was found for the future directed dimension. Similarly, the older participants rated the past directed items as more intense than the future counterparts, whereas this difference was absent in the younger group. These findings underscore the importance of considering past and future mental time travel in the perspective of life span development.

In addition, the present findings have implications for the understanding of daydreaming frequency and aging. Currently, most measures of daydreaming (and mind wandering) do not differentiate daydreaming about the future from daydreaming about the past. However, given the present findings, it is possible that only daydreaming about the future is associated with a decline in old age, whereas daydreaming about the past is not. Future research directed at examining age effects in daydreaming therefore should attempt to obtain separate measures of daydreaming about the past versus daydreaming about the future.

### 7.4. *Limitations*

The studies have a number of limitations that should be considered when evaluating the results. First, the cross-sectional and correlational nature of our data prohibits reasoning about causality. Second, the past and future directed items of the IAMI were worded similarly in order to ensure their comparability. At the same time, this may have artificially boosted their correlations. A similar limitation applies to the correlation between the IAMI and the voluntary control questions. Future research may have participants complete these questionnaires at different times in order to reduce potential effects of item similarities.

### 7.5. *Conclusions*

The Involuntary Autobiographical Memory Inventory was shown to be an efficient and reliable instrument for measuring the frequency of involuntary autobiographical memories and involuntary future thoughts and their correlations with measures of individual dispositions and demographics. The use of the scale in relation to these other measurements yielded novel findings with important theoretical implications for the understanding of autobiographical memory, daydreaming, emotional distress and aging.



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