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How to cite this publication

Please cite the final published version:

Berntsen, D. (2018). Spontaneous future cognitions: an integrative review. *Psychological Research*.
<https://doi.org/10.1007/s00426-018-1127-z>

Publication metadata

Title:	Spontaneous future cognitions: an integrative review
Author(s):	Berntsen, Dorthe
Journal:	Psychological Research
DOI/Link:	https://doi.org/10.1007/s00426-018-1127-z
Document version:	Accepted manuscript (post-print)

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Spontaneous Future Cognitions: An Integrative Review

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Abstract

Spontaneous future cognitions refer to mental representations about the future that enter consciousness with no immediately preceding attempt of bringing them to mind. They are studied under different terms in several areas of psychology, but with little interdisciplinary exchange of findings and theoretical developments. Different conceptions of spontaneous future cognition derive from separate literatures and are rarely considered together, leaving their potential conceptual overlaps as well as their unique features unclarified. In this article I review research on spontaneous future cognitions in relation to mind wandering, involuntary episodic future thoughts, and intrusive future imagery in cravings and clinical disorders. I conclude that more research is needed to clarify the potential functions served by spontaneous future cognitions in everyday life, under which conditions they may become dysfunctional, how they are triggered by situational cues, and how their content may be constrained by motivational factors and beliefs. The burgeoning field of spontaneous future cognitions forms a promising novel approach to the cognitive and motivational regulation of behavior in everyday life.

Spontaneous Future Cognitions: An Integrative Review

Spontaneous future cognitions are mental representations about the future that enter awareness with no preceding attempt of bringing them to mind. They are experienced as unintended, and as such share characteristics with involuntary autobiographical memories (i.e., spontaneously arising memories of past events, Berntsen, 1996). Their conceptual contrast are mental representations of future experiences that are generated at will, such as systematically envisioning a future trip for the sake of planning, or voluntarily daydreaming about a pleasant encounter in the future to escape a dull reality.

To illustrate some of the breadth of spontaneous future cognitions, imagine a group of airplane passengers, who are receiving safety briefings, while waiting for their plane to roll out on the runway to take off. All of them are engaged in spontaneous future cognitions, but their spontaneous future thoughts fall into different conceptual categories in the literature. First, one passenger is simply mind wandering (Smallwood & Schooler, 2006). In other words, this person is not paying attention to the video; his or her mind is elsewhere than on this task. The mind wandering literature tells us little about the content of the images and thoughts that runs through this person's head, but it suggests that a substantial amount will be related to the future (e.g., Baird, Smallwood & Schooler, 2011). A second person is afraid of flying and keenly following the safety video. When the video shows the brace position that must be adopted in case of an emergency landing, this person has vivid and intrusive images of the plane crashing. Such intrusive imagery of catastrophic future events is common in anxiety disorders (Beck, Laude & Bohnert, 1974). Third, a different passenger is also nervous, in this case because the safety instructions appear to be taking too long a time. According to this passenger's estimate, the plane should have taken off by now, and this person cannot stop worrying about missing the next

connection and the luggage not making it to the final destination. Worry is a type of uncontrolled future thought that seems to be verbal in nature rather than involving sensory rich images (Borkovec & Inz, 1990; Borkovec, Robinson, Pruzinsky & DePree, 1983). Extreme and uncontrollable levels of worry is a symptom of Generalized Anxiety Disorder (APA, 2013). The fourth person is following the safety video with interest and curiosity, having a longstanding interest in aviation. This person is seriously considering a career as a flight attendant. When watching the flight attendant in the video putting on the life jacket, this person spontaneously imagines delivering safety instructions for the first time in front of a group of airline passengers. This person is engaged in spontaneous episodic future thinking (Berntsen & Jacobsen, 2008). The fifth person in this group is distracted by the information that smoking is prohibited, including in the lavatories. Realizing that this means several hours with no cigarettes triggers a craving. A vivid image of opening a package of cigarettes, pulling one out, lighting it and inhaling the smoke, fills his or her mind and intensifies the cravings. This person is engaged in intrusive thoughts about a desired target (Kavangh, Andrage and May, 2005).

These conceptions of spontaneous future cognition derive from separate literatures and are rarely considered together, leaving their potential conceptual overlaps as well as their unique features unclarified. The goal of the present article is to provide a review of some of the most common conceptions of spontaneous future cognitions and discuss how they each contribute to our understanding of this topic.

Given the breadth of the topic and the scope of the present article, this review cannot address everything of potential relevance to the overarching topic of spontaneous future thoughts. For example, it does not include prospective memory The intention to remember to perform an action is by definition a voluntary memory task, although aspects of this process have

been shown to involve involuntary rehearsal (Kvavilashvili & Fisher, 2007). The broader discussion of top-down and automatic processes involved in prospective memory is outside the scope of this article and has been reviewed elsewhere (McDaniel, Umanath, Einstein, & Waldum, 2015). The literature on worry is also outside the scope of the present review, which would not be able to do justice to the complexity and extensiveness of this research area (but see Watkins, 2008, for an excellent overview).

The following review will fall into three parts. I first review theoretical questions and empirical findings in the field of mind wandering with the aim of clarifying how research on mind wandering contributes to the understanding of spontaneous future cognitions. I next review the field of spontaneous episodic future thinking, which are imagined future events that come to mind involuntarily. In contrast to the mind wandering literature, which to a large extent is rooted in the field of attention and executive control, spontaneous episodic future thinking has its background in research on autobiographical memory and mental time travel. The last part of this review deals with spontaneous future cognitions that are dysfunctional or unconstructive, such as intrusive images of negative events in people suffering from anxiety and PTSD, and intrusive images associated with cravings in addictions.

Mind Wandering and Daydreaming

In their seminal article reviving research on mind wandering, Smallwood and Schooler (2006) defined mind wandering as when “executive components of attention appear to shift away from the primary task, leading to failures in task performance and superficial representations of the external environment” (p. 946). By linking the phenomenon of mind wandering to attentional shifts and failure of focused attention, they situated research on mind wandering in the literature of attention, working memory and executive control. Terms often used synonymously with mind

wandering are task-unrelated thought, or stimulus-independent thought, similarly underscoring the attentional separation from an external task (Smallwood, 2013). As a consequence, mind wandering research typically has focused on situational and dispositional factors that lead the person to mind wander away from an ongoing task and the detrimental consequences such mind wandering episodes have on the performance on the ongoing task and less on the content of mind wandering episodes (Smallwood & Schooler, 2015, but see Christoff et al., 2016, Klinger, 2013 for different approaches).

Commonly used experimental paradigms for studying mind wandering involve laboratory tasks requiring sustained attention while thought probes are being administered to assess episodes of mind wandering during this task. Some studies have extended this paradigm to asking the participants to assess whether their mind wandering episodes were directed towards the future or the past, in order to probe mind wandering phenomenology. A general finding is that mind wandering appears to be more frequently future- than past related (e.g., Baird et al., 2011; Stawarczyk, Majerus, Maj, van der Linden, & D'Argembeau, 2011; see Smallwood & Schooler, 2015, for a review). However, the frequency of future- versus past related mind wandering varies with a number of factors. For example, Seli, Ralph, Konishi, Smilek and Schacter (2017) found that intentionally initiated mind wandering was more frequently about the future than mind wandering episodes initiated without intention. The emotional state of the person (e.g., Poerio, Totterdell & Miles, 2013) and the emotional valence of cues (Plimpton, Patel and Kvavilashvili, 2015) also influence whether mind wandering is future- or past oriented.

Several studies have examined how individual differences correlate with a propensity for mind wandering. Such studies have reported positive correlations between measures of negative affect, such as depressive symptoms, and mind wandering frequencies (e.g., Killingsworth &

Gilbert, 2010; Poerio, Totterdell, & Miles, 2013) and negative correlations between age and the tendency to engage in mind wandering (e.g., Jackson & Balota, 2012). Lower working memory capacity is associated with a tendency to mind wander, especially during demanding tasks, although findings are mixed (Kane et al., 2007; Kane & McVay, 2012; Kane et al., 2017).

There is considerable evidence that mind wandering is disadvantageous to the ongoing task, although it may also have some beneficial effects (e.g., Baird et al., 2012). Mind wandering has been found to reduce performance during driving (Berthie et al., 2015), in educational settings (e.g., Szpunar, 2017) and in medical practice (Hilton, 2011). However, although mind wandering may be detrimental to the ongoing task in the current moment, it may help the individual to pursue more long-term goals. According to Klinger and colleagues (e.g., Klinger, 2013; Klinger, Marchetti, & Koster, 2018), mind wandering and other types of spontaneous thoughts reflect current concerns that extend far beyond the present situation. Because relatively little is known about the specific content of mind wandering episodes, it is unclear to what extent mind wandering generally serves such higher-level goals (Stawarczyk, Majarus, & D'Argembeau, 2013).

In short, modern research on mind wandering has been less concerned with the subjective content and functionality of mind wandering, and mostly focused on exploring the situational and dispositional conditions for mind wandering episodes during on-going laboratory tasks, as well as immediate deficits in performance caused by mind wandering. By taking this focus, modern studies of mind wandering tend to concentrate on one of three dimensions in the conception and operationalization of daydreaming and mind wandering introduced in the 1970s by Jerome Singer and colleagues (e.g., Antrobus, Singer & Greenberg 1966; Huba, Segal, & Singer, 1977; Singer, 1974). They identified two dimensions of daydreaming that were

distinctive in terms of their phenomenology, one being negative and concerned with guilt and fear of failure, and one being positive and constructive, addressing aspects of daydreaming connected with creativity and future planning. They identified a third dimension that reflected poor attentional control, probing a general tendency to mind wander, being easily distracted and bored. The poor attentional control dimension in Huba et al.'s (1982) conceptions is very similar to the focus on attentional decoupling in contemporary mind wandering research. Indeed, Huba et al.'s (1982) subscale for poor attentional control correlates strongly with contemporary measures of dispositional mind wandering (Mrazek et al., 2013; Del Palacio-Gonzalez & Berntsen, 2018).

Singer and colleagues found that these three dimensions of daydreaming related differently to measures of personality. The Poor Attentional Control dimension correlated negatively with Conscientiousness. Positive-constructive daydreaming was positively associated with Openness. Guilt and Fear-of-Failure Daydreaming correlated positively with Neuroticism (McMillan, Kaufmann, & Singer, 2013, for a review). The recognition that daydreaming is not a unitary construct and the identification of these orthogonal dimensions enabled research on both functional and dysfunctional aspects of daydreaming and foreshadowed later research on rumination and related forms of repetitive thoughts (e.g., Watkins, 2008). It also helped to stimulate research on how current concerns of the individual may shape the content of daydreaming (Klinger, 1975; Klinger, 2013; Klinger et al., 2018) and how types of daydreaming may be related to creativity and future planning (McMillan et al., 2013).

In contrast, in the modern research program on mind wandering (Smallwood & Schooler, 2006) mind wandering generally has been conceived as a unitary construct addressing situations where attention unintentionally shifts away from a primary, ongoing task, to internally generated

thoughts. This focus on unintended attentional shifts has led to the development of powerful experimental paradigms and a highly influential research program (for reviews see Christoff, Irving, Fox, Spreng, Andrews-Hanna, 2016; Smallwood & Schooler, 2015). However, the idea of mind wandering as a unitary construct has recently been challenged by a series of seminal studies showing that mind wandering episodes do not always reflect attentional failures. Often mind wandering is initiated intentionally, and whether it is (or is not) interacts with key variables in the mind wandering literature (Seli et al., 2017; see Seli, Risko, Smilek, & Schacter, 2016 for a review). Intentional mind wandering is more common than unintentional mind wandering during easy tasks, whereas a reverse pattern is seen during difficult tasks (Seli, Risko & Smilek, 2016). Intentional mind wandering is also observed in real life contexts. During lectures, intentional mind wandering has been shown to be more frequent than unintentional mind wandering (Wammes, Boucher, Seli, Cheyne, & Smilek, 2016).

These recent findings has led leading mind wandering researchers to introduce a family-resemblance view of mind wandering, which implies viewing mind wandering as “a heterogeneous, fuzzy-boundaried construct that coheres amid patterns of overlapping and nonoverlapping features” (Seli et al., 2018a, p. 479). However, while a fuzzy-boundary view provides a valid description of the organization of everyday concepts (Rosch, 1978), unambiguous and operationalizable definitions are usually viewed as a prerequisite for a scientific approach. It is hard to see how a family-resemblance approach can satisfy this requirement (see Christoff et al., 2018; Seli et al., 2018a, 2018b, for this ongoing debate).

In summary, in its present state, mind wandering research is less suitable for clarifying characteristics of spontaneous future thoughts. First, mind wandering episodes, as examined in the typical experimental paradigms, often are not initiated spontaneously, but may occur

intentionally, especially during easy tasks (Seli et al., 2015; Seli, Risko, & Smilek, 2016; see Seli, Risko, Smilek, & Schacter, 2016, for a review). Second, mind wandering is not necessarily future directed and the extent to which it interacts with a number of factors that are still under investigation, including the emotional state of the person, and whether the mind wandering episode was intentionally initiated. We now turn to a different research program that specifically has addressed characteristics of spontaneous future thoughts.

Involuntary Episodic Future Thoughts

Involuntary episodic future thoughts are imagined events in the personal future that come to mind with no preceding conscious attempt at generating this representation (Berntsen and Jacobsen, 2008; Berntsen, Rubin, & Salgado, 2015). This operational definition corresponds to the definition of involuntary autobiographical memories (Berntsen, 1996), except the latter deals with remembered events in the personal past. As with involuntary autobiographical memories, involuntary episodic future thoughts are about personal events, and involve a marked sense of involuntarily pre-living or pre-experiencing the event, corresponding to the notions of reliving and re-experiencing in the autobiographical memory literature (Berntsen & Jacobsen, 2008).

Although mind wandering is often future-directed (e.g., Baird et al., 2011), involuntary episodic future thoughts differ conceptually from the notion of mind wandering in several ways (Berntsen et al., 2015). First, by definition, involuntary episodic future thoughts are unintended. Second, by definition, involuntary episodic future thoughts are future-directed. Third, by definition, involuntary episodic future thoughts are about personal events. As reviewed in the previous section on mind wandering, none of these requirements are satisfied by the concept of mind wandering. Although some mind wandering episodes *may* be unintentional, and *may* be

future directed, and *may* be about personal events, others may not be. Fourth, involuntary episodic future thoughts cannot be described simply as a subcategory of mind wandering episodes that satisfies these requirements, because involuntary episodic future thoughts do not meet the defining criteria of mind wandering as being task-unrelated and stimulus-independent. On the contrary, there is evidence that involuntary episodic future thoughts typically are triggered by features of the ongoing situation and may sometimes be task-related (Berntsen & Jacobsen, 2008). To illustrate, consider the following example from a 22-year-old female participant in Berntsen and Jacobsen's (2008) diary study on involuntary future thinking. The first part of the record describes the ongoing situation in which the involuntary episodic future thought comes to the participant's mind. The second part describes the spontaneously imagined event (p. 1097).

Ongoing situation. I was driving on the highway. My mother, grandmother and younger brother were in the car. We were on our way home from a family celebration. I was thinking that I would like to come home fast and therefore I was wondering whether I should increase the speed.

Involuntary episodic future thought. I was driving too fast and in a few weeks I would receive a letter in the mail, which I would open in my mother's living room. The letter would be a speeding ticket with my picture on it. I would receive the ticket because I had been taken by a well-hidden speed camera.

This unbidden imagination of the future event appears to be triggered by aspects of the ongoing situation, and the content is clearly task-relevant. Both characteristics are in contrast to definitions of mind wandering as being stimulus-independent and task-unrelated. In addition, the spontaneously imagined event may have beneficial effects on the participant's ongoing task of driving the car, for example, it may lead her to reduce the speed.

This example is not meant to be representative for all involuntary episodic future

thoughts in everyday life. It simply serves to illustrate the empirical fact that they typically have cues in the ongoing situation and may relate to the ongoing task (although they do not have to). Thus, they are not stimulus- or task independent.

In short, involuntary episodic future thoughts (as well as involuntary memories) are conceptually and empirically different from mind wandering. Treating them together under the umbrella term of “spontaneous thought” (e.g., Marchetti, Koster, Klinger & Alloy, 2016) abstracts from important differences. That said, both phenomena are most frequent when attention is diffuse, such as during non-demanding and/or dull tasks (Berntsen, 2009). This may suggest that they both require central cognitive resources or both reflect control system failures (see McVay & Kane, 2010, for review and discussion).

Theoretical Background and Basic Findings on Involuntary Episodic Future Thoughts

The conceptual differences between mind wandering and involuntary episodic future thoughts in part reflect that the two notions are rooted in different literatures. As mentioned in the section on mind wandering, the modern conception of mind wandering (Smallwood and Schooler, 2006) is primarily defined in terms of a separation of attention from an ongoing task, which contextualizes mind wandering in the broader literatures of attention, working memory and executive control. In contrast, the conception of involuntary episodic future thought derives from research on autobiographical memory and episodic future thinking.

In the mid-eighties, Tulving (1985) reformulated his concept of episodic memory to include the ability to mentally project oneself into possible future events. He described the case of KC, an amnesic patient who, in addition to being unable to recollect past events, was unable to imagine events in the future. Similar findings have been reported for other patients with damage to the Medial Temporal Lobe (e.g., Hassabis et al., 2007). The term, episodic future thinking,

was coined by Atance and O'Neill (2001) and in line with Tulving (1985), defined as “a projection of the self into the future to pre-experience an event” (p. 533).

The idea that imagining events in the future draws upon the same episodic memory system as remembering events in the past (Tulving, 1985) has been supported by several studies showing overlapping neural activity during the two processes (e.g., Addis, Wong, & Schacter, 2007; Botzung, Denkova, & Manning, 2008; Okuda et al., 2001; Szpunar, Watson & McDermott, 2007). Similarly, studies have demonstrated that the two processes are affected in much the same ways by a range of experimental manipulations (e.g., Anderson, Dewhurst & Nash, 2012; D'Argembeau & van der Linden, 2004), clinical disorders (e.g., Brown et al., 2013; D'Argembeau, Raffard, & van der Linden, 2008; Macleod, 2016) and ageing (e.g., Addis, Wong & Schacter, 2008, Jarvis & Miller, 2017). However, important differences are also observed (e.g., Berntsen & Bohn, 2010; Rasmussen & Berntsen, 2013; Rubin, 2014; see Schacter, Benoit, Szpunar, 2017, for a recent review).

The parallelism between remembering the personal past and imagining future events generated the hypothesis that imagined future events might arise involuntarily during everyday life, much in the same ways as memories of past events had been observed to come to mind spontaneously during everyday life (Berntsen, 1996; Berntsen & Jacobsen, 2008). To test this hypothesis, Berntsen and Jacobsen (2008) had participants record involuntary memories and involuntary episodic future thoughts in two separate parts of the same diary study. Following a standard diary procedure (Berntsen & Hall, 2004), each time the participant had recorded an involuntary episodic future thought (or involuntary memory), later the same day they were to record a voluntary future thought (or voluntary memory) in response to a word cue. Thereby it was possible to compare involuntary versus voluntary future thoughts to involuntary versus

voluntary autobiographical memories.

Consistent with expectations, Berntsen and Jacobsen (2008) found that their participants frequently had involuntary episodic future thoughts, and that these future thoughts took place under conditions very similar to conditions facilitating involuntary autobiographical memories. As with involuntary autobiographical memories, involuntary episodic future thoughts typically came to mind when attention was unfocused, and in response to identifiable cues in the current situation. The cues were similar to cues for the involuntary memories, although internal cues in terms of thoughts and emotion were more dominant for future than for past events. Berntsen and Jacobsen (2008) also found that differences in the characteristics of involuntary versus voluntary retrieval were similar for future and past events. Importantly, the involuntary future and past event representations were more specific (that is, more frequently referred to concrete episodes), possibly reflecting less reliance on top down search strategies and more reliance on associative processes, favoring distinctive and unique event features (Berntsen, 2010). In addition, involuntary future and past events were rated as more vivid, involved more negative mood impact (i.e., made participants feel less happy or satisfied here and now) and were less emotionally positive than their voluntary counterparts, although a clear dominance of positive relative to negative events was found for all four types of event representations, consistent with research on autobiographical memory (e.g., Walker, 2003).

Finnbogadottir and Berntsen (2011) replicated Berntsen and Jacobsen's (2008) findings using the same structured diary method while involving participants with higher versus lower levels of trait worry. Few differences were found between participants with higher versus lower levels of worry. However, consistent with Berntsen and Jacobsen (2008), Finnbogadottir and Berntsen (2011) found that both involuntary future thoughts and involuntary memories typically

came to mind when attention was unfocused and in response to situational cues. They also found that involuntary future thoughts and involuntary memories were more specific, vivid and had more negative mood impact than voluntary memories and future thoughts. These characteristics were replicated in an experimental study, inducing involuntary future thoughts and involuntary memories in a laboratory setting (Cole, Staugaard & Berntsen, 2016). This study adapted an experimental paradigm previously used to elicit involuntary and voluntary memories (Schlagman and Kvavilashvili, 2008) under controlled laboratory conditions. The involuntary task involved a monotonous task, which included potential verbal cues for generating involuntary thoughts about the future. Involuntary future representations were elicited faster than their voluntary counterparts, supporting their more automatic and less cognitively demanding nature. Consistent with the findings from diary studies, involuntary future thoughts as well as involuntary memories were more specific and had more emotional impact when they came to mind, compared with their voluntary parallels.

In summary, the hypothesis that imagined future events arise involuntarily during everyday life in the same ways as do memories of past events was supported in these studies. The studies also showed that such involuntarily imagined future events differ from deliberately imagined future events on important variables. Future events that are imagined involuntarily are more frequently about specific events and come with more emotional impact than future events generated deliberately. Similar effects of involuntary versus voluntary retrieval were found for memories of past events, consistent with the future past parallelism found in other paradigms.

Temporal Distribution and Adaptive Functions

How far into the future do people spontaneously project themselves? Spreng and Levine (2006) provided the first demonstration that the temporal distribution of imagined future events

appeared to mirror the temporal distribution of past events. Although they did not study spontaneously arising imaginations of future events, Spreng and Levine's study is relevant here because it represents the first and the most thorough analysis of the temporal distribution of imagined future events, and because the findings foreshadow findings I will report shortly on involuntary episodic future thoughts. Spreng and Levine (2006) had 349 students (voluntarily) generate memories of personal events or imagine future events in response to 90 word cues. When plotting the distribution of events against distance in time from the present, Spreng and Levine found that the frequency of both past and future events showed a highly systematic decline with increase in temporal distance, and that this decline could be described in terms of a standard 'retention' function for both temporal directions (Ebbinghaus, 1885) and fitted by a power function. They also found that the slope of the curve was slightly steeper for the future than for the past events.

Similarly, the three studies discussed above that were specifically designed to examine involuntary episodic future thoughts (Berntsen & Jacobsen, 2008; Cole et al., 2016; Finnbogadottir & Berntsen, 2011) showed a highly consistent temporal distribution of the imagined and remembered events. Figure 1 presents a reanalysis of the original data in the three studies. As Figure 1 shows, the frequency of all four categories of events (i.e., involuntary future and involuntary past; voluntary future and voluntary past) decreased with distance to the present in ways that correspond to the classic forgetting curve (Ebbinghaus, 1885). In other words, for all four categories of mental events across the three studies, there is a steep decline in frequency for the first couple of years, after which the curve levels off. Thus, all four types of mental events favor events that are close to the present. However, a closer inspection of the curves also indicates that this dominance of recent events is consistently more pronounced for future events,

and tend to be more pronounced for involuntary than voluntary event constructions.

More formal analyses showed that, in all three studies, a power function provided the best fit for the drop in involuntary future events with distance in time, with the following parameters: $y = 8.7466x^{-1.099}$; $R^2 = 0.93$; (Berntsen & Jacobsen, 2008), $y = 9.3181x^{-0.975}$, $R^2 = 0.93$ (Cole et al., 2016) and $y = 7.8211x^{-1.264}$, $R^2 = 0.89$ (Finnbogadottir & Berntsen, 2011).

Comparisons with the analogous functions for involuntary past events documented a steeper drop for the future events, as illustrated in Figure 1¹.

The forgetting curve was first identified by Ebbinghaus (1885) in his seminal study of the retention of nonsense syllables and has been replicated numerous times and for various types of memory material, including naturalistic events (Rubin & Wenzel, 1996). Obviously, the general consensus is that this curve reflects mechanisms of forgetting, such as interference or decay. However, this understanding seems challenged by the fact that the temporal distribution of imagined future events shows a similar curve. Despite the robustness of the data (cf. Figure 1), this intriguing finding has been left largely unaddressed.

Here I discuss three possible explanations of the “forgetting” curve for spontaneously imagined future events. First, it might be suggested that the temporal distribution of past and future events are the result of different mental processes, and that it is simply a coincidence that these different processes produce similar patterns of results. For the past, the retention function

¹ The corresponding equations for involuntary memories of past events were: $y = 10.242x^{-0.775}$; $R^2 = 0.94$ (Berntsen & Jacobsen, 2008), $y = 11.001x^{-0.759}$ $R^2 = 0.81$ (Cole et al., 2016), $y = 10.343x^{-0.833}$ $R^2 = 0.90$ (Finnbogadottir & Berntsen, 2011)

might reflect standard forgetting mechanisms, such as decay, interference or consolidation processes (Nørby, 2015). For the future, it is caused by some different mechanisms. One problem with this explanation is that it does not appear parsimonious to assume different explanations for similar patterns of data. Also, while this explanation may account for the forgetting curve for past events, it offers no explanation for the curve for future events.

Second, and alternatively, one might suggest that the curves for past and future events reflect the exact same mechanisms. This explanation would force us to radically rethink theories of forgetting because frequently invoked forgetting mechanisms (e.g., interference and decay) operate on already encoded and stored information. Such explanations would not work for imagined future events, since future events have not yet been encountered and encoded, unless we assume that spontaneously imagined future events derive from a pool of highly rehearsed and frequently imagined event scenarios, but this is counter to the evidence (Cole et al., 2016). Assuming similar mechanisms for both temporal directions therefore would challenge standard theories of forgetting and imply highly constructive processes, for both temporal directions (e.g., Bartlett, 1932; Rubin, 2014). It also does not explain why the slope of the curve is steeper for involuntary future than involuntary past events.

A third possibility is to take a middle-ground and propose that the temporal distributions for remembered past events and imagined future events to some extent reflect different processes, but that these processes are constrained by some of the same adaptive mechanisms. Such constraining factors should optimize the probability that the remembered or imagined events bear relevance to the ongoing situation, which likely would favor the construction of events close to the present. One of the most well-developed theories of such constraints is the conception of 'need probability' introduced in Anderson and Schooler's (1991) *Rational*

Analysis theory to explain the retention curve for *past* events. The basic idea of need probability is “that at any point in time, memories vary in how likely they are to be needed and the memory system tries to make available those memories that are most likely to be useful” (p. 400). Need probability reflects environmental regularities; information that has just been encountered (e.g., topics in newspaper headlines) is more likely to be encountered again compared with information that was encountered longer time ago and has not been encountered since. Anderson and Schooler (1991) showed that such environmental regularities followed the standard retention function. More specifically, in this theory, memory availability is formed by a *history factor* and a *context factor*. The history factor is retention time and practice, and context factor refers to cues in the present situation.

Extending the conception of need probability to account for the decline in future event frequency with distance in time would help to explain why both past and future events show such a retention-like curve. Moreover, optimizing relevance to the ongoing situation is likely to constrain the construction of future events even more than the construction of past events, because imagining future events is less influenced by already encoded and established traces of events (Berntsen & Bohn, 2010). This helps to explain why the decline by time consistently is steeper for future than past events (cf. Figure 1). Following this explanation, the process of spontaneously imagining future events favors the construction of events with a high probability of relevance to our present situation, which typically are events in the near future, whereas the accessibility of past events is influenced by a greater variety of factors, including the strength of the memory traces. For example, seeing a banana in the supermarket may spontaneously generate an image of bringing a banana for lunch tomorrow, whereas the same banana may trigger a spontaneous memory of a childhood event if this event was sufficiently distinctive and

emotional when it took place (Berntsen, 2009).

Focusing on temporally close future events allows us to better use such mental events to regulate and direct our own behavior, making choices and planning. Temporally close future events typically are events we can prepare for and act on. Generating images helps us to do so (Ng et al., 2016; Pearson et al., 2015; Trope & Liberman, 2003). In comparison, it is typically not as adaptive to act on events expected to happen years from now. For that reason, when we spontaneously imagine future events in response to environmental cues, events in the immediate future dominate.

This analysis is supported by studies showing that a large number of future-oriented thoughts occurring during the course of everyday life deals with concrete planning of actions (Barsics, van der Linden., & D'Argembeau, 2016; D'Argembeau, Renaud, van der Linden, 2011). Similarly, Cole and Berntsen (2016) examined how frequently future and past events that were retrieved in a laboratory setting either involuntarily versus voluntarily were perceived by the participants to refer to previously recorded current concerns (Klinger, 1975), such as losing weight or passing an important exam. Cole and Berntsen (2016) found that involuntary mental events more frequently referred to current concerns than their voluntary counterparts, and that future events did so more frequently than past events, irrespective of retrieval mode.

Rasmussen and Berntsen (2013) compared intentionally generated future and past events and found that future events were perceived to be associated with more self-functions (i.e., functions supporting identity and directing behavior) and that this was especially pronounced for positive future events. Similarly, Özbek, Bohn and Berntsen (in press) compared the perceived functionality of intentionally generated future, past and counterfactual events. They found that future events overall were perceived to be associated with more functional relevance than the

other two categories of events, and that future events were especially strongly associated with the reflective function (i.e., self- and directive functions). These studies suggest that imagined future events to a greater extent than past events may guide behavior (see Boyer, 2008; Conway, Loveday & Cole, 2016; Klinger et al., 2018; Schacter et al., 2017; Schacter, 2012, for further discussions of adaptive functions of future thoughts)

In summary, the greater dominance of temporally close events for future compared with past events may reflect that the construction of future events to a greater extent than past events is constrained by the individual's current goals and concerns (Klinger, 1975, 2013). When these goals and concerns are adaptive, having involuntary future thoughts likely is beneficial for the person, such as supporting planning, healthy consumption and realistic decision making. However, in situations where a person's current concerns and beliefs about themselves and the world are less constructive (such as in individuals suffering from irrational fears or addiction) involuntary future thoughts may become maladaptive and intrusive (e.g., Klinger et al., 2018) -- a topic to which we now turn.

Maladaptive Spontaneous Future Cognitions

There are multiple ways in which spontaneous future thoughts may be maladaptive. For example, addicts have intrusive images of desired drugs and the act of consuming them (e.g., vividly imagining having a drink) which may initiate episodes of cravings (May, Kavanagh & Andrade, 2015). In anxiety disorders, images of personal disasters and feared encounters regularly intrude into consciousness (e.g., Beck, Laude & Bohnert, 1974; Ottaviani & Beck, 1987). Broadly speaking, intrusive imagery is associated with a range of clinical disorders (see Brewin, Gregory, Lipton & Burgess, 2010, Holmes & Mathews, 2010, for reviews).

Intrusive imagery is, by definition, uncontrolled and, thus, involuntary. However, it is not

always clear whether this imagery is past- or future-directed, because this question has not been a target of systematic investigation. In the following, I focus on four clear cases of intrusive imagery that are future directed: (1) intrusive imagery about desired targets in craving, (2) fear- and anxiety provoking imagery of future events in clinical disorders, (3) intrusive imaginations of future traumatic events and their relation to “pre-traumatic” stress reactions, and (4) flash-forwards in individuals with suicidal ideation. Disturbing future cognitions encompass large literatures (e.g., Brewin et al., 2010; MacLeod, 2016; Watkins, 2008) and providing exhaustive reviews is outside the scope of the present work. Thus, the following short reviews simply serve as introductions to these fields with the aim of illustrating their connections with other areas of spontaneous future cognitions.

Intrusive Imagery in Craving

According to the Elaborated Intrusion (EI) Theory of craving and desire (Kavanagh, Andrade & May, 2005; May, Kavanagh & Andrade, 2015), craving episodes begin with an intrusive thought about a desired target (such as a drink). This thought is high in imagery and often involves imagining the actual consumption of the desired target with vivid bodily and sensory imagery (e.g., imagine actually smelling, tasting and swallowing the drink or inhaling the cigarette smoke). According to the EI theory, the initial intrusive thought arises spontaneously. Its duration is brief and may simply disappear from consciousness if it is not followed by an elaboration, which is more protracted in time and intentionally driven. The EI theory is not limited to maladaptive imagery in addictive behavior but also applies to cognitive processes underlying the processing of normal everyday desires and their fulfillment. The imagery of the desired target and its consumption is assumed to guide behavior and is expected to be stronger in the presence of highly target-related cues, and to be intensified by prolonged

elaboration.

There is robust evidence in support of key assumptions in the EI theory (see May et al., 2015, for a review). For example, Kavanagh, Andrade and May (2009) asked individuals with alcohol-related problems to identify the last time they had had a strong urge or craving for alcohol and to answer an alcohol craving experience questionnaire in relation to this episode. The great majority of the participants (82%) reported that they had experienced sensory imagery of drinking during the craving episode, notably tasting, seeing and swallowing the alcohol. Imagery during the craving episode was positively associated with the strength of craving and its duration. Thoughts about drinking with no associated imagery also showed positive, but somewhat weaker, associations with strength of craving. Number of intrusive thoughts about drinking over the latest 24 hours was positively correlated with how many times the participants had tried to stop thinking about drinking.

These findings suggest that spontaneous future related imagery about consuming a desired object is intrinsically related to episodes of cravings. This view is also consistent with a grounded theory of desire and motivated behavior introduced by Papies and Barsalou (2015), suggesting that reward simulations based on past learning experiences may be triggered spontaneously by situational cues that match aspects of this experience, and that such spontaneously activated situated conceptualizations direct the individuals behavior towards the target. These mechanisms are assumed to facilitate healthy goal-related behavior in everyday desire and well as cravings in addictive disorders.

Fear- and anxiety provoking imagery of future events in clinical disorders

Intrusive imagery of fear provoking future events is frequent in anxiety disorders, with the content of the imagined events usually being meaningfully related to the phenomenology of

the anxiety disorder. For example, Ottavianni and Beck (1987) interviewed 30 patients with panic disorders about the kind of thoughts that went through their minds when experiencing panic attacks. The great majority of the patients reported spontaneous imagery of physical or mental catastrophes, such as visualizing dying, or having a heart attack or losing control in a social situation. The content of the reported imagery was closely related to the patients' verbal reports of the thematic content of their fears. Often the panic attacks as well as the accompanying visualizations appeared to be triggered by misattributions of physical sensations, such as misinterpreting increased heart rate as the beginning of a fatal heart attack. For example, one of the patients described by Ottavianni and Beck (1987) reported experiencing rapid heart rate and shortness of breath. This was followed by uncontrollable thoughts that "his heart would explode" and "images of himself in the hospital" (p. 24).

Similarly, patients with Obsessive-Compulsive Disorders may experience intrusive future related imagery about loved ones, or entire communities, being harmed, if they do not perform, or imagine, certain compulsive acts (de Silva, 1986). For example, a male patient had repetitive intrusive thoughts about his family being harmed. In order to prevent this from happening, he would visualize photographs of his children and wife, his deceased parents and Virgin Mary and Jesus Christ in a specific and highly systematic order (de Silva, 1986). In some cases, such images of possible aversive situations in the future appear to be related to actual stressful events in the past (Speckens, Hackman, Ehlers & Cuthberg, 2007).

Health anxiety (hypochondriasis) is another anxiety-related disorder with future directed, intrusive imagery. Muse, McManus, Hackman, Williams, and Williams (2010) interviewed 55 patients with health anxiety about the kind of thoughts and imagery they experienced when being anxious about their health. The great majority of the participants reported spontaneous images

that in most cases (86%) were future directed, such as “visualizing being told by a doctor that they have cancer” or “picturing self dying in a hospice” (p. 795).

Individuals with persecutory delusions also experience spontaneous intrusive imagery about events in the future, such as being attacked or killed by relatives or strangers (Schulze, Freeman, Green, & Kuipers, 2013). Persecutory delusions are common in psychosis and may be acted upon (Freeman & Garety, 2014). In extreme cases, this may have fatal consequences, for example, if a psychotic person with severe persecutory delusions tries to attack, or even kill, the imagined persecutor in order to prevent an imagined, catastrophic event from happening.

In summary, it appears that most cases of intrusive future-related imagery reviewed here are episodic in nature in the sense of dealing with imagined events or scenes. A key question for future research is therefore whether these maladaptive, spontaneous future cognitions should be viewed as a dysfunctional subclass of everyday involuntary episodic future thoughts or whether they reflect special (e.g., disease specific) mechanism. This question parallels a debate concerning the status of intrusive, involuntary memories in clinical disorders relative to everyday involuntary memories (e.g., Berntsen & Rubin, 2014; Brewin, 2014).

Intrusive imaginations of future traumatic events in “pre-traumatic” stress reactions

Although Posttraumatic Stress Disorder (PTSD) is a diagnosis related to events in the past (as indicated by the prefix ‘post’), it is possible to develop future-related PTSD-like symptoms in the expectation of a stressful forthcoming event. Such ‘pre-traumatic’ stress reactions consist of intrusive images of the expected traumatic *future* event and its consequences. Berntsen and Rubin (2015) introduced a scale that measures ‘pre-traumatic’ stress reactions as a future-directed parallel to the posttraumatic stress reactions described in the diagnostic criteria

for PTSD. They reformulated items of a standard PTSD checklist (Blanchard, Jones-Alexander, Buckley, & Forneris, 1996) to address pre-experiencing and avoiding reminders of possible traumatic events in the future by rewording the instructions and the re-experience and avoidance items on the checklist to address stressful- or traumatic events in the future instead of in the past. The participants were asked to consider “a list of problems and complaints that people sometimes have before a possible, very stressful experience in the future”. The checklist included such problems as having “repeated, disturbing and unwanted images of the future stressful experience” and having “repeated, disturbing dreams of the future stressful experience” as well as “suddenly acting or feeling as if the future stressful experience already were happening (as if you were pre-living it)” or “avoiding imaginings, thoughts or feelings related to the future stressful experience”. Berntsen and Rubin (2015) applied this pre-traumatic stress reactions checklist to Danish soldiers before, during, and after deployment to Afghanistan. They found that the pre-traumatic stress reactions measured before the soldiers' deployment significantly predicted level of PTSD symptoms during and after their deployment, even while controlling for baseline PTSD symptoms and combat exposure measured during and after deployment.

Relatedly, child birth is a predictable future event that is stressful and potentially traumatic for the pregnant woman. Worries and fear of giving birth are common during pregnancy (Goutaudier, Bertoli, Séjourné & Chabrol, 2018). Goutaudier et al. (2018) examined pre-traumatic stress reactions, related to the forthcoming child birth, in 102 pregnant women. They found that fear of child birth, anticipated labor pain, symptoms of depression and anxiety predicted level of pretraumatic stress during pregnancy.

These findings suggest that PTSD is not simply a past-related disorder, but that intrusive

images of traumatic and stressful future events are as central to this disorder as are intrusive memories of traumatic events in the past. This has implications for treatment and for the conceptualization of the disorder that so far has been largely overlooked.

Flash-forwards and suicidal ideation in depression

Holmes et al. (2007) examined spontaneously arising images of suicide in fifteen depressed and previously suicidal patients. These images were vivid and persistent and could be conceived of as flash-forwards to the suicide. For example, one patient reported repeatedly imagining jumping from a specific cliff. The person described “looking at my feet and grass on one side and sea and rocks on the other side ... and I just thought I’d jump”. The result of this act was described as “blank and black and nothing ... it was like the ultimate salvation, my own choice”. (p. 428). In most cases (12 of 15 cases), these images were seen as comforting, although 7 of 15 also associated them with distress. Levels of preoccupation with these suicidal images was positively correlated with level of suicide ideation. These findings were replicated and extended by Crane, Shah, Barnhofer and Holmes (2012) in a community sample with a history of depression. Consistent with Holmes et al. (2007), participants who reported previous suicide ideation also reported flash forwards to imagined suicidal acts or its aftermaths, such as jumping from the balcony of a tall building or crashing the car with the goal of killing oneself. In many cases, this imagery was associated with relief and comfort, and more frequently so in individuals with higher levels of prior suicidality.

Ng, Di Simplicio, Manus, Kennerley, and Holmes (2016) examined spontaneous mental imagery of suicide in 82 suicidal and 80 non-suicidal individuals. They found that suicidal flash-forwards were found only in suicidal individuals. As in the previous studies, suicidal flash-forwards was associated with suicidal ideation. Also, the suicidal flash forwards were often

about scenes that were perceived as positive by the person (such as “my wife would touch my corpse in the coffin and showed how much she missed me” p. 457) or otherwise associated with comfort.

In summary, persistent and vivid images that can be conceived as spontaneous flash forward to suicide are frequent in depressed individuals with suicidal thoughts. In contrast to the fearful intrusive images in anxiety-related disorders, suicidal flash-forwards are often associated with a subjective experience of comfort and relief and may therefore pose a significant risk for actually conducting the act.

Final Discussion

Spontaneous future cognitions are a multifaceted phenomenon studied in many different areas of psychology, but with little interdisciplinary exchange of findings and theoretical developments. A better integration of these different fields of study is warranted in order to stimulate progress in research on spontaneous future cognitions. In the following, I discuss a number of questions that appears relevant across these different domains of research.

First, it is important to clarify to what extent spontaneous future cognitions are constrained by current concerns and goals of the individual. The fact that everyday involuntary future thoughts show a marked dominance of events imagined to happen in the near future (cf. Figure 1) tentatively suggests that personal concerns and goals may be a major determinant for their content, which may support action planning. However, systematic analyses of the content of spontaneously arising future thoughts as well as experimental studies are needed to clarify this question. If spontaneous future cognitions indeed are constrained by the current goals of the individual, then the dysfunctional, intrusive future imagery observed across a multitude of clinical disorders, to some extent may reflect maladaptive current concerns (such as a wish to

commit suicide in severe depression), or conflicts between immediate desires and more long-term goals (such as intrusive imagery of desired consumptions in cravings conflicting with a long-term goal of losing weight).

Second, the temporal distribution of spontaneously imagined future events is another important question. The reanalysis of data from three studies involving young participants showed a highly systematic pattern that could be described in terms of a standard retention function, with a marked dominance of imagined future events dated temporally close to the present (Figure 1). Future research should clarify to what extent this pattern replicates across study populations, such as younger versus older individuals, and across healthy and clinical samples. Research on voluntarily generated future events shows an interaction between emotional valence and distance to the present, with positive future events imagined to happen much closer to the present than negative future events (Rasmussen & Berntsen, 2013). Because this has been shown only for strategically generated events in young, healthy adults, it is important to clarify whether a similar pattern is found for *spontaneous* future events and whether it replicates across different populations. Possibly, a different, or maybe even reverse, pattern could be found in anxiety disorders. For example, it is possible that individuals with anxiety disorders to a greater extent spontaneously imagine highly negative events to happen in the immediate future, which would generate more intense anxiety compared with images of potential catastrophic events happening many years from the present.

Third, it is important to attain a deeper understanding of differences between involuntary and voluntary future cognitions. Previous research has shown that involuntary episodic future thoughts are more often about specific events and that they have stronger mood impact (especially negative impact) when they come to mind. This suggests that they instigate more

emotion regulation processes, such as avoidance and emotion suppression (Gross, 2001) in response to their occurrence. It also suggests that they may have a stronger impact on an individual's immediate behavior when they come to mind, than future cognitions generated in a deliberate and controlled fashion. These are important questions for future research.

Fourth, studies on everyday involuntary future thoughts have demonstrated the importance of situational cues for facilitating the spontaneous generation of imagined events. Currently, it is unclear whether situational cues also are central to the activation of dysfunctional future-related imagery in clinical disorders, or whether the activation of such imagery is more internally driven. It is also not clear whether spontaneous mind wandering episodes directed towards the future are initiated by cues in the ongoing situation (but see Plimpton et al., 2015). Furthermore, if momentary cues are central for the activation of spontaneous future thoughts, how would this interact with more prolonged current concerns and goals of the individual? According to Klinger (2013), current concerns affect the attentional focus of the individual, which in turn may direct attention towards concern-related cues. More research is needed to study the interplay between attentional biases, current concerns and cueing of spontaneous future cognitions.

Fifth, we know little about individual differences in the frequency and quality of spontaneous future cognitions. Research suggests weak to moderate correlations between the frequency of involuntary future thoughts (and memories) and measures of negative affect, such as depression, PTSD and anxiety, and stronger positive correlations with measures of daydreaming, other types of involuntary thought and imagery (Berntsen et al., 2015; Hyman et al., 2015) and hallucination proneness (Allé, Berna & Berntsen, 2018). Future research should expand this research to examine the relation between spontaneous future cognitions and

measures of self-regulation (e.g., Hoyle, 2010), in order to explore how individual differences in spontaneous future cognitions may be related to individual differences in goal pursuit and self-control.

Future projections that are out of touch with reality are maladaptive and can be dangerous, not just for the individuals themselves, but also for their fellow human beings and even the societies to which they belong. It is therefore a reasonable assumption that spontaneous future projections normally will have to be constrained by our physical, social and cultural reality to guide behavior in adaptive ways. Understanding these constraints and how they work together to produce meaningful spontaneous future cognitions are important tasks for future research. Pursuing these questions will not only lead to a deeper understanding of spontaneous future cognitions and their underlying processes. It may also generate important new insights regarding the motivation and regulation of human behavior in everyday life.

Compliance with Ethical Standards

The author declares no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. Preparation of this manuscript was supported by Grant DNRF89 from the Danish National Research Foundation and Grant 13481 from Velux Fonden. *Ethical approval:* This manuscript contains no new data from studies with human or animal participants performed by the author. It reviews already published (or submitted) research, for which reason information regarding informed consent is not applicable.

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Figure caption:

Figure 1: The distribution of involuntary and voluntary memories and future events by distance from the present across three studies

Figure 1. Temporal distribution of involuntary and voluntary memories and future events

