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On the Nature of Everyday Prospection: A Review and Theoretical Integration of Research on Mind-Wandering, Future Thinking and Prospective Memory

Lia Kvavilashvili[1], Jan Rummel[2]

[1] *Department of Psychology and Sport Sciences, University of Hertfordshire, United Kingdom*

[2] *Psychology Institute, Heidelberg University, Germany*

Address for correspondence:

Lia Kvavilashvili

Department of Psychology and Sport Sciences

University of Hertfordshire

College Lane

Hatfield, Herts, AL10 9AB

United Kingdom

Tel. +44 (0) 1707 285121

Email: L.Kvavilashvili@herts.ac.uk

Abstract

The ability to imagine and simulate events that may happen in the future has been studied in several related but independent research areas (e.g., episodic future thinking, mind-wandering, prospective memory), with a newly emerging field of involuntary future thinking focusing primarily on the spontaneous occurrence of such thoughts. In this paper, we review evidence from these diverse fields to address important questions about *why* do people think about the future, *what* are the typical and most frequent contents of such thoughts, and *how* do these thoughts occur (are they spontaneous or constructed deliberately)? Results of the literature review provide support for the pragmatic theory of prospection (Baumeister, Vohs, & Oettingen, 2016), by showing that when people engage in prospective thought naturally, without being explicitly instructed to do so, they predominantly think about their upcoming tasks and planned activities instead of simulating plausible but novel hypothetical scenarios. Moreover, prospective thoughts are more often spontaneous than deliberate and effortful, and their occurrence seems to increase the likelihood of planned activities being completed in the future. The findings are discussed in the context of a new "pragmatic dual process account" of future thinking and new avenues for future research on prospection are outlined.

Key words: *episodic future thinking, prospection, prospective memory, mind-wandering, spontaneous cognition*

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The human ability to imagine and plan for the future has been investigated in different sub-domains of cognitive psychology, most notably in research on episodic future thinking, future-oriented mind-wandering and prospective memory (for definitions, see glossary in Table 1). Although the literature on each of these topic areas is immense (i.e., 5,896 journal articles on "prospective memory", 780 journal articles on "mind wandering" and 459 journal articles on "future thinking", according to searches *in PsycINFO* with the respective keywords in February 2020), there has been very little research on the nature of prospective thought in everyday life. Consequently, the existing literature is relatively silent about the main question addressed in this paper, namely, how prospection manifests itself naturally when participants are not explicitly asked to think about or construct future events. In particular, *why* do people think about the future outside the laboratory, *what* are the typical and most frequent contents of such future thoughts, and *how* do these thoughts occur (are they deliberately constructed or pop into mind spontaneously)? To address these questions, we reviewed a small number of available studies that satisfied the following inclusion criteria. First, thoughts about the future had to occur naturally, without participants receiving instructions to deliberately construct the thoughts, either in the laboratory, or in the course of their daily lives. Second, participants had to report the actual contents of their thoughts which could be examined and coded by researchers.

Based on these inclusion criteria, the review of studies on mind-wandering and spontaneous future thinking (see Table 1), a newly emerging field within research on episodic future thinking (Cole & Kvavilashvili, 2019; 2020; Berntsen, 2019), provided strong support for the pragmatic theory of prospection, which considers planning as the most important and frequent form of episodic future thinking in the service of accomplishing one's

immediate needs and goals (Baumeister, Meranges, & Sjåstad, 2018; Baumeister, Vohs, & Oettingen, 2016; D'Argembeau, 2016). In addition, several studies on prospective memory showed that just thinking about such upcoming tasks and plans enhances the likelihood of them being carried out in the future (e.g., Kvavilashvili & Fisher, 2007). To provide a theoretical integration of the literature reviewed in this paper, we propose a new framework, based on the dual process account of future thinking (see Cole & Kvavilashvili, 2020), which places research on everyday prospection at the intersection of studying spontaneous and deliberate episodic future thinking, prospective memory and mind-wandering, and opens up interesting avenues for research across these related but currently separate fields of research.

The study of prospective thought in future thinking and mind-wandering research

Human beings have a remarkable ability to transcend the constraints of the current environment and activities, and mentally transport themselves not only into the past, but also into the future by thinking about upcoming events and tasks, hypothetical scenarios and even impossible events. This capacity for prospective thought has been the focus of rapidly growing research over the past decade (Michaelian, Klein, & Szpunar, 2016; Oettingen, Sevincer, & Gollwitzer, 2018; Schacter, Benoit, & Szpunar, 2017), and has been referred to as episodic future thinking, episodic simulation, episodic foresight and autobiographical planning, among several others. The variations in terminology reflect the fact that prospection is involved in numerous cognitive activities in everyday life such as problem solving, forecasting, planning, daydreaming, etc. (Bulley & Irish, 2018; Schacter, 2012).

However, according to the taxonomy proposed by Szpunar, Spreng and Schacter (2014), the great variety with which prospective thought manifests itself in daily life can be reduced to four basic forms of episodic future thinking: (1) simulation (constructing a mental representation of the specific future event/scenario), (2) prediction (estimating the likelihood of a particular event or outcome in the future), (3) intention (setting of a goal or intended

action) and (4) planning (identifying and organising steps for achieving a goal). These basic forms of future thinking support prospection from the initial conception of a possible future event or task to the process of attaining the goal or planned actions. That is, the translation of episodic future thinking into action may represent an important aspect of prospection, which may have contributed to the survival of our species and is essential for successful everyday functioning (Suddendorf & Corbalis, 2007). Szpunar et al. (2014) also emphasise that out of these four types of prospective thinking, only prediction, intention and planning can be considered as intrinsically future-oriented, while simulation is not always directed to the future, because people may engage in simulations of past and present events (e.g., imagining what could have happened in the past).

Nevertheless, the vast majority of cognitive and neuroscience research on future thinking has been focused predominantly on studying episodic future simulation, using a modified version of the autobiographical interview or word cuing technique, which requires participants to *deliberately* construct mental representations of possible personal future events in response to word cues (or other types of cues) provided by the researcher. In other words, participants have to simulate imaginary events or scenarios that might or might not happen to them within a particular future time-period (for overview of methods, see Miloyan & McFarlane, 2019). In most studies, such deliberate mental simulation is achieved without a need to formulate a real plan, solve a future problem, or linking it to any other kind of goal-directed activity (but see Cole & Berntsen, 2016; D'Argembeau & Mathy, 2011, Study 3; Neroni et al., 2016; Spreng et al., 2010; Spreng & Levine, 2013).

The research on mental simulation has been extremely important in enhancing our understanding of the phenomenology and brain mechanisms involved in episodic future thinking and its relationship with episodic memory (i.e., remembering events that happened in one's past), encapsulated in the concept of mental time travel into the past and the future

(Schacter et al., 2017; Suddendorf & Corballis, 2007; Tulving, 2002). However, the other three basic modes of prospection (prediction, intention and planning) have been somewhat neglected in the mainstream literature of episodic future thinking. In addition, thoughts about the future may often pop into mind without any intention to engage in these thoughts (see Table 1). The ubiquity of such spontaneous mental activity in daily life has been documented not only by research on involuntary mental time travel pioneered by Dorthe Berntsen and her colleagues (Cole, Staugaard & Berntsen, 2016; Berntsen & Jacobsen, 2008; Finnbogadóttir & Berntsen, 2013), but also by a rapidly growing body of research on mind-wandering or task-unrelated thinking (Christoff et al., 2016; Fox et al., 2015; Smallwood & Schooler, 2006; 2015).

Research on spontaneous future thinking (for reviews, see Cole & Kvavilashvili, 2019; Berntsen, 2019) has been primarily based on diary methods requiring participants to report instances of spontaneous future thoughts while being engaged in some unrelated activities (i.e., the self-caught method). Thus, it is limited to those instances in which people have meta-awareness of having a particular future thought (e.g., Schooler et al., 2011). By contrast, in mind-wandering research, various forms of experience sampling methods have been used probing participants for the contents of their thought (i.e., the probe-caught method) while being engaged in monotonous (more or less demanding) cognitive tasks such as the go/no-go, n-back, or vigilance tasks (Rummel & Boywitt, 2014; Smallwood & Schooler, 2015; Weinstein, 2018). There is also a growing body of research using similar experience sampling methods in everyday life asking participants to fill in questionnaires about their ongoing thoughts every time they receive a signal on a mobile device (e.g., Anderson & McDaniel, 2019; Gardner & Ascoli, 2015; Kane et al., 2007, 2017; McVay, Kane & Kwapil, 2009; Song & Wang, 2012; Warden, Plimpton, & Kvavilashvili, 2019).

A general finding that has emerged from these studies is that participants' reports of mind-wandering are more future- than past-oriented (Smallwood & Schooler, 2015;

Stawarczyk, 2018), and that this prospective bias in mind-wandering is affected more negatively by ongoing task demands than mind-wandering about the past (e.g., Smallwood, Nind & O'Conner, 2009). This contrasting pattern in past and future thinking has been explained by the *episodic constructive simulation hypothesis*, which stipulates that thinking about the future involves flexible re-construction/integration of elements recalled from episodic memory to arrive at a novel mental representation or simulation (Schacter, Addis & Buckner, 2008). It has been also suggested that these constructive processes may be more resource demanding than processes involved in episodic recall and, in line with this reasoning, several studies have reported stronger activations in parts of the brain's default network during future compared to past thinking (e.g., Addis, Wong & Schacter, 2007; Szpunar, Watson & McDermott, 2007). Together, findings on deliberate mental time travel and prospective bias in mind-wandering appear to support the idea that simulating possible real or imaginary scenarios is a constructive and cognitively demanding process.

More recent findings have started to question the generality of this assumption, however, by showing that even when using a standard word cue method, the majority of future thoughts (approximately 60%) are reported within few seconds and without much effort and strategic search (i.e., directly accessed/constructed future thoughts; Jeunehomme & D'Argembeau, 2016). In addition, Jeunehomme and D'Argembeau (2016) found that directly accessed or produced future thoughts were more likely to have been thought about already in the past (but they were not simply past events recast in the future). The authors therefore suggested that directly produced future thoughts could be conceptualised as "memories of the future rather than newly imagined future events" (p. 261) (see also Mazzoni, 2019). Finally, findings from studies on episodic future thinking and mind-wandering also show that the majority of future thoughts are about events happening later in the same day or the next seven days (e.g., Berntsen, 2019; D'Argembeau et al., 2011). These initial findings suggest that,

rather than deliberately simulating plausible but novel future scenarios/events, people are naturally inclined to think about the more 'immediate' future by reactivating their upcoming prospective memory tasks and plans for the day and the near future.

Different phases of prospective memory and how they relate to future thinking

Prospective memory involves the remembering of an intended action at an appropriate moment in the future (e.g., *remembering to pay a bill on time, send a birthday card or keep an appointment*), and is vital for successful everyday functioning. It usually consists of several phases, which are illustrated in Figure 1, starting with a person planning an intended action and defining the future context in which it shall be carried out (Ellis, 1996; Kliegel, Martin, McDaniel, & Einstein, 2002). Because prospective memory tasks are to be executed in the future rather than immediately (Ellis, 1996; Kvavilashvili & Ellis, 1996), this initial intention formation phase is usually followed by a delay period (i.e., a retention or storage phase) during which the person is engaged in other unrelated activities, but nevertheless, may be periodically thinking of the intended action, when being reminded of it by incidental environmental triggers, or when the intention simply pops into mind in the absence of any triggers (Kvavilashvili & Fisher, 2007). The retention phase is usually followed by the retrieval phase. This phase is defined as the context in which the appropriate opportunity for carrying out the intention may occur, and when such an opportunity is encountered, the prospective memory task may be executed if the intention is retrieved from memory in due time. For example, if someone intends to pass on a message to a friend at lunch time the following day, then having a lunch with the friend will be a retrieval phase, because it is at this time period that the intention can be potentially retrieved and executed. Some researchers have also proposed a forth, intention initiation or execution phase, which refers to the very moment in which an intention is executed (Ellis, 1996; Kliegel et al., 2002).

Prospective memory has been referred to as ‘memory for future intentions’ (Ellis, 1988; Hitch & Ferguson, 1991) and it is legitimate to ask about how future thinking is involved in prospective memory, especially in relation to four phases depicted in Figure 1. The involvement of future thinking in the retrieval and execution phases is somewhat ambiguous because at this stage, the hitherto future-oriented thoughts about intended actions and plans turn into thoughts about the very near future or present (such as “I need to do this right now”). Although much of the research on prospective memory has focused on the cognitive processes during the retrieval phase (McDaniel & Einstein & 2007; Cohen & Hicks, 2017), in this review, we will primarily consider research on the two earlier phases of prospective memory. This is because thinking about the future plays an important role both at encoding (Atance & O’Neill, 2001; Brewer & Marsh, 2010; Schacter et al., 2008) and retention phases of any given prospective memory task. However, while at the encoding stage, the process of forming an intention is always deliberate (based on a conscious decision to act in a particular way) (Kvavilashvili & Ellis, 1996), thinking about the upcoming prospective memory task in the retention interval can be deliberate, for example, when mentally revising one’s plans for a day, or spontaneous, when thoughts about the intention simply pop into one’s mind (Ellis & Nimmo-Smith, 1993; Szarras & Niedźwieńska, 2011).

Like in many other areas of cognitive psychology, most research on prospective memory is conducted in the laboratory, using a paradigm which mimics the prospective memory phases, depicted in Figure 1 (Einstein & McDaniel, 1990). This is achieved by giving participants a prospective memory task to remember to press a key in response to a stimulus while performing an ongoing task in the retrieval phase, and having participants perform another unrelated activity during a retention phase (inserted between prospective memory instructions and the onset of the ongoing task). During the ongoing task (i.e., the retrieval phase), participants need to remember, on their own, to perform the special response

at the appropriate moment (e.g., upon the occurrence of the intention-relevant stimulus). Notably, this paradigm has been optimized for studying the cognitive processes engaged during the prospective memory retrieval phase, probably because these processes are most relevant from a memory perspective. Additionally, naturalistic tasks have also been used to study prospective memory. In some studies, for example, participants are asked to carry out a simple prospective memory task in their daily life (e.g., make a phone call or press a button at a particular time) and the information about the timing and accuracy of prospective memory performance is collected (Maylor, 1990; Rendell & Thompson, 1993; Wilkins & Baddeley, 1978). Although both laboratory and naturalistic studies have provided important insights into how prospective memory may function, they have been focussed mainly on intention retrieval and execution. Thus, we still know very little about how people form intentions for planned or intended future tasks in the their everyday life, and how they think about these future tasks in the retention phase in which the intention is postponed for its later execution.

Asking this question is important not only for establishing the generalizability of laboratory findings on prospective memory (e.g., Kvavilashvili & Ellis, 2004; Rummel & Kvavilashvili, 2019), but also for addressing more general questions about the nature of prospective thought, especially in the light of rapidly growing research on episodic future thinking (Atance & O'Neill, 2001; Schacter et al., 2017; Szpunar, 2010) and mind-wandering (Fox et al., 2015; Smallwood & Schooler, 2015). Up until very recently, research on these topics and on prospective memory have been developing virtually independently from each other. However, initial findings indicate some interesting links between them both at behavioural and neural levels (Gonen-Yaakovi, & Burgess, 2012; Kvavilashvili, Niedźwieńska, Gilbert & Markostamou, 2020; Steindorf, & Rummel, 2017; Ward, 2016) that urgently need to be discussed. In so doing, we hope to obtain theoretical clarity about the

nature of the phenomena studied in these areas and assess the extent to which they may be similar to or different from each other (*cf.* Cole & Kvavilashvili, 2019).

How often do we think about the future in everyday life?

Before addressing a question about the nature of naturally occurring prospective thinking, it is first necessary to assess the prevalence of such thoughts in everyday life. While this is not an easy task, several studies have tried to address this question, using mainly diary and experience sampling methods. For example, in an initial study on involuntary mental time travel (Berntsen & Jacobsen, 2008), participants retrospectively estimated that they had experienced between 1 and 10 involuntary thoughts about the future per day (just as many as involuntary memories about the past). However, the first diary study by D'Argembeau et al. (2011, Study 1), in which participants had to acknowledge the experience of future thoughts (both spontaneous and deliberate ones) during one day by using an easily portable note book as tally list, participants recorded on average 59 thoughts (*SD* = 21, range: 27 to 102).

Finnbogadóttir and Berntsen (2013) used a similar recording method over a one-day period and showed that participants recorded, on average, 21.50 spontaneous future thoughts (*SD* = 28.11, range = 147), which did not differ from the number of recorded spontaneous thoughts about the past (*M* = 22.61, *SD* = 27.80, range = 132). The markedly lower number of recorded future thoughts is probably due to the fact that Finnbogadóttir and Berntsen's (2013) participants were asked to record only involuntary future projections, and that only participants with low and high scores on the Penn State Worry Questionnaire were selected (Meyer, Miller, Metzger, & Borkovec, 1990). In a more recent laboratory study of involuntary future thoughts by Cole et al. (2016), young participants had to detect infrequent target slides with vertical lines (and ignore slides with horizontal lines) while being exposed to incidental cue words during a 15-min long vigilance task. In this study, participants

reported on average 5.70 (*SD* = 4.23) spontaneous thoughts about the future, which amounts to approximately one spontaneous future thought every 3 minutes.

Finally, in the naturalistic experience sampling study by Gardner and Ascoli (2015), participants had to indicate on a diary page whether they had been thinking about a past personal event (referred to as autobiographical memory) or a future task or event (referred to as prospective memory) at the exact time when they were prompted by a random call on their mobile phone. If they had been thinking about the past or the future at the time of the prompt, they also had to estimate the duration of the thought up until the moment of being interrupted. The measures of recall probability and duration estimates allowed to calculate the approximate frequency of past and future thoughts per hour. The results showed that young to middle-age participants (aged 18 – 49), on average reported significantly more thoughts about the future (*M* = 16.6; *Mdn* =13.9) than the past (*M* = 13.3, *Mdn* = 8.9) per (subjectively determined) hour. In other words, one future thought was estimated to occur once every 4 minutes. It is interesting that, although older participants (aged 50 – 75) reported similar rates of past thoughts to younger adults, their hourly rate of future thoughts was significantly higher (*M* = 30.6, *Mdn* = 24.6), equivalent to having a future thought every 2 minutes.

Notably, the studies by D'Argembeau et al. (2011) and Gardner and Ascoli (2015) did not ask participants to report whether their thoughts were spontaneous or deliberate. A predominance of spontaneous over deliberate task-unrelated thoughts has, however, been reported in several laboratory studies of mind-wandering (e.g., Forster & Lavie, 2009, Experiment 3; Plimpton, Patel & Kvavilashvili, 2015; Seli, Risko, & Smilek, 2016; Seli, Maillet, Smilek, Oakman & Schacter, 2017; Stawarczyk, Majerus, Maj, Van der Linden and D'Argembeau, 2011; Stawarczyk, Cassol & D'Argembeau, 2013) and in a recent naturalistic experience sampling study (Warden, et al., 2019). Therefore, the evidence emerging from studies of involuntary future thoughts and mind-wandering suggests that, in everyday life,

people may engage in thinking about the future quite frequently (at least several times per hour) and, most of the time, such thoughts may occur spontaneously rather than deliberately.

What is the content of thoughts about the future in everyday life?

Most research on mind-wandering (both in and outside the laboratory) is based on participants' responses to questions with multiple choice options or ratings made on Likert type scales (for a review, see Weinstein, 2018). However, it has been acknowledged recently that there are important individual differences in mind-wandering contents that need to be considered (Welhaf et al., 2019). Similarly, although studies on deliberate and spontaneous mental time travel typically require participants to record the descriptions of their future (and past) thoughts, generally, the contents of these thoughts have not been analysed (e.g., Berntsen & Jacobsen, 2008). This information is needed, however, to find out if people engage in the four basic modes of prospection, proposed by Szpunar et al. (2014), equally often in everyday life or whether certain types of prospection occur more frequently than others. In this section, we will review the small number of studies that have addressed this question using questionnaire, diary and experimental methods (see Table 2 for details of methods used in these studies).

The content of future thoughts: Findings from questionnaire studies

The very first study that demonstrated that people tend to engage in realistic and planful thoughts rather than in entirely wishful or fanciful thinking while mind-wandering was conducted by Singer and McCraven (1961). They asked 240 college students about the frequency with which they engaged in daydreaming using a questionnaire that listed 93 specific topics. The results showed that thoughts related to immediate practical concerns and planning such as thinking about work-related tasks in the next 3-4 weeks, plans for the next vacation or how to enhance the income in the next year, were endorsed by more than 80% of

the sample as occurring relatively frequently alongside with more wishful speculative thoughts (e.g., inheriting a million dollars or what Heaven might be like).

In a more recent study by Bertié et al. (2015), 128 drivers completed a questionnaire relating to their most recent car trip. Most drivers (85%) reported mind-wandering while driving. The detailed analysis of 210 descriptions of specific mind-wandering episodes showed that the majority (50%) were focused on future events and tasks than the present (39.5%) or the past (11.5%). In addition, the majority of these future oriented thoughts (63%) concerned planning thoughts about the very near future (*I must not forget my health visit tomorrow morning at the medical centre*, *what do I have to do in the next three days?*) or near future (*admission for the Masters course*, *organization of the next school year*).

Although the findings from these two questionnaire studies are interesting, they should be interpreted with caution as participants had to assess the frequency and the nature of their mind-wandering episodes retrospectively, and it is possible that future thoughts about intended actions were more memorable/accessible than other thoughts during the journey. It is therefore necessary to assess the temporal focus and the contents of participants' thoughts without the potential retrospective bias using online thought probe methods in the laboratory and everyday life. Although probing participants online during laboratory vigilance tasks and in experience sampling studies of mind-wandering in everyday life is now a common practice (Weinstein, 2018), there is only a handful of studies that obtained actual descriptions of participants' thoughts and analysed their contents to examine what participants were actually thinking about while mind-wandering.

The content of future thoughts: Findings from laboratory studies

Since the primary focus of the present review is on naturally occurring future thoughts, here we review findings from those laboratory studies where participants' thoughts about the future were not generated in response to experimental instructions or current task

demands. Instead, participants were engaged in some monotonous (relatively undemanding) vigilance tasks and their naturally occurring future thoughts about matters outside the laboratory context (e.g., *my exam tomorrow morning*) were sampled by random thought probes during the task. Using this method, a primary goal of a laboratory study by Baird, Smallwood and Schooler (2011) was to test the hypothesis that "one potential function of spontaneous thought is to plan and anticipate personally relevant future goals, a process referred to as autobiographical planning" (*p*. 1604). Participants were intermittently stopped during a choice reaction task, and asked to type the description of any thoughts they had at that moment. These thought descriptions were later coded on several dimensions including task focus (on task, off task), temporal focus (past, present, future) and self-relevance (self-related, goal-directed). A description was classified as "goal-directed" when a specific goal involving an objective or desired result that a participant wanted to achieve was mentioned.

There was a strong prospective bias with a large proportion of thoughts being coded as future- (M = .43) than present- (M = .28) or past-oriented (M = .12). The analysis of participants' off task future thoughts showed that 53% involved thoughts about personal goals, and 39% were thoughts about the self only, while past thoughts consisted primarily of self-related thoughts (70%), with only 7% of thoughts being goal-directed. Most importantly, the proportion of goal-directed thoughts explained 41% of the variance in future-oriented thoughts, while self-relevant thoughts accounted for a non-significant 3% additional variance. Baird et al. (2011) concluded that the prospective bias in mind-wandering often involves planning for the future, which is likely to have functional significance by helping people to carry out their future plans.

Using a similar methodology, Stawarczyk et al. (2011) investigated the temporal focus, phenomenology and possible functions of *task-unrelated thoughts* that participants reported during an ongoing sustained attention to response task (SART; a go/no go task; see

Table 2). While performing this task, participants were intermittently probed with four response options, one of which corresponded to task-unrelated thoughts or being in a mind-wandering state. If this option was chosen, participants had to provide a brief description of their thought. After completing the task, participants indicated the temporal focus of their thoughts (past, present, future, atemporal), and rated them on various dimensions (valence, visual imagery, inner speech, spontaneity, goal-relatedness, etc.). Most importantly, participants had to indicate the function of their thought by choosing from seven response options. Out of these, three were deemed to refer to future goal-directed functions (to make a decision; to plan something; to re-appraise the situation), three options were not related to the future (to make the participants feel better; to keep the participant aroused; other), and the remaining option was for "thought[s] with no particular function".

The main hypotheses tested by Stawarczyk, et al. (2011; Experiment 2), was that if the primary function of mind-wandering were to plan the future, then the majority of task-unrelated thoughts would be future oriented, and this prospective bias should be increased in a condition in which participants were reminded of their pending goals upfront. For this purpose, participants in the personal goal condition had to write a one-page essay about their current projects and steps to achieve them, while participants in the mental navigation condition had to describe a route to a well-known location in the town prior to completing the laboratory task. Results confirmed the prospective bias in both conditions, which was reliably stronger in the personal goal than in the mental navigation condition, whereas the groups did not differ in the proportions of thoughts in other temporal categories. Importantly, the analyses of reported functions showed that thoughts classed as having future-related functions were significantly more frequent than thoughts having other functions or classed as aimless daydreams (i.e., thoughts having no function). This effect was also stronger in the personal-goal condition (*cf.* Steindorf & Rummel, 2017). Task-unrelated thoughts were also

rated as predominantly spontaneous, realistic, and referring to goals and concerns in the current day than later time points, such as thinking about "an appointment in the next hours," "possible leisure activities for the end of the day" or "work that need to be done before tomorrow" (*p*. 378).

These findings were replicated and extended in a follow-up study by Stawarczyk, et al. (2013), using a similar method and rating scales, on a new group on 67 young participants (without personal-goal priming). The results showed that while the majority of task-unrelated thoughts about the future (77%) were goal-directed (i.e., *making a decision; planning something; reappraising the situation*), the majority of task-unrelated thoughts about the past (79%) were not goal-directed (i.e., *trying to feel better; keeping oneself aroused; daydreams with no function or other, non-listed functions*).

Interestingly, the analyses of phenomenological qualities showed that future-oriented task-unrelated thoughts were rated as having lower levels of visual imagery, but higher levels of inner speech, intentionality, self-relevance and realism/concreteness as compared to past-oriented thoughts. The latter qualities of future thoughts (i.e., intentionality, self-relevance and realism) suggest that when participants think about the future, they think about their concrete plans and upcoming prospective memory tasks in the nearest future rather than more abstract long-term goals. Indeed, the ratings of temporal distance showed that 38% of future thoughts were envisioned to happen 'later today' with only 3% of thoughts referring to later in the year. For the past oriented thoughts, this trend was reversed with only 16% of thoughts referring to the events that happened earlier today and 31% of thoughts referring to events that happened in the last year. Based on these findings, Stawarczyk et al. (2013) concluded that "an important function of prospective mind wandering might be to manage personal goals and plan effective ways of attaining desired prospects" (*p*. 10).

Although participants in the experiments of Stawarczyk and colleagues provided the

descriptions of their thoughts in response to thought probes, these descriptions were not analysed to assess the possible functions of future-oriented task-unrelated thoughts. Instead, participants had to choose from the seven predetermined options three of which were deemed by researchers as having goal-directed functions (i.e., *making a decision, planning something, reappraising the situation*) and the three as not having such goal-directed function (i.e., *trying to feel better, keeping oneself aroused, daydreams with no function or other, non-listed functions*). These types of multiple-choice options are based on researchers' theoretical conceptions about the studied phenomena. For example, it is somewhat unclear why "reappraising the situation" was classified as being goal-directed. In order to assess the hypothesis that instances of prospective mind-wandering primarily involve thoughts about upcoming plans and prospective memory tasks, it is therefore necessary to carry out the content analysis of participants' free and unguided thought descriptions.

For example, Liefgreen, Dalton and Maguire (2020) used a novel ongoing task in which participants watched moving dots on the screen which created illusory motion either backwards or forwards, and reported the content of their thoughts in response to three thought probes. At the end of the task, participants further elaborated on their thought descriptions and rated them on various dimensions. These thought descriptions were later examined and coded by independent judges in terms of their temporal focus, relatedness to the stimuli on the screen, and whether they were oriented towards achieving a particular goal/devising a plan to achieve a goal or not. Results showed that the number of task-unrelated thoughts was significantly higher in the backward and forward motion conditions compared to a control condition with randomly moving dots. In addition, the proportion of future thoughts was significantly higher in the forward (.75) than the backward illusory-motion condition (.23). By contrast, the proportion of thoughts about the past was significantly higher in the backward (.74) than in the forward illusory-motion condition (.19). Most importantly for the

present paper, while the vast majority of thoughts in the forward vection condition were classed as goal-oriented (.78), only a small proportion of thoughts in the backward vection condition were goal-oriented (.23). The fact that these future-oriented thoughts referred to fairly immediate goals and plans could be inferred from a finding that the mean ratings of temporal distance were significantly shorter in the forward (M = 1.55, SD = 1) than the backward vection condition (M = 3.3, SD = 1.2) (ratings were made on a 5-point scale where 0 = earlier today/later today up to 5 = more than 3 years ago/more than 3 years ahead). Future studies will need to replicate these interesting findings using larger participant samples and more frequent thought probes. It will be also useful to ask participants whether their reported thoughts were intentional (deliberate) or spontaneous (unintentional) (Seli et al., 2016) and report the nature of future thoughts in the control condition without the motion illusion.

Plimpton et al. (2015) conducted a study about spontaneous past and future thinking in which participants were engaged in a cognitively undemanding vigilance task for 15 min and were intermittently stopped (11 times) to describe what was going through their mind at the time of the stop (see Table 2, for procedural details). They also had to indicate whether the thought was spontaneous (had popped into their mind without any prior intention to do so) or deliberate. At the end of the task, participants classed their thought descriptions as pertaining to the past, present or future.

The thematic content analysis (Smith, 2000) of spontaneous task-unrelated thoughts, classed as future thoughts by participants, was carried out in two stages, by two independent coders. In stage one, the coders read the thought descriptions to arrive at broad superordinate thematic categories which would encompass most of the thought descriptions. After discussing these themes, the coders agreed upon the three distinct categories which referred to thinking about ‘future plans and intended actions’ (e.g., *need to start a diet after my revision period*; *must buy a new duvet cover set*), ‘upcoming or scheduled events’ without

clearly specified intended actions (e.g., *family dinner this weekend*; *job interview I have next week*), and more abstract 'hypothetical events or scenarios' that may be conceived of as wishful/fanciful daydreaming (e.g., *would love to feel more settled financially, wishing for no money worries; feeling very scared if something happens to my sons; I wonder how would it look if you put red lipstick on a goldfish*). In stage two, the coders assigned each thought description to one of these three categories.

Results showed that, in young non-dysphoric participants, the majority of spontaneous future thoughts (60%) referred to intended actions and plans that had already been constructed or thought of in the past. These thoughts appeared to pop into mind as a means of reminding oneself of things that needed to be done (e.g., *I remembered that I need to book some days out with friends and for myself*). A further 38% of the thoughts also referred to one's upcoming, previously scheduled events, but in the absence of a specified intention or plan in relation to that event (e.g., *thinking about my upcoming holiday to Cork*). The average ratings of rehearsal (*how many times have you had this thought before*?) were high and ranged between scale points 3 (*a few times*) and 4 (*several times*), with 71% of all future thoughts expected by participants to actually take place in less than one month. These findings provided initial support for the idea that when people think about the future during a monotonous task, they think about previously constructed or intended events and tasks that are either scheduled to happen in the future (e.g., *job interview*) or depend on the individual to happen (e.g., *starting a diet after exams or remembering to book days out*).

Recently, Mazzoni (2019) replicated and extended these findings using a considerably shorter (5 min) version of the vigilance task in which participants reported their thoughts on 13 stop trials (see Table 2). In addition, instead of conducing a content analysis of descriptions of participants' future thoughts, Mazzoni (2019) had her participants categorise their spontaneous future thoughts as thoughts about future plans (*planning to buy tickets for a*

trip), future events or scenarios (*imagining being at a friend's upcoming graduation party*) and other (worries, comments, etc.), after carefully briefing them about the nature of these different types of future thoughts. To test the feasibility of this method, an initial pilot study was conducted on 30 participants. In line with findings of Plimpton et al. (2015), results showed that participants were more likely to class their spontaneous future thoughts as future plans than future scenarios/other (55% and 45%, respectively).

In the main experiment, Mazzoni (2019) investigated the effects of cognitive/perceptual load on spontaneous thoughts about the past and the future by manipulating the number and type of irrelevant cues presented in the vigilance task. In the less demanding condition, participants encountered irrelevant verbal cues on 50 trials (out of 200), while in two more demanding conditions they encountered 100 verbal cues or 50 verbal cues and 50 maths problems, in addition to monitoring the line patterns as part of the vigilance task. This manipulation was adopted from Vannucci et al. (2015), who showed that the number of involuntary memories dropped significantly in conditions with higher number of incidental stimuli, which participants inadvertently processed, even when being instructed not to pay attention to them. Consequently, Mazzoni (2019) was expecting that participants would report fewer task-unrelated thoughts about the past and the future in two conditions with higher number of incidental cues than in the condition with 50 cues only. In addition, for future task-unrelated thoughts, Mazzoni (2019) predicted that thoughts about future plans would be affected by cognitive load manipulation more strongly than imagining scenes and events, because creating a plan to achieve a goal (e.g., what to buy for a dinner party) is a more complex mental activity than imagining a simple scenario (e.g., having a mental image of guests arriving early).

Results again showed that participants were more likely to report thinking about future plans than future scenarios, and increased cognitive load reduced the number of

reported past and future thoughts. The most important and unexpected finding was the interaction between type of future thought and cognitive load showing that increased cognitive load markedly reduced the number of reported future scenarios, while the detrimental effect of this manipulation on future plans was much smaller and similar to what was found for thoughts about the past. In an attempt to explain this counterintuitive finding, Mazzoni (2019) suggested that rather than constructing future plans from scratch (which would be a cognitively demanding activity), participants may have spontaneously recalled previously formulated, but still pending future plans in response to incidental cue words encountered in the vigilance task, much in the same way as participants reported experiencing involuntary memories of past events in her study. Therefore, such spontaneous thoughts about future plans may be more accurately construed as 'memories of the future' (i.e., previously planned prospective memory tasks) than novel future plans constructed during the vigilance task for the first time (see also Jeunehomme & D'Argembeau, 2016).

The conclusion that spontaneous thoughts about future plans, captured during laboratory thought sampling procedures, are "memories of the future" rather than novel mental representations, accords well with the evidence from the studies, described in this section. Indeed, in all studies future plans outnumbered other future-related thoughts, and it would be difficult to explain their frequent occurrence during vigilance and go/no-go tasks (which are monotonous but still cognitively more taxing than mundane daily activities like brushing teeth or waiting for the bus) if they were not already formed at some point earlier. This idea was further supported by ratings of prior rehearsal in the study of Plimpton et al. (2015), in which participants indicated that it was not the first time that they had this particular future plan or upcoming event in mind (effectively, indicating that they had already constructed this future thought in the past). This result also converges with findings by Cole et al. (2016), who showed that spontaneous future thoughts during a vigilance task were not

novel constructions and had been thought about before the experiment.

The content of future thoughts: Findings from diary and experience sampling studies

Although the findings of Plimpton et al. (2015) and Mazzoni (2019) provide the most direct evidence that future-oriented mind-wandering mostly consists of thinking about intentions (i.e., upcoming prospective memory tasks) and planned events instead of mental simulation or prediction of future events, it is possible that participants engage in such thoughts only during monotonous experimental cognitive tasks. However, findings from some recent diary and experience sampling studies of everyday mind-wandering appear to support the results of these laboratory studies. For example, D'Argembeau et al. (2011, Study 2) asked participants to record and indicate the function of any 10 future oriented thoughts (including deliberate thoughts) experienced over a 5-day period. Out of 160 future thoughts recorded in the diaries, the vast majority of thoughts (70%) referred to the planning of an action (52.5%) and making a decision or setting oneself a goal (17.5%). The remaining thoughts referred to daydreams with no apparent purpose (11.25%), thoughts to reassure oneself or feel better (10%), and thoughts that could not be classed into any of these categories (8.25%). In addition, the temporal distance of thoughts from the present moment towards the past or future was related to their function, with 63% of thoughts reported to occur in the near future (i.e., 'later the same day', 'next week' and 'between a week and a month') being related to planning of an action (e.g., *I should leave earlier from work and do the groceries on my way home*). By contrast, distant thoughts ('between a month and a year', 'between 1 and 5 years', 'between 5 and 10 years', 'more than 10 years') were distributed more evenly across the thought categories with different functions. Finally, results showed that 'action planning' and 'making a decision' involved significantly higher ratings of inner speech than daydreams 'with no apparent reason', 'to reassure oneself' or 'feel better'.

Since participants in the study by D'Argembeau et al. (2011) were free to choose

which future thought to record in the diary, it is possible that the prevalence of planning thoughts about the near future was due to participants' biases or preferences in noticing and recording such thoughts. However, similar results were obtained in two naturalistic experience sampling studies by Baumeister, Hofmann, Summerville, Reiss, and Vohs (2018, Study 1) and Anderson and McDaniel (2019) (see Table 2). Participants of these studies had to complete brief online surveys about the type of thoughts experienced (by choosing from response options) when receiving six random smartphone text-messages per day delivered over the course of three or five days, respectively. Results of Baumeister et al.'s (2018) study, with 492 participants (aged 18 to 67) and 6,686 thought probes, showed that the vast majority of reported future thoughts (74%) involved thoughts about planning (defined as specifying actions to achieve a goal), compared to other types of future thoughts (e.g., *imagining, what you will do, what you hope to do, what other people will do, wondering what will happen, what you hope will happen, intentions, worries, fears, obligations, making decisions about the future, what you will say or write, possible future emotions or expected emotions*). In addition, the majority of future thoughts concerned the nearest future with 51% of thoughts referring to plans and events occurring later the same day. Considering that, in addition to planning, participants also endorsed other options potentially related to everyday prospective memory tasks (e.g., '*intentions*', *what you will do*' and '*what you will say or write*'), it appears that when participants report thinking about the future, they are predominantly engaged in thinking about their plans and upcoming prospective memory tasks.

In two studies reported by Anderson and McDaniel (2019), young undergraduate participants had the option of categorizing their future thought as a prospective memory thought (*I was thinking about something specific I need to remember to do in the future, e.g., do laundry, get groceries, turn in assignment*) or a non-prospective memory future thought (*I was thinking about the future, generally, for example, upcoming events, life goals, etc.*)

alongside some other response options referring to the present and the past. In both studies, a clear dominance of on-task (present) thoughts was found, as well as the prospective bias with more future- than past-oriented thoughts reported (as in Baumeister et al., 2018). Results of Study 1 showed that significantly more prospective memory than general future thoughts were reported. However, in Study 2 this pattern was reversed, and the discrepancy between the results is not clear. Interestingly, in Study 2, participants also stipulated whether their prospective memory thought involved forming a new intention at the time of the prompt, completing the intention or simply thinking about the intention that they had formed previously, but had not yet carried out. Results showed that only 29% of prospective memory thoughts were classed into the last category (i.e., of being reminded of pending prospective memory tasks), whereas 46% referred to the moment when the intention was being formed.

Taken together, the results of naturalistic studies by D'Argembeau et al. (2011), Baumeister et al. (2018) and Anderson and McDaniel (2019) provide further support for the idea that when people think about the future in their daily life, they often think about their upcoming intentions and plans (i.e., prospective memory tasks). What remains unclear, however, is whether participants deliberately engage in future planning as a stand-alone activity (i.e., not doing anything else) or whether such planning thoughts are more fleeting in nature and occur while people's minds wander during undemanding daily activities (e.g., preparing breakfast, having a shower, etc.). Indeed, in these studies participants did not indicate whether their thoughts were spontaneous or deliberate and what they were doing at the time. In addition, participants had to choose from response options provided rather than simply describe in their own words what they were thinking about at the time of the prompt.

To address these issues, Warden et al. (2019, Study 2) conducted an experience sampling study over the period of a single non-working day, in which young and old participants were prompted 30 times at random time points to record the nature, content and

context of their current thoughts in a diary (see Table 2). They had to keep a diary for 10 hours, and answer a questionnaire on a diary page about their current thought every time they felt the vibration of a special wristwatch that they had to wear for a day. For example, participants had to indicate the temporal focus of their recorded thought (i.e., past, present, future, atemporal) and whether it was experienced spontaneously (i.e., the thought simply popped into their mind) or deliberately (they themselves decided to think about it).

Initial coding of participants' thought descriptions in terms of whether they were related to the task at hand or task-unrelated showed that task-unrelated thoughts (or instances of mind-wandering) were reported by both young and old participants on 23% of occasions. The larger proportion of recorded thoughts was classed as task-related (45%), referring to instances in which attention and thoughts were fully focussed on what the participant was doing at that moment (for similar findings, see Anderson & McDaniel, 2019; Baumeister et al., 2018; Song & Wang, 2012). Results also showed that the majority of task-unrelated thoughts were classed by participants as being spontaneous (67%) than deliberate (23%). Moreover, while spontaneous task-unrelated thoughts were equally likely to be classed as thoughts about the past and the future, deliberate task-unrelated thoughts were significantly more likely to be future- than past-oriented (for similar findings obtained in a laboratory mind-wandering task, see Seli, Ralph, Konishi, Smilek, & Schacter, 2017).[1] Most importantly, the content analyses of the 113 future thoughts (69 spontaneous and 44 deliberate), using the coding scheme developed by Plimpton et al. (2015), showed that both young and older adults reported significantly higher number of thoughts about upcoming prospective memory tasks and plans (e.g., *need to give a call to my mother; what am I going to cook for dinner?*) than upcoming events with no particular intentions expressed (e.g., *I wonder what games they'll have at the party tonight)* or events of hypothetical nature (e.g., *what characteristics me and my partner would choose in a child if given the choice*).

In summary, evidence reviewed in this section provides strong initial empirical support for the following conclusions. First, whether probed in the laboratory or in their everyday life, people seem to be engaged in thinking about the future fairly frequently, often more frequently than thinking about the past.[2] Second, the majority of task-unrelated future thoughts were spontaneous rather than deliberate both in the laboratory and in everyday life, and they tended to occur when people were engaged in mundane habitual activities requiring fairly low levels of concentration. Third, when the content of future thoughts was examined by having participants choose from multiple response options or subjecting thought descriptions to content analysis, the results invariably pointed to the dominance of thoughts about simple prospective memory tasks, errands or obligations that needed to be completed later in the day or in the next few days rather than more abstract long-term goals or simulations of hypothetical events and wishful thinking or daydreaming.

What is the adaptive value of thoughts about the future in everyday life?

Although laboratory experiments on episodic future thinking have demonstrated that people are quite good at simulating and constructing plausible future events and scenarios, an ability they can clearly benefit from when having to make important decisions, it appears that in everyday life, future thinking is often simpler and more pragmatic by serving people's real and more immediate goals and concerns (*cf.* Klinger, 2013; Klinger, Marchetti, & Koster, 2018). However, what is the function of having previously formulated plans and intentions popping into mind before the planned actions can actually be carried out (i.e., during the retention phase between intention formation and retrieval, see Figure 1) as documented by the research reviewed in this paper? Or, to put it more broadly, what is the adaptive value of prospective bias documented in research on mind-wandering and spontaneous future-oriented cognition in general?

There is general agreement that the representations of unfulfilled intentions are more

strongly activated and easily accessible compared to other contents in long-term memory (*cf.* Zeigarnik, 1927). Empirical evidence for this notion comes from studies on the so-called *intention superiority effect* both inside (e.g., Goschke & Kuhl, 1993; Marsh, Hicks & Bink, 1998; Schult & Steffens, 2013) and outside the laboratory (Freeman & Ellis, 2003; Maylor, Darby & Della Sala, 2000). This accessibility is assumed to facilitate the spontaneous noticing of target events at retrieval phase, increasing the chances of successful intention fulfilment (but see Goschke & Kuhl, 1996). This noticing can also increase the number of spontaneous thoughts of the upcoming task in the delay interval or the retention phase, which could further strengthen the intention representation and related contents (Ellis, 1996; Ellis & Nimmo-Smith, 1993; Kvavilashvili & Fisher, 2007). However, whether such re-activation or strengthening of intention representation in the retention phase actually increases the chances of successful plan execution is an open question (*cf.* Stawarczyk, 2018). Some researchers have argued that the number of these thoughts or rehearsals would be positively correlated with plan execution (Kvavilashvili & Fisher, 2007; Mason & Reinholtz, 2015), while others have suggested that it is the act of rehearsal that is important rather than the quantity of these thoughts (Ellis & Nimmo-Smith, 1993). By contrast, Lewin (1926/1951) suggested that such thoughts would prematurely reduce the tension associated with the intention representation, resulting in forgetting rather than remembering of an intended action.

Positive effects of intention rehearsal during the retrieval phase have been found in most laboratory studies of prospective memory (Einstein, McDaniel, Richardson, Guynn, & Cunfer, 1995; Guynn, McDaniel, & Einstein, 1998; Harris & Wilkins, 1982; Kvavilashvili, 1987; Rummel, Smeekens & Kane, 2017; Taylor, Marsh, Hicks, & Hancock, 2004). However, one could argue that the results may not generalize to real-life situations with much longer delay intervals (hours, days, weeks) compared to minutes typically used in laboratory tasks. Therefore, to examine the functional significance of spontaneous thoughts about

upcoming tasks and events on subsequent chances of executing these very same tasks in the future, it is necessary to carry out naturalistic studies with longer delay intervals.

One of the first studies of this kind involved asking participants to make a phone call at a pre-arranged time (e.g., at 12:00 pm) on the 7th day from an initial meeting with the researcher, and having them keep a structured diary to record instances when they spontaneously thought about this upcoming task during the intention-retention interval (Kvavilashvili & Fisher, 2007). In Studies 1 and 3, only young participants were tested, whereas in Study 2 the effects of age were also examined by comparing the groups of younger and older adults. In all three studies, recorded thoughts were often reported to have external or internal triggers, although a significantly larger number of thoughts were reported without any apparent triggers in Studies 2 and 3. There was also a small proportion of thoughts involving more deliberate planning or updating of one's mental to-do-list in the near future. Most importantly, results showed that in young participants, successful prospective memory performance (remembering within 10 minutes of the target time) was positively correlated with the number of recorded thoughts about the upcoming prospective memory task, with correlations ranging from .39 to .53 across the three studies. However, when the correlations were examined separately for thoughts with different types of reported triggers, it was found that in Study 2, only thoughts without triggers and deliberate planning thoughts correlated positively with successful performance, whereas in Study 3 the correlation was significant only for thoughts without triggers.[3] Based on these findings, Kvavilashvili and Fisher (2007) put forward a hypothesis that the activation levels of upcoming (as yet unfulfilled) intentions can perhaps be best measured by the number of spontaneous rehearsals of intention without any (internal or external) incidental cues (see also Warden et al., 2019).

These results were replicated and extended by Szarras and Niedźwieńska (2011) who investigated the relationship between prospective memory thoughts and performance in

participants' own real-life prospective memory tasks. Specifically, participants generated a list of jobs, appointments and activities they planned to carry out in the next 10 days in a written speeded fluency task (lasting 4 minutes) and then recorded all spontaneous and self-initiated deliberate thoughts about these intentions over the next 10 days in a pocket-sized diary.[4] On average, participants listed 12.64 (*SD* =3.35) intentions related mainly to work/university (e.g., *subscribing to an online class, having a meeting with a professor*) and social relationships (e.g., *making a phone call, buying a present*), and recorded 1.88 (*SD* = 1.21) thoughts or rehearsals per task in their diaries (*cf.* Ellis & Nimmo-Smith, 1993). Out of all recorded rehearsals, 41% were reported as being triggered by incidental cues (in one's environment or own thoughts), 27% as having no triggers and 32% were described as being self-initiated, deliberate thoughts about the upcoming prospective memory task.

Importantly, Szarras and Niedźwieńska (2011) compared the number of completed and unfulfilled intentions (as reported by participants at the end of the diary-keeping period) in terms of different types of cues for reported thoughts (i.e., thoughts triggered by incidental cues, no cues, or deliberately rehearsed). Results showed that significantly higher number of deliberately rehearsed thoughts were reported for completed than uncompleted intentions, whereas the two types of tasks did not differ in other types of thoughts (i.e., triggered by incidental cues or no cues). Completed tasks were also rated as more important than uncompleted tasks. However, it remains an open question whether deliberate rehearsal mediated the relationship between perceived importance and task completion or whether perceived importance influenced rehearsal rates and task completion independently.

Finally, in a series of studies by Mason and Reinholtz (2015), participants had to form an intention to contact the researcher (by sending an email or a text-message) after several days from the initial meeting (for example between 3:00 and 4:00 pm on Thursday), without using any external mnemonic devices (e.g., electronic calendars with prompting) to complete

this everyday prospective memory task. Crucially, participants had to report instances of spontaneously thinking about this prospective memory task in the delay period by using the electronic counter app to record these thoughts (Studies 1 and 2) or report the frequency of such thoughts retrospectively in a post-study survey (Studies 3 and 4). The results of Studies 1, 2 and 3 showed a significant positive relationship between the number of thoughts about the upcoming prospective memory task and its successful execution in the intended time-frame. In addition, the results of Study 1 showed an intention superiority effect as thoughts about the upcoming task occurred more frequently in the 24-hour period before the designated time than in the 24-hour period after its completion (using an elegant design, this effect was assessed both within and between participants).

In summary, the evidence reviewed in this section, provides strong initial support for the adaptive significance of future thinking and future-oriented mind-wandering in everyday life. The studies showed that spontaneous (and deliberate) thoughts about upcoming tasks, plans and obligations increased the chances of these tasks being accomplished. These findings also raise several important questions for future research. For example, it will be important to investigate the nature of triggers of such future thoughts. Although a large number of thoughts were reported to have been triggered by incidental environmental and internal cues (Kvavilashvili & Fisher, 2007; Szarras & Niedźwieńska, 2011), it appears that they are not driving retrieval success of intended tasks. A positive relationship between rehearsal occasions and subsequent execution was found only for spontaneous thoughts without easily identifiable triggers (Kvavilashvili & Fisher, 2007) and self-initiated deliberate thoughts (Kvavilashvili & Fisher, 2007; Szarras & Niedźwieńska, 2011).

Theoretically, the findings reviewed in this section suggest that an efficient reminder system may exist, which ensures that representations of intended future actions accrue much higher levels of activation (as implied by the intention superiority effect, Goschke & Kuhl,

1993; 1996) than representations of past events, so that representations of future tasks periodically pop into one's mind even without relevant cues. As part of this pop-up experience, the intention representation may be re-activated and, on some occasions, a more deliberate elaboration of one's planned activity (or even cancellation or reformulation of intended tasks) may take place. Such a flexible system would be highly efficient for successful everyday functioning and getting things accomplished with minimal mental effort and time involved (*cf.* McDaniel & Einstein, 2007). If this reasoning is correct, then thoughts about future tasks should pop into one's mind without any relevant cues to much greater extent than thoughts and memories about the past, which have been shown to be mostly elicited by incidental external and internal triggers (Schlagman & Kvavilashvili, 2008; Mace, 2004; Plimpton et al., 2015). Initial evidence in support of this idea comes from a study by Warden et al. (2019, Study1), in which participants kept a 2-week diary of spontaneous thoughts about their own previously formulated prospective memory tasks and involuntary autobiographical memories by filling in a brief questionnaire every time they experienced such thoughts in their daily life.

However, more systematic research is needed to investigate this question as well as the functional significance of spontaneous thoughts elicited by incidental triggers. For example, one interesting hypothesis worth testing is that spontaneous re-activations of intention representations without any cues and in response to incidental cues both are essential for successful execution of intended tasks provided that they occur in the retention (i.e., delay interval) and retrieval phases of a prospective memory task, respectively (see Figure 1). Indeed, results of Kvavilashvili and Fisher (2007) showed the positive effect of non-cued intention rehearsals in the retention phase on subsequent intention execution. It is highly likely, however, that if an incidental cue is encountered in the retrieval phase in which the prospective memory task can be executed, and the intention pops into mind in response to

this cue, this will then result in immediate intention execution. This type of "double-reminder" system is likely to be highly efficient in enabling people to carry out their intended tasks and plans over long delay intervals in everyday life.

The taxonomy of prospective thought and theoretical considerations

The aim of the present review was to examine the nature of prospective thought in everyday life. We wanted to find out which type of prospection (simulation, prediction, intention or planning), outlined by the taxonomy of Szpunar et al. (2014), is most prevalent when people do not have to deliberately simulate or construct future events and scenarios in response to explicit instructions, but are left to their own devices instead. Despite a large body of research on prospective thought across multiple research domains, including the burgeoning field of episodic future thinking, there are very few studies that have addressed this important question. The review of existing studies, mainly from research domains of mind-wandering, spontaneous future thinking and prospective memory, suggests that it is intention- and planning-related thoughts that people tend to engage in most when thinking about their future either in the laboratory (when completing ongoing vigilance and go/no-go tasks) or in their everyday life (in studies using experience-sampling methodology). Moreover, such thoughts seem to take the form of spontaneous re-occurrence (or rehearsal) in one's mind of previously formulated and constructed plans and intentions during delay periods when the intention or a plan cannot be carried out immediately. In other words, previously formulated intentions and plans appear to simply pop into mind when a person is engaged in other unrelated activities. Importantly, such thoughts seem to often occur in response to incidental triggers, although the number of spontaneous future thoughts without any identifiable triggers appears to be quite large, too (Kvavilashvili & Fisher, 2007).

Taken together, the pattern of findings provides strong support for the pragmatic theory of prospection proposed by Baumeister and colleagues, which states that planning

could be the most common form of prospection in everyday life (Baumeister et al., 2016; 2018). According to this theory, planning is defined as setting up a goal to achieve a desired end state (e.g., I need to post a birthday card) and specifying the exact context/time in which this intention or goal can be achieved (e.g., when I walk past a post box on my way to work tomorrow morning). This type of planning is clearly involved in prospective memory tasks at the initial intention formation phase depicted in Figure 1 (e.g., if I see an animal word when completing a lexical decision task later in the session, then I will press a slash key). Thus, according to Baumeister et al.'s (2016) theory, prospective thought should be crucially linked with processes involved in prospective memory (see also Cole & Kvavilashvili, 2019).

However, the pragmatic theory of prospection has been predominantly focussed on deliberate, wilful construction of future plans and intentions. The pragmatic value of one's ability to deliberately formulate what one needs to do and when, is obvious as it enables people to organize their lives by meeting obligations and carrying out multiple tasks; without forming such intentions one would not be able to lead meaningful and successful life. In relation to this point, an important and non-trivial empirical question is whether such deliberately formulated plans and intentions are actually carried out in the future when the context for their fulfilment arrives. This question has been the focus of prospective memory research for several decades with some positive results showing that people are quite good at carrying out intended tasks above the chance level, both in and outside the laboratory (Cohen & Hicks, 2017; McDaniel & Einstein, 2007; Rummel & McDaniel, 2019).[5]

In an attempt to integrate research from prospective memory with the research on prospection from other areas, we believe we have identified several novel hypotheses that are worth being tested in the future. Perhaps the most important contribution of the present review to the pragmatic theory of prospection, and research fields studying future thinking, has been the finding that – once such future plans and intention representations are wilfully

constructed – thoughts about these plans and intentions will keep coming to people's minds periodically while they are engaged in relatively undemanding tasks, long before the intended tasks can actually be completed. Indications for an adaptive value of such spontaneous rehearsals of future tasks for their subsequent execution was found in several naturalistic diary studies of prospective memory reviewed in this paper (Kvavilashvili & Fisher, 2007; Mason & Reinholtz, 2015; Szarras & Niedźwieńska, 2011), although the assumption of a causal relationship between rehearsals and task completion remains to be tested.[6]

To account for these diverse processes involved in future thinking, Cole and Kvavilashvili (2020) recently proposed a dual process account, which stipulates that thoughts about the future are brought to consciousness via two distinct routes, each associated with separate processes and functions. On the one hand, people have the unique ability to wilfully construct and simulate thoughts (and images) about the future, which is a slow and effortful process as demonstrated in numerous studies of episodic future thinking using the standard cue word paradigm (for reviews of this literature, see Schacter, 2012; Schacter et al., 2017). On the other hand, thoughts about the future can also come to mind rapidly and effortlessly without any deliberate attempt to construct them at the time of their occurrence (e.g., Cole et al., 2016; Plimpton et al., 2015). Most importantly, and in line with the pattern of findings that emerged in the present review, Cole and Kvavilashvili (2020) proposed that spontaneous future thoughts are not as freshly created and novel as are usually deliberate thoughts about the future. Rather they are 'pre-made', that is, they had been previously (deliberately) constructed and then re-occur in consciousness, often in response to cues in one's environment or thoughts. According to Cole and Kvavilashvili (2020), this 'pre-made future thought' hypothesis explains why these thoughts occur spontaneously, rapidly and effortlessly, are similar to involuntary memories (e.g., often triggered by incidental cues), and why they predominantly involve thoughts about previously constructed plans and tasks which

need to be completed in the future. Consequently, their occurrence can be explained by simple and well-understood memory processes, rather than postulating any additional mechanisms specific to spontaneous future thoughts (see also Berntsen, 2019).

Towards an integrative view on prospective thought: The pragmatic dual process account

Based on the dual process account of future thinking, here we sketch out a theoretical framework that, in our opinion, accommodates findings from diverse literatures on mind-wandering, future thinking and prospective memory, as well as previous theoretical taxonomies in these areas (e.g., Baumeister et al., 2016; 2018; Szpunar et al., 2014), in the most parsimonious way. The new framework adopts the stance that most future thinking is related to achieving specific goals and plans, as people often have little time or desire to expend large amounts of time on aimless daydreaming or wishful future thinking (although there may be important individual differences in this respect in general population).[7] It also links effortful and spontaneous future thinking to the different stages involved in prospective memory tasks documented in prospective memory literature (Ellis, 1996; Kliegel et al., 2002) and described at the beginning of this paper (see Figure 1).

In line with pragmatic theory of prospection (Baumeister et al., 2016; 2018), our approach assumes that the most frequent or the default mode of everyday prospection involves formulating fairly simple intentions (in the '*if/when X then Y'* format) to be performed in the future (e.g., meeting a friend for lunch after finishing a class next Tuesday, paying a bill before 5:00 pm next Friday, or sending a message before leaving home tomorrow). This initial stage, depicted as "Deliberate Future Thinking 2" in the model (see Figure 2), involves making a conscious decision to complete a particular action or task in the future, and as such, is a deliberate process involving some executive resources (Ellis, 1996; Kvavilashvili & Ellis, 1996). However, such decisions are rather simplistic (e.g., upon

opening a fridge, a person may notice that she has run out of milk and may decide to by some milk on her way back from work in the evening). For this reason, they are usually made quickly, without the need to simulate alternative options (e.g., which supermarket would be most convenient to go to), potential obstacles in meeting this goal (e.g., realizing that due to major road works, access to one's usual supermarket may be hampered) and planning alternative courses of action (referred to as the matrix of 'maybe' in the theory of pragmatic prospection by Baumeister et al., 2016). The need for engaging in such constructive and slow, effortful processes (depicted as "Deliberate Future Thinking 1" in Figure 2) may occur in more complex situations involving competing demands, motivational conflicts, or when planning a sequence of actions to achieve a superordinate goal (e.g., steps involved in planning a trip to a foreign country; see Kvavilashvili & Ellis, 1996). The main point of the model is that, although humans have the ability to engage in such constructive episodic future thinking processes (as demonstrated by numerous studies on deliberate episodic future thinking), the majority of everyday situations allow them to circumvent this initial stage and form their intentions quickly and without too much expenditure of effort and executive resources (e.g., see Scullin et al., 2018). Therefore, such decisions about the future can often occur 'on the go' while being engaged in other activities such as driving, jogging or doing washing up (Anderson & McDaniel, 2019).

The formation of an intention to do something in the future can also be considered a 'memory of the future' (Cole & Kvavilashvili, 2020; Jeneuhomme & D'Argembeau, 2016; Ingvar, 1985; Mazzoni, 2019), because a memory representation is generated which links the to-be-carried out task with a particular future time or context in which the intention can be carried out (i.e., the retrieval phase, see Figure 2). Building on this general idea, we find it likely that people spontaneously experience the re-occurrence of such "memories of the future" in the retention and retrieval phases that follow the initial formation of the intention

(denoted as T_1, T_2 and T_3 in Figure 2). Evidence for such spontaneous future thoughts has been documented in different studies on mind-wandering, future thinking and prospective memory, reviewed in this paper. Whereas a spontaneous occurrence of such thoughts in the retention phase involves mental time travel into the future (as the intended action cannot be carried out at the present time), their occurrence in the retrieval phase may effectively signify the appropriate moment to execute a task, thus transforming the hitherto future thought into a thought about the present (Cole & Kvavilashvili, 2020; Conway, Loveday, & Cole, 2016). Once the task has been executed, a new memory of this completion may be formed to ensure that the person knows it has been completed and does not attempt to carry it out again (Ellis, 1996; Kvavilashvili & Ellis, 1996).

The framework presented in Figure 2 does not rule out that effortful future thinking can occur in the retention and/or retrieval phases in any given planned task (as indicated by the dotted arrows next to the two types of deliberate thought). However, such deliberate processes, after the intention has been formed, are less frequent than simple re-activations of future thoughts, which have functional significance in keeping one's intention representations active and ready for action when the circumstances for intention execution arise.

In summary, the proposed pragmatic dual process model may provide a useful initial framework for studying the nature and mechanisms of everyday prospection. This model and the review of relevant studies indicates that the progress in the study of naturally occurring prospective thought can only be achieved by more collaborative approach, and by adopting methods across different research fields to creatively address new research questions which can result in novel findings and further increase our understanding of everyday prospection (e.g., Scullin et al., 2018; Seli, Smilek, Ralph & Schacter, 2018; Rummel et al., 2017).

Conclusions and future directions

The review of several diary and experience sampling studies, reported in this paper,

shows that when people think about their future, this tends to take the form of mostly spontaneous thoughts that come to mind while people are mind-wandering and not entirely concentrating on a task at hand. Such thoughts occur very frequently in everyday life, once in 2-4 minutes, according to some estimates (e.g., Gardner & Ascoli, 2015), and more frequently than thoughts about the past (aka the prospective bias in mind-wandering).

The analyses of the contents of such thoughts, further suggest that thoughts about the future often involve upcoming intentions or prospective memory tasks in the immediate or near future (the same day, next day or week). In other words, in everyday life, future thinking appears to be very pragmatic, and means-to-end oriented (*cf.* Baumeister et al., 2016). Rather than engaging in simulating hypothetical scenarios, people often simply think about real upcoming events, mostly in terms of what they need to do in the next few minutes, hours or days (see also Berntsen, 2019). Most importantly, findings from prospective memory research suggest that such thoughts have functional significance by enhancing the chances of people carrying out intended actions when the right moment or context arrives.

These findings and the pragmatic dual process account, proposed in this paper, emphasise the importance of studying prospective thinking in everyday life to further increase our understanding of *why* and *how* people think about the future when they are not instructed to do so by researchers. Diary and experience sampling studies can be particularly useful for providing initial answers to these questions, and stimulating new research ideas that can be investigated in the laboratory under more controlled conditions (e.g., Kopp, D'Mello, & Mills, 2015; Rummel et al., 2017; Seli et al., 2018; Steindorf & Rummel, 2017).

As the first step in this direction, more studies need to be conducted that examine the precise content of participants' future thoughts captured in and outside the laboratory, and their intentionality (Cole & Kvavilashvili, 2020). Although some doubts have been expressed about how accurately people can report their ongoing thoughts at the time of the prompt, this

is cognitively less taxing than when participants are keeping their thoughts in mind to evaluate if they fit with the response options provided, which can result in marked biases in participants' responses (Seli, Beaty et al., 2018; Weinstein, 2018). Consequently, if future laboratory and naturalistic experience sampling studies of mind-wandering started obtaining participants' thought descriptions, it would be possible to launch a more targeted investigation of types of everyday prospection. For example, it would be interesting to find out why in studies by Plimpton et al. (2015) and Warden et al. (2019), alongside thoughts about intentions/planning and scheduled future events, participants reported so few instances of mental simulation of plausible events and prediction of possible future outcomes – two main types of prospective thought in the taxonomy of Szpunar et al. (2014).

In relation to studies of prospective memory, reviewed in this paper, future research will need to determine whether thoughts about future intentions, reported by participants, occurred at the initial stage of deciding to carry out a particular action in the future (e.g., *I should buy a birthday card tomorrow while shopping*) or in the retention phase between forming the intention and the opportunity of carrying it out (e.g., *reminding oneself or thinking about not to forget the card tomorrow*) (see also Anderson & McDaniel, 2019, Study 2). While the former coincides with the deliberate and strategic processes of forming an intention, the latter predominantly appears to engage spontaneous processes, that is, when the intention simply pops into one's mind. What is currently unclear, however, is whether instances of participants reporting thinking about the future deliberately, coincide predominantly with the process of (deliberately) forming intentions to be carried out in the future, and whether reports of spontaneous future thoughts coincide with simply remembering about previously formulated intentions of upcoming tasks.

Another important and related question concerns the representational format of deliberate and spontaneous future thinking when it occurs naturally. If future thinking is

mainly means-end oriented and in the service of accomplishing simple goals and planned actions, then the pragmatic view on prospection would suggest that a detailed episodic "pre-living" is not necessary for getting things accomplished in daily life because it would not be cost effective. In D'Argembeau et al. (2011), for example, only 43% of the future-oriented thoughts were episodic in nature (i.e., referred to single events occurring at a particular time and place), while 55% of the thoughts were more generic/abstract and, involved, presumably less imagery and mental time travel (see also Busby-Grant & Walsh, 2016).

Consequently, future studies need to investigate the extent to which future thinking involves imagining the perceptual/contextual details of future events versus just thinking about them in more abstract terms, relying on verbal narrative. For example, several mind-wandering studies have demonstrated that task-unrelated thoughts about the future were lower on imagery and higher on inner speech than thinking about the past (e.g., Stawarczyk et al., 2013). This finding ties in well with the idea that naturally occurring thoughts about the future predominantly involve planning upcoming tasks, as prospective-memory-related thoughts are likely to be mediated by inner speech (e.g., in terms of intention rehearsal).

In summary, the review of a small, but growing number of studies from diverse fields of enquiry, presented in this paper, clearly demonstrates that, when people think about the future in their daily life, they frequently engage in thinking about their upcoming prospective memory tasks and planned events. With the present paper, we hope to make a point for the usefulness of the concept of prospective memory for the study of prospection in everyday life (both spontaneous and deliberate). Although the taxonomy of prospective thought proposed by Szpunar et al. (2014) considers 'intention' as only one of the four basic forms of prospection in everyday life, as suggested by Gonen-Yaacovi and Burgess (2012), prospective memory may "in the future be viewed as perhaps the most developed subclass under the broader heading of 'prospection.'" (*p*. 191).

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Table 1.

Glossary of key terms used in the paper

Episodic future thinking: Refers to our ability to mentally imagine and simulate experiences and events that might take place in one's personal future (imminent, near or distant). This ability and its underlying brain mechanisms have been studied predominantly in the laboratory with the word cue method in which participants are explicitly asked to individually imagine plausible future events in response to a set of cue words. This paradigm is most suitable to study intentional or deliberate forms of future thinking which emphasise the constructive (i.e., slow and effortful) nature of episodic future thinking and its links to processes and brain mechanisms involved in episodic memory.

Mind-wandering: Refers to a chain of freely flowing task-unrelated thoughts, which occur spontaneously while the person is supposed to be attending to a particular ongoing task (e.g., meeting, driving, etc.). Although in its typical form, mind-wandering has been defined as spontaneously occurring and stimulus-independent thinking, recent studies indicate that task-unrelated thoughts can sometimes be instigated deliberately (intentionally) or occur in response to incidental stimuli. Moreover, several studies have reported the strong prospective bias in mind-wandering with larger number of thoughts referring to the events in the future than those in the past or current situation. It has been suggested that many different forms of spontaneous cognition (e.g., involuntary memories of past events, spontaneous thoughts about future events and tasks) can be construed as raw material from which episodes of freely flowing mind-wandering are constructed.

Prospective memory: Involves a conscious decision to carry out a particular task in the future (i.e., forming an intention or a plan) and remembering to enact the intended action

after a delay either at a pre-specified time (e.g., making a phone call at 11:00 am) or in response to a particular target event (e.g., passing on a message when seeing a friend at lunch), termed time- and event-based prospective memory, respectively. Research has focussed predominantly on how these tasks are retrieved at the future moment, without explicit prompts to carry out the task (e.g., whether spontaneous or more strategic/effortful processes are necessary). However, processes involved at encoding (imagining the time/context and how one will carry out the task in the future) and during the retention interval (thinking about one's upcoming task spontaneously or deliberately) are also crucially important for successful prospective memory. Moreover, diary and experience-sampling studies have shown that people often think about their future intentions or prospective memory tasks while completing some other mundane tasks, which could be classed as instances of future-oriented task-unrelated thinking or mind-wandering.

Spontaneous (involuntary) future thinking: Involves mental representations about the future, which come to mind unintended (unexpectedly) while being engaged in other habitual activities, and in response to irrelevant stimuli in the environment. They can refer to planned tasks or events (e.g., buying a train ticket tomorrow, going to an interview next week), plausible future events (e.g., imagining what a trip to Japan or having children would look like) or hypothetical scenarios and wishful thinking (e.g., imagining winning the lottery, marrying a celebrity). However, the studies that examined the contents of such spontaneous future thoughts, captured in and outside the laboratory with experience sampling methods, have shown that the majority of such future thoughts involved thinking about one's upcoming intended/planned tasks and events. Moreover, such thoughts predominantly served the purpose of reminding oneself to do something in the future (i.e., I need to remember to buy the train ticket tomorrow) than just thinking about or imagining the details of the scheduled event (e.g., the upcoming interview).

Spontaneous (involuntary) versus deliberate future thinking:

Thoughts about the future can be constructed deliberately (i.e., having a conscious intention to engage in future thinking) or they can come to mind spontaneously without a conscious decision to do so, that is, the thoughts about the future may simply pop into mind while a person is engaged in some other unrelated activities. In addition, studies have shown that such thoughts often occur in response to incidental triggers in the environment (e.g., seeing a train station on TV may result in thoughts about how one will need buy a train ticket tomorrow). Therefore, being spontaneous does not mean that the thought does not have a trigger, but simply that there was no intention to think about it at the time of its occurrence. Such spontaneous thoughts have been studied fairly independently across several fields of research (e.g., mind-wandering, spontaneous future thinking, prospective memory), and depending on the literature, the terms ‘spontaneous’ and ‘involuntary’ have been used interchangeably to denote the absence of a deliberate decision to construct a particular thought about a future event or a task.

Figure Captions

Figure 1. The depiction of four phases of prospective memory adapted from Ellis (1996) and Kliegel et al. (2002).

Figure 2. An illustration of when deliberate and spontaneous future thoughts play a crucial role in the course of intention formation, retention and retrieval.

[1] This finding suggests that strong prospective bias obtained in many studies (for review, see Stawarczyk, 2018) may be (at least partially) due to the fact that researchers have not distinguished spontaneous (unintentional) mind-wandering from deliberate (intentional) mind-wandering.

[2] It is important to note that the prospective bias has not been uniformly found in all studies with some studies finding the prevalence of spontaneous thoughts about the past (e.g., Plimpton, et al., 2015), while others reporting equal numbers of past and future thoughts (e.g., Mason et al., 2007; McVay, Unsworth, McMillan & Kane, 2013). The presence or absence of prospective bias has been found to depend on a number of variables, such as presence of incidental cues (Vannucci, Pelagatti, & Marchetti, 2017), negative mood or dysphoria (Smallwood & O'Connor, 2011), personal states of participants, such as their currently active physiological needs (Rummel & Nied, 2017) or the spontaneous vs. intentional nature of task-unrelated thoughts (Warden et al., 2019).

[3] Although no significant age effects were found in Study 2 in terms of the number of recorded thoughts or prospective memory performance, the correlation between the number of thoughts and remembering to make a call was not significant in older adults.

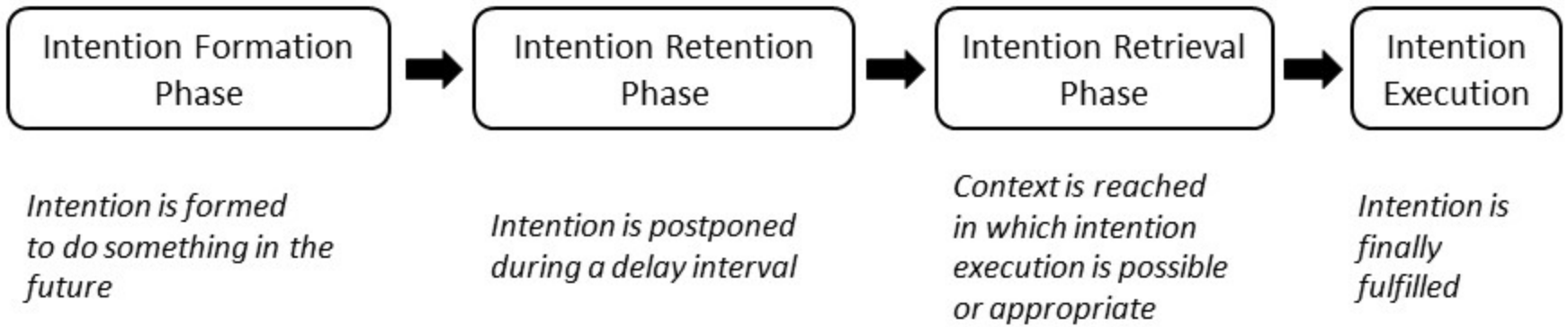
[4] Note that Kvavilashvili and Fisher (2007) did not ask participants to record instances of deliberate thoughts of prospective memory tasks but, nevertheless, a small number of recorded thoughts were later classed into deliberate category by independent coders as the thoughts were reported to occur while participants were engaged in deliberate updating of their upcoming plans.

[5] Moreover, success rates can be further increased by forming implementation intentions (Gollwitzer & Sheeran, 2006; McDaniel, Howard & Butler, 2008; McFarland & Glisky, 2011; Meeks & Marsh, 2010; Rummel, Einstein, & Rampey, 2012), or using imagery and mental simulation of intended actions without the verbalisation of "*If X, then Y*" statements (characteristic of implementation intentions) at the initial encoding stage of prospective memory tasks (e.g., Altgassen, Kretschmer & Schnitzspahn, 2017; Altgassen et al., 2015; Brewer & Marsh, 2010; Brewer, Knight, Meeks, & Marsh, 2011; Kretschmer-Trendowicz, Ellis & Altgassen, 2016; Kretschmer-Trendowicz, Schnitzspahn, Reuter & Altgassen, 2019; Neroni, Gamboz & Brandimonte, 2014).

[6] Although such spontaneous rehearsals may be less effective when facing obstacles or more difficult goals (e.g., feeling tired before going to a gym after work), extensive research on mental contrasting (Oettingen, 2012; Oettingen & Schwörer, 2013) suggests that after the initial goal setting phase, accomplishing difficult goals and overcoming obstacles may rely on more automatic associative processes (see also Gollwitzer & Sheeran, 2006). Consequently, studying the role of spontaneous rehearsals in the context of achieving difficult goals (e.g., loosing weight, quitting smoking, etc.) may be an interesting avenue for research within the fields of future thinking and mental contrasting.

[7] In addition, there may be important differences between the general population and some clinical conditions. For example, Plimpton et al. (2015) found that dysphoric participants reported significantly higher number of spontaneous future thoughts about hypothetical

scenarios and wishful thinking than non-dysphoric participants, who in turn reported higher number of thoughts about upcoming intended tasks and scheduled events.


Intention Formation Phase
Intention Retention Phase
Intention Retrieval Phase
Intention Execution
Intention is formed to do something in the future
Intention is postponed during a delay interval
Context is reached in which intention execution is possible or appropriate
Intention is finally fulfilled

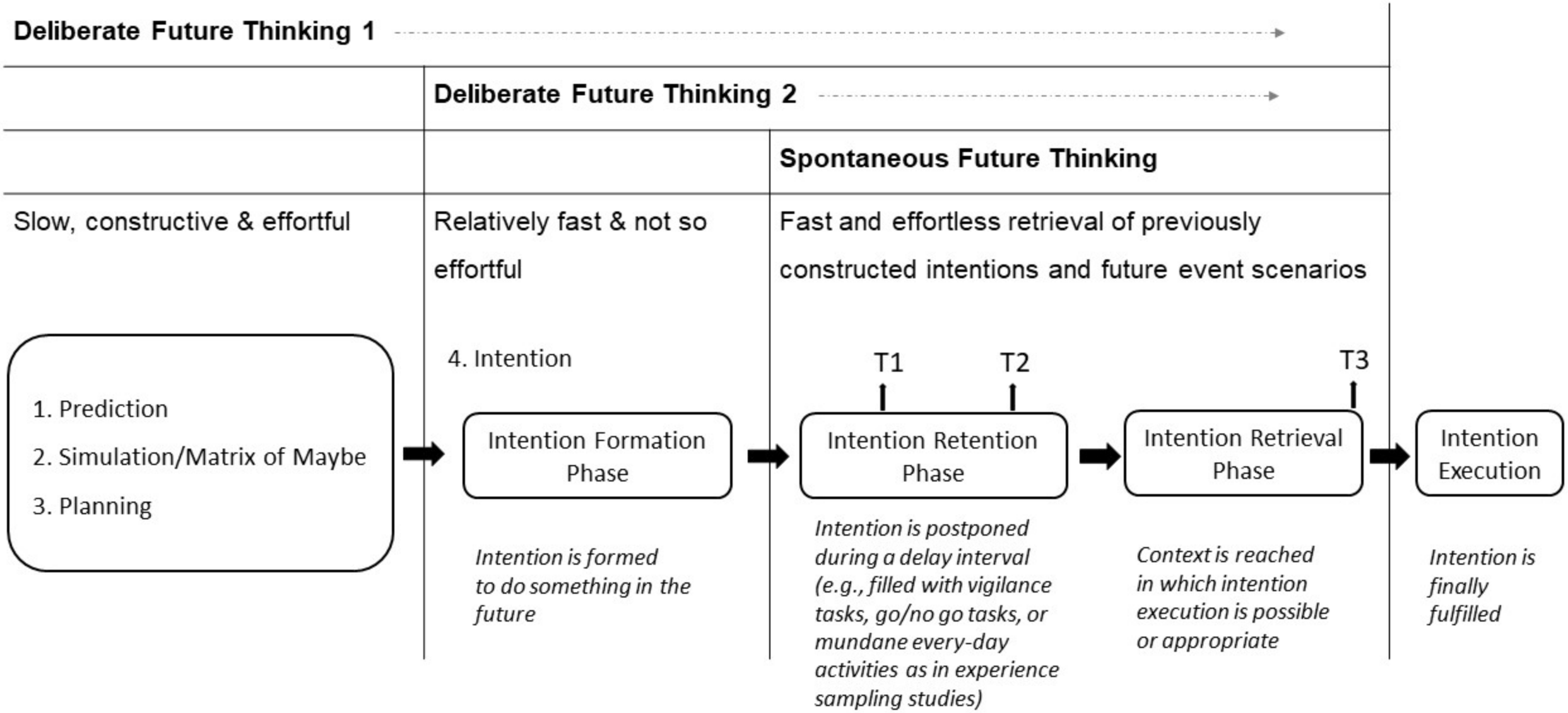

Deliberate Future Thinking 1
Deliberate Future Thinking 2
Spontaneous Future Thinking
Slow, constructive & effortful
Relatively fast & not so effortful
Fast and effortless retrieval of previously constructed intentions and future event scenarios
1. Prediction
2. Simulation/Matrix of Maybe
3. Planning
4. Intention
Intention Formation Phase
Intention is formed to do something in the future
T1
T2
Intention Retention Phase
Intention is postponed during a delay interval (e.g., filled with vigilance tasks, go/no go tasks, or mundane every-day activities as in experience sampling studies)
T3
Intention Retrieval Phase
Context is reached in which intention execution is possible or appropriate
Intention Execution
Intention is finally fulfilled

Table 2

Brief description of methods used in papers in which participants' future thoughts occurred naturally (i.e., without explicit instructions to think about the future) and participants provided brief descriptions of their future thoughts or assigned these thoughts to some pre-defined content categories. The studies are listed in the order in which they are presented in the paper.

Study	**Research Field**	**Methodology**	**Materials/tasks used**	**Participants**
Singer & McCraven (1961)	Daydreaming/ Mind-wandering	Retrospective survey (pen and paper)	*The Daydream Questionnaire* with 93 items describing the contents of possible daydreams. Example items included "I think of the specific steps to be taken in connection to my job during the next three or four weeks", "I think about the details of my next vacation", "I see myself in Heaven and see myself transformed", "I see myself eating and drinking at a great banquet with unusual delicacies". Participants had to rate the frequency with which they experienced each type of daydream content on a 1-6 scale.	*N* = 240 (160 female) Age range: 19 – 50 years Participants were undergraduate and graduate students with very diverse backgrounds, attending Teachers' college at three different US universities.
Bertie et al. (2015)	Mind-wandering	Online retrospective survey	*A 73-item questionnaire about mind-wandering* during the most recent car trip, administered with the Open Source Platform Lime Survey. The average time gap between filling in the questionnaire and the trip was 8.18 hours (SD=6.6) The questionnaire consisted of several sections. Section 1 collected background information (demographic and details of the last car trip). In Section 2 (Presence of mind-wandering), participants had to estimate the number of off-task thoughts and the percentage of time spend on mind-wandering during the trip. In Section 3 (Content of thoughts) participants had to report as precisely as they could their memory of all the off-task thoughts they had during the trip. For each thought, they had to indicate its temporal focus (past, present, future), emotional valence (positive, negative, neutral), theme (professional, private, everyday life), and the presence of triggers.	*N* = 128 (62% women) Age range: 20 – 55 years Mean age = 36.46 (*SD* = 10.08) Participants were experienced drivers (84% holding a licence for at least 5 years)

Baird et al. (2011)	Mind-wandering	Laboratory study	*The choice reaction time (CRT) task* – was used to measure mind-wandering. This task measures stimulus-independent mind-wandering because participants were not exposed to any meaningful incidental cues that could elicit spontaneous task-unrelated thoughts. Stimuli (digits 1 to 9) were presented for 1750 ms (followed by 1250 ms fixation cross). No response was required for black digits (n = 260), but when participants saw target digits in green colour (n = 30), participants had to indicate by button press whether the digit was odd or even. Participants reported the contents of their thoughts during 20 random thought probes ("Please describe anything in your stream of consciousness in the moments prior to the probe'') by typing in their thoughts into a textbox on the screen. All participants completed this task as well as a working memory (operation span) task in counterbalanced order. Four independent judges rated the thought descriptions as being task-related versus task-unrelated, referring to the past, present or future, and being self- versus goal-related. Thoughts were classed as self-related if participants specifically mentioned themselves in their thought, and as goal-directed if they involved mentioning a particular goal – an objective or desired outcome that the participant intended/planned to achieve.	N = 47 Age range: 17 – 32 years
Stawarczyk et al. (2011, Experiment 2)	Mind-wandering	Laboratory study	*Sustained attention to response task (SART)* – was used to measure mind-wandering. Because participants are not exposed to any meaningful cues, the SART measures primarily stimulus independent mind-wandering (similar to the CRT task, see above). Stimuli (digits between 1 and 9) presented individually on screen for 500 ms, with 2000 ms between each digit. Participants responded as fast as possible to all non-target digits with a button press. However, when they saw the target digit '3', they had to withhold their response. Targets occurred on 11% of trials (out of 540) presented across 30 blocks of various length (range 25 to 65 seconds). At the end of each block, the presentation was interrupted by thought probes which asked participant to indicate the nature of their preceding thoughts by choosing one of four options. If the participant indicated that they were thinking about something completely unrelated to the SART and immediate external	Participants were randomly assigned to two conditions: Personal goal condition n = 23 (16 female) Mental navigation condition n = 23 (17 female) Age range: 19 – 29 years Groups did not differ in mean age and essay writing time. Seven additional participants were excluded (six from personal goal

			environment, they were asked to type a brief description of their thought into a text box on the screen. After completing the SART, participants were shown their thought descriptions, one by one, and asked to complete a brief questionnaire asking them to rate their thoughts on various dimensions (e.g., on visual imagery, realism, whether the thought was spontaneous or deliberate, related to current goals, etc) using a 7-point rating scale. *Essay writing task* – was completed before the SART. Participants in the personal goal condition had to write a one page essay about their one or two most important current personal projects and the steps that they need to take to achieve these goals. Participants in the control mental navigation condition had to describe in detail the itinerary from the building where the experiment was conducted to a well-known location in the centre of the city. Although this control condition involved planning processes, they involved thinking about familiar driving routes rather than personal goals.	condition) because they guessed that one of the goals of the study was to assess the impact of essay writing on the nature of thoughts during thought probes
Stawarczyk et al. (2013)	Mind-wandering	Laboratory study	*Sustained attention to response task (SART)* – was identical to the SART used by Stawarczyk et al. (2011) (see above). Unlike Stawarczyk et al. (2011), in this experiment, participants did not complete the essay writing task before the SART.	*N* = 67 (35 female) Age range: 18 – 30 years Mean age = 23.28 (*SD* = 2.08). Recruited from the general population in Belgium. Individuals with medical, neurological or psychiatric disorders were excluded from the study.
Liefgreen et al. (2020)	Mind-wandering	Laboratory study	A simple *visual stimulus presentation task* was used to examine the role of backward- and forward-motion illusion on the nature and temporal focus of task-unrelated thoughts. Participants watched the presentation of stimuli on the screen for 15 minutes. Stimuli were dots which moved from the centre of the screen either outwards or inwards, creating the illusion of forward or backward	*N* = 39 (20 female) Mean age = 27.1 (*SD* = 9) Participants were randomly assigned to three conditions (*n* = 13 per condition).

			motion, respectively. Participants in the control condition watched randomly moving dots that did not create an illusion of motion. During the stimulus presentation, participants provided brief answers to occasional questions posed by the experimenter without taking their eyes off the screen. Two "trivia" questions, occurring at 3 and 10 min from the stimulus onset, involved asking participants to count to ten out aloud as fast as possible and to describe what are the main ingredients in a cup of coffee. Three thought probes 'what were you thinking about now, just before I asked?' occurred at 5, 8 and 13 min from stimulus onset and answers were noted by the researcher. At the end of the stimulus presentation, participants provided more detailed descriptions of each of the three thoughts reported, indicated their temporal focus (past, present, future, atemporal), and rated thoughts on several dimensions (e.g., vividness, temporal distance from now, etc.). At the end of the experiment, independent coders classified participants' thought descriptions along several thought dimensions. For example, thoughts were classed as task-dependent or task-independent, as goal-oriented or non-goal oriented (i.e., if the thought involved reaching a particular goal or devising a plan to reach a goal, whether short- or long-term), as realistic or of fantastical nature, etc.	Participants were recruited from a volunteer database at the UK university.
Plimpton et al. (2015)	Mind-wandering	Laboratory study	A simple *vigilance task with incidental verbal cues* – was used to study spontaneous but stimulus-dependent mind-wandering. The task was adapted from Schlagman and Kvavilashvili (2008) to investigate spontaneous thoughts about the past, present and future while detecting infrequent target slides with patterns of vertical lines (n = 11) among frequent non-target slides with patterns of horizontal lines (n = 589). Participants had to press the space bar as soon as they saw these target slides, which occurred on 1.8% of trials at random intervals with a minimum 40 and a maximum of 60 slides between two consecutive targets. Each slide was presented for 1.5 seconds and also contained an irrelevant word phrase in the centre of the screen in 18-point Arial font (e.g., family pet, failing an exam, paper bag). There were equal numbers of positive, negative and neutral phrases (n = 200)). Participants were told that they could ignore these word phrases because participants in	Two groups of participants (aged 19 – 53) were tested, based on their scores on Beck's Depression Inventory: Non-dysphoric participants n = 21 (14 female) BDI score range: 0 – 9 Dysphoric participants n = 19 (13 female) BDI score range: 16 – 32 Four participants were excluded from the analyses,

			another condition had to (allegedly) detect particular words and ignore the line patterns. Participants were also told that to measure their concentration, the vigilance task would occasionally stop and ask them to fill in a questionnaire about the thoughts that they had immediately before the though probe. Participants were randomly stopped ten times with a minimum of 35 and a maximum of 70 slides between the probes. *Thought probe Questionnaire* – Participants filled in ten 2-page questionnaires. On Page 1, participants had to describe their current thought, indicate whether it was spontaneous or deliberate, and whether the thought was triggered by something or there was no cue. After participants finished the vigilance task, participants read each of their thought descriptions and completed a second page of the questionnaire for these thoughts by indicating their temporal focus (past, present, future) and rating them on various dimensions. At the end of the study, 2 independent coders classified the thought descriptions as being task-related or task-unrelated. Thoughts about the future (33 in dysphoric and 42 in non-dysphoric group) were subjected to the additional content analysis, which resulted in three different categories of future thoughts (see text for details).	because they reported no or very few spontaneous task-unrelated thoughts, resulting in a final sample of n = 19 non-dysphoric and n = 17 dysphoric participants.
Mazzoni (2019)	Mind-wandering	Laboratory study	A simple *vigilance task with incidental cues* – Vigilance task was similar to the one used by Plimpton et al. (2015), but consisted of only 200 slides (5 target slides with vertical lines and 195 non-target slides with horizontal lines). Participants had to say out loud "Yes" as soon as they saw a target. During 13 random thought probes, participants provided a brief description of their thought contents at that moment. In the pilot study, irrelevant cue words were presented on 100 slides. In the main experiment, the number and the type of irrelevant cues was manipulated by exposing participants with irrelevant word phrases either on 50 trials (infrequent condition) or 100 trials (frequent condition). Participants of a third condition were presented with 50 word phrases and 50 maths problems. In both studies, participants had to classify their future thought descriptions into one of the following categories: future plans, future scenarios (imagining future events which did involve planning a task) and other (worries, comments, etc.). In the	Pilot Study N = 30 (26 female) Age range: 20 – 21 Main experiment N = 60 (n = 20 per experimental condition; 52 female) Age range: 20 – 23 In both studies, participants were undergraduates at a UK university

			main experiment, participants also rated the thoughts on several dimensions on 5-point rating scales (e.g., vividness, specificity, importance, etc.)	
D'Argembeau et al. (2011)	Episodic future thinking	Diary method	In this 2-part *diary study*, participants had to keep two separate (and different) diaries over different time periods of any thoughts about the future experienced in the course of their daily life. Participants were briefed about a broad range of contents that their personal future thoughts could refer to, and it was emphasised that researchers were interested in any thoughts about their personal future, irrespective of their content, importance, emotional valence, level of abstraction, and temporal distance. In Part 1, participants carried a pen and notebook with them and indicate the occurrence of any future-oriented thought they had over a 1-day period by putting a tally on a diary page. In a follow-up laboratory session participants had to rate on 7-point scale the extent to which they had omitted recording some of the thoughts during the day. In Part 2, the same participants were asked to record a total of 10 thoughts in maximum of five days using a diary booklet in which they had to briefly describe a future thought when it occurred and rate the phenomenological characteristics of their thought (e.g., visual images, inner speech, affective content, personal importance, and the extent to which it came spontaneously to mind). In addition, they had to indicate the future time period the thought referred to and what the main function or purpose of the thought was: To make a decision/ to set myself a goal; to plan an action; to reassure myself or feel better; a daydream with no obvious purpose; other.	*N* = 16 (8 female) Age range 19 – 28 Mean age = 22.2 (SD = 2.6) 14 participants were students at a Belgian University and two participants had started full employment.
Baumeister, Hofmann, Summerville, Reiss, and Vohs (2018, Study 1)	Mind-wandering	Naturalistic experience sampling	In this 3-day *experience sampling study*, participants received a text message via their smartphones at six random times each day (between 9:00 am and 9:00 pm), with a delay of at least 45 minutes between messages, resulting in 18 thought probes per participant. Each text-message contained a link directing participants to a brief survey about their emotional state (i.e., happy, aroused) and thoughts prior to	*N* = 492 (62% female) Age range: 18 – 67 years Mean age = 28.81 (*SD* = 9.61) 48% identified themselves as college students.

			receiving a text message. For example, participants had to indicate whether their thought referred to the past, present, future, or was atemporal. If a participant chose 'future', s/he had to indicate the time span from available nine response options (e.g., later today, tomorrow, a few days from now, 1-4 weeks from now, etc.). These questions were followed by providing more information about the precise content of future thought by choosing one of the 15 suggested response options: *planning, imagining, what you will do, what you hope to do, what other people will do, wondering what will happen, what you hope will happen, intentions, worries, fears, obligations, making decisions about the future, what you will say or write, possible future emotions or expected emotions*, *other (please specify).* Similarly, if a participant chose 'past event', s/he had to indicate how long ago it had occurred (e.g., earlier today, yesterday, a few days ago, 1-4 weeks ago, etc.), and what was the content of their memory by choosing one or more options out of 16 options provided (e.g., *trying to make sense of it /understand, replaying thoughts over and over, implications of the past for the future*). Out of 8,856 text messages received, participants responded by correctly completing the thought survey on 6,686 probes, resulting in 75% response rate. The median delay in responding was 8 minutes.	Participants were recruited from the general population via online advertisements. They received $5 for completing initial surveys and $.50 for every mobile survey to which they responded (max. $9) over a 3-day period.
Anderson and McDaniel (2019)	Prospective memory	Naturalistic experience sampling	In this 6-day *experience sampling study*, participants received five text message alerts per day (i.e., 30 per participant) on their mobile phones. Messages were sent randomly between 9 a.m. and 10 p.m., with a delay of at least one hour between messages. Each text-message contained a link directing participants to a Qualtrix survey, asking participants to complete a questionnaire about their thoughts at the moment of being interrupted by the text message prompt. In particular, participants had to indicate whether the thought they had referred to a specific prospective memory task, something personal and future-related, something personal and past-related, some semantic information, the task they were currently performing, nothing, or other. They also had to indicate where they were at the time (home, work/school, or other), if they had company or were alone, if they had been on their phone already when receiving the message.	$N = 61$ (Study 1) $N = 122$ (Study 2) All participants were undergraduate students at a US university and completed the study for course credit or monetary compensation

			In Study 2, participants answered some additional questions after they indicated what type of thought they had. For example, if they indicated that their thought involved a prospective memory task, participants were first asked: "Were you forming the intention you were thinking about, completing the intention, or simply thinking about an intention you had already created and have yet to complete?". In addition, they had to indicate if their thought was triggered by an external cue (i.e., something in their environment made them think about it), or whether it was self-initiated (i.e., thinking about it intentionally without being reminded by anything). In Study 1, out of 1,830 text messages received, participants responded by correctly completing the survey on 1,531 probes, resulted in 84% response rate. On average, participants completed each survey in 56 seconds. In Study 2, response rate was also very high (85%) and resulted in 3,099 valid thought surveys which were, on average, completed in 53 seconds.	
Warden et al. (2019, Study 2)	Mind-wandering	Naturalistic experience sampling	This 1-day *experience sampling study* was conducted either on Saturday or Sunday when participants were not at work (for better comparability between younger and older adults). After an initial telephone interview assessing participants' eligibility for the study, a researcher had a meeting with participants in groups of 2 - 4, at 9:00 a.m. or 10:00 a.m. of the day when the study took place. Participants were asked to wear a wristwatch (https://www.watchminder.com/) for a period of 10 hours. Every time this watch started to vibrate, participants had to record their thoughts at that moment in a pocket-sized diary. Participants could choose to wear the watch and keep the diary between 11.00 and 21.00 or 12.00 and 22.00. For each time slot, a random probing times were set with minimum and maximum intervals of 15 and 25 min, respectively. All participants received 30 prompts to indicate what was going through their mind at that exact moment, and then answer eight questions using the diary as soon as possible after having received the prompt. In the diary, participants had to first briefly describe the exact contents of their thought and indicate whether it occurred spontaneously (i.e., simply	Young adults *N* = 24 (16 female) Age range: 18 – 28 years Mean age = 25.00 (*SD* = 2.28) Older adults *N* = 23 (11 female) Age range: 67 – 90 years Mean age = 74.35 (*SD* = 6.97) Most participants were recruited from the general population (only seven from a UK university). All participants were healthy, and did not report past experiences of a serious head injury, stroke, serious

			popped into their mind) or they deliberately chose to think about it. Participants had to indicate the presence of any trigger (environment, preceding thoughts, no trigger) and the temporal focus of the thought (past, present, future or no particular time). If the thought related to the past or future, participants had to indicate when the original event took place, or how far into the future they were projecting it. Participants had to record what they were doing when the watch vibrated and rate how much they were concentrating on their current activity on a 5-point scale (1 = *not concentrating at all*, 5 = *fully concentrating*). After the task was completed, participants completed a post-diary compliance questionnaire. All participants kept the dairy and wore the watch for 10 hours (with the exception of one old participant who wore the watch for 7.5 hours) and responded on average to 92% of probes. In addition, 82% of the thought questionnaires were completed within 3 minutes of receiving the prompt.	mental health problems or memory problems diagnosed by a clinician, and sight problems that would interfere with keeping a diary. The data of one older participant was excluded due to consistent errors in recording thought in the dairy.