The diversity of mind wandering

The role of individual differences and cognitive factors

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The role of individual differences and cognitive factors

av

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Abstract

Many individuals spend a substantial portion of their waking time thinking about topics unrelated to current activities and surroundings (mind wandering). This dissertation sought to contribute to our knowledge of why some people mind wander more than others. Mind wandering in cognitive tasks is more common in individuals with poor executive cognitive control (working memory updating, inhibiting task-inappropriate response, shifting between tasks), but these studies have paid little attention to the variety of contents of mind wandering and individual differences moderators. Individuals vary in how much they find their mind wandering enjoyable or helpful (a positive mind wandering style) or dysphoric and anguished (a negative style).

Paper I tested whether positive or negative styles of mind wandering moderated the relation between executive control and mind wandering, which could help reconcile two cognitive hypotheses of mind wandering. The control-failure hypothesis suggests that mind wandering occurs because of disruptions in executive control, whereas the global availability hypothesis suggests that the availability of executive resources fosters mind wandering. The results indicated that the relation between working memory capacity and mind wandering depended on a negative mind wandering style: Those individuals with a high-negative mind wandering style exhibited a negative relation between working memory and mind wandering (consistent with the control-failure hypothesis), whereas the relation was positive in those with a low-negative style (consistent with the global availability hypothesis). Paper II evaluated affect and cognitive variables by relating mind wandering during a signal detection task to individual differences in negative affectivity (neuroticism) and self-regulatory abilities. Mind wandering was associated with neuroticism and low effortful control, but not with shifting ability. Regression analyses indicated that effortful control predicted lower neutral mind wandering whereas neuroticism predicted negative mind wandering. The subsequent two papers extended this research by examining mind wandering, affect, and control in selected populations.

A trait relevant to attentional control and negative affect is dissociation, which includes amnesia and experiential disconnectedness from self/others (detachment). Paper III evaluated everyday mentation in people scoring high or low in dissociation and in hypnotic suggestibility (hypnotizability). Mind wandering episodes were characterized by a reduced sense of control/awareness of mentations, especially in those scoring high on both hypnotizability and dissociation. Paper IV applied attachment theory to study everyday mentations in adults with childhood exposures to traumatizing events. A negative mind wandering style and everyday experiences of dissociation, negative affect, and low control/awareness were associated with a self-report, but not a discourse, measure of unresolved/disorganized attachment. The latter construct did not predict overall amount of mind wandering.

The results of this dissertation help integrate cognitive hypotheses of mind wandering within broader cognitive, affective, and developmental frameworks. I suggest that mind wandering consists of different subtypes that operate through different cognitive processes in which one is characterized by neutral or negative affect, poor working memory monitoring, and low effortful control, and appears more often in high dissociative/ high hypnotizable individuals, whereas another subtype is characterized by positive affect but is less clear in its relation to executive functioning.

Keywords: mind wandering, daydreaming, executive control, experience sampling, dissociative experiences, attachment

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Populärvetenskaplig sammanfattning på svenska

Variation i dagdrömmar: Individuella skillnader och kognitiva faktorers roll

Människor spenderar en stor del av sin vakna tid åt att tänka på saker som är orelaterade till den uppgift de håller på med eller den omgivning de befinner sig i (dagdrömmar). Under tiden man jobbar, läser en tidning, eller väntar på bussen kan man exempelvis börja tänka på något trevligt man ska göra nästa helg eller en tidigare deprimerande händelse som upprör en. Dagdrömmar är förenade med både fördelar (t.ex. att förbereda sig inför framtiden) och nackdelar (t.ex. att prestationen försämras på den uppgift man håller på med) och det är därför viktigt att förstå hur dagdrömmar regleras. Denna avhandling innehåller fyra studier som syftar till att öka vår kunskap om individuella skillnader i dagdrömmar genom att undersöka betydelsen av uppmärksamhetskontroll och affekt.

Individuella skillnader i uppmärksamhetskontroll visar sig bl.a. i hur lätt man har för att hämma olämpliga beteenden, uppdatera information i arbetsminnet, eller att växla mellan olika uppgifter. Tidigare forskning har visat att människor med lägre uppmärksamhetskontroll dagdrömmer mer än andra, men sambandet är svagt och det är möjligt att olika dagdrömmar regleras på olika sätt. Individer varierar i vilken utsträckning de finner dagdrömmar trevliga och hjälpsamma (positiv dagdrömsstil) eller deprimerande och upprörande (negativ dagdrömsstil).

Studie 1 indikerade att sambandet mellan dagdrömmar och uppmärksamhetskontroll i form av arbetsminnekapacitet var olika beroende på om man hade en negativ dagdrömsstil eller ej: Arbetsminnekapacitet var negativt relaterat till dagdrömmar för de med hög-negativ dagdrömsstil och positivt för de med låg-negativ dagdrömsstil. Resultaten visade däremot inget sådant samband för den positiva dagdrömsstilen. Studie 2 visade att individer med högre emotionell instabilitet eller lägre självregleringsförmåga dagdrömde mer än andra. Studien fann inte stöd för antagandet att människor med högre förmåga att växla mellan uppgifter oftare skiftar till mer positiva dagdrömmar när de gör uppgifter som kräver relativt lite uppmärksamhet.

Studie 3 visade att människor med hög dissociation (dvs. de som t.ex. har upplevelser av att vara frånkopplade från sina tankar, känslor, eller kropp) eller hög mottaglighet för hypnos dagdrömde mer än andra. Resultaten indikerade att dagdrömmar utmärktes av låg kontroll/medvetenhet om vad man nyss tänkte på, och att detta samband var starkast hos de med hög dissociation och hög mottaglighet för hypnos. Studie 4 testade om vuxna individer med traumatiska upplevelser i barndomen varierade i dagdrömmande beroende på om de hade olösta traumatiska händelser i barndomen, men fann inget sådant samband. Däremot bekräftade studien tidigare

resultat som visat att dagdrömmar ofta karakteriseras av låg kontroll/medvetenhet, hög dissociation, och hög negativ affekt.

Sammantaget bidrar resultaten i den här avhandlingen till att förena olika kognitiva teorier om dagdrömmar och belyser vikten av att beakta variationen i dagdrömmars innehåll när man försöker förstå dessa i förhållande till uppmärksamhetskontroll och olika personlighetsegenskaper. Jag föreslår att det finns olika underkategorier av dagdrömmar som verkar genom olika kognitiva processer. En kategori är mer vanligt förekommande hos människor som är dissociativa och mottagliga för hypnos. Den utmärks av neutral eller negativ affekt, låg arbetsminneskapacitet och låg självregleringsförmåga. En annan kategori som utmärks av positiv affekt är mindre klar i sin relation till uppmärksamhetskontroll.

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List of Papers

This dissertation includes the following papers.

I:

Marcusson-Clavertz, D., Cardeña, E., & Terhune, D. B. (2015). Daydreaming style moderates the relation between working memory and mind wandering: Integrating two hypotheses. *Journal of Experimental Psychology: Learning, Memory, and Cognition.* Advance online publication. doi: 10.1037/xlm0000180

II:

Marcusson-Clavertz, D., Persson, S. D., Bengtsson, H., & Cardeña, E. (2015). *Individual differences in mind wandering: Neuroticism, mental set shifting, and effortful control.* Manuscript under review.

III:

Cardeña, E., & Marcusson-Clavertz, D. (in press). The relation of hypnotizability and dissociation to everyday mentation: An experience sampling study. *Psychology of Consciousness: Theory, Research, and Practice*.

IV:

Marcusson-Clavertz, D., Gušić, S., Bengtsson, H., Jacobsen, H., & Cardeña, E. (2015). *Dissociation and mind wandering in individuals with high and low unresolved/disorganized attachment: An experience sampling study*. Manuscript in preparation.

Abbreviations

AAI: Adult Attachment Interview

BLAAQ-U: Berkeley–Leiden Adult Attachment Questionnaire-Unresolved

DES: Dissociative Experiences Scale

ESM: Experience sampling method

SAE: Survey of Anomalous Experiences

SART: Sustained attention to response task

SAS: Supervisory attention system

SIPI: Short Imaginal Processes Inventory

U/d: Unresolved/disorganized

Contents

1. Introduction

This Kappa presents four papers investigating individual differences in mind wandering. I will first define mind wandering and compare it to other attention-related constructs before discussing the theoretical underpinnings of this dissertation. I will then review the central instruments used to measure mind wandering in the four papers before presenting each paper and discussing its findings.

1.1. What is Mind Wandering?

In this dissertation I have adopted a definition of *mind wandering* as mentation unrelated to one's ongoing activity and independent of current stimuli in the surroundings (Stawarczyk, Majerus, Maj, Van der Linden, & D'Argembeau, 2011). To exemplify: while reading a book, a person might start to think about something irrelevant to the book such as planning what to eat for dinner, remembering a movie he or she watched yesterday, or imagining taking a trip to the moon. This class of experiences has been given many names in the history of psychological research, such as *daydreaming*, *attentional lapse*, and *absent-mindedness*. Mind wandering was the chosen term in a seminal review paper published in 2006 (Smallwood & Schooler, 2006) and since then it has been the standard term in the field. One of the reasons why Smallwood and Schooler preferred the term "mind wandering" was because they considered it intuitive, supposedly understood by both scholars and laypeople, but another reason may be that it is a relatively neutral term compared to others that have strong negative connotations (e.g., absent-mindedness or attentional lapses). The term *daydreaming* was more common in earlier decades (e.g., Singer & Antrobus, 1963) but has declined in use, perhaps because it was interpreted differently by various scholars. Klinger (1978–1979) evaluated three common definitions of daydreaming: daydreaming as fanciful, dream-like thoughts including wishful fantasies (Freud, 1953), task or activity-unrelated thoughts (Singer, 1966) and respondent (reflexive, spontaneous) thoughts (Klinger, 1971). Klinger showed that when individual mentations were sampled, these three dimensions were orthogonal to each other, which suggests that many task-unrelated thoughts are not perceived to be spontaneous but presumably rather deliberate (but see our principal components analysis in Paper III, which showed substantial covariation between these three characteristics).

Mind wandering has sometimes been construed as a subcategory of daydreaming mentation characterized by distractibility or poor attentional control, such as difficulties in maintaining concentration at work, whereas the broader term daydreaming may also include unconstrained thinking while resting in the absence of any explicit task (Huba, Singer, Aneshensel, & Antrobus, 1982). In contrast, I adopted the term mind wandering

and the definition by Stawarczyk et al. (2011) in this dissertation because the term is standard within the field and the definition is neutral to whether mind wandering reflect failures in executive control or not, which is a subject of study in this dissertation. I use the terms "task" and "activity" interchangeably, so even if the activity one is doing at the moment requires little in terms of task performance (e.g., taking a train ride, waiting for someone) the term mind wandering is applicable on those occasions. In other words, I do not consider mind wandering a subset of daydreaming but use the terms interchangeably. I mostly use *mind wandering* except when emphasizing dream-like aspects of the mentations or when citing other researchers' work, names of questionnaires, and so on.

Is mind wandering by definition a spontaneous phenomenon? At least some researchers would say no to this question including Seli, Carriere, and Smilek (2014) who divided mind wandering into two subtypes, deliberate and spontaneous, but nevertheless considered both types to qualify as mind wandering. My perspective is inspired by a classic framework of attentional control (Norman & Shallice, 1986) in which *automatic* and *intentional* behaviors (the latter characterized by a sense of will) are considered on a continuum rather than as a dichotomy and correspond to the degree of activation of certain executive control processes (i.e., inhibition, shifting, and working memory updating). If the level of spontaneity of mind wandering varies on a continuum it becomes theoretically problematic to define mind wandering as spontaneous without specifying the threshold or cut-off of spontaneity. Another problematic issue is that the level of spontaneity might vary as a thought or action proceeds from initiation to execution. For instance, during a lecture a certain word spoken by the lecturer might quite automatically trigger associations to a personal concern in one of the students, but once the task-unrelated mentation has emerged the student might choose to intentionally continue it. An inverse example would be a student giving up on the lecture and intentionally choosing to drift away to lecture-irrelevant topics, but once this action has been initiated the thoughts may seem to wander rather automatically from topic to topic. Thus, although some degree of spontaneity might be required for an episode to count as mind wandering (otherwise it could be said that the person just switched to another task), I consider mind wandering phenomena to vary in the degree of spontaneity.

Mind wandering and related attention constructs. In the 21st century, psychological research on mind wandering has attracted interest from several sub-disciplines, but perhaps mostly from neuroscience and cognitive psychology and this trend has shaped contemporary instrumentations of mind wandering. Within neuroscience mind wandering has frequently been studied in the context of people being shown visual stimuli while being in a functional magnetic resonance imaging or other scanner, and in these circumstances it has been natural to define mind wandering as *stimulus independent thoughts* (Mason et al., 2007). In cognitive psychology, mind wandering has frequently been measured while participants perform cognitive tasks (e.g., vigilance tasks) and here it has been natural to define mind wandering as *task-unrelated thoughts* (e.g., Smallwood, Davies, et al., 2004). Stawarczyk et al. (2011) integrated these two variations into a two-dimensional classification system in which any mentation has to satisfy both conditions (task- and stimulus-independence) to be qualified as mind wandering.

In contrast to mind wandering, thoughts unrelated to the task but dependent on a stimulus in current surroundings were designated as *external distractions* (e.g., listening to people talking nearby while reading a book). The term "distraction" has negative connotations so perhaps it would be better to name it *task-unrelated sensory impressions,* but I will use the former in this dissertation. Mind wandering and external distractions are not discriminated when only task-relatedness is considered, but recent research suggests that the two may be distinct phenomena with unique relations to other constructs such as attentional control (Stawarczyk, Majerus, Catale, & D'Argembeau, 2014). Mentation related to current activity but independent of current stimulus has been termed *task-related reappraisals* or *task-related interferences*. It includes thoughts about one's performance (e.g., "I am not good at this task"; "I wonder if I am doing better than others on this task") but also thoughts about past experiences or future imaginations unrelated to present sensory input but related to the task (e.g., watching a movie but thinking about a previous scene instead of paying attention to the ongoing one). The fourth category in this 2 × 2 categorization is *task-focus* mentation which refers to thoughts or images that are related to the ongoing task and dependent on current stimulus (e.g., listening to a lecturer).

1.2. Why is it Important to Study Mind Wandering?

Mind wandering is a common phenomenon observed in virtually all everyday activities. A study of mentation in daily life, with an undergraduate sample, indicated that mind wandering constitutes roughly 20% of mentation, whereas 10% are external distractions, 10% are task-related reappraisals, and 60% are task-focus mentations (Paper I). These figures are consistent with other experience sampling studies finding approximately one-third of waking life mentation to be task-unrelated (Kane et al., 2007), although another study that sampled a broader population of individuals found that about one-half of daily life mentation were task-unrelated (Killingsworth & Gilbert, 2010). The latter study also observed mind wandering to occur frequently during all reported activities with one exception (making love) suggesting that mind wandering is a ubiquitous and integral part of human cognition. Thus, a comprehensive understanding of the mind cannot be reached without understanding mind wandering.

A second reason to study mind wandering is that it is associated with several practical consequences including costs and benefits (Mooneyham & Schooler, 2013). We are less efficient in processing current external stimuli during mind wandering (Schooler et al., 2011) and generally perform the task at hand worse (Randall, Oswald, & Beier, 2014). Two important examples of this effect in applied settings are that mind wandering diminishes reading comprehension (Smallwood, McSpadden, & Schooler, 2008) and monitoring of the environment while driving (He, Becic, Lee, & McCarley, 2011). Thus, there are reasons to study the underlying cognitive mechanisms of mind wandering to understand how to minimize the adverse consequences associated with this phenomenon.

On the other hand, mind wandering has also been associated with several benefits. Multiple studies have indicated that a large portion of mind wandering is future-, self-,

and goal-oriented (Mooneyham & Schooler, 2013), and that individuals who frequently engage in future-oriented mind wandering have greater working memory capacity (Baird, Smallwood, & Schooler, 2011; but see also McVay, Unsworth, McMillan, & Kane, 2013), suggesting that these thoughts may be functional in helping us prepare our future and keep personal goals active in the mind (Klinger, 2013). Because mind wandering is associated with reduced processing of the external environment, it allows for a mental "escape" from the here and now, as suggested by the observation that when exposed to painful stimuli individuals feel less pain during mind wandering (Kam, Xu, & Handy, 2014) and time is contracted during mind wandering, which may help unpleasant events pass quicker (Terhune, Croucher, Marcusson-Clavertz, & MacDonald, 2015). Social-oriented mind wandering has been associated with enhancements of subsequent moods (Poerio, Totterdell, Emerson, & Miles, 2015). In sum, mind wandering is associated with several costs and benefits and these seem to vary according to the content of the mentation and the context in which it occurs (Smallwood & Andrews-Hanna, 2013). It may thus be desirable to understand how to control or regulate mind wandering so as to maximize its benefits and minimize its cost. The focal subject of this dissertation is to increase our understanding of mind wandering mentation and how it is regulated.

1.3. Current Status of Knowledge

1.3.1. Mind wandering and executive control

Because mind wandering mentation is by definition irrelevant to the activity one originally set out to do, it may not be surprising that mind wandering has commonly been construed as an attentional lapse (McVay & Kane, 2010; but see also Baars, 2010), a distraction to irrelevant self-generated thoughts akin to external distractions. This assumption has led many researchers to investigate how mind wandering relates to *executive control*, which refers to top-down processes that operate on lower processes and regulate the flow of information in working memory, inhibit undesired or goal-inappropriate automatic actions, and shift to more appropriate goal-directed behaviors (Diamond, 2013). A large number of studies have examined how mind wandering relates to individual differences in executive control capacities using a wide range of measures. In 2014, these studies were subjected to a meta-analysis that supported the proposition that individuals with high executive control functioning reported spending less time mind wandering (Randall et al., 2014). However, the association was very weak, r = -.11, 95% CI = [-.19, -.09], N = 2912, explaining about 1% of the variance in mind wandering scores. When correcting for unreliability of measurements the association was still weak, r = -.14, suggesting that the magnitude of the relation was not strongly affected by inconsistency of measurements. This suggests to me that if executive control resources are integral to the productivity of mind wandering episodes, it is likely that its impact is moderated by other factors. The meta-analysis treated executive cognitive resources and mind wandering as two homogeneous phenomena. Based on research indicating that executive control processes are diverse and comprise distinct subcomponents (Miyake et al., 2000) and that individuals differ greatly in their

attitudes and affective responses to mind wandering episodes (Huba et al., 1982), this dissertation attempted to clarify our understanding of their relation.

1.3.2. Mind wandering and affect

There has been number of studies relating affect to mind wandering. Individual differences in dysphoria in nonclinical individuals are associated with mind wandering (Smallwood, O'Connor, Sudberry, Haskell, & Ballantyne, 2004). A mood induction experiment showed that induction of negative mood led to higher scores on behavioral and subjective indices of mind wandering compared to a positive mood induction, but comparisons to a neutral mood induction were not significant (Smallwood, Fitzgerald, Miles, & Phillips, 2009). Experience sampling studies have indicated that that people feel unhappier when they mind wander, although the results are mixed as to whether mind wandering precedes changes in negative affect or vice versa (Killingsworth & Gilbert, 2010; Poerio, Totterdell, & Miles, 2013). Although these studies generally support an association between negative mood and mind wandering, various scholars have emphasized the heterogeneity of mind wandering and the hazard of generalizing this association to all mind wandering episodes (e.g., Baars, 2010). There is also a gap in the literature on whether the association between affect and mind wandering is mediated or moderated by personality traits or cognitive factors.

1.4. Research Aims

The aim of this dissertation was to increase our understanding of mind wandering by examining important moderating factors in the relation between executive control processes and mind wandering and the role of cognitive and affect-related traits. These traits include people's propensities to engage in positive and negative mentation, neuroticism, hypnotizability, dissociation, and unresolved/disorganized attachment. Paper I tested the prediction that for individuals whose mind wandering episodes typically are positive, executive control processes and mind wandering are positively related, but they are negatively related for those whose mind wandering episodes typically are negative. Paper II distinguished between positive, neutral, and negative mind wandering episodes and examined whether these relate to mental set shifting, effortful control, and neuroticism. It also examined whether the latter interacts with executive control processes on mind wandering. The last two papers examined mind wandering in selected populations based on the assumption that mind wandering more strongly reflects executive control deficits in some populations: Paper III examined whether people differing in hypnotizability and dissociation exhibit differences in control of mentation, mind wandering, and how these variables relate to each other. Paper IV assessed whether adults with childhood trauma and differing on unresolved/disorganized attachment showed different patterns in control of mentation and mind wandering. The last two papers also examined how changes within individuals in negative affect related to mind wandering.

2. Theories

This dissertation approached the central research question at hand (i.e., how do executive control processes and mind wandering relate to each other) mainly within a cognitive psychology framework, which has produced several theoretical and empirical advances on the subject within the last decade. However, individual differences in regulation of attention, emotion, and action have been the focus of many researchers from a large number of sub-disciplines of psychology, including developmental, clinical, and personality, and the goal was to use some of these broader frameworks to supplement the cognitive theories of mind wandering. For instance, individuals differ greatly in their propensities to automatically direct attention towards negative stimuli (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & Van IJzendoorn, 2007). Similar attentional biases may play a role in the cultivation of mind wandering episodes. The following section reviews prominent cognitive theories of mind wandering and the subsequent one reviews broader frameworks from other fields.

2.1. Cognitive Theories of Mind Wandering

In 2010, *Psychological Bulletin* published a seminal debate that presented two seemingly opposing views of the relation between executive cognitive processes and mind wandering, one proposing that executive resources are used to *prevent* mind wandering (McVay & Kane, 2010), the other purporting that executive resources *enable* mind wandering (Smallwood, 2010). Three years later, an attempt was made to reconcile the hypotheses by suggesting that they answer related but distinct questions (why mind wandering occurs vs. how it operates once it has been initiated; Smallwood, 2013). Two additional hypotheses were presented to shed new light on possible boundary conditions of the previous hypotheses by proposing that mind wandering is a heterogeneous collection of thoughts and images that may be regulated differently depending on the *content* of the mentation and the *context* of the ongoing task (Smallwood & Andrews-Hanna, 2013). I now review each of these theoretical accounts and the foundational assumptions on which they are based.

2.1.1. The control-failure hypothesis and current concerns

The *control-failure* hypothesis was presented by McVay and Kane (2010) primarily to explain why the frequency of mind wandering differs between individuals. It proposes that mind wandering occurs because of failures in higher-order cognitive processes to restrict attention to goal-related information. It predicts that *all else being equal*, individuals with higher executive cognitive capacities (e.g., greater inhibition

skills) should mind wander less frequently than others. Fundamental predecessors of their theorizing include the following:

- Hierarchical frameworks of attention that postulate that higher levels of controlled processing modulates the activity of lower levels of processing (e.g., Norman & Shallice, 1986).
- Klinger's (2009) proposal that mind wandering is triggered by cues relevant to personal, current concerns.
- The activation of a specific set of neural regions during resting (Raichle et al., 2001).

These predecessors are reviewed next before returning to the control-failure hypothesis itself.

The Norman and Shallice Model. Norman and Shallice (1986) presented a highly influential model of attentional control that distinguished between automatic and controlled processing. Two ways in which they defined "automatic" were by construing an automatic behavior as something that is a) *initiated* or b) *performed* without awareness of it being initiated or performed. So-called "absent-minded errors" are typical examples of automatic behaviors. For instance, while driving to a friend during the weekend a person might unintentionally take the routine route to the office the person always take on workdays. Norman and Shallice posited that people have a large repertoire, or database, of *action schemas* for well-learned or routine tasks that permit them to perform these tasks automatically without deliberate or conscious control. To exemplify, "having dinner" might be a schema that triggers several related schemas including "using a fork and a knife", "chewing", and "drinking". Schemas compete for selection and the schema that exceeds a particular threshold becomes activated. An external stimulus, such as the sight of a glass of juice, might then trigger a set of behaviors—such as reaching out and grabbing the glass to drink—without the need for conscious awareness.

In contrast, an additional control system is needed when performing tasks that require planning, troubleshooting, overcoming habitual or prepotent responses, or carrying out novel, difficult, or dangerous behaviors. Norman and Shallice (1986) labelled this higher-order control system the supervisory attention system (SAS), whereas others use the term *executive control* (Diamond, 2013). Norman and Shallice proposed that the SAS modulates the activation level of lower-level schemas, either by increasing or decreasing their activation level. For instance, if a delicious dessert is shown to a person it might trigger schemas related to eating the dessert, but if the person is motivated to keep to his or her diet the SAS might operate by inhibiting the schemas pertaining to eating the dessert. The degree of SAS activation corresponds to the sense of *will* or *intention,* and usually SAS activation is required at the initiation phase of behavior rather than the execution phase. For instance, upon waking up on a Monday morning a person might have a prepotent response or urge to stay in bed and go back to sleep, requiring involvement of the SAS to activate a "get up" scheme, but once activated routine motor behaviors can proceed automatically with low need for controlled processing.

Automatic cues and current concerns. If external stimuli can trigger sequences of well-coordinated, goal-directed behaviors automatically, as Norman and Shallice (1986) proposed, it is plausible that they may also trigger sequences of goal-directed internal thoughts automatically. Klinger (1971, 2009, 2013) has argued that the thematic content of people's thoughts is determined by their personal goals. He based his theorizing on two fundamental assumptions: First, that successful pursuit of goals is necessary for survival and, second, that because the human species spend a large portion of their waking conscious experiences on mind wandering it must serve some adaptive functions. Klinger (2013) posited that thoughts pertaining to personal goals (current concerns) are cognitively prioritized and more easily activated by cues. Evidence supporting this position comes from experiments using the color–word Stroop task, in which participants are required to inhibit a habitual response of reading the words in favor of naming the colors they are printed in. Responses to Stroop stimuli are slower when the words are goal-related than when they are not (Riemann & McNally, 1995), suggesting that goal-related stimuli capture attention more automatically than goal-unrelated stimuli. Mind wandering may permit us to mentally process personal goals during moments when the external surroundings are not favorable for goal-pursuit (e.g., driving on a highway). Mind wandering is more often future- than past- or present-oriented and often related to the self and personal goals (Baird et al., 2011), suggesting that it helps us to pursue our personal goals. Thus, it seems that we humans have a strong readiness to spontaneously think about personal concerns. Spontaneous thoughts in the absence of an explicit task have also been studied within a neurophysiological framework.

Default mode network. A set of neural regions, including the ventromedial prefrontal cortex, are increasingly activated during times when there is no ostensible task at hand (e.g., resting) and these regions have been termed the *default mode network* (Raichle et al., 2001). This network has also been shown to be transiently activated during moments in which participants report mind wandering (Christoff, Gordon, Smallwood, Smith, & Schooler, 2009). Mason et al. (2007) proposed that mind wandering reflects intrusions of the default mode network into conscious experiences.

On the basis of these lines of research, McVay and Kane (2010) argued that the default mode network regions automatically generate mentation related to current goals. Their use of the term automatic is akin to the first definition of Norman and Shallice (1986), that automatic behavior or thoughts are initiated without conscious awareness of their initiation. McVay and Kane argued that the default mode runs continuously by relating incoming information to our current goals. However, similar to how the SAS is believed to modulate lower-level control processing, McVay and Kane argued that executive control processes are implemented to constrain the activity of the default mode network and accordingly prevent the occurrences of mind wandering in task contexts. Consequently, if executive control processes are disengaged or reduced, the default mode network activity is left unconstrained and mind wandering is increased. In support of this hypothesis, the default and executive control networks are generally anti-correlated (Buckner, Andrews-Hanna, & Schacter, 2008), and trial-by-trial reductions in executive network regions are associated with slowing of reaction times, possibly reflecting attentional lapses (Weissman, Roberts, Visscher, & Woldorff, 2006). Groups known to exhibit general deficits in executive functioning (e.g., individuals with

attention deficit hyperactivity disorder) have shown elevated mind wandering tendencies (Shaw & Giambra, 1993). Alcohol consumption which is known to reduce executive control functioning is associated with elevated mind wandering (Sayette, Reichle, & Schooler, 2009). As previously mentioned, a meta-analysis of individual differences in performance in executive control tasks (e.g., the Stroop) revealed that such performance is weakly negatively associated with mind wandering (Randall et al., 2014). All of these findings are consistent with the control-failure hypothesis.

There are three important observations to consider when evaluating the limits of the control-failure hypothesis. First, several studies have found that older adults report *less* mind wandering than younger adults (e.g., Giambra, 1977, 1989, 1993) despite evidence indicating lower executive control capacities in older individuals (Braver & West, 2008). This finding is difficult to reconcile with the control-failure hypothesis. McVay and Kane (2010) speculated that this observation can be understood within the current concerns framework: One study indicated that older adults (60–82) report fewer current concerns than young adults (17–28) (Parks, Klinger, & Perlmutter, 1988–1989) and thus there may be fewer cues available that trigger concerns in older individuals, hence fewer mind wandering episodes. This explanation remains to be tested.

Second, the majority of mind wandering episodes occur during low-demanding activities (Paper I). The control-failure hypothesis may thus be applicable only in a context in which a person is engaging in a relatively difficult task, placing important constraints to its comprehensiveness (Smallwood, 2010). Research in which mind wandering has been evaluated during ostensibly low- or medium-demanding tasks have yielded diverse results, including *positive* correlations between working memory capacity and mind wandering (Levinson, Smallwood, & Davidson, 2012), inconsistent with the control-failure hypothesis.

Third, the hypothesis does not discriminate between different types of mind wandering although it is possible that some types of mind wandering are more adaptive (e.g., creativity, preparing the future) than others (e.g., rumination). A study using a signal discrimination task observed that future-oriented mind wandering was positively related to working memory capacity whereas past-oriented mind wandering was negatively related to working memory capacity, suggesting that the control-failure hypothesis may only cover a subset of mind wandering episodes (Baird et al., 2011; but see also McVay et al., 2013). Thus, there is a need for resolving the conflict between these observations and the control-failure hypothesis.

2.1.2. The global availability hypothesis

The global availability hypothesis of Smallwood (2010) proposes that mind wandering mentations require executive resources because they are conscious experiences that are available for reporting (i.e., they are globally available to the cognitive system). In other words, executive resources *enable* mind wandering. The hypothesis is based on a family of models termed global workspace models which will now be considered.

The global workspace theory. As formulated by Baars (1997, 2002, 2005), this theory views the brain as a system of an enormous amount of specialized processors

widely distributed in the brain. These processors would work autonomously and the focal content would not be reportable if it were not for a central executive that integrates them and make them globally available or "broadcasted" to the brain system as a whole. This global availability makes the events reportable and this corresponds to subjective consciousness. Global workspace theory claims that consciousness serves a functional role of manipulating and integrating information from specialized processors. For instance, consciousness is presumed to integrate information when trying to comprehend a sentence, including processing of semantics, syntax, and visual knowledge. Empirical findings taken to support this proposition include studies showing that the comprehension of combinations of words is severely limited during unconscious processing compared to conscious processing, as in subliminal priming of multiple words (Greenwald, Klinger, & Liu, 1989; Greenwald & Liu, 1985). An important proposition is that the executive system has a limited capacity for making information globally available to the system, which implies that various bits of cognitive processing compete for the same "spotlight". This limitation is illustrated in the dichotic listening task, in which two different messages are presented to each ear but individuals cannot consciously be aware of more than one message at a time.

Working memory. The global workspace theory shares some features with Baddeley's working memory capacity model (Baddeley, 1992). According to the latter, working memory is a set of cognitive systems that momentarily store and manipulate information necessary for cognitively complex activities such as problem-solving and decision-making. The working memory system includes lower-order specialized processors ("slave systems") that are responsible for storage and rehearsal of speech-based information including inner speech ("the phonological loop") and visual imagery ("the visuospatial sketchpad") and a higher-order system ("the central executive") that coordinates the flow of information from the two slave systems. This coordination of information flow suggests that the central executive component of working memory is responsible for attentional control, and this function has been corroborated by evidence from multiple research paradigms (e.g., dichotic listening tasks, antisaccade movements) in which individuals with higher working memory capacity are more efficient at not attending to distractors (Conway, Cowan, & Bunting, 2001; Kane, Conway, Bleckley, & Engle, 2001; Kane & Engle, 2003). Baars (2002) argued on the basis of the global workspace theory that active elements of working memory (e.g., inner speech, visual images) are reportable events and therefore conscious events that are broadcasted to the system as a whole.

Returning to Smallwood's global availability hypothesis, it proposes that mind wandering episodes are reportable conscious events that are thus "globally available". However, because global availability is limited (not all information can be broadcasted at once), mind wandering competes for the same broadcasting spotlight as task-oriented working memory elements. To give two contrasting examples: If a person is given the task to simply rehearse, say, the number 3, only a small amount of working memory resources are utilized and there is surplus of resources left for mind wandering. In contrast, if the task is to count backwards from 150 by subtracting 3 each time, a greater amount of working memory resources are required to manipulate each number and there are fewer resources left to mind wander. There is evidence to support the proposal that mind wandering decreases when working memory demands of the task increase

(Rummel & Boywitt, 2014) and this is consistent with the global availability hypothesis.

Smallwood further argued that because mind wandering episodes constitute complex, well-connected, sequences of information processing (e.g., planning the future by comparing two possible future scenarios), they may also need to be insulated from external distractions. Hence, executive resources are proposed to be used to *sustain* a mind wandering episode. Evidence taken to support this claim comes from neurophenomenological observations that experiences of mind wandering are associated not only with activity in the default mode network but also with the executive network such as dorsolateral prefrontal cortex and anterior cingulate cortex, even when participants reported not having been aware of mind wandering before the probe (Christoff et al., 2009), although the neuroimaging measurement in this study had relatively low temporal resolution making it difficult to disentangle the precise temporal order of network activations.

One piece of evidence that arguably is more consistent with the global availability than the control-failure hypothesis is the aforementioned finding that older adults report fewer mind wandering episodes than younger adults despite the decreased availability of executive resources with age. A second piece of evidence consistent with the global availability hypothesis is that in two experiments using ostensibly low-demanding tasks (visual search and breath-awareness) those with higher working memory capacity reported more mind wandering (Levinson et al., 2012). Inconsistent with the global availability hypothesis, overall mind wandering measured in daily life did not correlate with working memory capacity (Kane et al., 2007) and when mind wandering is measured during ostensibly medium-to-high demanding tasks they are *negatively* associated (Randall et al., 2014).

Smallwood (2013) later made an important distinction between the control-failure and the global availability hypotheses, proposing that the former attempts to explain *why* mind wandering occur whereas the latter attempts to explain *how* the cognitive processes operate during mind wandering. For instance, during a lecture a word spoken by the lecturer might act as cue to automatically prompt associations to a certain current concern in one of the students, say thoughts about a particular relationship. If the student has not devoted enough preparatory control resources to prime lecture-related information these task-irrelevant thoughts are more likely to become activated. Once this processing of the task-irrelevant concern has become sufficiently activated the information is globally available and becomes a conscious, reportable experience and executive resources may now be employed to sustain this thought segment instead (e.g., by retrieving long-term memories of the relationship and process this information in working memory to decide whether to call the person or not after the class).

However, the theoretical attempt to integrate the two hypotheses by proposing that they affect different points in the timeline of mind wandering episodes needs experimental testing. It has not yet been shown that control-failures only reflect the *initiation* of mind wandering episodes. It is plausible to conjecture that control-failures may explain why a mind wandering process is prolonged too (e.g., poor conflict monitoring and resolution). It is possible that the degree of control employed to prevent

mind wandering depends on how motivated the person is to focus on the task, and this motivation, in turn, may depend on the content of mind wandering mentations and the type of task one is doing at the moment. We next consider two hypotheses addressing these issues.

2.1.3. The context-regulation hypothesis

This hypothesis proposes that people regulate mind wandering frequency so as to minimize the likelihood that it will impair performance on the ongoing task. That is, at times when mind wandering is likely to result in an important error, such as during a high-demanding cognitive task, individuals reduce mind wandering. In contrast, when task demands are low, individuals increase mind wandering because it is associated with several benefits beyond the task (e.g., preparing the future, creativity). Individuals who regulate mind wandering depending on the task context in this manner are said to have a more adaptive or functional cognitive processing style. Consistent with this hypothesis, people report fewer mind wandering episodes as task demands increase, those with higher working memory capacity are better at *reducing* the time spent on mind wandering as task demands increase, and this reduction in mind wandering correlates with performance on the task (Rummel & Boywitt, 2014; see also Kane et al., 2007; but see also Paper I).

2.1.4. The content-regulation hypothesis

Usually, research on executive resources and mind wandering treat the latter, if not also the former, as a homogeneous phenomenon. Andrews-Hanna and Smallwood (2013) called for a more nuanced view of mind wandering and on the basis of several observations, some from the clinical literature, formulated the content-regulation hypothesis. They wrote that the content-regulation suggests that:

the relationship between self-generated thought and psychological wellbeing depends on assessing how individuals regulate the content of their mental experiences so as to maximize thoughts with a productive outcomes [sic], and minimize those which are detrimental to their happiness or other life outcomes. (p. 4)

This formulation appears to be a tautology because minimal mentations that are detrimental to people's happiness can be said to be a defining aspect of their wellbeing. Nevertheless, based on their reasoning one can conjecture that individuals with greater executive control capacities are better able to regulate mind wandering so as to maximize mentation content associated with productive outcomes (e.g., problem-solving and future-planning thoughts) and minimize mentation content with unproductive outcomes (e.g., passive-repetitive/ruminative thoughts about one's mood).

One study found that during a seemingly low-demanding task, participants with higher working memory capacity mind wandered more often about future-oriented topics and less often about past-oriented ones (Baird et al., 2011). However, a reanalysis of two independent large-*N* studies did not replicate the association between future-oriented mind wandering and working memory capacity (they did not evaluate past-

oriented thoughts; McVay et al., 2013). A possibility is that this discrepancy can be attributed to the difference in cognitive tasks employed in the studies, as the latter administered seemingly high-demanding tasks such as a reading task. According to the context-regulation hypothesis, people would be less prone to switch to future-oriented mind wandering during high-demanding tasks because it would impair performance.

2.2. Other Theoretical Frameworks Relevant to Mind Wandering

This section considers a selected few theoretical frameworks that have been successful in predicting intra- and inter-individual differences in regulation of attention and affect. Before reviewing these frameworks, a few empirical observations are noteworthy. First, episodes of mind wandering are generally accompanied by higher negative affect (Killingsworth & Gilbert, 2010). Second, those mind wandering episodes that involve other people (termed social mind wandering) have been shown to be associated with subsequent increases in happiness, and this association was specifically observed when the mind wandering episodes involved people with whom the person claimed to have a high-quality relationship (Poerio et al., 2015). These findings suggest that the processes involved in the regulation of affect and mind wandering are closely related and that the quality of interpersonal relationships plays an important role in the modulation of affective content of mentations. Research based on attachment theory has observed that individuals who are disorganized when speaking about past abuse or loss of attachment figure (e.g., a parent) report higher emotional distress (Riggs & Jacobvitz, 2002) and intrusions of traumatizing memories (Koren-Karie, Oppenheim, & Getzler-Yosef, 2008) than organized individuals. We therefore consider attachment theory next, which is focused on how the quality of representations of self and others shapes a person's ability to regulate affect.

2.2.1. Attachment theory

Following the theory of evolution, attachment theory posits that species-specific characteristics have evolved in humans to promote certain proximity-seeking behaviors (attachment behaviors; Bowlby, 1973, 1980, 1982). Because infants cannot survive independently, they need to attract the attention of caregivers to increase the likelihood of survival and reproduction, such as crying for help when facing danger. Attachment behaviors are primarily directed at selected individuals that can provide protection and comfort, usually parents or other primary caregivers, and, later in life, partners. Thus, at times when distress is felt, such as fear or sadness, affect is regulated by the provision of protection and comfort from the attachment figure. Importantly, these interactions with attachment figures are proposed to be internalized and stored as mental representations, termed internal working models, of ourselves and others and automatically influence our thoughts and actions in future interactions.

An infant that is protected repeatedly and comforted at times of distress will formulate representations of significant others as predictable and trustworthy and form a

secure attachment (Ainsworth, Blehar, Waters, & Wall, 1978). The theory further posits that infants will likely use one of two secondary strategies if protection and comfort is not reliably received: if the infant is hopeful about the interaction, a hyperactivated (*anxious-ambivalent*) attachment style may be used by exaggerating the attachment behaviors (e.g., crying more loudly and repeatedly) to increase the likelihood that the caregiver will pay attention. If the infant is less hopeful a hypoactivated (*avoidant*) attachment style may be used to deactivate the attachment behaviors) to suppress negative affect. Attachment behaviors are thought to be strongest in infancy but continue to influence regulations of attention and emotion throughout life.

Some children develop contradictory internal working models that are thought to manifest in disoriented or paradoxical behaviors, such as approaching the caretaker with head averted. This pattern has been termed disorganized attachment (Main & Solomon, 1990) and it predicts the development of dissociation (Carlson, 1998), which refers to the experienced loss of access to information or control of mental processes ordinarily amenable to control, manifested by involuntary mental intrusions or amnesia, and a feeling of being disconnected or detached from the self, others, or the surroundings (Cardeña & Carlson, 2011). It has been argued that a frightening parent may cause disorganized attachment because the child is predisposed to approach the parent when distressed (solution to alarm), but in the case of a frightening parent simultaneously needs to avoid him or her (source of alarm), resulting in a paradox and incoherent working models of the parent as both the source and solution of alarm (Hesse & Main, 2006; Liotti, 2009).

Attachment is also measured in adolescence and adulthood, by analyzing the discourse of attachment representations in the answers to the Adult Attachment Interview (AAI; George, Kaplan, & Main, 1996). The AAI is a semi-structured interview in which the interviewees talk about their childhood experiences and their relations to their attachment figures and their narratives tend to fit three structured categories. *Secure* individuals tend to value attachment relationships and produce a globally coherent discourse. *Dismissing* individuals tend to devalue attachment relationships or idealize attachment figures without being able to provide concrete examples for these claims. *Preoccupied* individuals are still very engaged with, often angry about, attachment-related memories and fail to produce coherent narratives. There are also two types of disorganized patterns identified with the AAI: *Cannot classify* refers to a globally inconsistent representation of attachment figures. This can occur because these individuals manifest either both dismissing and preoccupied attachment patterns or none to a sufficient degree to warrant a fit into any of the three organized categories. In contrast, *unresolved/disorganized* (U/d) attachment refers to responses to specific trauma or loss-related questions, in which lapses in monitoring of reasoning and discourse are manifested in the narratives. Individuals with U/d attachment may, for example, fail to complete sentences or report contradictory information (e.g., the time of death of a loved one as occurring at two different times).

U/d attachment may indicate a failure to integrate traumatizing experiences into existing internal working models (Koren-Karie et al., 2008) and that aspects of the traumatizing experience have been excluded from awareness (Hesse & Main, 1999, 2006). Therefore, eliciting these U/d representations is thought to overwhelm

consciousness leading to dissociation. Individuals with U/d attachment report higher levels of dissociation than those without U/d attachment (e.g., Joubert, Webster, & Hackett, 2012; Koren-Karie et al., 2008; but see also Stovall-McClough & Cloitre, 2006). U/d attachment has also been associated with poor inhibition of negative emotional stimuli in an emotional Stroop task (Atkinson et al., 2009), which may reflect an attentional bias to negative stimuli or a more general deficit in inhibiting task-irrelevant processing.

In summary, attachment theory predicts individual differences in regulation of affect and attention and is therefore a promising framework for increasing our knowledge of regulation of mind wandering. Insofar as mind wandering is affected by reductions in executive control, individuals with U/d attachment might exhibit temporary lapses in their control, which might increase mind wandering. However, these propositions need to be tested.

2.2.2. Temperament and personality frameworks

In contrast to attachment theory, which focuses on interpersonal interactions as predictors of individual differences in affect and regulation of attention, temperament frameworks focus on genetic endowment as a predictor of differences in affect and regulation (Rothbart, Ahadi, & Evans, 2000). Temperament has been defined as relatively stable individual differences in *reactivity* (i.e., excitability and responsivity) and *self-regulation* (i.e., modulation of reactivity) assumed to be based on genetic makeup, maturation, and experience (Rothbart & Derryberry, 1981). Temperament is often seen as a subdomain of personality, which also includes beliefs and values (Evans & Rothbart, 2007). The factor analytic structure of temperament constructs has varied across studies, and may depend on age as some of these characteristics emerge earlier in life than others (Rothbart et al., 2000).

Two constructs usually subsumed under reactivity are *extraversion/surgency* and *negative affectivity*: the former refers to a predisposition to find pleasure in high-intensive stimuli, enjoy being sociable, and experience positive affect (positive/appetitive). Negative affectivity refers to a predisposition to experience sadness, fear, discomfort, frustration, and anger. A construct typically used to refer to voluntarily controlled self-regulation is *effortful control*, which includes the capacity to inhibit inappropriate behavior, carry out behaviors when there are strong tendencies to avoid them, and deliberately focus and shift attention when situationally appropriate. The two reactivity constructs and effortful control, which are mainly derived from research within the field of developmental psychology, overlap strongly with the big five personality traits (Rothbart et al., 2000). For example, in a large-*N* undergraduate study (Evans & Rothbart, 2007), negative affectivity was associated with the personality construct neuroticism/emotional instability (r = .74), extraversion/surgency was associated with extraversion (r = .67), whereas effortful control was associated with conscientiousness (r = .64).

Individual differences in neuroticism are associated with biases in attentional processing of emotional stimuli. For instance, an emotional Stroop study showed that

individuals who were higher in neuroticism had more difficulties inhibiting negative than neutral or positive stimuli, suggesting that neuroticism is associated with a readiness to respond to negative stimuli (Richards, French, Johnson, Naparstek, & Williams, 1992). However, the study also found that an induction of a positive mood increased attentional bias towards positive stimuli and induction of a negative mood increased bias towards negative stimuli in high-neurotic but not low-neurotic individuals. This may indicate that emotionally unstable individuals are prone to process information congruent with their current mood. Another study found that neuroticism predicts negative emotional responses to negative mood inductions whereas extraversion/surgency predicts positive emotional responses to positive mood inductions (Larsen & Ketelaar, 1991). Importantly, neuroticism has also been shown to predict higher discomfort during moments when there is no overt stressor (Watson & Clark, 1984). This finding can be taken to suggest that in the absence of external stressors, neurotic individuals drift away to anxiety-provoking topics unrelated to current stimuli (e.g., worrying about a new, upcoming job; see also Perkins, Arnone, Smallwood, & Mobbs, 2015). This interpretation points to an association between neuroticism and mind wandering, which has not yet been tested.

3. Methods

3.1. Challenges in Studying Mind Wandering

Two characteristics of mind wandering make it a particularly challenging research topic:

- Mind wandering is a *private, inner experience* defined in terms of the content of consciousness (i.e., whether the content is unrelated to the ongoing activity and external input).

- Mind wandering may commence *without meta-awareness*, that is, the person may not know that a mind wandering episode has begun until later.

The first property indicates that we cannot obtain direct evidence of whether someone is mind wandering at a particular time but only indirect evidence by asking the person about the content of his/her consciousness. Critics of introspection may take this as sufficient reason for ignoring the study of mind wandering altogether. In defense of introspection, verbal reports have been shown to be more valid when individuals are asked to describe the content of their experiences than to make inferences about the underlying cognitive processes (Ericsson & Simon, 1980). Ericsson and Simon further argued that verbal reports tend to be more accurate when they are collected close in time to the referent experience and when individuals have foreknowledge that the experience is important. Asking participants at repeated occasions whether they were mind wandering right before a probe or signal fits these general recommendations for acquiring relatively high-accurate verbal reports.

Jack and Roepstorff (2003) made the argument that all three types of measurements (physiological, behavioral, and subjective) have limitations of not directly measuring what they are usually intended for in psychology:

- physiological data such as functional magnetic resonance imaging measure: 1) blood flow and, less directly, 2) neural activity, as related to 3) specific cognitive activity (e.g., attending a stimulus),

- behavioral data such as average response times (RTs) to stimuli may index: 1) stable behavioral patterns, 2) information processing, and 3) specific cognitive activity,

- whereas subjective data shows evidence for: 1) our meta-cognitive beliefs about the content of consciousness, 2) the actual content itself, and 3) the specific cognitive activity underlying those mentations.

Thus, when evaluating mind wandering all methods are indirect and to compensate for their limitations researchers have measured the extent they converge with each other (triangulation; see Cardeña & Pekala, 2014). Several studies have shown strong overlap among measures. For instance, it is reasonable to conjecture that because mind wandering mentations are by definition unrelated to external input and ongoing tasks they should be accompanied by reduced physiological processing of external stimuli and increased behavioral errors in tasks that rely on constant monitoring of stimuli. Christoff et al. (2009) showed that default mode networks regions, such as ventromedial prefrontal cortex and dorsomedial prefrontal cortex, were more activated during intervals preceding verbal reports of mind wandering and behavioral markers of mind wandering (signal detection errors). Similar triangulations of physiological, behavioral, and subjective measures have been shown with electroencephalographic recordings/event-related potentials and eye-tracking (Schooler et al., 2011; Smallwood, Beach, Schooler, & Handy, 2008). Another study showed that a behavioral pattern of gradually speeding up RTs to repetitive non-target stimuli (thought to reflect non-discriminative habitual responses) right before a thought-sampling probe of infrequent target stimuli is likely to precede a mind wandering report and a behavioral error (Smallwood, McSpadden, Luus, & Schooler, 2008). Taken together these studies indicate that subjective reports of mind wandering are accompanied by reduced processing of the external surroundings and task stimuli, supporting the validity of subjective reports.

However, the evidence supporting the overall validity of verbal reports does not imply that *all* reports of mind wandering are valid and more research should be conducted to explore the possibilities of increasing the validity of mind wandering measures. A recent study tested whether a commonly observed association between mind wandering and poor task performance varied according to the confidence participants had in their reports of mind wandering (Seli, Jonker, Cheyne, Cortes, & Smilek, 2015). Participants were generally highly confident in their reports but some reports were given with low confidence. As expected, mind wandering and task performance were more strongly related when people reported medium-to-strong confidence in their reports. It remains to be tested to what extent low-confidence reports are due to low meta-cognition at the moment of the probe or due to the occurrences of untimely switches between task-focus and mind wandering right before the probe (in which case, a continuous response scale might be preferable to the dichotomous one typically used).

The second characteristic of mind wandering, that it may commence *without meta-awareness,* prohibits us from specifying the exact point in time when a mind wandering episode begins, making causal investigations very problematic (Smallwood, 2013). Compare this to standard psychology experiments in which the causes of a certain psychological phenomenon can be studied by manipulating the presence of an *imperative stimulus* and examining the subsequent response to it (Smallwood referred to these as task-based experiment). In a mind-wandering based experiment you cannot ask the person to mind wander in response to a stimulus, as that mentation would by definition not qualify as mind wandering. Thus, at this date there is no way to precisely determine when a mind wandering episode has begun and this makes it challenging to distinguish between occurrences (onsets/frequencies of mind wandering episodes) and

processes (the duration of a mind wandering episode). This important limitation should be kept in mind when evaluating the results of contemporary research in this domain as well as the studies presented in this dissertation. Rather, the approach that many researchers have taken (either explicitly or implicitly) is to study the *amount of time spent* on mind wandering episodes, which collapse frequency and duration (see Smallwood, 2013; but see also Hasenkamp, Wilson-Mendenhall, Duncan, & Barsalou, 2012).

In summary, mind wandering is characterized by low meta-awareness that one has started to mind wander. Participants might not be sufficiently skilled to catch mind wandering on their own, but external probes that signal participants to become aware of the content of most recent mentation have been shown to provide reports with apparently high accuracy. However, cognitive theorizing has suggested that mind wandering may be very sensitive to task contexts (Smallwood & Andrews-Hanna, 2013), suggesting that mind wandering reports collected in a narrow task context such as the laboratory may have very limited generalizability to other contexts. The next section reviews a central method that addresses these issues.

3.2. Experience Sampling Method (ESM)

In the *experience sampling method* (ESM) participants report about their activities and mentation at repeated occasions in their natural setting. The method reviewed here concerns ESM research in which participants respond to a questionnaire when prompted by a quasi-random signal (e.g., a beep from a personal digital assistant or a smartphone device). It is common to administer ESM signals for about a week with about 10 samples per day but these numbers vary greatly from study to study. This method has also been called *ecological momentary assessment*, usually in contexts in which events, not experiences, are emphasized.

The most prominent advantage of ESM sampling in daily life is its ecological validity (Hektner, Schmidt, & Csikszentmihalyi, 2006) because the sampling of experiences is not restricted to a narrow context (e.g., the laboratory) in which generalizability to other contexts is highly questionable. For instance, if one is interested in examining the prevalence of mind wandering, it is not obvious that mind wandering during laboratory tasks will generalize to mind wandering while making breakfast, talking on the phone with a friend, walking to work, and so on. McVay, Kane, and Kwapil (2009) showed that there is a weak association between mind wandering during a laboratory task and in daily life using ESM, suggesting that there is a large amount of unique variance in the two contexts.

In addition to ecological validity, the repeated sampling in ESM makes it useful for analyzing both within-individual changes and between-individual differences. A good example of this comes from research on alcohol and anxiety that has shown that for drinkers moments of higher intake of alcohol are associated with *lower* anxiety (within-individuals, sometimes referred to as level-1), but people who more frequently consume alcohol generally feel *higher* anxiety (between-individuals, level-2; Swendsen et al.,

2000; Tennen, Affleck, Armeli, & Carney, 2000). ESM designs are particularly suited for evaluating relations such as these.

A third advantage of ESM is the reduction of long-term memory biases, because participants are typically asked about their most recent experience. In contrast, global self-reports using one-time questionnaires have been shown to be susceptible to several memory biases, such as heavy reliance on biased heuristics (Hektner et al., 2006) although convergence between ESM and one-time questionnaires has been observed (e.g., Barrett, 1997; Diener, Smith, & Fujita, 1995).

Validity. Various studies indicate that ESM can be used to get valid reports of activities and mentation (for a review see Hektner et al., 2006). For instance, a study showed that ESM reports of physical activity were associated with a physiological measure of heart rate (r = .41) and the latter was also related to participants' reports of what they were doing (e.g., lying down, walking, sitting; Hoover, 1983, as cited in Hektner et al., 2006). For the purpose of this dissertation it is more pertinent to examine the validity of ESM mind wandering reports. First, the internal structure of ESM reports has shown support for their validity, for instance, a principal components analysis indicated that reports of mind wandering clustered together with reports of thinking about past- or future-oriented matters but not present-oriented matters, which is consistent with the definition of mind wandering as independent of current external input (Paper III). Second, when the ESM variables that clustered together according to the principal components analysis in Paper III were aggregated for each individual they formed a reliable index of individual tendencies to mind wander/daydream (Cronbach's α = .70). Third, several laboratory findings have been conceptually replicated with ESM devices, such as the negative association between task performance and mind wandering (McVay et al., 2009). Fourth, ESM mind wandering reports are associated with situational variables in a way that makes logical sense, such as increased mind wandering during activities that are boring (Kane et al., 2007; McVay et al., 2009) or requiring low effort or concentration (McVay et al., 2009; Paper I; but see also Kane et al., 2007), and when feeling stressed and sleepy (Kane et al., 2007; McVay et al., 2009). Fifth, as previously mentioned thought probes randomly administered during *laboratory* tasks have converged with physiological indicators of reduced external processing (Schooler et al., 2011) and behavioral errors on task-relevant stimuli (Randall et al., 2014), it is thus reasonable to assume that participant's apparent ability to respond accurately to thought probes in the laboratory would generalize to being able to respond accurately to the same probe questions outside the laboratory. In summary, although Seli et al. (2015) showed that some responses to thought probes were reported with lower confidence than others—and this deserves further inquiry—there is a great deal of evidence indicating high validity of subjective reports of mind wandering in response to ESM signals.

As with any method, ESM is not free from limitations (Scollon, Kim-Prieto, & Diener, 2003). First, it requires participants to use the ESM device for several days including workdays. This will likely discourage some people from participating, causing self-selection biases or attrition. People in some occupations might find it harder to participate (e.g., clerks) whereas others might find it easier (e.g., unemployed, undergraduate students). Because psychology research typically tests undergraduate

samples, the difference between these and samples in ESM research may not be that large, but this needs to be examined in the future. A second limitation is that some events (e.g., being robbed) and experiences (e.g., feeling intense fear) may not be captured by ESM reports because participants do not always respond to the signals (about 70–80% signal-response rate is common; Hektner et al., 2006). These cases may be better captured by diaries, interviews or other techniques (cf. Cardeña & Pekala, 2014). On the other hand, the ESM is still likely to capture a broader sample of events and experiences than studies carried out in the laboratory. Researchers can statistically evaluate whether signal-response rates vary according to certain demographic and other variables to estimate the presence of biased sampling. Decreasing the number of days participants carry the ESM device, the amount of signals per day, and the number of questions answered may also increase response rates. Monetary and other incentives have been shown to increase response rates in survey research (Lynn, 2001). Another way to increase response rate, and perhaps the accuracy of reports, is to create an "alliance" with the participants and make them feel that their contribution is important (Hektner et al., 2006). A third limitation is reactivity. Because participants are asked to track a certain behavior or experience during a week they may show greater awareness of this attribute and perhaps modify it. There is little research on this topic (but for a review see Barta, Tennen, & Litt, 2011). If reactivity were evident, one would expect ESM reports to change across time. The review of Barta et al. provides evidence for reactivity in some contexts but not others. Reactivity may depend on whether participants are required to monitor only a specific kind of experience and the desirability of the experience.

3.3. The Sustained Attention to Response Task (SART)

One of the most common laboratory measures used in mind wandering research is the SART (Robertson, Manly, Andrade, Baddeley, & Yiend, 1997). Robertson et al. developed the SART to measure failures to sustain attention rather than mind wandering per se (external distractions and task-related reappraisals may also qualify as failures to sustain attention but not as mind wandering). The original SART is a go/no-go task in which participants watch a sequence of visual stimuli and respond with a key press each time they see a digit between 1 and 9 (non-targets) except for number 3 (target) for which they are asked to withhold response. Each digit is shown for 250 ms with an interstimulus interval of 900 ms and participants are asked to give equal weight to latency and accuracy. The monotonous nature of the task, to press a button on each non-target (89% of all trials), was devised to encourage automatic responding and induce insufficient attention towards the stimuli leading to commission errors on the targets (action slips). In support of this, Robertson et al. found that shortening of response times prior to targets predicted commission errors on the targets, that these commission errors were associated with self-reports and informant-reports of attention and memory slips in daily life (measured with a questionnaire), and that people with frontal lobe damage (traumatic brain injury patients) made more commission errors than controls.

It has been argued that motor responses in the SART reflect impulse responding rather than sustain attention failures (Helton, Kern, & Walker, 2009; but see also Paper

I). Smallwood, Davies, and colleagues (2004) published a modification of the SART in which they added thought probes at the end of blocks asking participants to report freely what was passing through their minds before the probe. These reports were then coded as task-related or unrelated by two judges. Although inter-rater agreement was high (they agreed on 94% of the reports) it has been much more common to let participants judge online with a button press whether the thought they had was task-related or not (cf. Giambra, 1995). In support of the validity of the SART measures, as mentioned above, subjective reports of mind wandering and behavioral errors predict similar activations of the default mode network and reduced physiological processing of SART stimuli (Christoff et al., 2009; Smallwood, Beach, et al., 2008).

Another change of the SART procedure was to introduce a slow version with 2050 ms interstimulus interval (compared to the fast original SART with 950 ms interstimulus interval) which induced higher levels of mind wandering (Smallwood, Davies, et al., 2004). Different research teams have tended to use either a fast or slow version of the SART and this makes comparison of these studies difficult. Furthermore, little is known about how the SART generalizes to contexts outside the laboratory, although one experience sampling found a weak association between mind wandering in the SART and daily life (McVay et al., 2009). Intermittent thought probes are also commonly administered during other cognitive laboratory tasks, including the color-word Stroop task and reading tasks (for a review see Randall et al., 2014) allowing for evaluations of online mind wandering and cognitive functioning within various domains.

3.4. The Short Imaginal Processes Inventory (SIPI)

The SIPI is a common self-report measure of daydreaming or mind wandering styles (Huba et al., 1982). Its 45 items were derived from the Imaginal Processes Inventory, a 344-item questionnaire based on interviews and other personality questionnaires (Singer & Antrobus, 1970). An advantage of the short form is that participants usually complete it in less than 10 minutes, whereas the longer version may take up to an hour to complete. Factor analyses of the two versions revealed three stable daydreaming styles (Huba et al., 1982). Individuals who score high on the *Positive-constructive* daydreaming style report that their mind wandering is enjoyable, useful, and includes vivid imagery. Individuals who score high on the *Guilt/fear-of-failure* daydreaming style report that their mind wandering is often of dysphoric character. They endorse imaginations about failing responsibilities and becoming angry at others. On the other hand, they also report fantasizing about winning awards and joining recognized groups, which may indicate a positive mood (Paper I), possibly as a means to reduce guilt or a sense of failure. Individuals who endorse the *Poor attentional control* style report that they easily lose interest in what they do, become distracted, and drift away to task-unrelated matters.

A study with a large-*N* undergraduate sample showed that the Positive-constructive scale was weakly associated with the Guilt/fear-of-failure and the Poor attentional control scales, whereas the latter two were moderately associated with each other (Huba

et al., 1982). The three SIPI scales showed high internal consistencies with reliability coefficients exceeding .80. Another study reported test–retest correlations that indicated high stability over a month for the Positive-constructive (r = .59), the Guilt/fear-of-failure (r = .73) and the Poor attentional control (r = .73) scales (Tanaka & Huba, 1986).

4. Research Papers

4.1. Paper I

The first aim of Paper I was to examine the relations between executive control processes (including working memory capacity and cognitive inhibition) and mind wandering. Previous proposals have suggested that executive control processes prevent mind wandering (*control-failure hypothesis*; McVay & Kane, 2010) or enable it (*global availability hypothesis*; Smallwood, 2010). A possibility is that people may be differentially inclined to prevent or enable mind wandering depending on whether they typically have positive or negative mind wandering. Specifically, we expected that for those whose mind wandering episodes are characterized by high positive/low negative features, executive control and mind wandering would be positively related (consistent with the global availability hypothesis), whereas for those whose mind wandering episodes are low positive/high negative, executive control and mind wandering would be negatively related (consistent with control-failure hypothesis). The second aim was to examine whether mind wandering during a laboratory task generalizes to mind wandering in daily life using experience sampling

The sample (N = 111) carried a personal digital assistant for four days (10 samples per day), which probed them about recent mentations, including whether they were mind wandering (*ESM mind wandering*). Participants also completed two 1-hour laboratory sessions. They performed the symmetry span task (a measure of *working memory capacity*), the SART with thought probes (*SART mind wandering*), and two versions of a color-word Stroop task (*cognitive inhibition*). We manipulated the proportion of congruent trials in the Stroop task from low (25%) to high (75%) because the former proportion is argued to tax *proactive control* (preparatory, sustained activation) and the latter should tax *reactive control* (transient, momentary activation; De Pisapia & Braver, 2006). In addition, participants completed the SIPI (a measure of individual *daydreaming styles*, including positive and negative mind wandering tendencies).

In support of a moderating influence of a negative daydreaming style, working memory capacity was more negatively related to mind wandering in daily life, as the negative daydreaming style increased. Simple slope analyses indicated that working memory and mind wandering were negatively related in those with a high negative daydreaming style, whereas the relation was suggestively positive in those with a low negative style. There was no support for our prediction that the positive daydreaming style would moderate the relation between working memory capacity and mind wandering. In contrast, the positive daydreaming style marginally regulated the relation between mind wandering and cognitive inhibition (but only in the high-congruent proportion). Simple slope analyses indicated that mind wandering was associated with

poor cognitive inhibition, but only in those with a low positive daydreaming style. Pertaining to the second aim of this study, we did not find support for an association between mind wandering during the SART and overall mind wandering in daily life, although the association was suggestively enhanced when mind wandering in daily life was evaluated during high-demanding tasks. This suggests that mind wandering in the SART only generalizes to other high-demanding activities.

These results have several implications for cognitive theories of mind wandering. They suggest that mind wandering episodes are not uniformly related to executive control. The negative relation between working memory capacity and mind wandering in individuals whose mind wandering tends to be negative supports the control-failure hypothesis. In contrast, the suggestively positive relation between working memory and mind wandering in those whose mind wandering rarely is negative is consistent with the global availability hypothesis. Taken together, these results also extend another proposal (*the content-regulation hypothesis*; Smallwood & Andrews-Hanna, 2013)—which suggests that the relation between functional outcomes and mind wandering depends on the content of those episodes—by showing that the relation between working memory capacity and mind wandering depends on people's daydreaming styles (consisting of highly positive and/or highly negative features).

The Stroop results are more consistent with the control-failure than the global availability hypothesis: poor cognitive inhibition (possibly low reactive control) was related to mind wandering, but only in those with a low positive daydreaming style. This may be interpreted to reflect that deliberate positive mind wandering is unrelated to individual differences in reactive control but that the latter is related to spontaneous mind wandering.

4.2. Paper II

The second paper followed up on the first by distinguishing between positive and negative mind wandering episodes during a relatively low-challenging task and examining their relations to individual differences in executive control capacities and neuroticism. First, based on the global availability hypothesis we expected that those with higher shifting ability would report more positive mind wandering because they would have surplus of resources to enable mind wandering while maintaining high accuracy rate on the low-challenging task. Second, based on the control-failure hypothesis and previous findings on executive control and emotion-regulation we expected that higher executive control would be associated with lower negative mind wandering. Third, we expected that neuroticism would predict negative mind wandering and that this relation would be dampened in those with high executive control.

This sample (N = 156) completed one 1-hour laboratory session each. Participants completed two measures of executive control capacities: a self-report measure of *Effortful control* (i.e., activation control, attentional control, and inhibitory control) and a task-switching test of *shifting* ability in which they were required to randomly switch between two task sets. In addition, participants completed 10 items on *Neuroticism*

taken from the international personality item pool and the SIPI as a measure of daydreaming styles. *Positive, neutral, negative,* and *total mind wandering* was measured using thought probes in a signal detection task that was designed to be low-challenging because most mind wandering episodes occur during low-challenging activities (Paper I; see also Teasdale et al., 1995). The four categories of mind wandering were regressed on Effortful control, shifting, and Neuroticism (and two interaction terms between the latter and the two former predictors).

Although shifting ability predicted lower mind wandering during the task-switching test, the results did not support our first expectation that shifting would predict positive mind wandering in the low-challenging signal detection test. We expected that Effortful control would predict lower negative mind wandering but it predicted lower total and neutral mind wandering. As expected, Neuroticism predicted negative mind wandering. There was no interaction between Neuroticism and the two executive functioning variables on total mind wandering. Neuroticism and Effortful control each shared about 8% variance with total mind wandering, but only Effortful control contributed with unique variance and the two predictors did not interact. Finally, we analyzed whether total mind wandering was predicted by an interaction between executive control processes and daydreaming styles, but there was no support for an interaction between these variables.

These results have implications for the control-failure and global availability hypotheses. The negative associations between Effortful control and mind wandering supports the control-failure hypothesis, and can be interpreted to suggest that individuals with high Effortful control are characterized by a strong tendency to focus working memory resources to task-relevant stimuli at the expense of mind wandering. The negative association between shifting and mind wandering in the task-switching test is also consistent with the control failure hypothesis. This finding adds to the previous literature indicating that during ostensibly demanding tasks executive functioning and mind wandering are weakly negatively related (Randall et al., 2014) by showing that this relation is also evident for the shifting ability. However, the null correlation between shifting and mind wandering in the low-challenging signal detection test does not provide support for the control-failure or the global availability hypotheses.

The results supports the proposal that neuroticism and mind wandering in a low-challenging task are related (Perkins et al., 2015) by showing a medium correlation between two. As expected, Neuroticism strongly predicted negative mind wandering. Previous research have indicated relations between dysphoric states and mind wandering (Smallwood, O'Connor, et al., 2004) and between states of negative affect and mind wandering (e.g., Killingsworth & Gilbert, 2010) and Paper II extends these findings by indicating that one of the big five personality traits, neuroticism, is closely related to the propensity to think about task-unrelated matters.

Why then the discrepancy between Effortful control and shifting regarding their relations to mind wandering? The association between Effortful control and shifting ability was small and only significant when the former measure was restricted to the attentional control subscale. A look at the items on the Effortful control scale suggest

that people scoring high on this measure report strong adherence to long-term goals in the face of tempting distractions, suggesting that they strongly prime task-related information and that task-irrelevant distractors rarely are sufficiently activated to overcome the goal-related information. Thus, people with high effortful control may more rigidly maintain focus on the ongoing task, even if the task is relatively low-challenging and thus they rarely engage in mind wandering. In contrast, the shifting ability, as measured by task-switching performance, may rather tap the fluency of updating goals and mental sets in working memory and this may allow individuals to flexibly switch back-and-forth between positive mind wandering and task-focus episodes.

4.3. Paper III

In Paper III we continued examining the relations between mind wandering, affect, and control by sampling everyday mentation in a selected population of individuals varying in hypnotic responsiveness (hypnotizability) and dissociation.

Crawford and colleagues have argued that high hypnotizable individuals are better than lows at focusing and sustaining their attention and get more absorbed in their experiences or the task they do than low hypnotizables (Crawford, Brown, & Moon, 1993) although other studies have found that highs mind wander more than lows (Green & Lynn, 2008). However, high hypnotizables are not a homogeneous population (McConkey & Barnier, 2004) and studies have shown evidence for high-dissociative and low-dissociative subtypes of high hypnotizables with different profiles pertaining to control of attention, psychopathology, memory, and other variables (Marcusson-Clavertz, Terhune, & Cardeña, 2012; Terhune & Cardeña, 2010; Terhune, Cardeña, & Lindgren, 2011a, 2011b). Specifically, individuals who score high on both hypnotizability and dissociation exhibit reductions in executive control during hypnosis (Terhune et al., 2011a), and attentional lapses in this group varied with changes in affect and alterations in consciousness (Marcusson-Clavertz et al., 2012) in a laboratory setting. High dissociative high hypnotizable individuals have also reported higher pathological fantasy-proneness including difficulty distinguishing fantasy from reality, suggesting that their mentations may operate through other cognitive mechanisms than those of other groups (Terhune et al., 2011b).

The sample (N = 46) comprised individuals high or low in hypnotizability and dissociation (2 × 2 design). They were divided into 14 low hypnotizable/low dissociative, 10 low hypnotizable/high dissociative, 11 high hypnotizable/low dissociative, and 11 high hypnotizable/high dissociative. Participants carried a personal digital assistant for five days with eight ESM probes per day to answer questions about their recent mentation and activities. First, we expected that high dissociative individuals would report less control, more experiential detachment, and more negative affect in daily life than low-dissociatives. Second, we expected that high hypnotizables would report greater absorption and daydreaming than lows. Third, we expected that the combination of high hypnotizablility and high dissociative tendencies would be

associated with low control and more frequent mind wandering. Fourth, we expected that mind wandering states would be accompanied by low control.

Participants' responses to mentation items were subjected to a principal components analysis that led to the extraction of five components: *focus/absorption* (e.g., concentrating on the ongoing activity, feeling absorbed), *daydreaming* (or mind wandering; e.g., task-unrelated and stimulus-independent mentation, thinking about the past and future, fancifulness, spontaneity, vivid imagery), *negative affect* (e.g., worry, feeling loneliness, low happiness, low acceptance of mentation), *control/awareness* (e.g., being aware of and feeling control over mentation, easily remembering), and *detachment* (feeling disconnected from the self and others). At a between-individuals level each of these indices showed high reliabilities ($\alpha > .70$).

The results supported our first set of expectations as high-dissociative individuals reported lower control/awareness of mentations, higher negative affect, and higher detachment in daily life than low-dissociative did. The second set of expectations had mixed results, as high-hypnotizables reported greater daydreaming but not more focus/absorption than low-hypnotizables did. Contrary to the third set of expectations, the combination of high dissociation and a high hypnotizability was not significantly associated with lower control/awareness and higher mind wandering. Lastly, in support of our expectation, mind wandering was characterized by a sense of low control/awareness. There was evidence for a cross-level interaction because the relation between control/awareness and mind wandering differed as function of hypnotizability and dissociation combined. The group who scored high on both dissociation and hypnotizability had a more strongly negative slope than the other three groups combined. In other words, high hypnotizable/high dissociatives were more likely than others to experience mind wandering when their level of control/awareness was low. In addition, we found that being engaged in sensory impressions was associated with a reduction in negative affect compared to being engaged in a thought. Surprisingly, mind wandering was not associated with negative affect in this study. That may be because our index of mind wandering involved items on vivid imagery and future-oriented thoughts which have previously been subsumed under a positive-constructive daydreaming style (Huba et al., 1982).

This study generally supported proposals stating that the combination of hypnotizability and dissociation accounts for additional variance in attentional control and affect than the sum of the two predictors. It contributes to a literature that can be taken to suggest that individuals scoring high on both hypnotizability and dissociation are prone to enter a state (either via hypnosis or daydreaming) of temporarily reduced control and increased mind wandering. This research is cross-sectional and the developmental precedents (e.g., heredity, childhood experiences) of this state propensity remain to be understood.

4.4. Paper IV

Paper IV is similar to III in that it sought to examine daily life experiences of mind wandering, states of control, and affect in selected populations. Here we employed an attachment framework to examine the mentation of adults who have experienced potentially traumatizing events in their childhood (e.g., loss of separation from parents, violent and sexual abuse). Previous research have indicated that when traumatic events of abuse and/or loss of attachment figures are probed during an interview (the AAI) some interviewees manifest temporary lapses in the monitoring of their reasoning and discourse. This representation has been termed *unresolved/disorganized (U/d) attachment* (Hesse & Main, 1999, 2006). This pattern has been taken to reflect the failure to integrate traumatic experiences into a coherent representation, possibly overwhelming consciousness and leading to dissociation.

Previous studies have indicated that individuals with U/d attachment report greater dissociative experiences, anomalous beliefs (although possibly confounding beliefs and experiences), and depressive thoughts (e.g., Koren-Karie et al., 2008; Thomson & Jaque, 2014). Using ESM, we expected that individuals with higher U/d attachment would report more daily life mentation characterized by mind wandering, negative affect, detachment, and a low sense of control/awareness. Second, we expected that individuals with U/d attachment would endorse a style of mind wandering about unpleasant and frightening topics (Guilt/fear-of-failure). Third, we expected that they would be prone to have anomalous experiences (e.g., ostensible telepathy) and attribute them to paranormal (e.g., telepathy) rather than conventional explanations (e.g., chance). Fourth, we tested predictions based on earlier research indicating that mind wandering states are more likely to occur during low sense of control and high detachment (as shown in Paper III) and high negative affect (as shown in Killingsworth & Gilbert, 2010).

The sample of adults with childhood trauma (N = 45) completed three laboratory sessions and recorded their everyday mentation for five consecutive days. They were screened for experiences of traumatizing events in childhood (*Childhood Traumatic Events Scale*; Pennebaker & Susman, 1988) from a larger sample of volunteers. The sample included eight participants diagnosed with borderline personality disorder recruited via a psychiatric institution in Landskrona because we expected that this would increase the likelihood of finding individuals with U/d attachment. The remaining were students and other individuals from the city of Lund. Participants completed two measures of U/d attachment, the AAI and the Berkeley–Leiden Adult Attachment Questionnaire-Unresolved, BLAAQ-U) in two separate sessions. Between the second and third session they carried the personal digital assistant for five days (10 samples per day). In the last session they completed the Survey of Anomalous Experiences (SAE) and the Dissociative Experiences Scale (DES).

The results indicated that the self-report measure (BLAAQ-U) and the discourse analysis (AAI) scores in U/d attachment showed a medium-sized association with each other, sharing about 10% variance. Our first set of expectation received mixed support as individuals with U/d attachment experienced higher negative affect, less

control/awareness, and more feelings of experiential detachment (which can be considered a dissociative manifestation), although these relations were only observed with the BLAAQ-U measure of U/d. Of great interest, an exploratory analyses indicated that individuals with U/d attachment, according to the BLAAQ-U, reported increased detachment at moments when they had recently thought about one of their parents (within 5 minutes before the probe) compared to when they had not been thinking about their parents. In contradiction to our prediction, individuals with U/d attachment did not report greater mind wandering and this null result was observed regardless of the attachment measure. The BLAAQ-U measure of U/d attachment supported our expectation of an association between U/d attachment and Guilt/fear-of-failure mind wandering style, whereas the AAI scale did not. In contrast, the latter scale did predict anomalous beliefs rather than anomalous experiences. Lastly, we replicated the associations of a state of mind wandering to low control/awareness, high detachment, and high negative affect.

The results suggest that attachment theory can be useful for understanding individual differences in proneness to have mind wandering characterized by guilt and fear-of-failure and anomalous beliefs. The exploratory finding of an association between the BLAAQ-U scale of U/d attachment and detachment experiences when having recently thought about parents points to the ecological validity of the questionnaire because when individuals with U/d attachment are thinking about attachment figures the activation of disorganized internal working models should increase the likelihood of dissociative reactions.

5. Discussion

5.1. Summary of Principal Findings

This dissertation sought to increase our understanding of individual differences in mind wandering. The principal findings highlight the heterogeneity of mind wandering mentation and the need to consider this heterogeneity when relating mind wandering to executive control processes. The results also indicate that at least some mind wandering episodes are related to states of negative affect and the closely related trait of neuroticism, and more distal traits such as hypnotizability and dissociation.

In Paper I, we attempted to integrate two cognitive hypotheses of mind wandering by examining individual differences in the typical content of mind wandering (daydreaming styles) as a moderating variable. The control-failure hypothesis proposes that executive control processes *prevent* mind wandering whereas the global availability hypothesis proposes that executive resources *support* mind wandering. First, the study found that a negative daydreaming style (Guilt/fear-of-failure) moderated the relation between working memory capacity and mind wandering: working memory and mind wandering were negatively related for those whose mind wandering content was characterized by highly negative features (consistent with the control-failure hypothesis), but positively related for the others (consistent with the global availability hypothesis). Second, the study found that a positive daydreaming style (Positive-constructive) moderated the relation between cognitive inhibition and mind wandering: mind wandering was associated with failures in inhibiting infrequent stimuli, but only in those with a low positive style (i.e., who rarely consider their mind wandering to be useful or enjoyable). The latter finding is consistent with the control-failure hypothesis.

Paper II followed up on the first by distinguishing between positive and negative mind wandering episodes during a low-challenging signal detection test and examining how these related to executive control processes (Effortful control and shifting) and Neuroticism. This study found that Neuroticism and low Effortful control showed medium associations with mind wandering and Effortful control uniquely predicted low neutral and total mind wandering, whereas Neuroticism uniquely predicted negative mind wandering. A negative association between shifting and estimated mind wandering in the task-switching test provided further support for the control-failure hypothesis, whereas there were nonsignificant results regarding the association between shifting and mind wandering in the signal detection test.

Paper III examined whether the relation between mind wandering and perceived control is moderated by hypnotizability and dissociation. In support of a moderating effect, individuals scoring high on both hypnotizability and dissociation reported a more strongly negative association between mind wandering and perceived

control/awareness. Hypnotizability and dissociation also contributed to overall levels of mind wandering, with those scoring low on both traits reporting lower mind wandering than the other groups. High dissociatives also reported lower control and more mind wandering, detachment, and negative affect. These results suggest that hypnotizability and dissociation have a combined contribution to the relation between mind wandering and control of everyday mentation. A sense of low control of thoughts and feelings and experiential detachment predicted the propensity to mind wander.

Paper IV tested whether individuals who vary in their resolution of traumatic events in childhood or adolescence (U/d attachment) differed in sense of control, negative affect, dissociation, and mind wandering. Although our two measures of unresolved state of mind displayed a medium association with each other it was only the self-report measure that showed relations with negative affect, dissociation and lower control. Those who scored as U/d experienced higher dissociation in daily life, particularly when they had recently thought about their parents. In contrast to our expectations, unresolved state of mind did not predict mind wandering in daily life but the self-report measure of U/d attachment did predict a style of negatively toned mind wandering (Guilt/fear-of-failure).

5.2. General Discussion

The results of this dissertation show that it is important to account for the diverse content of mind wandering when relating it to other personality traits and cognitive factors. Although the meta-analysis by Randall et al. (2014) indicated a negative association between executive control and mind wandering, supporting the control-failure hypothesis of mind wandering, a central finding of this dissertation points to the limitations in the generalizability of this effect. Rummel and Boywitt (2014) have shown previously that mind wandering is regulated differently depending on the cognitive demands of the ongoing task, and this dissertation suggests that the regulation of mind wandering varies according to the content as well. Specifically, Paper I found that working memory capacity was negatively associated with mind wandering only in those whose mind wandering episodes tend to be of negative character. It also found that failures in cognitive inhibition were only related to mind wandering in those whose episodes rarely are positive. This suggests that mind wandering episodes in daily life are regulated differently as a function of the affective value of the episodes.

Following up on the indication that the emotional valence of mind wandering episodes is relevant for the relation between control and mind wandering, Papers II and III examined affect-related traits, including neuroticism and dissociation. The former paper showed support for the notion that neurotic individuals spend more time mind wandering during a relatively monotonous, cognitive task, whereas the latter indicates that dissociation too is associated with mind wandering. However, the latter finding was qualified by a two-way interaction in which those scoring low on both hypnotizability and dissociation showed lower mind wandering than others. In contrast, mind wandering was more likely to be reported during low control/awareness, especially in those scoring high on both traits. Another study showed that this group reports higher

pathological fantasy proneness (e.g., difficulty distinguishing fantasy from reality) and exposure to stressful life events (Terhune et al., 2011b) than the other groups. The latter finding points to traumatizing events as possible antecedents of greater tendencies to experience involuntariness of thoughts and actions.

Childhood exposures to potentially traumatizing events involving family members are moderately associated with executive control deficits and dissociation (DePrince, Weinzierl, & Combs, 2009) and ruminative response styles (e.g., passive-repetitive thoughts about how sad one feels) and depression (O'Mahen, Karl, Moberly, & Fedock, 2015). Extending these findings, Paper IV observed that individuals with U/d attachment, measured via self-report, showed lower control/awareness of their mentation and higher negative affect and dissociation during daily life, and endorsed mind wandering styles characterized by disturbing content and distractible thoughts. However, there was no evidence in the experience sampling data that they spent more time mind wandering than more organized/resolved individuals. This is a null result that should be interpreted with caution given the modest *N*. It is nevertheless surprising when one considers the associations between mind wandering and Neuroticism (Paper II), negative affect and low control/awareness (Paper IV), and between U/d attachment and negative affect and low control/awareness (Paper IV), that individuals with U/d attachment did not spend more time mind wandering. A speculative interpretation is that individuals with U/d attachment do not spend more time mind wandering than others but that the underlying cognitive processes behind mind wandering operate differently in this group than in others. Following Smallwood's (2013) distinction between occurrences (onsets) and processes (maintenance) of mind wandering, it may be that lower cognitive inhibition in U/d individuals leads to more occurrences of spontaneous mind wandering episodes but that lower executive resources makes it difficult for them to protect mind wandering episodes from sensory impressions. In other words, their thought segments may be brief, wandering from topic to topic, which gives the general impression that they mind wander a lot (as reported via the SIPI questionnaire) without spending more time mind wandering (as reported via experience sampling). A neurophysiological approach could shed light on this by examining the duration and magnitude of activity in default mode network and executive network regions in this group. Insofar as thought segments are brief in this group I would expect transient activations and deactivations in these two networks. Another approach worth pursuing would be to ask individuals with U/d attachment to freely report what passes through their minds in as much detail as possible in response to thought probes or to a thinking-out-loud method and perform content analysis on their reports, comparing task-focus and mind wandering mentations between this and comparison groups. I expect that unresolved individuals will report less detailed or coherent mind wandering segments.

5.3. Limitations

This dissertation examined the relation between mind wandering and executive control within an individual-differences framework. A general limitation is the correlational nature in most of the analyses presented here, so any causal inference based on these findings is speculative. It bears mentioning that an experimental

approach to studying mind wandering is complicated by the fact that we do not have a direct measure of inner, private experiences and mind wandering can occur without meta-awareness limiting us from pinpointing the exact moment an episode of this kind has started. Instead this research project emphasized ecological validity by measuring mind wandering across a wide range of activities in the laboratory and in people's natural settings to increase the likelihood that the findings would be generalizable across a wide range of contexts. Nevertheless, the procedures used here could not discriminate between onsets and durations of mind wandering episodes, which is a recently highlighted issue in the field (Smallwood, 2013).

A second limitation is that participants themselves had to make judgments about whether their mentation was related to what they were doing or not. A possibility that needs to be tested is whether people differ in their response thresholds when judging a mental episode as mind wandering. A study indicated that participants were generally confident about their reports but the reports that were given with low confidence had lower predictive validity (Seli et al., 2015), suggesting that there is some ambiguity that may facilitate biased reports. Low-confidence reports could occur because of low awareness of mentation but it could also be because some mentations are on the border between task-focus and mind wandering and sometimes probes may appear at the time of transition from one subject to another. An alternative approach would be to let independent judges code the content of participant's mentations but this require participants to provide sufficiently detailed reports and coders to know enough details about the task or activity to make accurate judgements. A study by Smallwood, O'Connor, et al. (2004) found high inter-rater agreement between independent coders. A welcomed addition would be to ask participants and independent judges to rate each mentation and examine the agreement between their ratings.

A third limitation is that the studies generally evaluated a large number of variables, which increases the false discovery rate (the probability that a significant finding is false). There were several reasons for the large numbers of measures. The subject of the dissertation was to test moderators of the relation between mind wandering and executive control: moderation analyses require evaluations of main effects and their product term and executive attention was treated as a diverse collection of related but distinct processes including working memory updating, inhibition, and shifting. In addition, the studies examined the validity of several measures including the convergent validity between measures that are supposed to tap the same construct (e.g., the BLAAQ-U and the AAI), which is an asset of this dissertation research. The benefits include opportunities to examine the generalizability or external validity of measures and effects, which was a central aim of this project. This inclusion produces a cost in terms of Type-I errors if the significance level is unadjusted and/or Type-II errors (not rejecting the null hypothesis when it is incorrect) if it is adjusted. The decision to maintain the alpha level at .05 is arguable but care was taken to report the analyses in as clear and transparent manner as possible so that the reader could easily evaluate the number of analyses and the risk of Type-I errors. For instance, in Paper I all analyses pertaining to the research question about moderation were presented in a single regression model and shown in a table and the full model was tested against a null model before evaluating individual predictors. I do welcome replication attempts to evaluate the reproducibility of these findings. This project contributed to the literature

by also attempting to replicate findings from previous research. For instance, Paper I failed to replicate the relation between future-oriented mind wandering and working memory capacity, whereas paper IV successfully replicated the relations of mind wandering to states of negative affect, detachment, and a low sense of control

A fourth limitation was that the tasks administered to measure mind wandering in the laboratory (the SART and the signal detection tasks) were slightly below 30 min and stronger negative associations between executive control and mind wandering have recently been observed in studies using tasks longer than 30 min (Randall et al., 2014). This effect of time-on-task on the association between mind wandering and executive control processes may be because of temporal changes in the underlying cognitive phenomena, including reductions in executive control capacities (Thomson, Besner, & Smilek, 2015) or declines in motivation to perform the task. Reliability may also increase with time-on-task: the valence reports evaluated in Paper II, for example, had moderate reliability and a longer task might have increased the reliability of these reports. A fifth limitation is that we measured some of the executive subcomponents in separate studies, such as shifting in Paper II and working memory and inhibition in Paper I and IV. These studies differed on several other variables, which complicates comparisons. In Paper I we substituted the methodological shortcoming of not examining shifting for a more in-depth look at inhibition by manipulating congruency proportion, whereas in Paper II we chose to examine shifting because it had not previously been examined as a correlate of mind wandering even though it seemed a very likely candidate.

5.4. Conclusions

This project has contributed to the literature on mind wandering by integrating two seemingly competing hypotheses of mind wandering and showing that the association between executive cognitive control and mind wandering varies according to the valence of mind wandering content. It has further shown that individual predisposition to experience strong negative affect and the combination of dissociation and hypnotizability is associated with time spent on mind wandering. Lastly, it evaluated developmental variables related to the aforementioned traits, childhood trauma and U/d attachment, and although the study did not observe differences between individuals varying in U/d attachment in terms of time spent mind wandering, those scoring high on U/d attachment endorsed mind wandering of a more negative character. Generally, the results suggest that mind wandering consists of various subtypes that operate through different cognitive processes and is moderated by proximal and distal variables. Future research may benefit from pursuing a more fine-grained, in-depth study of the *content* of mind wandering in the populations studied here (people varying in neuroticism, hypnotizability, dissociation, and U/d attachment) to describe the possible subtypes and use electroencephalographic or other measures with high temporal resolution to follow up on the findings relating mind wandering to working memory updating, proactive and reactive control, and shifting.

6. References

Ainsworth, M. D., Blehar, M. C., Waters, E., & Wall, S. (1978). *Patterns of attachment: A psychological study of the strange situation.* Hillsdale, NJ: Erlbaum.

Atkinson, L., Leung, E., Goldberg, S., Benoit, D., Poulton, L., Myhal, N., . . . Kerr, S. (2009). Attachment and selective attention: Disorganization and emotional Stroop reaction time. *Development and Psychopathology, 21,* 99–126. doi: 10.1017/S0954579409000078

Baars, B. J. (1997). In the theatre of consciousness: Global workspace theory, a rigorous scientific theory of consciousness. *Journal of Consciousness Studies, 4*, 292–309.

Baars, B. J. (2002). The conscious access hypothesis: Origins and recent evidence. *Trends in Cognitive Sciences, 6*, 47–52. doi: 10.1016/S1364-6613(00)01819-2

Baars, B. J. (2005) Global workspace theory of consciousness: Toward a cognitive neuroscience of human experience. *Progress in Brain Research, 150,* 45–53. doi: 10.1016/S0079-6123(05)50004-9

Baars, B. J. (2010). Spontaneous repetitive thoughts can be adaptive: Postscript on "mind wandering". *Psychological Bulletin, 136*, 208–210. doi: 10.1037/a0018726

Baddeley, A. (1992). Working memory. *Science, 255*, 556–559. doi: 10.1126/science.1736359

Baird, B., Smallwood, J., & Schooler, J. W. (2011). Back to the future: Autobiographical planning and the functionality of mind-wandering. *Consciousness and Cognition, 20*, 1604–1611. doi: 10.1016/j.concog.2011.08.007

Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M. J., & Van IJzendoorn, M. H. (2007). Threat-related attentional bias in anxious and nonanxious individuals: A meta-analytic study. *Psychological Bulletin, 133*, 1–24. doi: 10.1037/0033-2909.133.1.1

Barrett, L. F. (1997). The relationships among momentary emotion experiences, personality descriptions, and retrospective ratings of emotion. *Personality and Social Psychology Bulletin, 23*, 1100–1110.

Barta, W. D., Tennen, H., & Litt, M. D. (2011). Measurement reactivity in diary research. In M. R. Mehl & T. A. Conner (Eds.), *Handbook of research methods for studying daily life* (pp. 108–123). New York, NY: Guilford Press.

Bowlby, J. (1973). *Attachment and loss: Vol. 2, Separation: Anxiety and anger*. New York, NY: Basic Books.

Bowlby, J. (1980). *Attachment and loss: Vol. 3, Loss: Sadness and depression*. New York, NY: Basic Books.

Bowlby, J. (1982). *Attachment and loss: Vol. 1, Attachment* (Rev. ed., Original work published in 1969). New York, NY: Basic Books.

Braver, T. S., & West, R. (2008). *Working memory, executive control, and aging*. New York, NY: Psychology Press.

Buckner, R. L., Andrews-Hanna, J. R., & Schacter, D. L. (2008). The brain's default network: Anatomy, function, and relevance to disease. *Annals of the New York Academy of Sciences, 1124,* 1–38. doi: 10.1196/annals.1440.011

Cardeña, E., & Carlson, E. (2011). Acute Stress Disorder revisited. *Annual Review of Clinical Psychology, 7,* 245–267. doi: 10.1146/annurev-clinpsy-032210-104502

Cardeña, E., & Pekala, R. J. (2014). Methodological issues in the study of altering consciousness and anomalous experience. In E. Cardeña, S. J. Lynn, & S. Krippner (Eds.), *Varieties of anomalous experience: Examining the scientific evidence* (2nd ed.), (pp. 21–56). Washington, DC: American Psychological Association.

Carlson, E. A. (1998). A prospective longitudinal study of attachment disorganization/disorientation. *Child Development, 69,* 1107–1128.

Christoff, K., Gordon, A. M., Smallwood, J., Smith, R., & Schooler, J. W. (2009). Experience sampling during fMRI reveals default network and executive system contributions to mind wandering. *Proceedings of the National Academy of Sciences, 106*, 8719–8724. doi: 10.1073/pnas.0900234106

Conway, A. R. A., Cowan, N., & Bunting, M. F. (2001). The cocktail party phenomenon revisited: The importance of working memory capacity. *Psychonomic Bulletin and Review, 8*, 331–335. doi: 10.3758/BF03196169

Crawford, H. J., Brown, A. M., & Moon, C. E. (1993). Sustained attentional and disattentional abilities: Differences between low and highly hypnotizable persons. *Journal of Abnormal Psychology, 102*, 534–543. doi: 10.1037/0021-843X.102.4.534

De Pisapia, N., & Braver, T. S. (2006). A model of dual control mechanisms through anterior cingulate and prefrontal cortex interactions. *Neurocomputing, 69*, 1322–1326. doi: 10.1016/j.neucom.2005.12.100

DePrince, A. P., Weinzierl, K. M., & Combs, M. D. (2009). Executive function performance and trauma exposure in a community sample of children. *Child Abuse and Neglect, 33*, 353–361. doi: 10.1016/j.chiabu.2008.08.002

Diamond, A. (2013). Executive functions. *Annual Review of Psychology, 64*, 135–168. doi: 10.1146/annurev-psych-113011-143750

Diener, E., Smith, H., & Fujita, F. (1995). The personality structure of affect. *Journal of Personality and Social Psychology, 69*, 130–141. doi: 10.1037/0022-3514.69.1.130

Ericsson, K. A., & Simon, H. A. (1980). Verbal reports as data. *Psychological Review, 87*, 215–251. doi: 10.1037/0033-295X.87.3.215

Evans, D. E., & Rothbart, M. K. (2007). Developing a model for adult temperament. *Journal of Research in Personality, 41*, 868–888. doi: 10.1016/j.jrp.2006.11.002

Freud, S. (1953). The relation of the poet to day-dreaming (Original work published in 1908) *Collected papers (vol. 4)*. London, UK: Hogarth.

George, C., Kaplan, N., & Main, M. (1996). *Attachment Interview for Adults.* Unpublished manuscript, University of California, Berkeley.

Giambra, L. M. (1977). Adult male day dreaming across the life span: A replication, further analyses, and tentative norms based upon retrospective reports. *International Journal of Aging and Human Development, 8*, 197–228.

Giambra, L. M. (1989). Task-unrelated-thought frequency as a function of age: a laboratory study. *Psychology and Aging, 4*, 136–143. doi: 10.1037/0882-7974.4.2.136

Giambra, L. M. (1993). The influence of aging on spontaneous shifts of attention from external stimuli to the contents of consciousness. *Experimental Gerontology, 28*, 485–492. doi: 10.1016/0531-5565(93)90073-M

Giambra, L. M. (1995). A laboratory method for investigating influences on switching attention to task-unrelated imagery and thought. *Consciousness and Cognition, 4*, 1–21. doi: 10.1006/ccog.1995.1001

Green, J. P., & Lynn, S. J. (2008). Fantasy proneness and hypnotizability: Another look.
Contemporary Hypnosis, 25, 156–164. doi: 10.1002/ch.360

Greenwald, A. G., Klinger, M. R., & Liu, T. J. (1989). Unconscious processing of dichoptically masked words. *Memory & Cognition, 17*, 35–47. doi: 10.3758/BF03199555

Greenwald, A. G., & Liu, T. J. (1985). *Limited unconscious processing of meaning.* Paper presented at the annual meeting of the Psychonomic Society, Boston, MA.

Hasenkamp, W., Wilson-Mendenhall, C. D., Duncan, E., & Barsalou, L. W. (2012). Mind wandering and attention during focused meditation: A fine-grained temporal analysis of fluctuating cognitive states. *Neuroimage, 59*, 750–760. doi: 10.1016/j.neuroimage.2011.07.008

He, J., Becic, E., Lee, Y. C., & McCarley, J. S. (2011). Mind wandering behind the wheel: Performance and oculomotor correlates. *Human Factors, 53*, 13–21. doi: 10.1177/0018720810391530

Hektner, J. M., Schmidt, J. A., & Csikszentmihalyi, M. E. (2006). *Experience sampling method: measuring the quality of everyday life.* Thousand Oaks, CA: Sage Publications, Inc.

Helton, W. S., Kern, R. P., & Walker, D. R. (2009). Conscious thought and the sustained attention to response task. *Consciousness and Cognition, 18*, 600–607. doi: 10.1016/j.concog.2009.06.002

Hesse, E., & Main, M. (1999). Second-generation effects of unresolved trauma in nonmaltreating parents: Dissociated, frightened, and threatening parental behavior. *Psychoanalytic Inquiry, 19,* 481–540. doi: 10.1080/07351699909534265

Hesse, E., & Main, M. (2006). Frightened, threatening, and dissociative parental behavior in low-risk samples: Description, discussion, and interpretations. *Development and Psychopathology, 18,* 309–343. doi: 10.1017/S0954579406060172

Huba, G. J., Singer, J. L., Aneshensel, C. S., & Antrobus, J. S. (1982). *The short imaginal processes inventory*. Port Hurson, MI: Research Psychologists Press.

Jack, A. I., & Roepstorff, A. (2003). Why trust the subject? *Journal of Consciousness Studies, 10*, v-xx.

Joubert, D., Webster, L., & Hackett, R. K. (2012). Unresolved attachment status and trauma-related symptomatology in maltreated adolescents: An examination of cognitive mediators. *Child Psychiatry and Human Development, 43*, 471–483. doi: 10.1007/s10578-011-0276-8

Kam, J. W. Y., Xu, J., & Handy, T. C. (2014). I don't feel your pain (as much): The desensitizing effect of mind wandering on the perception of others' discomfort. *Cognitive, Affective and Behavioral Neuroscience, 14*, 286–296. doi: 10.3758/s13415-013-0197-z

Kane, M. J., Brown, L. H., McVay, J. C., Silvia, P. J., Myin-Germeys, I., & Kwapil, T. R. (2007). For whom the mind wanders, and when: An experience-sampling study of working memory and executive control in daily life. *Psychological Science, 18*, 614–621. doi: 10.1111/j.1467-9280.2007.01948.x

Kane, M. J., Conway, A. R. A., Bleckley, M. K., & Engle, R. W. (2001). A controlled-attention view of working-memory capacity. *Journal of Experimental Psychology: General, 130*, 169–183. doi: 10.1037//0096-3445.130.2.169

Kane, M. J., & Engle, R. W. (2003). Working-memory capacity and the control of attention: The contributions of goal neglect, response competition, and task set to Stroop interference. *Journal of Experimental Psychology: General, 132*, 47–70. doi: 10.1037/0096-3445.132.1.47

Killingsworth, M. A., & Gilbert, D. T. (2010). A wandering mind is an unhappy mind. *Science, 330*, 932–932. doi: 10.1126/science.1192439

Klinger, E. (1971). *Structure and functions of fantasy*. New York, NY: Wiley.

Klinger, E. (1978–1979). Dimensions of thought and imagery in normal waking states. *Journal of Altered States of Consciousness, 4*, 97–113.

Klinger, E. (2009). Daydreaming and fantasizing: Thought flow and motivation. In K. D. Markman, W. M. P. Klein, & J. A. Suhr (Eds.), *Handbook of imagination and mental simulation* (pp. 225–239). New York, NY: Psychology Press.

Klinger, E. (2013). Goal commitments and the content of thoughts and dreams: Basic principles. *Frontiers in Psychology, 4*. doi: 10.3389/Fpsyg.2013.00415

Koren-Karie, N., Oppenheim, D., & Getzler-Yosef, R. (2008). Shaping children's internal working models through mother-child dialogues: The importance of resolving past maternal trauma. *Attachment and Human Development, 10*, 465–483. doi: 10.1080/14616730802461482

Larsen, R. J., & Ketelaar, T. (1991). Personality and susceptibility to positive and negative emotional states. *Journal of Personality and Social Psychology, 61*, 132–140. doi: 10.1037/0022-3514.61.1.132

Levinson, D. B., Smallwood, J., & Davidson, R. J. (2012). The persistence of thought: Evidence for a role of working memory in the maintenance of task-unrelated thinking. *Psychological Science, 23*, 375–380. doi: 10.1177/0956797611431465

Liotti, G. (2009). Attachment and dissociation. In P. F. Dell & J. A. O'Neill (Eds.), *Dissociation and the dissociative disorders: DSM-V and beyond.* (pp. 53–65): New York, NY: Routledge.

Lynn, P. (2001). The impact of incentives on response rates to personal interview surveys: Role and perceptions of interviewers. *International Journal of Public Opinion Research, 13*, X–335.

Main, M., & Solomon, J. (1990). Procedures for identifying disorganized/disoriented infants during the Ainsworth Strange Situation. In M. Greenberg, D. Cicchetti, & M. Cummings (Eds.), *Attachment in the preschool years* (pp. 121–160). Chicago, IL: University of Chicago Press.

Marcusson-Clavertz, D., Terhune, D. B., & Cardeña, E. (2012). Individual differences and state effects on mind-wandering: Hypnotizability, dissociation, and sensory homogenization. *Consciousness and Cognition, 21*(3), 1097–1108. doi: 10.1016/j.concog.2012.04.002

Mason, M. F., Norton, M. I., Van Horn, J. D., Wegner, D. M., Grafton, S. T., & Macrae, C. N. (2007). Wandering minds: The default network and stimulus-independent thought. *Science, 315*, 393–395. doi: 10.1126/science.1131295

McConkey, K. M., & Barnier, A. J. (2004). High hypnotizability: Unity and diversity in behaviour and experience. In M. Heap, R. J. Brown, & D. A. Oakley (Eds.), *The highly hypnotizable person: Theoretical, experimental and clinical issues* (pp. 61–84). New York, NY: Brunner-Routledge.

McVay, J. C., & Kane, M. J. (2010). Does mind wandering reflect executive function or executive failure? Comment on Smallwood and Schooler (2006) and Watkins (2008). *Psychological Bulletin, 136*, 188–197. doi: 10.1037/A0018298

McVay, J. C., Kane, M. J., & Kwapil, T. R. (2009). Tracking the train of thought from the laboratory into everyday life: An experience-sampling study of mind-wandering across controlled and ecological contexts. *Psychonomic Bulletin & Review, 16,* 857–863. doi: 10.3758/Pbr.16.5.857

McVay, J. C., Unsworth, N., McMillan, B. D., & Kane, M. J. (2013). Working memory capacity does not always support future-oriented mind-wandering. *Canadian Journal of Experimental Psychology, 67*, 41–50. doi: 10.1037/A0031252

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology, 41*, 49–100. doi: 10.1006/cogp.1999.0734

Mooneyham, B. W., & Schooler, J. W. (2013). The costs and benefits of mind-wandering: A review. *Canadian Journal of Experimental Psychology, 67*, 11–18. doi: 10.1037/A0031569

Norman, D. A., & Shallice, T. (1986). Attention to action: Willed and automatic control of behavior. In R. J. Davidson, G. E. Schwartz, & D. Shapiro (Eds.),

Consciousness and self-regulation: Advances in research and theory (Vol. 4, pp. 1–18). New York, NY: Plenum Press.

O'Mahen, H. A., Karl, A., Moberly, N., & Fedock, G. (2015). The association between childhood maltreatment and emotion regulation: Two different mechanisms contributing to depression? *Journal of Affective Disorders, 174*, 287–295. doi: 10.1016/j.jad.2014.11.028

Parks, C. W., Jr., Klinger, E., & Perlmutter, M. (1988–1989). Dimensions of thought as a function of age, gender, and task difficulty. *Imagination, Cognition and Personality, 8*, 49–62.

Pennebaker, J. W., & Susman, J. R. (1988). Disclosure of traumas and psychosomatic processes. *Social Science and Medicine, 26*, 327–332. doi: 10.1016/0277-9536(88)90397-8

Perkins, A. M., Arnone, D., Smallwood, J., & Mobbs, D. (2015). Thinking too much: Self-generated thought as the engine of neuroticism. *Trends in Cognitive Sciences*. doi: 10.1016/j.tics.2015.07.003

Poerio, G. L., Totterdell, P., Emerson, L. M., & Miles, E. (2015). Love is the triumph of the imagination: Daydreams about significant others are associated with increased happiness, love and connection. *Consciousness and Cognition, 33*, 135–144. doi: 10.1016/j.concog.2014.12.011

Poerio, G. L., Totterdell, P., & Miles, E. (2013). Mind-wandering and negative mood: Does one thing really lead to another? *Consciousness and Cognition, 22*, 1412–1421. doi: 10.1016/j.concog.2013.09.012

Raichle, M. E., MacLeod, A. M., Snyder, A. Z., Powers, W. J., Gusnard, D. A., & Shulman, G. L. (2001). A default mode of brain function. *Proceedings of the National Academy of Sciences, 98*, 676–682. doi: 10.1073/pnas.98.2.676

Randall, J. G., Oswald, F. L., & Beier, M. E. (2014). Mind-wandering, cognition, and performance: A theory-driven meta-analysis of attention regulation. *Psychological Bulletin, 140*, 1411–1431. doi: 10.1037/A0037428

Richards, A., French, C. C., Johnson, W., Naparstek, J., & Williams, J. (1992). Effects of mood manipulation and anxiety on performance of an emotional Stroop task. *British Journal of Psychology, 83*, 479–491.

Riemann, B. C., & McNally, R. J. (1995). Cognitive processing of personally relevant information. *Cognition and Emotion, 9*, 325–340. doi: 10.1080/02699939508408970

Riggs, S. A., & Jacobvitz, D. (2002). Expectant parents' representations of early attachment relationships: Associations with mental health and family history. *Journal of Consulting and Clinical Psychology, 70*, 195-204. doi: 10.1037//0022-006X.70.1.195

Robertson, I. H., Manly, T., Andrade, J., Baddeley, B. T., & Yiend, J. (1997). 'Oops!': Performance correlates of everyday attentional failures in traumatic brain injured and normal subjects. *Neuropsychologia, 35*, 747–758. doi: 10.1016/S0028-3932(97)00015-8

Rothbart, M. K., Ahadi, S. A., & Evans, D. E. (2000). Temperament and personality: Origins and outcomes. *Journal of Personality and Social Psychology, 78*, 122–135. doi: 10.1037/0022-3514.78.1.122

Rothbart, M. K., & Derryberry, D. (1981). Development of individual differences in temperament. In M. E. Lamb & A. L. Brown (Eds.), *Advances in developmental psychology* (Vol. 1, pp. 37–86). Hillsdale, NJ: Erlbaum.

Rummel, J., & Boywitt, C. D. (2014). Controlling the stream of thought: Working memory capacity predicts adjustment of mind-wandering to situational demands. *Psychonomic Bulletin & Review, 21*, 1309–1315. doi: 10.3758/s13423-013-0580-3

Sayette, M. A., Reichle, E. D., & Schooler, J. W. (2009). Lost in the sauce: The effects of alcohol on mind wandering. *Psychological Science, 20*, 747–752. doi: 10.1111/j.1467-9280.2009.02351.x

Schooler, J. W., Smallwood, J., Christoff, K., Handy, T. C., Reichle, E. D., & Sayette, M. A. (2011). Meta-awareness, perceptual decoupling and the wandering mind. *Trends in Cognitive Sciences, 15*, 319–326. doi: 10.1016/j.tics.2011.05.006

Scollon, C. N., Kim-Prieto, C., & Diener, E. (2003). Experience sampling: Promises and pitfalls, strengths and weaknesses. *Journal of Happiness Studies, 4*, 5–34. doi: 10.1023/A:1023605205115

Seli, P., Carriere, J. S. A., & Smilek, D. (2014). Not all mind wandering is created equal: Dissociating deliberate from spontaneous mind wandering. *Psychological Research*. doi: 10.1007/s00426-014-0617-x

Seli, P., Jonker, T. R., Cheyne, J. A., Cortes, K., & Smilek, D. (2015). Can research participants comment authoritatively on the validity of their self-reports of mind wandering and task engagement? *Journal of Experimental Psychology: Human Perception and Performance, 41*, 703–709. doi: 10.1037/xhp0000029

Shaw, G. A., & Giambra, L. (1993). Task-unrelated thoughts of college students diagnosed as hyperactive in childhood. *Developmental Neuropsychology, 9*, 17–30. doi: 10.1080/87565649309540541

Singer, J. L. (1966). *Daydreaming: An introduction to the experimental study of inner experiences.* New York, NY: Random House.

Singer, J. L., & Antrobus, J. S. (1963). A factor-analytic study of daydreaming and conceptually related cognitive and personality variables. *Perceptual and Motor Skills, 17*, 187–209. doi: 10.2466/pms.1963.17.1.187

Singer, J. L., & Antrobus, J. S. (1970). *Manual for the Imaginal Processes Inventory.* Princeton, NJ: Educational Testing Service.

Smallwood, J. (2010). Why the global availability of mind wandering necessitates resource competition: Reply to McVay and Kane (2010). *Psychological Bulletin, 136*, 202–207. doi: 10.1037/A0018673

Smallwood, J. (2013). Distinguishing how from why the mind wanders: A process-occurrence framework for self-generated mental activity. *Psychological Bulletin, 139*, 519–535. doi: 10.1037/A0030010

Smallwood, J., & Andrews-Hanna, J. (2013). Not all minds that wander are lost: The importance of a balanced perspective on the mind-wandering state. *Frontiers in Psychology, 4*. doi: 10.3389/fpsyg.2013.00441

Smallwood, J., Beach, E., Schooler, J. W., & Handy, T. C. (2008). Going AWOL in the brain: Mind wandering reduces cortical analysis of external events. *Journal of Cognitive Neuroscience, 20*, 458–469. doi: 10.1162/jocn.2008.20.3.458

Smallwood, J., Davies, J. B., Heim, D., Finnigan, F., Sudberry, M., O'Connor, R., & Obonsawin, M. (2004). Subjective experience and the attentional lapse: Task engagement and disengagement during sustained attention. *Consciousness and Cognition, 13,* 657–690.

Smallwood, J., Fitzgerald, A., Miles, L. K., & Phillips, L. H. (2009). Shifting moods, wandering minds: Negative moods lead the mind to wander. *Emotion, 9*, 271–276. doi: 10.1037/A0014855

Smallwood, J., McSpadden, M., Luus, B., & Schooler, J. (2008). Segmenting the stream of consciousness: The psychological correlates of temporal structures in the time series data of a continuous performance task. *Brain and Cognition, 66*, 50–56. doi: 10.1016/j.bandc.2007.05.004

Smallwood, J., McSpadden, M., & Schooler, J. W. (2008). When attention matters: The curious incident of the wandering mind. *Memory & Cognition, 36*, 1144–1150. doi: 10.3758/Mc.36.6.1144

Smallwood, J., O'Connor, R. C., Sudberry, M. V., Haskell, C., & Ballantyne, C. (2004). The consequences of encoding information on the maintenance of internally generated images and thoughts: The role of meaning complexes. *Consciousness and Cognition, 13*, 789–820. doi: 10.1016/j.concog.2004.07.004

Smallwood, J., & Schooler, J. W. (2006). The restless mind. *Psychological Bulletin, 132*, 946–958. doi: 10.1037/0033-2909.132.6.946

Stawarczyk, D., Majerus, S., Catale, C., & D'Argembeau, A. (2014). Relationships between mind-wandering and attentional control abilities in young adults and adolescents. *Acta Psychologica, 148*, 25–36. doi: 10.1016/j.actpsy.2014.01.007

Stawarczyk, D., Majerus, S., Maj, M., Van der Linden, M., & D'Argembeau, A. (2011). Mind-wandering: Phenomenology and function as assessed with a novel experience sampling method. *Acta Psychologica, 136*, 370–381. doi: 10.1016/j.actpsy.2011.01.002

Stovall-McClough, K. C., Cloitre, M. (2006). Unresolved attachment, PTSD, and dissociation in women with childhood abuse histories. *Journal of Consulting and Clinical Psychology, 74,* 219–228. doi: 10.1037/0022-006X.74.2.219

Swendsen, J. D., Tennen, H., Carney, M. A., Affleck, G., Willard, A., & Hromi, A. (2000). Mood and alcohol consumption: An experience sampling test of the self-medication hypothesis. *Journal of Abnormal Psychology, 109*, 198–204. doi: 10.1037//0021-843X.109.2.198

Tanaka, J. S., & Huba, G. J. (1986). Longitudinal stability of three second-order daydreaming factors. *Imagination, Cognition, and Personality, 5,* 231–238. doi: 10.2190/LKRA-5JLK-1LTC-MHY0

Teasdale, J. D., Dritschel, B. H., Taylor, M. J., Proctor, L., Lloyd, C. A., Nimmo-Smith, I., & Baddeley, A. D. (1995). Stimulus-independent thought depends on central executive resources. *Memory and Cognition, 23,* 551–559. doi: 10.3758/Bf03197257

Tennen, H., Affleck, G., Armeli, S., & Carney, M. A. (2000). A daily process approach to coping: Linking theory, research, and practice. *American Psychologist, 55*, 626–636.

Terhune, D. B., & Cardeña, E. (2010). Differential patterns of spontaneous experiential response to a hypnotic induction: A latent profile analysis. *Consciousness and Cognition, 19*, 1140–1150. doi: 10.1016/j.concog.2010.03.006

Terhune, D. B., Cardeña, E., & Lindgren, M. (2011a). Dissociated control as a signature of typological variability in high hypnotic suggestibility. *Consciousness and Cognition, 20*, 727–736. doi: 10.1016/j.concog.2010.11.005

Terhune, D. B., Cardeña, E., & Lindgren, M. (2011b). Dissociative tendencies and individual differences in high hypnotic suggestibility. *Cognitive Neuropsychiatry, 16*, 113–135. doi: 10.1080/13546805.2010.503048

Terhune, D. B., Croucher, M., Marcusson-Clavertz, D., & Macdonald, J. S. P. (2015). *Time contracts and temporal precision declines when the mind wanders.* Unpublished manuscript.

Thomson, D. R., Besner, D., & Smilek, D. (2015). A resource-control account of sustained attention: Evidence from mind-wandering and vigilance paradigms. *Perspectives on Psychological Science, 10*, 82–96. doi: 10.1177/1745691614556681

Thomson, P., & Jaque, S. V. (2014). Unresolved mourning, supernatural beliefs and dissociation: a mediation analysis. *Attachment and Human Development.* doi: 10.1080/14616734.2014.926945

Watson, D., & Clark, L. A. (1984). Negative affectivity: The disposition to experience aversive emotional states. *Psychological Bulletin, 96*, 465–490. doi: 10.1037/0033-2909.96.3.465

Weissman, D. H., Roberts, K. C., Visscher, K. M., & Woldorff, M. G. (2006). The neural bases of momentary lapses in attention. *Nature Neuroscience, 9*, 971–978. doi: 10.1038/nn1727