RESTING STATE AND COGNITIVE VULNERABILITY TO DEPRESSION:

A NEUROCOGNITIVE INVESTIGATION

Igor Marchetti

“*We can discover meaning in life in three different ways:*

by creating a work or doing a deed;

by experiencing something or encountering someone;

and by the attitude we take toward unavoidable suffering”

Man’s Search for Meaning - 1946
Viktor Frankl, 1905 – 1997

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Igor
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CONTENTS

CHAPTER 1

General introduction

Rest, Self-Generated Thought (SGT), and Default Mode Network (DMN)

Modern life is usually defined as busy and hectic and little spare time is dedicated to rest. Notwithstanding this, it is very common to experience either long or short periods of idleness during waking hours. For instance, it often happens that while attending a conference presentation our attention drifts away from what the speaker is saying towards unrelated topics, such as fantasies, memories, or (un)likely future scenarios; or, while reading a doctoral thesis, we might unsurprisingly realize that we cannot remember a single word of the last page.

All these examples underline that our mind is often not focused on the task at hand nor on the surrounding environment, but rather it gravitates internally towards topics that are not elicited by external stimuli (Barron, Riby, Greer, & Smallwood, 2011; Smilek, Carriere, & Cheyne, 2010). Accordingly, both early and recent estimates report that we spend 30% up to 50% of waking hours being substantially inattentive to what is happening around us (Franklin et al., 2013; Kane et al., 2007; Killingsworth & Gilbert, 2010; Klinger & Cox, 1987/1988). However, it is highly unlikely that a single homogeneous type of thinking is present for such an extensive part of our mental activity, rather it has been documented that multiple and only partially similar mental activities occur while not being actively engaged in any task (Klinger & Cox, 1987/1988). This variety of rest-related mental phenomena has been defined and labeled differently throughout the 20th century, with key labels including daydreaming (Smith, 1904; Varendock, 1921), stimulus-independent thought (Mason et al., 2007), spontaneous thought (Christoff, Ream, & Gabrieli, 2004), task-unrelated thought (Giambra, 1989), mindwandering (Smallwood & Schooler, 2006). Recently, a process-based term has been proposed to group them all, namely self-generated thought (SGT), consisting of

"[…] *thoughts and feelings* [that] *arise independently of the concurrent perceptual input and any external task being performed*" (Smallwood, 2013, pp. 519).

During the last decade, rest (i.e., SGT and its underlying neural substrate) has attracted researchers' attention exponentially (Callard, Smallwood, Golchert, & Margulies, 2013). For instance, in 2001 Raichle and colleagues published a groundbreaking article where they described a pattern of brain deactivation, called Default Mode Network (DMN), occurring in goal-directed tasks compared to passive control conditions (see also Shulman, et al., 1997). In other words, it seems that brain activity is not only reactive to stimuli, but that some of neural and metabolic brain activity is not directly associated with subjects' performance of a task. As a matter of fact, the discovery of DMN has impacted human neuroscience to such an extent that, according to Raichle (2009), a paradigm shift is currently occurring in neuroscience, from a perspective mainly focusing on task-evoked activity to another oriented to brain's intrinsic activity.

A similar shift of interest occurred in cognitive psychology too, where mental functioning during rest, such as SGT, is now the focus of intense research and debate (Andrews-Hanna, Smallwood, & Spreng, in press; McVay & Kane, 2012; Schooler, et al., 2011; Smallwood, 2013; Smallwood & Schooler, 2006). Not only is SGT extremely frequent (Killingworth & Gilbert, 2010) and supported by the DMN (Christoff et al., 2009; Mason et al., 2007), but it also substantially impacts mental functioning and well-being, with both pros and cons being reported (Mooneyham & Schooler, 2013; Ottaviani & Couyoumdjian, 2013).

Several features have been associated with SGT, such as self-centered focus, temporality, and emotional impact. First, during off-task thoughts or pure resting state, SGT is often focused on the self (Diaz et al., 2013; Klinger, 2009; Northoff et al., 2006). For instance, Green (1923) explicitly claimed that "[a]*ll the daydreams are ego-centred.* […] *Each of the daydreams is like a little play, whose hero is the dreamer himself* (pp. 27-28). This clearly stresses that during SGT self-salient and self-central information is actively processed, thus implicating SGT in supporting self-identity and continuity across time (Prebble, Addis, & Tippett, 2013; Smallwood et al., 2011; Song & Wang, 2012). Second, a consistent literature shows that SGT is tightly linked to temporal projection.

Specifically, in healthy individuals future-related bias is most often reported (Smallwood et al., 2011; Song & Wang, 2012; Stawarczyk, Cassol, D'Argembeau, 2013), although under specific circumstances both distant past-related bias or a-temporality have also been documented (Jackson, Weinstein, & Balota, 2013; Smallwood & O'Connor, 2011). Third, high frequency of SGT seems to mostly lead to unhappiness and negative mood (Killingsworth & Gilbert, 2010), although some authors raised both theoretical and empirical reservations against this point (Franklin et al., 2013; Klinger, 2013; Poerio, Totterdell, & Miles, 2013).

In sum, SGT seems to be a pivotal mechanism, pervasively implicated in both mental functioning and well-being (Smallwood, 2013). Nevertheless, even highly adaptive mechanisms may sometimes support maladaptive functions, and SGT likely is no exception (Klinger, 1996, 2013). Considering its relation with identity, time, and emotions, SGT has been linked to major psychopatologies (Andrews-Hanna et al., in press; Klinger, 1996, 2009; Smallwood & Schooler, 2006). Among all the possible candidates, depression represents the ideal context where to investigate the pathogenic role of SGT, considering that depression has been robustly associated with self-debasing thinking (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008), aberrant time perspective (Jaspers, 1997; Williams et al., 1996), and negative mood (American Psychiatric Association, 2013).

Depression and Cognitive Vulnerability to Depression

Major depression is a frequent and severe psychiatric condition characterized by negative mood, anhedonia, loss of energy, feelings of guilt or worthlessness, and suicidal thoughts (American Psychiatric Association, 2013). This results in a high burden at personal level (i.e., personal suffering) and life-time prevalence of 15-30% (Kessler et al., 2003). Consequently, the negative effects of depression impacts society too, with huge costs being documented (Greenberg et al., 2003). For instance, in 2010 in Europe about 30 million individuals were estimated to be clinically depressed for a total cost of about 92 billion euro to society (Gustavsson et al., 2011).

Although effective short-term psychological and pharmacological treatments have been established (Gitlin, 2009; Hollon & Dimidjian, 2009), depression tends to recur. For instance, the risk of new episodes linearly increases with the number of previous episodes (Keller, 2003), so that, after multiple prior episodes of depression, even minor stressors can become triggers for new depressive episodes (Monroe & Harkness, 2005). This clearly suggests the existence of an underlying vulnerability unsuccessfully targeted by current treatments.

Vulnerability can be considered a trait-like latent endogenous process (i.e., genetic, biological, and psychological) reactive to stress (Ingram & Siegle, 2009), that facilitates, enhances, and supports the pathogenic process. In depression context, of particular importance are the (neuro)cognitive vulnerability factors that have been robustly associated with both concurrent and future depressive symptoms (De Raedt & Koster, 2010), such as rumination (Nolen-Hoeksema et al., 2008), cognitive reactivity (Teasdale, 1988), impaired attentional control (De Raedt & Koster, 2010), hopelessness (Abramson, Metalsky, & Alloy, 1989), and low self-esteem (Ingram, 1998).

Although these vulnerability factors have mostly been investigated in relation to task performance, there are several reasons to hypothesize that resting state could be the ideal context to explore their impact on mental functioning and well-being. First, depressed individuals are characterized by lower behavioral activation (Mazzucchelli, Kane, & Rees, 2009), that is they spend a noticeable amount of time in idleness where there is ample opportunity to engage in SGT (Antrobus, Singer, & Greenberg, 1966; Klinger, 2013). Second, clinical reports document that after (long) periods of inactivity depressed individuals usually report more negative mood and lower levels of mastery and pleasure (Martinsen, 2008). Third, the aforementioned cognitive vulnerability factors share many similarities with SGT. For instance, both rumination and low self-esteem are based on self-focus and so is SGT; hopelessness is markedly characterized by an aberrantly negative prospection bias, whereas ruminative thought is more likely focused on the past; finally, like SGT, cognitive reactivity is particularly susceptible to mild stressors.

Notwithstanding these encouraging premises, so far no research has clearly addressed the plausible depressogenic role of rest, SGT, and its underlying neural substrate, that is DMN. With this thesis, we aim at filling this gap in the literature, by adopting a neurocognitive and neurophilosophical approach.

Thesis Outline

The main aim of this dissertation is to highlight the clinical implications of resting brain and SGT on mental health, with particular focus on depression. We will present a series of both empirical investigations and theoretical efforts that help clarify how and under what circumstances undirected thought and the neurobiological substrate contribute to depressive outcomes. In order to shed light on the underlying mechanism, we propose a process-based perspective focusing on the contribution of well-established cognitive risk factors for depression, such as rumination, cognitive reactivity, etc. We below report the outline of the doctoral dissertation.

Chapter 2 starts off reviewing the extant literature on rest-related large-scale brain networks, the most representative of which is the Default Mode Network (DMN). To do so, we will first describe the anatomical and functional features of the DMN as well as the most recent findings about its role in major depression. Then, we will propose a theoretical framework that could account for vulnerability to recurrent depression. Specifically, we suggest that alterations in the interplay between task positive (TP) and task negative (TN) elements of the Default Mode Network (DMN) act as a neurobiological risk factor for recurrent depression mediated by cognitive mechanisms, such as rumination, cognitive reactivity, and impaired attentional control.

In **Chapter 3**, we present an empirical study about the relation between mindwandering (i.e., attentional disengagement from a task toward internally-generated information) and negative thinking. By capitalizing on the theoretical perspective presented in chapter 2 and the extant literature associating mindwandering with negative mood, we explore whether the intensity of undirected thought could support depressogenic outcomes. Specifically, we hypothesize that mindwandering could lead to negative mood either by imposing a depressive thinking style or by enhancing the accessibility of negative thoughts. To test these two hypotheses, we use a well-established task known be conducive to mindwandering (i.e., the Sustained Attention to Response Task, SART) with pseudo-random thoughts probes administered during the task itself, while the accessibility of negative thoughts is measured by means of the Scrambled Sentences Test (SST).

In order to be able to capture even little variations of state rumination during our rest-related studies, we needed a psychometrically-sound measure for state rumination, which is lacking in the literature. The studies contained in **Chapter 4** address this lack. Indeed, we report a series of 5 studies describing the validation process of a 6-item self-report questionnaire, the Momentary Ruminative Self-Focus Inventory (MRSI). In study 1, 2, and 3, the factorial structure of the MRSI is tested by means of both the Exploratory Factorial Analysis and the Confirmatory Factorial Analysis. In study 4 and 5, concurrent and criterion validity are evaluated.

In **Chapter 5**, we test at the behavioral level some of the key predictions derived from the theoretical framework presented in chapter 2. However, compared with the study reported in chapter 3, we here focus on pure rest, rather than mindwandering during an external task. In more detail, we predict that high levels of rest-related internal focus lead to depressive outcomes with the interplay of two specific cognitive risk factors, that is rumination and cognitive reactivity. To test this hypothesis, we have our participants undergo a validated task of resting state, during which pseudo-random thought probes on the intensity of both internal and external focus are administered pseudo-randomly. State levels of rumination are measured by means of the MRSI.

Chapter 6 contains a questionnaire study that investigates the relation between the habitual tendency to engage in daydreaming and depressive symptoms. By capitalizing on the extant literature and the findings reported in chapter 5, we propose that daydreaming could account for concurrent levels of depressive symptoms via multiple serial mediation of self-focus and rumination. To test this hypothesis, we run a cross-sectional study where individual levels of daydreaming are hypothesized to predict depression. A preliminary validation of the Dutch version of the Daydreaming Frequency Scale is also presented.

Taking into account our own findings and the vast literature on SGT, in **Chapter 7** we elaborate a neurocognitive theoretical framework about the depressogenic role of daydreaming. We propose that daydreaming leads to both concurrent and future depression via interplay of several risk factors, such as rumination, hopelessness, low self-esteem, and cognitive reactivity. Concurrent additive effects with regard to mindfulness and stress are also presented. Specifically, we propose that in at-risk individuals daydreaming could magnify their susceptibility to depression and speed up a depressive upward spiral. Finally, some preliminary findings on the relation between daydreaming and mania are reported.

Chapter 8 reports a new neurophilosophical model concerning how the representations of the “self” and the “other” interact with each other in supporting higher-order functions, such as self-consciousness. By relying on the intersubjective theory, as proposed by Georg Wilhelm Friedrich Hegel in 1807, we highlight how tightly the self-other dyad is represented in the brain at level of both the Default Mode Network and the Mirror Neuron System. Some theory-based hypotheses are derived and we present preliminary findings confirming the explanatory power of this new model.

Finally, in **Chapter 9** we end this dissertation by proposing an overview on the role of daydreaming in depression. Limitations, clinical implications, and future research are outlined.

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CHAPTER 2

The Default Mode Network and recurrent depression: A neurobiological model of cognitive risk factors[1]

ABSTRACT

A neurobiological account of cognitive vulnerability for recurrent depression is presented based on recent developments of resting state neural networks. We propose that alterations in the interplay between task positive (TP) and task negative (TN) elements of the Default Mode Network (DMN) act as a neurobiological risk factor for recurrent depression mediated by cognitive mechanisms. In the framework, depression is characterized by an imbalance between TN-TP components leading to an overpowering of TP by TN activity. The TN-TP imbalance is associated with a dysfunctional internally-focused cognitive style as well as a failure to attenuate TN activity in the transition from rest to task. Thus we propose the TN-TP imbalance as overarching neural mechanism involved in crucial cognitive risk factors for recurrent depression, namely rumination, impaired attentional control, and cognitive reactivity. During remission the TN-TP imbalance persists predisposing to vulnerability of recurrent depression. Empirical data to support this model is reviewed. Finally, we specify how this framework can guide future research efforts.

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[1] Based on Marchetti, I., Koster, E. H. W., Sonuga-Barke, E. J., & De Raedt, R. (2012). The Default Mode Network and recurrent depression: A neurobiological model of cognitive risk factors. *Neuropsychology Review*, *22*(3), 229-251. doi: 10.1007/s11065-012-9199-9.

Introduction

Depression is a severe psychiatric illness that is associated with high levels of personal suffering and with substantial costs to society (Gustavsson et al., 2011). Major depression has a life-time prevalence of 15-30% (Kessler et al., 2003). Pharmacological and psychological interventions show efficacy in the short term. However, there is a pressing need for improved long term effectiveness of treatments. This is especially true with regard to the prevention of *recurrence*. Numerous studies indicate that remitted patients have a 70% risk of developing new depressive episodes. Moreover, the risk of new episodes increases as a function of the number of previous episodes (Keller, 2003). After multiple prior episodes of depression even minor stressors can become triggers for new depressive episodes (Monroe & Harkness, 2005).

Understanding risk for recurrent depression in remitted patients is important for the development of its effective treatment. The neural correlates of depression are increasingly well understood (for reviews, see Davidson et al., 2002; Disner et al., 2011; Price & Drevets, 2012). For instance, imaging research has identified the neural circuitry involved in emotion-attention interactions as an important focus in the pathophysiology of depression. This has led to a conceptualization of depression as a failure to recruit top-down control (related to prefrontal regions – e.g., dorsolateral prefrontal cortex, DLPFC) to regulate limbic activity (e.g., amygdala; Davidson et al., 2002; Mayberg, 1997; Ochsner et al., 2002; Phillips et al. 2003; Phan et al., 2004). A crucial structure in this circuitry is the anterior cingulate cortex (ACC) with the ventral ACC processing of emotion-related signals, and the dorsal ACC involved in response selection and conflict monitoring signals (Bush et al., 2000). ACC signals to DLPFC to alter the direction of attention or to modify the distribution of processing resources (Hopfinger et al., 2000). This can inhibit emotion processing in amygdala via connections with other frontal regions, such as orbitofrontal cortex (OFC; Taylor & Fragopanagos, 2005).

Depression-related disruptions in this circuitry are well established especially during tasks involving emotion processing. These neural disruptions correspond to specific information-processing characteristics observed in depression (Disner et al., 2011; De Raedt & Koster, 2010). Depressed individuals are unable to swiftly reallocate attention away from negative to positive or task-relevant information (Koster et al., 2005; Leyman et al, 2007). Depression-related failures to exercise cognitive control in the face of stressful information appear to enhance the tendency towards rumination (Koster et al., 2011). A recent fMRI study found that difficulty disengaging attention from negative information is related to depressive brooding, and that brooding was correlated with DLPFC activity (Vanderhasselt et al., 2011). Moreover, ACC related cognitive impairments were found to increase linearly with the number of prior depressive episodes illustrating that such effects persist even after remission of depression (Vanderhasselt & De Raedt, 2009). Thus, deficient cognitive control is considered an important vulnerability factor for recurrent depressive episodes (for a review, see De Raedt & Koster, 2010), a view supported by recent findings that such deficits predicts recurrence of symptoms in a sample of patients in remission (Demeyer, De Lissnyder, Koster, & De Raedt, 2012).

Alongside this focus on the “task-related” disruption on fronto-limbic circuits there is a growing interest in disruptions in “task-independent” resting state neural networks in the pathophysiology of depression (Hamilton, Furman, & Gotlib, 2011). In the current article we develop a framework of *Default Mode Network* (DMN) dysregulation as a neural substrate of depression. Central to our model is the notion that DMN is a system comprised of two tightly locked but anti-correlated subcomponents namely the *Task Negative* (TN) and *Task Positive* (TP) circuits (Fox et al., 2005). DMN dysregulation has been implicated in a range of psychiatric disorders (Broyd et al., 2009), such as, for instance, depression and schizophrenia (e.g. Bar, 2009b; Northoff & Qin, 2011; Northoff et al., 2011; Pizzagalli, 2011; Whitfield-Gabrieli & Ford, 2012). Our hypothesis is that dysfunction in the TP and TN components can result in an imbalance in the default mode system as a whole leading to deficits in the psychological functions subserved by the DMN. These aberrant psychological functions are thus thought to embody cognitive deficits that have been specifically linked to depression such as rumination and poor attentional control. In particular, we argue that DMN dysregulation, mediated by key aspects of depression-related cognitive impairment, underpins neurobiological risk for *recurrent depression* (Figure 1). Specifically, we propose that an imbalance between TP and TN circuits in the DMN system drives the three well-established components of cognitive vulnerability for recurrent depression: (1) rumination, (2) impaired attentional control, and (3) cognitive reactivity. These risk phenomena have been studied and conceptualized independently of each other in the past, while here we propose DMN system dysregulation as a common underlying mechanism to explain them.

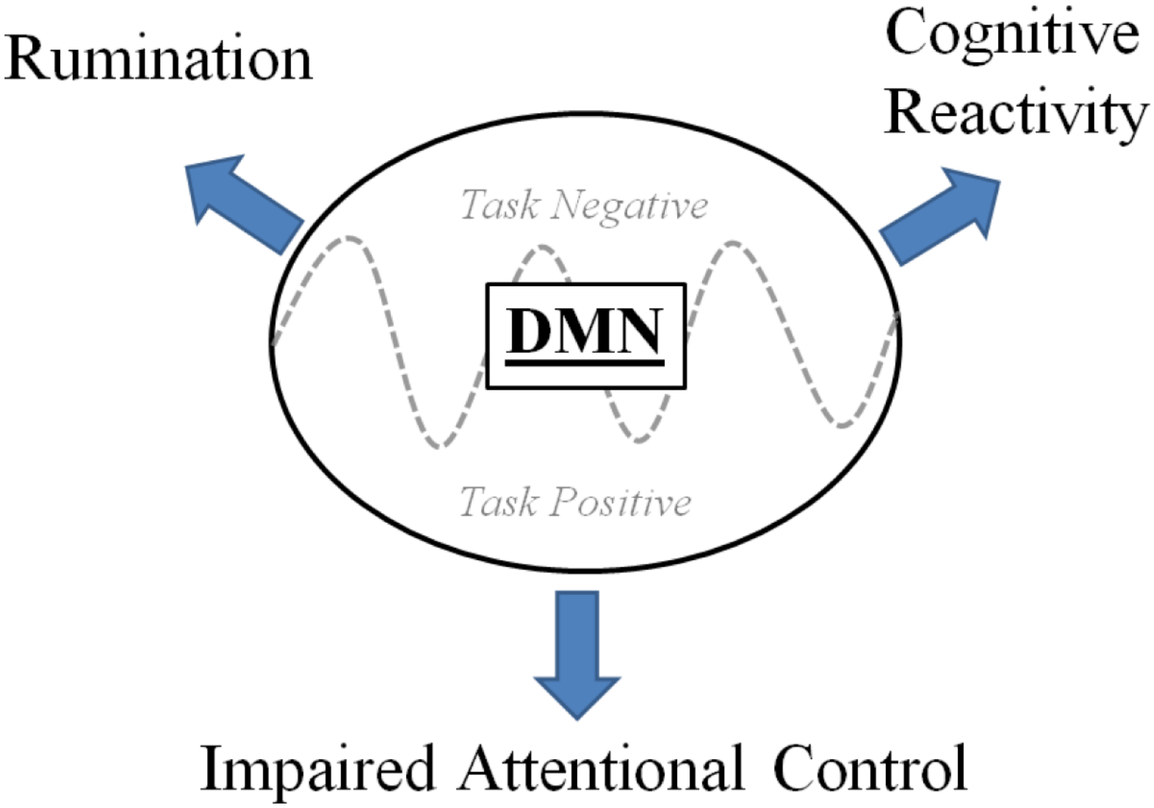

Figure 1. *Theoretical framework – Default Mode Network and cognitive risk factors*

The aim of this paper therefore is to explain cognitive and neural processes underpinning risk for recurrent depression in terms of our emerging knowledge of the resting brain. First, we will describe current understanding of the DMN, its neural correlates, and functional significance. Second, the state of art concerning the role of the DMN in major depression will be presented, shedding light on specific neuropsychological features. Third, we will argue that the TN and TP components of the DMN system are core neural hubs underpinning the main cognitive risk factors for recurrent depression. We will describe the available data supporting this proposition. Finally, future directions for research are described, based upon our new framework that allows more specific predictions of the interplay between the TN, the TP and cognitive risk factors to be tested. In this way the current paper builds upon previous views on DMN in depression (Bar, 2009b; Northoff et al., 2011) and recurrent depression (De Raedt & Koster, 2010) to establish an integrative understanding of neural and cognitive risk factors for recurrent depression.

The Default Mode Network (DMN) as system of coordinated "Task-Positive" and "Task-Negative" components

The resting brain exhibits spontaneous patterns of self-organization framed in terms of multiple long range neural networks characterized by task independent patterns of temporally coherent neural activity (Beckmann et al., 2005; Damoiseaux, et al., 2006; De Luca et al., 2006; Raichle et al., 2001; Shulman et al., 1997). Perhaps the most robust regions considered part of this resting network consists of a series of primarily midline regions including the medial prefrontal cortex (MPFC), the most rostral parts of the anterior cingulate cortex (rACC), the precuneus, the posterior cingulate cortex (PCC), and the retrosplenial cortex (Rsp) along with more lateralized regions of the parietal cortex (Raichle & Snyder, 2007) as well as mediolateral temporal cortex (MLTC) and hippocampal formation (Buckner et al., 2008) (Figure 2). This network shows enhanced functional coherence during rest which parametrically attenuates in an event-related fashion during cognitive tasks (McKiernan et al., 2003; Singh & Fawcett, 2008). Originally, characterized as underpinning a default mode of brain activity, the circuitry in this network has been proposed to subserve internal attention (Fox et al., 2005), during which internally-generated information dominates and exogenous stimulation is processed only to a limited extent (Chun et al., 2011). It has also been linked to other psychological functions, characterized by predominant internally-oriented attention. *Mindwandering,* for instance, is defined as naturally occurring mental activity which spontaneously and automatically arises when an individual is not engaged in an attention demanding task (Gruberger et al., 2011). Mason et al. (2007) manipulated proficiency on a working memory task during rehearsal and a novel task. They found a strong positive correlation between degree of mindwandering and BOLD signal changes in the MPFC, PCC, precuneus, superior frontal gyrus, rACC, and middle and superior temporal gyrus (see also Christoff et al., 2009). *Self-related processing* is the evaluation of information in relation to an individual's own mental concept of themselves (Christoff et al., 2011). Studies have found increased activity in the MPFC and PCC during self-related processing tasks compared to rest

(Fossati et al., 2003; Gusnard et al., 2001; Mitchell et al., 2006; Ochsner et al., 2005). Interestingly, empirical data show that different self-related sub-processes involve specific brain components. While the ventromedial prefrontal cortex (VMPFC) plays a role in identifying stimuli as self-salient (Gusnard et al., 2001; Schmitz and Johnson, 2007), the PCC, the lateral parietal cortex, and the hippocampal formation are considered important for the processing of autobiographical and past self-relevant stimuli (Cavanna, 2007). Other neuropsychological functions are also associated with activity within these regions, such as autobiographical memory (Addis et al., 2007), theory of mind, (Mitchell et al., 2005) and future prospection (Andrews-Hanna et al., 2010; Sonuga-Barke & Fairchild, 2012).

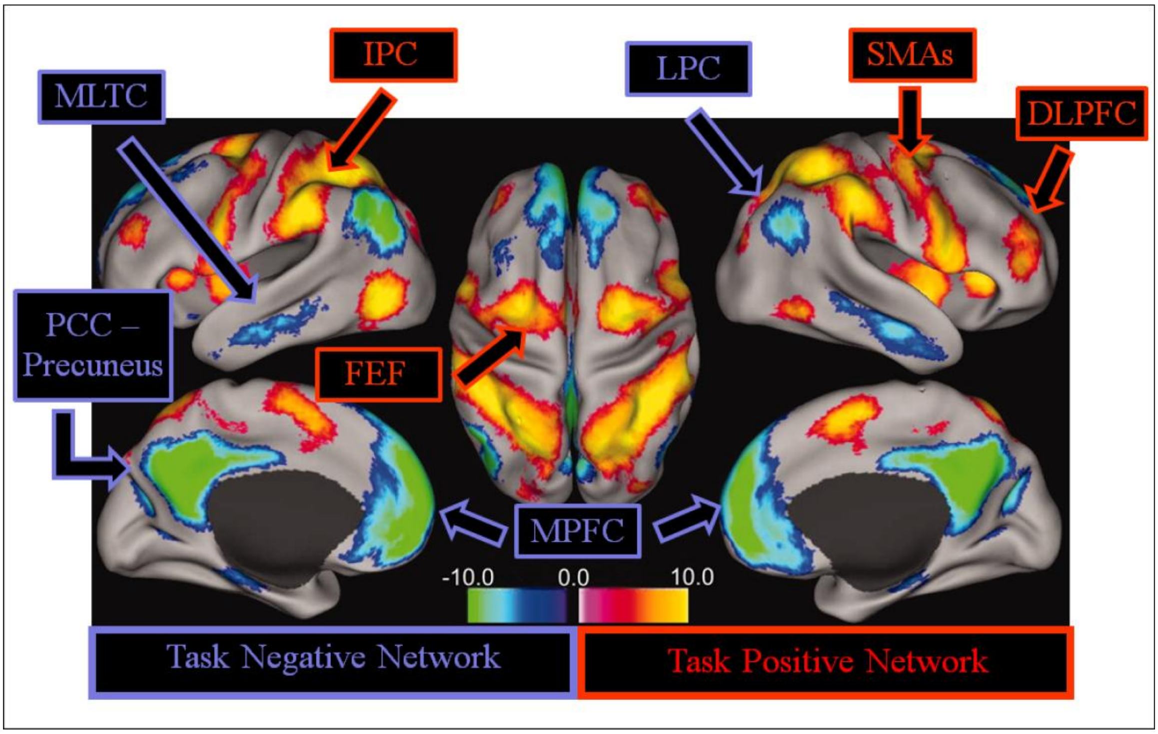

Figure 2. *Spatial distribution of BOLD signal fluctuations at rest, representing major areas of the anticorrelated task negative (TN; green-blue) and task positive (TP; yellow-orange) networks. MPFC: medioprefrontal cortex; PCC: posterior cingulate cortex; MLTC: mediolateral temporal cortex; LPC: lateral parietal cortex; DLPFC: dorsolateral prefrontal cortex; FEF: frontal eye fields; IPC: inferior parietal cortex; SMAs: supplementary motor areas. Reproduced and adjusted with permission from Fox et al. (2005) (permissions by Dr. Michael D. Fox and PNAS, copyright 2005, National Academy of Sciences, U.S.A.)*

Other influential theories have tried to capture the psychological functions of the DMN. The *Internal Mentation Hypothesis* (Buckner et al, 2008) postulates that the sorts of mental activities subserved by this resting network (e.g. MPFC, rACC, the precuneus, PCC, Rsp, LPC MLTC, and hippocampal formation) involve the ability to project oneself somewhere in time (i.e., past or future) or space (i.e., theory of mind). Interestingly, some memory-related brain regions (e.g. MTLC and hippocampus) also play an important role in facilitating mental simulation (Andrews-Hanna et al., 2010). Moreover, MTLC, by binding past-related information and providing building blocks for future scenarios (Hassabis & Maguire, 2007), subserves the ability to project oneself in the future (Andrews-Hanna et al., 2010), while hippocampus and frontoparietal midlines are activated during tasks involving autobiographical memory and future prospection (Andrews-Hanna et al., 2010). Alternatively, Bar et al. (2007) have argued that the regions within this network play a key role in associative conditioning which in turn is crucial as basic "*units of thought*", given their intrinsic nature to connect multiple strands of information. Bar et al. define such associations as multimodal links between perceptual, conceptual, and emotional representations (e.g. schemata) which are formed by a lifetime of extracting repeating patterns and statistical regularities from experience. Several studies (Bar & Aminoff, 2003; Bar, 2004; Aminoff et al., 2007) have shown that attending to highly inter-associated objects activates the medioparietal cortex, MTLC, and MPFC. It is noteworthy that from a theoretical standpoint these associative links rely on memory processes, a fact supported also by the contribution of the MTLC. Recently, Bar (2009a) suggested that associative conditioning goes beyond the simple stimulus-stimulus link – rather it may also be seen as a "*mindset*" which shapes behavior even at the level of sophisticated psychological functions, such as motivations and expectations. A mindset is indeed regarded as a "*list of needs, goals, desires, predictions, context-sensitive conventions and attitudes*" (Bar, 2009a, pag. 1239), that form a specific set of salient memories, attitudes and predictions interacting with environmental stimuli. Crucially, in this model the response to stimuli (either internal or external) is almost entirely dependent on the specific kind of mindset operating (mindset-stimulus interaction specificity).

Because there is some evidence that internally-oriented attention associated with this circuitry in some ways impairs efficient performance on most tasks requiring substantial controlled processing (Barron et al., 2011; Braboszcz & Delorme, 2011; MacLean et al., 2009; for a review see Smallwood & Schooler, 2006) and because failures to attenuate neural activity in this system have been shown to be linked to attentional lapses (Christoff et al., 2009, Weissman et al., 2006), it has been characterized as a *task negative* (TN) component. Such network is tightly coordinated with a second resting brain network (Cabeza & Nyberg, 2000, Corbetta & Shulman, 2002), which shows similar patterns of low frequency (~0.01 - 0.08 Hz) functional connectivity (Fox et al., 2005). This second component of the default mode resting network consists of regions, such as the DLPFC, the inferior parietal cortex (IPC), the supplementary motor area (SMA), frontal eye fields, and extrastriate cortex (Fox et al., 2005; Fransson, 2006; Figure 2), which are routinely activated during attention demanding, goal-directed task performance (Dosenbach et al., 2006; Duncan & Owen, 2000). For this reason it has been termed the task positive component. During rest the TP has been claimed to subserve intermittent "*external awareness*", defined as the conscious perception through different sensory modalities of one`s surrounding environment (Vanhaudenhuyse et al., 2011).

Crucially, TN and TP activity is thought to be anti-correlated both in rest and task periods (Figure 3). Given such tightly anti-correlated and coordinated patterns of neural activity, and the complementary nature of the associated psychological functions, the TP and TN have been conceptualized as two components of one system regulating activity within the brain's default state (Broyd et al., 2009; Sonuga-Barke & Castellanos, 2007). It has indeed been suggested that normal activity during rest within this system involves the "toggling" between TN and TP activity (Fox et al., 2005; Fransson, 2005, 2006). While the TN and TP show a putative antagonism of function, at the psychological level this TN-TP interplay has been reframed in terms of a coordinated ongoing switching between internally- vs. externally-oriented attention (Fransson, 2005, 2006; Sonuga-Barke & Castellanos, 2007). In a recent study, healthy participants were required to simultaneously rate the intensity of their internally- and externally-oriented attention during rest (Vanhaudenhuyse et al., 2011). Consistent with previous results, internal and external awareness was found to be anti-correlated (Spearman`s rho = -.44), and stronger internal awareness correlated with increased activity in the TN regions, such as MPFC, ACC, PCC, precuneus, and parahippocampal cortices, while external awareness correlated with TP structures, such as the DLPFC and the IPC. Sridharan et al. (2008) identified the right fronto-insular cortex (rFIC), consisting of the right VLPFC and the right insula, as a key region in the control of TP-TN interplay – with activation preceding the switch between TN and TP activity (so called salience network; Seeley et al., 2007). Moreover, a similar analysis revealed that the TN component exerts more influence than the TP in this process (Uddin et al., 2009). In sum, this antithetical relation between TN and TP has been proposed by many to constitute a core element of DMN function (Broyd et al., 2009; Fox et al., 2005; Sonuga-Barke & Castellanos, 2007).

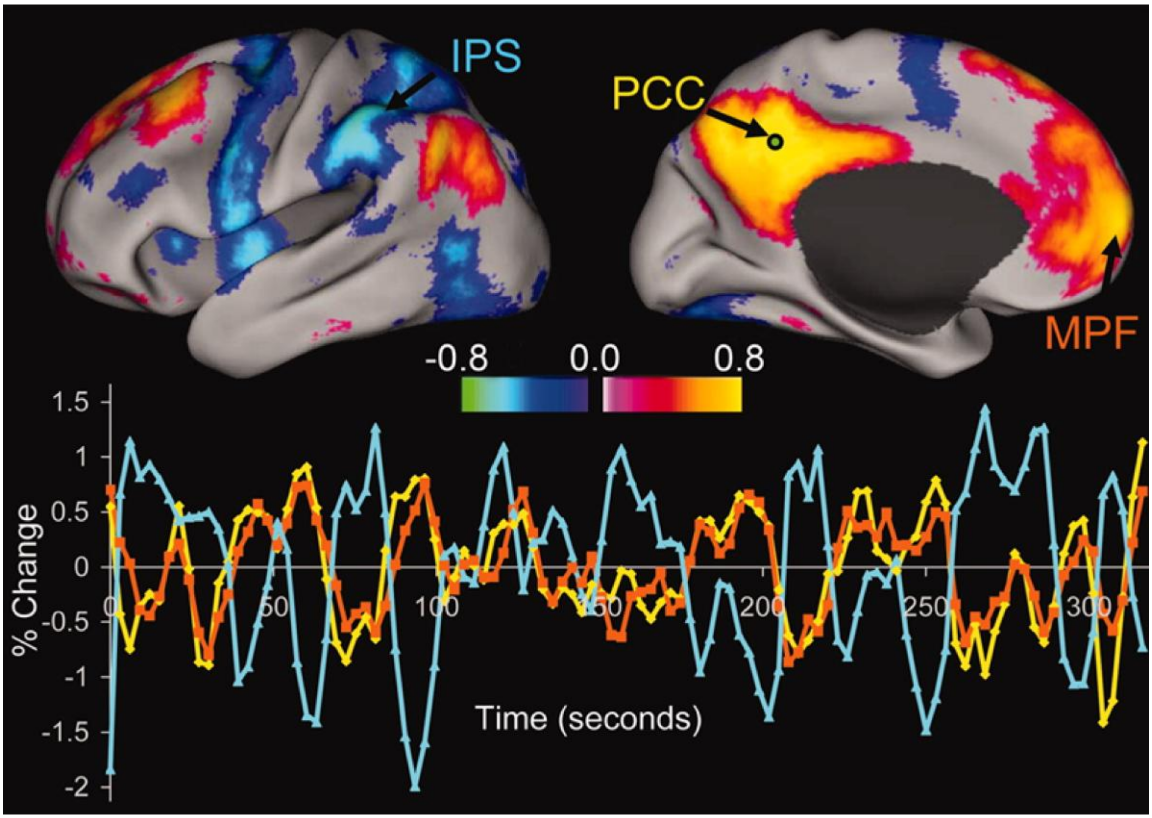

Figure 3. *Intrinsic anticorrelation between task negative (TN) and task positive (TP) networks in the brain of a single subject during resting state. Posterior cingulate cortex/Precuneus (PCC; yellow) and medial prefrontal cortex (MPFC, orange) are set as TN seed regions, while intraparietal sulcus (IPS; blue) as TP seed region. Both correlations (positive values) and anticorrelations (negative values) are shown for single run and thresholded at r = 0.3. Reproduced with permission from Fox et al. (2005) (permissions by Dr. Michael D. Fox and PNAS, copyright 2005, National Academy of Sciences, U.S.A.)*

However, the TN-TP anti-correlation is still under debate (Cole at el., 2010; Van Dijk et al., 2010). It has been argued that regressing out the mean global signal, a pre-processing procedure performed to control for unwanted variation in the BOLD signal, may artificially introduce spurious anti-correlations between time series (Murphy et al., 2009). Although previous studies have not reached a consistent conclusion on this issue

(Chang & Glover, 2009; Fox et al., 2009; Weissenbacher et al., 2009), improved analytical approaches have been recently proposed, such as regressing out time-locked cardiac and respiratory artifacts (RETROICOR; Glover et al., 2000) or controlling for non-neuronal sources of noise (CompCor; Behzadi et al., 2007). Adopting these procedures does not extinguish the TN-TP anticorrelation (Chai et al., 2012; Chang & Glover, 2009)

Function-wise, there are a number of hypotheses concerning the purpose of TN-TP switching during rest. One suggestion is that dominant internally-focused attention, supported by the TN connectivity, is interleaved by periodic and intermittent phases of TP increased connectivity, which reflects a general state of vigilance, by which the environment is scanned for novel and unexpected stimuli, to increase preparedness implicated in response selection, and planning of actions (Fransson, 2005, 2006). The possible function of the TP in mitigating the internally-oriented attention is allowing external information to be processed more effectively. This would provide a clear evolutionary advantage in terms of survival and adaptation to the environment, enhancing the likelihood to detect threatening stimuli (Broyd et al., 2009). Alternatively, during rest the TN connectivity may reflect the internal generation of different predictions and mental simulations about external events, both of which are TN-related functions (Bar, 2009a; Buckner et al., 2008). Therefore, during this ongoing internal mentation, the TP may allow people to constantly update self-relevant information processing, so that individuals can anticipate short and long term outcomes through different predictions and simulations (Sonuga-Barke & Castellanos, 2007).

The balance between TP and TN may be disturbed in a number of ways in both normal and clinical populations. During rest, one DMN component can temporally dominate over the other, leading to an imbalance in related psychological functions. Alternatively, TN and TP may become desynchronized so that these two orientations enter into a competitive rather than a complementary relationship, or, on the contrary, they may show an excessive anti-correlation, resulting in an aberrant antagonism. There may be a failure to attenuate sufficiently during the transition to task performance in one component compared to another so residual activity within either the TP or the TN interferes with task performance and attention. All of these forms of disruption are likely to have profound implications for mental functioning and personal well-being. Indeed several abnormalities in TN-TP interplay at the level of functional connectivity have been reported to impact on both mental health and behavioral performance.

An exaggerated anti-correlation between the TN and the TP was reported in several severe (psycho)pathologies, such as schizophrenia (Zhou et al., 2007) and depression (Zhou et al., 2010), whereas a reduced and blurred anti-correlation was reported in autism (Kennedy & Courchesne, 2008) and in healthy individuals showing less consistent behavioral performance (Kelly et al., 2008, Hampson, et al., 2010). These data speak in favor of the existence of an optimal degree of anti-correlation between the two networks, above and below which detrimental effects can be observed. Thus, the nature of the antithetical relation between the TN and the TP should be considered when explaining how resting state activity influences mental health and psychopathology.

More recently, a new approach investigating the imbalance between the TN and the TP has been proposed to take into account the temporal perspective, defined as "*dominance*" of one network over the other one (Hamilton et al., 2011a). For instance, TN-dominance over the TP is operationalized as the time points where the TN BOLD signal is greater than the TP BOLD signal. The increased duration of TN-dominance over the TP is thought to reflect elevated levels of TN functions. This approach, which has the clear advantage of not needing to take into account the strength of the anti-correlation but only the ongoing temporal pattern of the DMN components, provides a new and promising index. This index might capture individual differences in thinking styles such a rumination, a crucial factor in depression (Berman & Jonides, 2011; Hamilton et al., 2011a).

Finally, rest-to-task transition appears to be important for both the DMN components (Northoff et al., 2010; Northoff et al., 2011) and disrupted attenuation or impaired activation of DMN system activity should be carefully considered to explain cognitive impairment. Previous models have focused on the failure to attenuate spontaneous TN neural processes during active task performance as a cause of attentional lapses and related cognitive deficits (Sonuga-Barke & Castellanos, 2007). A key idea in our model is that DMN abnormalities during rest-to-task transitions relating to both TN and TP can undermine mental and brain activity in a way that has implications for depression-related cognitive risks, so that two aberrant non-mutually

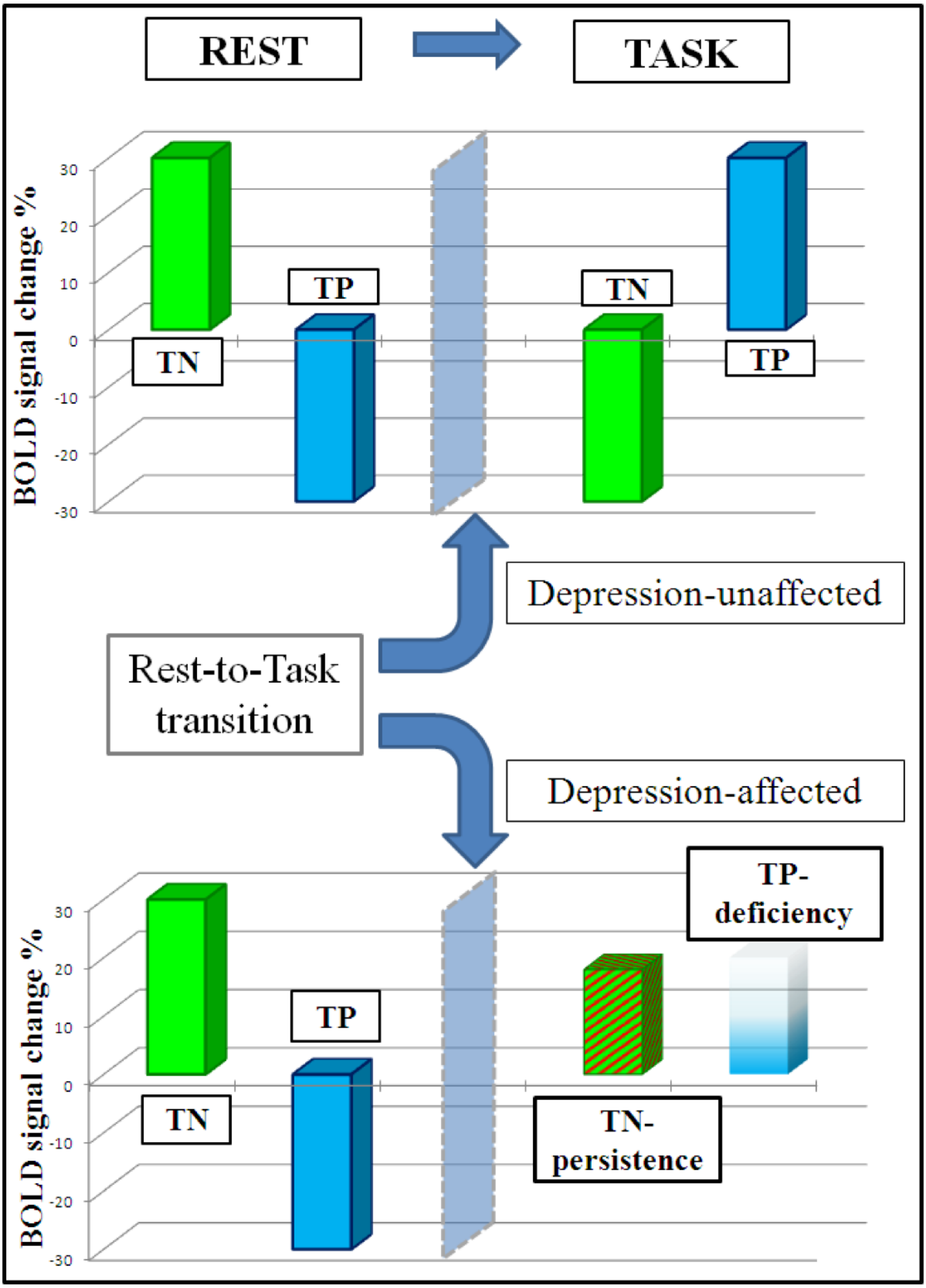

Figure 4. *Rest-to-Task transition in never-depressed and depressed individuals*

exclusive profiles may be proposed (Figure 4). The first relates to a failure to deactivate TN when an individual begins to engage in a goal-oriented task and continues to show an inappropriate level of spontaneous and intrusive internally-oriented TN activation.

We term this *TN-persistence*. The second relates to a failure to fully engage TP regions during rest-to-task transition so that the attention to task-relevant stimuli is reduced. This is called *TP-deficiency.* Interestingly, both TN-persistence and TP-deficiency have been reported in mental disorders (Grimm et al., 2009; Hooley et al., 2005; Mitterschiffthaler et al., 2008; Sheline et al., 2009) as well as in some conditions in healthy participants (Polli et al., 2005; Weissman et al., 2006).

Within our framework we propose specific links between DMN aberrations at the level of TN and TP functioning in relation to cognitive risk factors, known to be of crucial importance for recurrent depression. We first turn to research on the DMN in depression.

The Default Mode Network (DMN) in depression

Altered functional connectivity and temporal sequencing during rest

Studies have reported a hyper-connectivity of TN brain regions in depression during rest (e.g. Berman et al., 2011, Zhou et al., 2010). Greicius et al. (2007) were the first to report increased functional connectivity of the subgenual cingulate cortex (SubG), the thalamus, the OFC, and the precuneus in depressed individuals. In particular connectivity of the SubG with other TN areas distinguished depressed from healthy participants (Cohen`s *d* = 1.01) and was positively correlated with depression refractoriness, as measured by the length in weeks of the current episode. The SubG was also functionally connected with thalamus during rest, which led the authors to conclude that "[…] *in depressed subjects, activity in medial thalamus is excessively coupled to activity in the 'affective' subgenual cingulate, at the cost of reduced connectivity to the 'cognitive' dorsal anterior cingulate*" (Greicius et al., 2007; pp 435). Consistent with this, non-refractory depression was associated with reduced fronto-limbic connectivity - a finding congruent with reduced inhibitory control (of the PFC) over the limbic system activity seen in depression (Dannlowski et al., 2009). Moreover, refractory depression has been related to diminished thalamo-frontal connectivity (Lui et al., 2011). These results suggest a possible differential role of the thalamus in the various resting state functional connectivity profiles among depression-related subtypes. This latter finding provides an initial justification to consider the specificity of

TN activity in recurrent vs. non refractory depression. Note that the findings relating to this are not fully consistent as Bluhm et al., (2009) reported increased connectivity between the PCC/precuneus and caudate nucleus in healthy controls, whereas medication-free depressed individuals did not show enhancement of connectivity in the areas reported by Greicius et al. (2007). These authors suggested that, given the role of the caudate nucleus in reward processing (Yacubian et al., 2006), this connectivity pattern may be related to anhedonia in depression. While these inconsistent results may simply be due to the use of different methods of analysis (Hasler & Northoff, 2011), they could also be linked to different stages of the depressive illness (e.g. strengthened vs. decoupled links between emotion, cognition and bodily sensations), whereby early (or first onset) and recurrent (or chronically) depressed individuals may show different connectivity patterns. This latter idea is in line with our proposal to investigate the specificity of the DMN components after remission, to focus on “scars” of former episodes. Indeed it has been proposed that neurobiological abnormalities in depression increase with each new episode, thereby increasing individual vulnerability (for a review, see De Raedt & Koster, 2010).

Recently, the specific temporal order of activation in DMN related regions in depression has been investigated using Granger Causality Analysis (Hamilton at al., 2010). Increased activity in the hippocampus predicted subsequent activation of the SubG, which in turn showed a reciprocal augmentation with the MPFC. Additionally, SubG activity seemed to inhibit the dorsal medioprefrontal cortex (DMPFC), the PCC and the DLPFC. Interestingly, increased hippocampal activation also preceded reduced activation of the DLPFC - suggesting that hippocampus hyperactivity may contribute in important ways to resting state abnormalities in depression. Other recent connectivity data also supports the idea that the hippocampus plays an important role in depression. For instance, increased hippocampus functional connectivity with thalamus, frontal and posterior cingulate regions has been reported in an elderly depressed population (Goveas et al., 2011). Therefore, even though the hippocampus was not consistently detected as part of the TN in earlier studies, this area and its functions, such as contextual memory retrieval, are increasingly considered important. This region seems to contribute to TN functional connectivity both in healthy and depressed subjects (Buckner, 2010; Hamilton et al., 2010; Perry et al., 2011).

An important question about aberrant DMN is the extent to which increased functional connectivity could be due to well-known anatomical abnormalities in depression (e.g. Davidson et al., 2002). Although functional and structural connectivity (i.e. Diffusion Tensor Imaging, DTI) can be highly overlapping, nevertheless they do not map onto each other one-to-one in healthy subjects (Greicius et al., 2009). A recent review indeed indicates that strong functional connectivity can be present even among anatomically unrelated structures (Honey et al., 2010). Unfortunately no studies have investigated this issue in depressed patients thus far, but it has been proposed that the divergence between structural and functional connectivity might be strong in mood disorders, perhaps mediated by neurochemical imbalance (Hasler & Northoff, 2011). This provides an interesting area of research, since functional connectivity research in depression could capture specific pathological features above and beyond existing anatomical models (e.g. Price & Drevets, 2012).

DMN rest-to-task transition in depression: TN-persistence vs. TP-deficiency.

Given the partial overlap between DMN regions and emotion regulation structures (e.g. Goldin et al., 2008; Ochsner et al., 2004), recent studies have investigated how these regions respond to emotional stimuli in depression, and specifically whether rest-to-task transition in emotional contexts is affected by TN-persistence and TP-deficiency (Figure 4).

Several recent studies report failures of depressed individuals to deactivate TN regions during task engagement (Grimm et al., 2009; Sheline et al., 2009). Grimm et al. (2009) reported reduced rest-to-task attenuation of the rACC, VMPFC, and dorsal PCC activity to the presentation of emotional pictures by participants with major depression compared with healthy participants. Amongst the depressed individuals reduced deactivation in VMPFC was highly correlated with feelings of hopelessness, whereas reduced deactivation in the dorsal PCC was correlated with depressive symptoms. In another study, depressed participants failed to show a reduction of BOLD signal in the rACC, VMPFC, lateral temporal cortex (LTC), and lateral parietal cortex (LPC) during both passive viewing and active reappraisal of emotional stimuli (Sheline et al., 2009). Depressed individuals also displayed greater activation in response to negative compared with neutral pictures in left parahippocampus, right hippocampus, and left amygdala during a passive viewing task suggesting that both automatic and effortful processing of emotional stimuli is influenced by aberrant TN-persistence.

Important for our framework, currently depressed patients show TP-deficiency during rest-to-affective task transition, underlining that not only is TN less effectively suppressed, but also that TP brain regions are less efficiently activated in depression. Despite a lack of activation studies which take into account the whole TP network, several studies report that a key TP region, that is the DLPFC, shows deficient activation patterns during rest-to-affective task transitions (Fales et al., 2008, 2009; Holmes & Pizzagalli, 2008; Mitterschiffthaler et al., 2008; Siegle et al., 2007). Depressed individuals exhibited less recruitment of the DPLFC compared with healthy individuals in a modified emotional Stroop task (Mitterschiffthaler et al., 2008). Depressed patients also show less right DLPFC recruitment when required to ignore negative stimuli in an attentional interference task with emotional material (Fales et al., 2008). Moreover, increasing brain activity by multiple sessions of repetitive Transcranial Magnetic Stimulation (rTMS) over the left DLPFC normalized the inhibition of negative emotional stimuli in treatment resistant depressed patients, which was correlated with a decrease in depressive symptoms (Leyman et al., 2011). These results are indicative of difficulties that depressed patients have in activating TP components so as to appropriately execute cognitive control during affective tasks.

A recent meta-analysis reported the effects of pharmacotherapy (e.g. mainly SSRIs) on emotion processing in major depression, supporting abnormal rest-to-affective task transition as specific feature of depression and, in turn, a target for therapeutic interventions (Delaveau et al., 2011). Several findings are in line with the hypothesis that pharmacological treatments effectively targeted both TN-persistence and TP-deficiency: after several weeks of treatment depressed participants displayed reduced activation in SubG, dorsal PCC, and precuneus and increased activation in DLPFC and VLPFC during emotional tasks. An interesting hypothesis to pursue is that antidepressant medication may work by rebalancing TN and TP during rest-to-task transitions.

Altered TN-TP anti-correlation in depression

Zhou et al. (2010) detected an increased degree of anti-correlation between TN and TP in depression using both the PCC/precuneus (TN) and the right DLPFC (TP) as seed regions. This was interpreted as an exaggerated antagonism between these two components, which, the authors argued, may be involved in biased processing of information in depression. For instance, during spontaneous low frequency oscillations, the TP, comprising areas which are known to subserve attention and emotion regulation (e.g. bilateral DLPFC and IPL), might represent active attempts to regulate emotions and deploy attention even without current external stimulation. On the other hand, the fluctuations of the TN (e.g. MPFC, SubG, and PCC/precuneus) may be the neurobiological underpinning of enhanced memory for negative emotional experiences and increased maladaptive self-focus. While the optimal attunement between TN and TP is thought to reflect efficient intrinsic brain organization (Fox et al., 2005), such an exaggerated TN-TP antagonism might reduce the integration between different strands of information (e.g. “internal” vs. “external”), potentially resulting in attention and memory biases. Recently, a study demonstrated a differential role of the rFIC in switching activation between the TN and TP connectivity in depression (Hamilton et al., 2011a). That is, during the ongoing anti-correlated TN-TP fluctuations in rest, an increased activity of the rFIC was detected when TN showed a peak in activation while the opposite pattern was found in healthy participants, who showed increased activity of the rFIC when TP activity peaked. The authors suggested that the rFIC plays an affective regulatory function, so that when the negative state subserved by the TN in depression reaches its peak, the rFIC induces an increased activation in the TP to counterbalance this undesired state.

Blurred boundaries among neural networks during rest: the “Dorsal Nexus”

So far, we have delineated specific DMN dysfunctions which occur during rest or in transition to task. Nevertheless, a broader perspective could be fruitful in shedding light on how the TN and TP activity are related to each other and to other neural networks. Recently, Epstein et al. (2011) demonstrated that when exposed to emotional material healthy people show a clear segregation between the TN (e.g.

PCC/Precuneus and MPFC) and emotional processing networks (e.g. insula, amygdala, and ventral striatum). In contrast, in depressed patients these networks are not clearly disentangled but partially overlapping. These results are in line with another study showing that in depression the TN leads the organization of the whole brain during rest, resulting in a perturbation of other neural networks (Zhang et al., 2011). Such problematic failures to clearly segregate networks in depression appear to occur not only interneurally, but also intraneurally within the DMN components. In fact, the TN-TP imbalance in depression may also take the form of an abnormal overlap between TN and TP as this could undermine the attunement between the two resting networks. Sheline et al. (2010) compared connectivity maps of three different resting state networks in depressed and healthy participants. The three networks were the TN (precuneus seed), the TP (DLPFC seed), and the affective network (SubG seed). DMPFC, defined by the authors as the "*dorsal nexus*" to stress the hub role played by this region, was the sole region which distinguished depressed from never depressed participants and was found to be part of all three networks. Moreover, this area was functionally connected with brain regions shown to be crucial in depressive pathophysiology (e.g., DLPFC, VMPFC, superior DMPFC, rACC, PCC, and precuneus). DMPFC activation was also highly correlated with depressive symptoms. DMPFC dysregulation was hypothesized to be the key driver of depression-related impairments, such as attentional problems, increased autonomic responding, and enhanced negative self-focus. The crucial role of this hub area is confirmed by a recent study which shows that SSRIs target the DMPFC by reducing its connectivity to the hippocampus during rest (McCabe et al., 2011).

The DMN as a depression vulnerability marker in at-risk subjects

Even though research has mainly investigated the role of the DMN in currently depressed patients, some preliminary pieces of evidence suggest that dysfunctions at level of default brain could precede the clinical episode. One approach is to examine close biological relatives, such as non-affected offspring of depressed parents, as depression in parents is associated with a higher risk of major depression in the offspring (Hammen, Burge, & Adrian, 1991). Norbury, Mannie, and Cowen (2011) report that people who have never personally suffered from major depression but have a biological parent with a history of depression show increased TN functional connectivity during rest (e.g. DMPFC and middle temporal gyrus) compared with offspring of non-depressed parents. Beyond the TN hyperconnectivity, other evidence supports the presence of DMN dysfunctions among vulnerable individuals. Confirming the heuristic utility of what we termed as rest-to-affective task transition, Di Simplicio, Norbury, and Harmer (2011) reported the efficacy of SSRIs in normalizing such transition in at-risk subjects. The researchers administered either placebo or citalopram (i.e. SSRI) for 7 days to people with high levels of neuroticism, a personality trait reported to strongly predict the onset of major depression (Kendler, Gatz, Gardner, & Pedersen, 2006). Afterwards, both groups underwent an experiment requiring subjects to classify negative and positive self-descriptors. The analyses revealed that, compared with placebo, citalopram administration significantly decreased activation of the VMPFC and rACC in response to negative self-referred stimuli. This confirms the presence in at-risk subjects of TN-persistence which can be ameliorated by SSRI medication, as reported in currently depressed individuals (Delaveau et al., 2011).

Although more research is recommended, some speculation on DMN in relation to the course of depression is warranted. First, it seems that at-risk individuals could show similar DMN aberrations but to a milder degree, both in rest period and in rest-to-task transition phase. Such a notion has been supported in the context of schizophrenia, another clinical syndrome which demonstrates notable genetic influence and inheritability (for a review, Whitfield-Gabrieli & Ford, 2012). For instance, unaffected siblings of schizophrenic patients show TN hyperconnectivity during rest to a lesser extent than a clinical group, but still greater than healthy controls. Moreover, TP connectivity clearly differentiates clinically affected from unaffected siblings (Liu et al., 2012). These results suggest that it is also possible in depression that at-risk individuals may be characterized by a neurobiological profile that partially mirrors aberrations observed in clinical depression. Second, such research in at-risk populations suggests that DMN dysfunctions might predict future clinical episodes. In other words, the aberrations within the DMN might precede the onset of major depression. However, it is still a matter of debate by what mechanism the transition from non-symptomatic phases to the first depressive episode occurs. In this context, both theoretical models and empirical research (i.e. longitudinal studies) are needed (Whitfield-Gabrieli & Ford, 2012). Third, given the specific cognitive signature of recurrent depression (marked attentional problems, high levels of rumination, and cognitive reactivity), we argue that DMN aberrations, likely present to a milder extent even before the first clinical episode, become more pronounced with increasing episodes and are associated with recurrence in remitted depressed samples. This proposal is described in detail in the next sections.

The DMN in depression: Theoretical advances

Several recent attempts have been made to relate different facets of depressive phenomenology to DMN (Hasler & Northoff, 2011; Pizzagalli, 2011). Among others, Northoff et al. (2011) proposed a DMN system theory of depression, focusing on underlying mechanisms of symptoms. They proposed neural hyperactivity during rest as one of the endophenotypes for unipolar mood disorder. In this model aberrant resting brain performance is thus seen as a ‘neural predisposition’ or susceptibility marker with abnormal rest-stimulus transitions as the final cause of depression. They propose that specific subcortico-cortical systems play distinct roles in the depressive phenomenology. For instance, the rest-related hyperactivity of the rACC, VMPFC, DMPFC, amygdala, and hippocampus is hypothesized to be responsible for sustained negative mood, while decreased TN performance during rest-to-task transition could account for the abnormally high levels of sadness (e.g. Sheline et al., 2009). The deviant perception of subjective time in depressed individuals would be due to an increased rest-related activity of VMPFC, DMPFC, and rACC, whereas hopelessness, which appears closely related to prospection abilities, is linked to reduced rest-stimulus interaction (e.g. Grimm et al., 2009). Finally, the rest-related hyperactivity of rACC, VMPFC, DMPFC, peri-aqueductal gray, and the dorsomedial thalamus could be responsible for depressive self-focus and rumination (e.g. Berman et al., 2011; Greicius et al., 2007).

It is noteworthy that, despite the increasing efforts to highlight the role of the DMN in depression, the issue of remitted depression is virtually uncovered in literature. Unfortunately, the absence of a theoretical roadmap has so far impeded a systematic and fruitful investigation of the links between DMN and recurrent depression.

The DMN in depression: Summary

A number of depression-related DMN abnormalities have been reported both during rest and rest-to-task transition. These include (i) increased TN functional connectivity during rest between the MPFC, the PCC, and the SubG (Berman et al., 2011; Greicius et al., 2007, Zhang et al., 2011) with a promising role for areas not universally reported to be part of the TN, such as the hippocampus (Goveas et al., 2011, Zhang et al., 2011) and the thalamus (Lui et al., 2011); (ii) evidence of both TN-persistence (Grimm et al., 2009; Sheline et al., 2009) and TP-deficiency (Mitterschiffthaler et al., 2008; Leyman et al., 2011) following rest-to-affective task transitions with these effects leading to poor attentional control during task involving emotional material. Importantly, these problems with transition from rest seemed to be ameliorated by pharmacotherapy (Delaveau et al., 2011); (iii) an increased level of TN-TP anti-correlation during rest (Zhou et al., 2010); (iv) an altered pattern of TN-to-TP switching with the brain regions thought to drive switching (e.g. rFIC) functioning differently in depressed compared with healthy subjects (Hamilton et al., 2010); (v) less segregation between TP, TN and other resting state networks (Epstein et al., 2011; Zhang et al., 2011) and a strong role for the DMPFC across these networks in depression (Sheline et al., 2010); (vi) at-risk individuals seem to show a depression-like DMN pattern (Di Simplicio et al., 2011; Norbury et al., 2011). Recently, several theoretical models try to account for different aspects of current depression in relation to DMN (Hasler & Northoff, 2011; Northoff et al., 2011; Pizzagalli, 2011).

Cognitive Risk for Recurrent Depression and the DMN

In this section we focus specifically on recurrence of depression in remitted patients, reviewing the literature on cognitive vulnerability factors and describing how default mode dysregulation can provide a unifying explanation of these deficits (Figure.1). As we have described, major depression is characterized by DMN abnormalities. Our model of recurrence is built on the idea that remitted depressed individuals, especially after a history with several depressive episodes, still show most of the DMN aberrations, albeit probably to a lesser extent than in the acute symptom phase. In this sense, the DMN disruptions can be defined as a “depressive scar”

(Lewinsohn et al., 1981) and as such are predicted to be influenced by the number and duration of previous depressive episodes (Wichers et al., 2010). Crucially, we suggest that this neurobiological scar is manifest primarily in terms of dysregulation in the pattern of synchronized switching between internally- and externally-oriented attention which marks the normal interplay between TN and TP components of the DMN system. In turn this dysregulation leads to specific and well established cognitive deficits considered as risk factors for recurrent depression; (i) rumination, (ii) impaired attention control, and (iii) cognitive reactivity.

Rumination and TN-dominance over TP

Rumination has been defined as “behaviors and thoughts that focus one’s attention on one’s depressive symptoms and on the implications of those symptoms” (Nolen-Hoeksema, 1991, p. 569). The response style theory of depression (Nolen-Hoeksema, 1991) proposes that individuals differ in their reaction to negative mood states and that rumination is a trait-like response style to distress. Individuals engage in depressive rumination because they believe that ruminating about their mood and symptoms will lead to greater self-understanding. However, rather than leading to increased self-understanding, depressive rumination augments sad mood and negative thinking by focusing attention on current mood (Lyubomirsky & Nolen-Hoeksema, 1995). The harmful effects of rumination may not stem from attention to distress per se, but from internally-oriented attention that is negative, evaluative, and judgmental (Rude et al., 2007).

To assess individual differences in the tendency to ruminate, Nolen-Hoeksema and Morrow (1991) developed the Ruminative Response Scale (RRS). This scale has high internal consistency and acceptable convergent validity (Butler and Nolen-Hoeksema, 1994; Nolen-Hoeksema and Morrow, 1991). Factor analysis of the RRS has identified two distinct subtypes of rumination (Treynor et al., 2003). The first, *reflective pondering*, is a more adaptive form of rumination and reflects the degree to which individuals engage in cognitive problem solving to try to improve their mood. The second, *depressive brooding*, - the degree to which individuals passively focus on symptoms of distress and the meaning of those symptoms - is a more maladaptive form of rumination. Rumination in response to negative mood increases vulnerability to depression. Numerous studies have demonstrated that rumination is associated with depressive symptoms (Treynor et al., 2003) and prospectively with the onset (Nolen-Hoeksema, 2000), severity (Just and Alloy, 1997; Nolen-Hoeksema and Morrow, 1991) and duration (Nolen-Hoeksema, 2000) of depression. The ability to control ruminative thought is associated with recovery from depression (Kuehner & Weber, 1999; Schmaling et al., 2002). Rumination is also associated with cognitive reactivity, one of the crucial predictors of recurrent depression, even when depression levels were statistically controlled (Moulds et al., 2008).

Here we argue that rumination is related to a tendency toward enhanced TN connectivity and TN-dominance over the TP component of the DMN system. In fact, Zhu et al. (2011) reported that in unmedicated individuals with major depression, increased MPFC and SubG connectivity correlated with rumination, measured with the Cognition Emotion Regulation Questionnaire (CERQ, Garnefski, Kraaij, & Spinhoven, 2001). In line with this, Berman et al. (2011) found increased TN-SubG connectivity in depressed patients during rest periods of a cognitively demanding task. Levels of connectivity between the SubG and the PCC were highly correlated with rumination scores in both clinical and non-clinical sub-samples. The maladaptive ruminative response (i.e. brooding) was correlated with SubG-PCC connectivity across all sub-samples. While healthy participants did not differ in the SubG-PCC connectivity between rest and task-related blocks, depressed patients showed hyperactive connectivity during rest phases and hypoactive connectivity during active blocks. On one hand, these results suggest that when depressed people are left to themselves they are more prone to experience maladaptive internally-oriented rumination. On the other hand, it is possible that during active task periods the enhanced activation of the TP counteracts the TN, which may provide temporary relief from rumination. Moreover, this can result in an abnormal activation of the SubG, implicated, for instance, in reduced likelihood of recovery from depression (Siegle et al., 2006) and an increase in the risk of depression as a consequence of adolescent peer rejection (Masten et al., 2011).

Hamilton et al. (2011a) examined the association between TN-TP interplay and rumination using a new approach to data analysis to measure the dominance of one network over the other one. This new index quantifies the number of time periods when the TN BOLD signal is greater than the TP BOLD signal. This allows an estimate of the increased duration of TN-dominance over the TP and an assessment of whether this is reflected by elevated levels of TN functions. Comparing the TN-dominance level in depressed patients and controls, the study reported that this positively correlated with the *depression subscale* – another RRS subscale which along with the brooding subscale measures cognitions characterized by “a passive comparison of one’s current situation with some unachieved standard” (Treynor et al., 2003, p.256) – and negatively correlated with the *adaptive reflective pondering* subscale of the RRS in the depressed group. This pattern held also after controlling for brooding and depressive symptoms measured with the Beck Depression Inventory-II (BDI-II, Beck et al., 1996). Interestingly, current findings support this association between rumination and TN connectivity or dominance only during rest, exactly when task specific regions are intrinsically less activated (Berman & Jonides, 2011). Here we argue that the neurobiological dynamics of rumination (see also Pizzagalli, 2011) are represented by a specific psychological mechanism, namely an aberrant attentional switching in depressed patients which leads to excessive internally-oriented attention (i.e. maladaptive self-focus), a phenomenon subserved by TN hyperactivity. This in turn leads to a failure to use external stimuli to distract from rumination (Disner et al., 2011; De Raedt & Koster, 2010). Increased TP activity to compensate this TN activity could indeed provide environmental stimulation necessary for distraction, efficacious to counterbalance rumination (Huffziger & Kuehner, 2009; Morrow & Nolen-Hoeksema, 1990). Here we propose that this tendency towards TN dominance over TP persists in individuals with a history of depression after recovery from the acute symptoms phase, leaving them vulnerable to rumination during future difficult or stressful times. We predict that remitted depressed individuals, compared with healthy participants, will display an; (i) increased TN functional connectivity during rest, with the SubG being expected to play a major role; (ii) increased TN-dominance over TP during rest; (iii) increased internally-oriented attention during rest. Moreover we propose that (iv) these DMN connectivity indexes and internal attention preference during rest are both correlated with rumination and that (v) connectivity indexes predict, partially mediated by rumination, future depressive relapse in remitted depressed individuals.

Impaired attentional control, TN persistence, and TP-deficiency in rest-to-task transitions

Attention deficits and impairments in concentration are important diagnostic criteria for depressive episodes (APA, 2000). It has been proposed that impairments in general attentional control functions involved in working memory might drive both these deficits (e.g., concentration) and more specific emotion-related cognitive biases, such as mood-congruent interpretation biases, memory biases, and attentional biases (Joormann, 2005). There is some neuropsychological evidence suggesting that depression is associated with *general impairments* (valence unspecific) in cognitive control but typically the findings are mixed (for a review, see Joormann et al., 2007b), with marked general impairments most often being present in severe depression (Kaiser et al., 2003). Given these inconsistent findings it has been argued that attentional control is particularly hampered in relation to the processing of negative, mood-congruent information (Joormann et al., 2007b). Indeed, depression is associated with difficulties in inhibitory processing of task-irrelevant negative material (Goeleven et al., 2006; Joormann, 2004), as well as problematic trial-by-trial updating of negative information in working memory (Joormann & Gotlib, 2008; Levens & Gotlib, 2010). Recently, attentional control has been related to specific cognitive vulnerability factors for depression, such as a rumination (for a review, see Koster et al., 2011) and emotion regulation (for a review, see Joormann & D'Avanzato, 2010). Research indicates that rumination is related to impaired attentional control during the processing of both non-emotional (Davis and Nolen-Hoeksema, 2000; De Lissnyder et al., 2010) and emotional information (De Lissnyder et al., 2010; Joormann & Gotlib, 2008; Lau et al., 2007). Depressive brooding in particular seems strongly related to impaired attentional control. Current research suggests that impaired attentional control plays an important role in depression vulnerability rather than just representing a simple correlate of a depressed state. A number of prospective studies suggest that attentional biases are associated with emotional reactivity and precede the development of anxiety and depression (Beevers & Carver, 2003; MacLeod & Hagan, 1992). In the context of depression, Beevers and Carver (2003) demonstrated that such biases interact with intervening life stresses to predict higher scores on depression seven weeks later.

Mood-congruent attentional bias has also been demonstrated after negative mood induction in never depressed offspring at risk for the development of depression (Joormann et al., 2007a). Importantly for the current argument, attentional control is reduced during recurrent depressive episodes and this persists even during remission. Electrophysiological markers of cognitive control (N450) have been shown to decrease linearly with more frequent occurrences of depressive episodes in remitted patients (Vanderhasselt & De Raedt, 2009).

DMN system dysregulation is probably implicated in poor attentional control during task performance. In particular it has been argued that attentional lapses occur when TN activity is not sufficiently attenuated during the transition from rest-to-task and so interferes with task-related activations in TP regions (Sonuga-Barke & Castellanos, 2007). This default mode interference is said to occur when TN activation exceeds a threshold under which attentional failures are not apparent, but above which the interference could effectively impact on the task. Supporting this hypothesis, Prado and Weissman (2011) demonstrated that during a multimodal selective attention task increased current-trial connectivity between the PCC and the left DLPFC was associated with worse performance (e.g. longer RTs). Moreover, extending the default-mode interference hypothesis, the PCC/left DLPFC connectivity could also predict better performance (e.g. faster RTs) in the next trail, suggesting that current task-unrelated preparatory mental activity can enhance performance of an upcoming task at the cost of worse current performance. Consistent with this, in non-clinical participants longer RTs on a selective attention task were associated with both decreased activation of TP structures, such the right DLPFC, and increased activation of PCC, precuneus, and MTLC, key TN brain regions (Weissman et al., 2006). In a similar way, Polli et al. (2005) found that errors during an antisaccade task were characterized by a failure to deactivate PCC, left superior temporal gyrus, rACC, and DMPFC. Li et al (2007) reported that errors in a stop signal task were preceded by an increased activation of, among other regions, the PCC and precuneus. Interestingly, a recent study stressed that the PCC seems to precede TN-related attentional lapses in that reduced TN deactivation during a speeded Eriksen flanker task predicted errors up to 30s before the error actually occurred (Eichele et al., 2008).These pieces of evidence support a crucial role of *TN-persistence* in attentional lapses, mainly driven by PCC. In addition, Castellanos et al. (2005) reported that subjects affected by ADHD compared with controls showed an increased Intra-Individual Variability (IIV), defined as very long and relatively infrequent RTs, which temporally mirrored the typical DMN low-frequency pattern (~0.01 - 0.08 Hz). In keeping with this, Kelly et al. (2008) reported that in healthy subjects asked to attend an Eriksen flanker task the IIV, here defined as coefficient of variation (CV), was negatively correlated with the magnitude of the anti-correlation of the DMN components, that is the less the TN and TP were tuned and anti-correlated, the less congruent and consistent the performance was (e.g. increased CV). An increased IIV has been also reported to characterize several clinical syndromes, including depression, and this suggests its possible role as pathological marker (Kaiser et al., 2008). In sum, a wealth of research has indicated that the DMN is associated with impaired attentional control. In particular TN-persistence, TP-deficiency, and reduced TN-TP anti-correlation producing spontaneous fluctuations in performance during task have all been found to be remarkably good predictors of attentional lapses.

Building on the default mode interference hypothesis (Sonuga-Barke & Castellanos, 2007) we argue that reduced attentional control in remitted depressed patients is the result of a failure to properly attenuate the TN network during rest-to-task transitions leading to a disruption of task-related activity in TP regions. We see this pattern of TN-persistence as being due to depression-related alterations during rest, especially TN dominance and increased coherence. This pattern of DMN activity makes it more difficult to effectively switch from rest to task, while at the same time making interference by the TN activity into task-related activity more likely. We therefore predict that remitted depressed individuals, compared with healthy controls, will (i) display TN-persistence in rest-to-task transition, mainly led by the PCC; (ii) show TP-deficiency, mainly at the level of the DLPFC, in attention demanding tasks using non-emotional material; (iii) that TN-persistence during tasks will be predicted by TN-dominance and increased TN functional connectivity during rest, linking excessive rumination with poor attentional control; and (iv) that DMN-related attentional impairments in remitted depressed individuals can predict future depressive relapse.

To date no studies have directly investigated the role of the TN over TP persistence in depressed patients performing an attentional task. There is some evidence underpinning the TP component on attention demanding task performance using non-emotional material. Halari et al. (2009) found depression-related decreases in right DLPFC, using selective attention paradigms (Simon task) and attention switching tasks. A single session of rTMS over the left DLPFC in depressed patients improved performance in an attention-demanding task (task switching) although mood remained stable (Vanderhasselt et al., 2009). This preliminary evidence suggests that currently depressed individuals might show TP-deficiency during rest-to-task transition, even when using non-emotional material. Moreover, remitted depressed individuals showed TP-deficiency, namely reduced left DLPFC activation, after remission (Aizenstein et al., 2009). Nevertheless, there is also some preliminary evidence that in depression and recovery individuals show a similar pattern in attention demanding tasks using emotional material. For instance, multiple sessions of rTMS over the left DLPFC in depressed patients resulted in increased inhibition of negative information (Leyman et al., 2009). Finally, a recent prospective study showed that remitted depressed individuals had impaired cognitive control while switching from angry to neutral faces which predicted rumination as well as depressive symptoms a year later (Demeyer et al., 2012). In conclusion, DMN dysfunction during rest-to-affective task transition appears to be worth deeper consideration, given its possible role in efficiently adjusting to tasks and predicting future depressive relapse.

Cognitive Reactivity, increased TN connectivity and rest-to-affective task transition

Research on information-processing in emotional disorders has been guided predominantly by Beck’s cognitive schema theory (Beck, 1967; Clark et al., 1999) and Bower’s associative network theory (Bower, 1981). Beck and colleagues argued that information-processing is guided by schemata, defined as memory structures which, built from previous experiences, contain and organize information about the self, the world, and the future. Depression is characterized by negative schemata involving loss and failure which are thought to bias encoding of information. Specific information processing biases at the level of attention, interpretation, and memory mediate incoming information processing and subjective (emotional) experience. A fundamental aspect of Beck's cognitive model of depression is that cognitive structures or schemata remain latent until activated by relevant stimuli.

Although broad and general, this notion lies at the roots of the concept of cognitive reactivity, which has been central to the understanding of cognitive vulnerability factors for depression. Cognitive reactivity relates to fluctuations in negative self-attitudes in response to daily (stressful) events (Butler et al., 1994). The crucial question is why certain individuals are or become more reactive to stressors than others. Teasdale (1988) proposed the *differential activation hypothesis* (DAH) to account for this observation. This hypothesis assumes that, after each depressive episode, the link between low mood and negative thinking is strengthened. Therefore, a depressive mood, which can be induced by daily stressors or experimental manipulation, re-activates the negative thinking patterns more easily after multiple depressive episodes. Proposing an association-based mechanism, the DAH can explain the often reported phenomenon that after several depressive episodes even minor hassles can evoke strong depressive symptoms, and a downward spiral of negative thoughts.

Support for this theory comes from studies showing that people who have experienced depression in the past, as compared to never depressed individuals, report more dysfunctional attitudes, negative cognitive biases, and decreased positive biases after negative mood induction (for a review, see Scher et al., 2005). Moreover, some longitudinal studies have shown that the interaction between cognitive reactivity and stress is a significant predictor of the onset of depressive episodes (e.g. Hankin et al., 2004; but see Barnett & Gotlib, 1990). An influential study which supports the role of cognitive reactivity in relapse of depression in remitted individuals found that mood-induced cognitive reactivity significantly predicted relapse over a 18-months interval (Segal et al., 2006). This evidence clearly supports the existence of latent vulnerability factors in at-risk individuals which are not detected during euthymic phases, but easily activated by stressors.

How is the concept of cognitive reactivity linked to DMN activity? Although direct research on DMN activity in relation to cognitive reactivity is lacking, a relation can be inferred from several lines of research. Cognitive reactivity has been mainly conceptualized as an associative processing between the self, negative mood and negative thinking (Bower, 1981; Teasdale, 1988). Interestingly, the TN circuit overlaps with the brain regions activated during associative conditioning (Bar et al., 2007) and the strength of the association elicited by a stimulus has been shown to be related to the TN activation (Bar & Aminoff, 2003; Bar, 2004; Aminoff et al., 2007). In particular, MPFC, PCC and MTLC (e.g. hippocampus and parahippocampus) play a fundamental role in both basic as well as more complex associative processes (Aminoff et al., 2007; Bar, 2004; Eichenbaum, 2000).

Bar (2009b) proposed a link between aberrations in TN-related associative processing and negative mood (as well as depression). This hypothesis encompasses a bidirectional influence between broad associative thinking and mood. Broad associative thinking is linked to positive affect whereas narrow associative processing is related to negative mood. While the former phenomenon seems to be important in relation to protective factors (cf. the “broaden-and-build theory” of resilience; Fredrickson, 2004), the latter has been applied to depression and related risk factors especially rumination. Bar speculates that during rest MPFC hyperactivity, comprising also the SubG, (see Drevets et al., 2002; Greicius et al., 2007) could dramatically limit activation linked to associative processing in the MTLC. The main psychological outcome of this constraint is both a narrowed associative network and rumination, causing negative mood which in turn reduces the likelihood to broaden the associative links afterwards. Preliminary evidence supporting this hypothesis is provided by an fMRI study that showed enhanced connectivity in the MPFC and MTLC in depression (Berman et al., 2011).

Supporting the link between DMN and cognitive reactivity, the MPFC, the PCC, and the MTLC are all areas involved, albeit to different degrees, in memory and self-related processing (Andrews-Hanna et al., 2010; Cavanna, 2007; Gusnard et al., 2001), functions which are both related to the concept of self-schemata (Beck, 1967). In line with literature showing negative self-evaluation after recovery (Dozois & Dobson, 2001; Seeds & Dozois, 2010), we propose that remitted depressed patients still possess latent negative self-schemata (e.g. negative *mindset*), the neural substrate of which is represented by increased levels of TN functional connectivity during rest. Interestingly, our proposition is partially in line with a recent theory, in which the MPFC, ACC, amygdala and other sub-cortical regions are explicitly invoked to support negative self-schemata in current depression (Disner et al., 2011).

There are many similarities between proposed functions of the DMN, association-based mindset (Bar, 2009a), internal mentation (Buckner et al., 2008) and cognitive reactivity. Not only is cognitive reactivity related to negative evaluation of the self but also to problematic beliefs about the future (i.e., hopelessness; Alloy et al., 1997; Antypa et al., 2010; Barnhofer & Chittka, 2010). According to the Internal Mentation Hypothesis, the TN plays a role in several functions in which mental simulation is required (Buckner et al., 2008), such as temporal self-projection. Interestingly, a recent study shows that currently depressed individuals report a specific impairment in generating episodic details concerning future events (King et al., 2011). Likewise, in remitted depressed and never depressed subjects, hopelessness, an important facet of the cognitive reactivity construct (Van der Does, 2002), predicts lower positive future fluency after negative mood induction (Williams et al., 2008). Note that hopelessness is involved in one`s ability to project oneself in the future and this may be associated with TN abnormalities both in depressed (Grimm et al., 2009) and healthy individuals (Wiebking et al., 2011).

Despite important differences between the internal mentation (Buckner et al., 2008) and association-based mindset hypothesis (Bar et al., 2007), we suggest common underlying mechanisms. Given the need for past information to both create associative links and mentally simulate new scenarios, it can be argued that both theories rely on memory and memory-related brain regions, such as the MTLC and hippocampus (Buckner, 2010; Perry et al., 2011). Therefore, the TN which may also implicate the hippocampus (Buckner et al., 2008), could provide an overarching influence on these associated functions. An increasing amount of data highlights the role of the hippocampus and memory for TN functional connectivity in the context of depression (Goveas et al., 2011, Hamilton et al., 2010), so that the same pattern can be expected even after recovery. Indeed, as remitted depressed patients continue to show impairments in most of the domains supposed to be embedded in this network, it is plausible that abnormal resting state functional connectivity in the TN plays a crucial role in this specific population.

Providing some evidence for our position, a recent study investigated resting state TN functional connectivity in late-life depression before and after 12 weeks of pharmacotherapy (Wu et al., 2011). Contrary to the findings from a study on mid-life depression (Greicius et al., 2007), this research reported decreased SubG-PCC connectivity in currently depressed patients. This inconsistency with previous research could be due to different data collection and data analysis approaches, as well as to cerebrovascular peculiarities of late-life depression (Alexopoulos et al., 1997). Crucial to our proposal, pharmacological treatment improved SubG-PCC connectivity but fully remitted depressed individuals continued to differ from healthy participants. Despite differences in the direction of connectivity, this clearly supports the notion that even after gaining recovery remitted depressed individuals display abnormal TN functional connectivity during rest.

As mentioned above, remitted depressed patients, characterized by high levels of cognitive reactivity, do not usually show negative thinking unless they encounter stress in everyday life or undergo negative mood induction in the laboratory (Scher et al., 2005). A manipulation involving negative mood (e.g. listening to a sad music) or self-reference (e.g. recalling a sad autobiographical memory) appears to successfully activate latent schemata as evidenced by depressotypic negative biases (Phillips et al., 2010). Therefore, rest-to-affective task transition is the ideal context to investigate whether individuals, with high levels of cognitive reactivity, are able to (de)activate the DMN. Mirroring the depression-related *TN-persistence* during rest-to- affective task transition (Grimm et al., 2009; Sheline et al., 2010) and the mindset-stimulus interaction specificity (Bar, 2009a), remitted depressed individuals are supposed to show both *TN-persistence* and *TP-deficiency*. In a recent study, remitted depressed individuals (with three or more major depression episodes) and healthy controls underwent a blocked design fMRI study where sad or neutral video clips were shown (Farb et al., 2011). A remitted depressed subgroup, consisting of patients who relapsed within the following 18 months, showed a statistically significant activation of the VMPFC in response to sad stimuli in comparison with controls. Patients who stayed in remission could not be distinguished from controls in terms of activation in TN. Crucial for our proposal, VMPFC-persistence was found to predict relapse. Moreover, Hooley et al. (2005) reported that, compared with healthy individuals, remitted depressed individuals displayed substantially reduced DLPFC activation, when confronted with negative information (maternal critical remarks). This is in line with the idea that, as for currently depressed individuals (Fales et al., 2008, 2009; Holmes and Pizzagalli, 2008;

Mitterschiffthaler et al., 2008; Siegle et al., 2007), remitted depressed individuals also still show TP-deficiency when challenged by negative emotions.

Finally, there is emerging evidence showing that specific therapies for recurrent depression, such as Mindfulness-based Cognitive Therapy (MBCT), may elicit therapeutic effects through their influences on the DMN. In this context mindfulness refers to a particular way of focusing on the present moment characterized by full attention to internal and external contexts, non-judgment and openness to current experience, increased acceptance, and lower experiential avoidance. There is evidence for the value of this treatment as a prophylaxis for recurrent depression (Chiesa et al., 2011). Specifically, MBCT is designed to target the strong associative links between the self and negative thoughts and feelings (e.g. cognitive reactivity) in order to prevent relapse (Segal et al., 2002). Indeed after MBCT, the relapse rate in remitted patients at high risk for recurrence has been shown to decrease dramatically (Ma & Teasdale, 2004). Two recent studies have found that mindfulness disposition is negatively correlated with cognitive reactivity and that MBCT can directly influence this risk factor reducing its level or deactivating its potential toxic effects on mental activity (Kuyken et al., 2010; Raes et al., 2009). A recent fMRI study found that resting state mindfulness disposition was negatively correlated with TN activation in the MPFC, PCC, temporal cortex, as well as subcortical areas, such as amygdala, hippocampus, and thalamus in healthy participants (Way et al., 2010). Interestingly, the authors suggest that lower TN activation in people with higher levels of mindfulness may reflect weakened links between thoughts, feelings, and the self, supposed to be crucial in dormant negative schemata. After mindfulness training, there appears to be a mindfulness-linked improvement in TN-TP balance in response to sadness provocation (Farb et al., 2010). Following mindfulness training vs. no training, participants displayed increased activation in the DLPFC and SubG as well as increased deactivation in the PCC, left PFC and IFG. Thus, not only does mindfulness seem capable of targeting TN components by reducing its rest-related activation but also by ameliorating aberrations during rest-to-affective task transitions.

In sum, there are several findings consistent with our proposal linking cognitive reactivity with the DMN. First, remitted depressed individuals reporting high levels of cognitive reactivity show negative self-views as well as reduced positive future prospection. Both concepts of self-schemata and future self-projection have been attributed to resting state TN activity (Bar, 2009a; Buckner et al., 2008). This leads to the proposal that remitted depressed individuals show increased TN functional connectivity similar to currently depressed patients. On the basis of this notion we propose that remitted depressed individuals will display increased TN connectivity during rest, which supports the idea of latent negative self-schemata, given the role of TN in internally-oriented attention (Fox et al., 2005), self-related processing (Gusnard et al. 2001), and associative processing (Bar et al., 2007). Additionally, decreased TP connectivity during rest and related reduced externally-oriented attention might fail to provide exogenous information which may disconfirm and update negative self-schemata. Second, mirroring the mindset-stimulus interaction specificity, remitted depressed individuals are predicted to resemble currently depressed individuals in showing aberrant rest-to-affective task transition. Both TN-persistence and TP-deficiency after emotional challenge have been reported in comparison with healthy people, supporting our proposal that depression-like DMN impairments clearly persist even after recovering. Third, mindfulness-based interventions appear capable of both reducing TN regions activity in rest and improve rest-to-affective task imbalance.

In addition to our previous predictions about (i) enhanced TN functional connectivity during rest, (ii) increased TN-dominance over TP during rest, (iii) increased TN-persistence and (iv) TP-deficiency, we predict that (v) these patterns will be positively correlated with cognitive reactivity measures (as well as rumination and attentional impairment) and (vi) that this abnormal DMN activity will predict, partially via increased cognitive reactivity, future depressive relapse.

Conclusion and Future research

In this paper, we introduced a framework which integrates cognitive and neurobiological factors involved in recurrent depression. In particular we propose that specific forms of DMN system dysregulation lead to cognitive deficits that make remitted individuals more vulnerable to the onset of future episodes of depression. We argue that three well-established cognitive risk factors – rumination, poor attentional control, and cognitive reactivity, which have been studied in isolation, have their roots in the TN dominance and hyper-connectivity. These TN features are associated with excessive and maladaptive self-focus and subsequent difficulties in both switching to an extrospective perspective during rest and effectively transitioning into tasks, impairing TP functioning. We suggest that remitted depressed individuals still show aberrant DMN, and that DMN dysfunction may represent a residual neural “depressive scar”, which is linearly influenced by the amount and severity of previous depressive episodes (Wichers, et al., 2010). At the same time the DMN is proposed to be a good predictor of recovery-related cognitive risk factors as well as future depressive recurrence. Although much more research is needed, initial support for our model comes from a number of sources. First, rumination has been connected in healthy and depressed subjects to increased TN connectivity and TN-dominance over the TP during rest (Berman et al., 2011; Hamilton et al., 2011a, Zhu et al., 2011). More specifically, midline structures, such as MPFC, SubG and PCC, play a crucial role in problematic self-related processing such as rumination. Second, attentional control failures, considered to be crucial in depression recurrence (De Raedt & Koster, 2010), are linked to inappropriate DMN rest-to-task transitioning (i.e. TN-persistence and TP-deficiency), mainly guided by the PCC (Eichele et al., 2008), which might be related to the internal-external switch of our attention resources. Third, cognitive reactivity, defined as the ease with which negative latent schemata are activated by appropriate triggers, is thought to be neurobiologically subserved by abnormally increased rest-related TN connectivity (particularly between the MPFC, the PCC and the hippocampus/parahippocampus) as well as by an aberrant DMN rest-to-task transition in the emotional context.

As some of the predictions are quite tentative, we now note several general restrictions that apply to our framework. First, it is noteworthy that there still is ongoing debate about different ways to conceptualize and analyze rest-related task-independent activity. A clear taxonomy of different approaches to investigate resting state is still lacking and a clear consensus on the best way to analyze resting state has not been reached. For instance, studies concerning resting brain activation, rest-related functional connectivity, as well as rest-stimulus interaction, sometimes give inconsistent results likely due to methodological differences (Hasler & Northoff, 2011; Whitfield-Gabrieli & Ford, 2012). Second, the TN-TP anti-correlation is still a topic of debate (Cole et al., 2010). For instance, some authors have argued that apparent antagonism between DMN subcomponents is a technical and methodological artifact (Murphy et al., 2009), whereas most of studies support the idea that there actually is antagonism of function between these two DMN sub-systems (e.g. Chai et al., 2012; Fox et al., 2009; Liang et al., 2012; Kelly et al., 2008; Margulies et al., 2007). However, the situation is fluid and views may change due to emerging knowledge on TN-TP switching. Third, based on new general developments as well as specific research in depression, future understanding of the DMN in recurrent depression can provide more specific links of different cognitive vulnerability factors to some aspects of this network. Finally, it is important to acknowledge that depression is a complex disorder that can be the outcome of a wide variety of biological, psychological, and environmental factors and the same obviously holds for recurrent depression (Monroe & Harkness, 2011). For example, in most patients increased emotional reactivity is observed, leading to the so called depressive interlock loop (Teasdale & Barnard, 1995), characterized by increased coupling between negative thoughts, emotion, bodily sensations and behavior, whereas other patients show blunted affect and decreased reactivity (see DSM-IV-TR, APA, 2000). Therefore, we argue that specific symptom clusters should be taken into account in future research.

In keeping with this, a change from a syndrome-driven towards a process-based perspective in conceptualizing mental disorders may provide substantial progress in the development of our understanding of psychopathology (Borsboom et al., 2011). For instance, despite notable differences, both depression and schizophrenia share similar DMN aberrations, such as TN hyperconnectivity, TN-persistence, and TN-TP abnormal interplay (for a review Whitfield-Gabrieli & Ford, 2012). This clearly raises the question about how specific these default brain aberrations may be for each single disorder. It may be that at a general level TN and TP subserve respectively internal and external focus, as we propose in our model, so that mentally-affected individuals showing DMN aberrations are actually characterized by sub-optimal capability of switching between different attentional focuses. However, what still remains unclear is the process through which different forms of psychopathology showing partially similar neurobiological patterns are characterized by different symptom profiles related to the same basic processes, such as dominant internally-oriented attention (e.g. self-focus in depression vs. paranoid ideation in schizophrenia). Arguably, a dimensional approach could overcome such problem in that certain psychological processes could be fruitfully investigated per se, both in clinical and non-clinical samples (Whitfield-Gabrieli & Ford, 2012). Investigating more basic processes one by one, rather than taking into account an entire and complex syndrome, could indeed enhance understanding of the mechanisms that are crucial in pathological phenotypes, such as the interplay with other networks (Hamilton, Chen, & Gotlib, 2013; Menon, 2011).

Although initial evidence for our framework is promising, more systematic research is required. Below we provide an agenda for future research goals derived from the current framework. The very core of our framework is that remitted depressed individuals still show most depression-related DMN aberrations, which can account for residual symptoms during recovery as well as future depressive recurrence. Hence, the ideal context to test our predictions is by comparing DMN system activity in (medication-free) currently depressed, never depressed and remitted depressed individuals (reporting a different amount of past depressive episodes). To do this, both cross-sectional and longitudinal studies are required. Therefore, as a first step, we provide an overview of important theoretical predictions (Table 1). Afterwards, longitudinal studies which, taking into account all three risk factors at the same time, investigate the potential role of the DMN in predicting future depressive recurrence appear to be the most appropriate further step. In such studies remitted depressed and never depressed individuals are suggested to be recruited and assessed at baseline and follow-ups either with self-report questionnaires and clinician-based interviews. DMN aberrations are thus expected to predict future major depression in the clinical group, partially via cognitive risk factors, whereas this pattern is predicted not to emerge in never depressed individuals. Moreover, we speculate that the DMN contribution to explaining future recurrence might be an overarching predictor which significantly reduces the unique predictive power which each risk factor has singularly. Additionally, the proposed links between cognitive risk factors and DMN may be organized in a hierarchical way so that vulnerability factors do not all predict future recurrent depression to the same degree. Rumination could be the main output of dysfunctional DMN with both cognitive reactivity and impaired attention control as byproducts of such maladaptive self-focus; but attentional process might also be the core vulnerability factor. Consequently, mediation models appear to be the most appropriate way to map the neural pattern (DMN), psychological functioning (internally-oriented attention) and cognitive deficits (risk factors) in a consistent frame capable of explaining recurrence in depression.

Table 1.

Theoretically-derived research goals

	Risk factor	**Predictions**	**Research Paradigm**
Cross-sectional Studies: *CR, ND and RD*	Rumination	TN increased functional connectivity	rs-fMRI
		TN-dominance over TP	rs-fMRI
		Increased internally oriented attention	rs-fMRI with random internal and external attentional probes
	Impaired Attentional Control	Rest-to-Task transition: • TN-persistence • TP-deficiency	Rest period followed by an attention demanding task using non-emotional material
	Cognitive Reactivity	TN increased functional connectivity	rs-fMRI
		TN-dominance over TP	rs-fMRI
		Rest-to-Task transition: • TN-persistence • TP-deficiency	Rest period followed by an attention demanding task using emotional material. Outside the scanner both self-report questionnaires and experimental mood manipulation are suggested to ascertain cognitive reactivity

Note. **CR** – currently depressed; **ND** – never depressed; **RD** – remitted depressed; **rs-fRMI** - resting state fMRI; **TN** – Task Negative; **TP** – Task Positive

In conclusion, the current analysis motivates a focus on interrelated networks and resting state activity instead of BOLD signal in specific brain structures *per se*. This could indeed be a paradigmatic shift that enhances our insight in the relationship between depression vulnerability and psychological processes, because this relationship implies an interplay between many different brain functions. Therefore, an approach taking into account the associative nature of mental processes and brain functioning provides a promising avenue for future research on inter-individual differences in vulnerability and resilience.

Addendum

Since the publication of our theoretical framework (Marchetti, Koster, Sonuga-Barke, & De Raedt, 2012), two independent research groups have tested and substantially confirmed our hypothesis. We here report these two studies in detail.

Nixon et al., (2014) recruited 20 remitted depressed individuals and 20 matched healthy controls and had them undergo a slow-paced Go/NoGo task. By adopting bilateral precuneus as seed regions, task-based whole-brain functional connectivity analysis was performed. Importantly, compared to healthy controls, the clinical groups reported an increased connectivity between both the right and left precuneus and the right dorsomedial prefrontal cortex (rDMPFC; BA 9). Moreover, considering the important role played by antidepressant in normalizing the rest-to-task transition (Delaveu et al., 2011), the authors also explored the possible impact of pharmacotherapy on the reported DMN hyperconnectivity. Unmedicated remitted depressed individuals still showed increased precuneus-rDMPFC, whereas medicated remitted depressed individuals were not distinguishable from healthy controls. Additionally analysis confirmed the role of DMPFC, and specifically the “dorsal nexus” (Sheline et al., 2010). By means of a region of interest (ROI) analysis, the authors confirmed the existence of hyperconnectivity between the bilateral dorsal nexus and bilateral precuneus in remitted depressed compared to healthy controls.

Zamoscik, Huffziger, Ebner-Priemer, Kuehner, and Kirsch (2014) recruited 29 remitted depressed and 29 matched healthy controls, and had them undergo negative mood induction in the context of fMRI data acquisition. Within the framework of cognitive reactivity (i.e., recalling sad autobiographical memories while listening to sad music; Scher et al., 2005), the clinical group showed increased connectivity between the posterior cingulate cortex (PCC) and the parahippocampal gyri (PHG), when compared with healthy controls. Importantly, the authors also reported informative associations of this neurobiological index with variables mapping on vulnerability to depression. First, the strength of the PCC-PHC during sad provocation correlated with the number of previous episodes ($R^2 = .29$, $p < .003$). Second, the reported DMN hyperconnectivity was positively associated with sadder mood and more ruminative thinking in daily life, as measured with ambulatory assessment method, in the clinical group ($R^2 = .24$, $p < .019$ for negative mood; $R^2 = .28$, $p < .004$), but not in healthy controls. This finding held even after controlling for the number of previous episodes and depressive score, measured at the time of fRMI data acquisition. Third, in remitted depressed individuals the PCC-PHG connectivity explained future depressive symptoms ($R^2 = .13$, $p < .015$) and habitual brooding ($R^2 = .07$, $p < .005$), but not habitual reflective pondering in a 6-month follow-up. This result held even after controlling for depressive and ruminative scores at the baseline.

These studies provide preliminary, but important, evidence supporting our hypothesis. Both studies indeed confirm our main prediction, that is the DMN is functionally hyperconnected in the remitted depressed individual compared to healthy controls. However, it is important to stress that different neurological loci have been reported, so future studies should highlight the specific contribution of these areas and maybe ascertain the existence of different DMN sub-networks in this clinical group (Andrews-Hanna et al., 2010).

Importantly, the study carried out by Zamoscik and colleagues (2014) provided support to many aspects of our theoretical framework. For instance, increased DMN connectivity was detected in the context of cognitive reactivity (i.e., activation of present but dormant negative schemata by priming negative mood and negative self-referential thoughts), a major cognitive risk factors that we theoretically linked the DMN. Moreover, confirming the association between DMN hyperconnectivity and rumination, a positive relation between has reported between the PCC-PHG connectivity in remitted depressed individuals and state rumination, as measured 10 times a day per 2 days. Finally, the authors supported out hypothesis that not only aberrantly highly connected DMN in remitted depressed could represent a “scar” due to previous depressive episodes, but also that it could have a specific role in predicting future depressive symptoms. In keeping with this, PCC-PHG hyperconnectivity during sad provocation has been significantly associated with the number of previous episodes and future depressive symptoms and tendency to engage in depressive brooding (but not in reflective pondering) in remitted depressed individuals. However, at the moment it is not possible to exclude a pre-existing, perhaps genetic, vulnerability to DMN aberrations, so that it is hard to clarify the timing between DMN aberrations and past depressive symptoms.

Confirming the explicatory power of our rest-to-transition construct, Nixon and colleagues (2014) reported that, compared to healthy controls, remitted depressed showed an increased precuneus-rDMPFC during task engagement, although no behavioral differences were reported in the attention-demanding task. Moreover, in line with our hypothesis and previous evidence (Delaveu et al., 2011), antidepressant medication seems able to normalize DMN-related aberrations. Unmedicated remitted depressed individuals were statistically distinguishable from healthy controls, whereas this was not the case for medicated remitted depressed individuals.

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CHAPTER 3

Mindwandering heightens the accessibility of negative relative to positive thought[1]

ABSTRACT

Mindwandering (MW) is associated with both positive and negative outcomes. Among the latter, negative mood and negative cognitions have been reported. However, the underlying mechanisms linking mindwandering to negative mood and cognition are still unclear. We hypothesized that MW could either *directly* enhance negative thinking or *indirectly* heighten the accessibility of negative thoughts. In an undergraduate sample (n = 79) we measured emotional thoughts during the Sustained Attention on Response Task (SART) which induces MW, and accessibility of negative cognitions by means of the Scrambled Sentences Task (SST) after the task. We also measured depressive symptoms and rumination. Results show that in individuals with elevated levels of depressive symptoms MW during SART predicts higher accessibility of negative thoughts *after* the task, rather than negative thinking *during* the task. These findings contribute to our understanding of the underlying mechanisms of MW and provide insight into the relationship between task-involvement and affect.

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[1] Based on Marchetti, I., Koster, E. H. W., & De Raedt, R. (2012). Mindwandering heightens the accessibility of negative relative to positive thought. *Consciousness and Cognition*, *21*(3), 1517-1525. doi: 10.1016/j.concog.2012.05.013

“*The mind wanders, not just away from where we aim it,*
but also toward what we forbid it to explore”
- Daniel M. Wegner (1997, p.304)

Introduction

A typical feature of the human mind is its tendency to spontaneously generate thoughts and to freely wander despite the external environment (Smallwood & Schooler, 2006). With the exception of several early studies (e.g. Antrobus, 1968; Singer, 1966), this phenomenon has only recently been systematically investigated (see Gruberger, Ben-Simon, Lvkovitz, Zangen, & Hendler, 2011; Smallwood & Schooler, 2006). Because of the elusive nature of the wandering mind, several terms for this construct have been used, such as “*mindwandering*” (Smallwood & Schooler, 2006), “*stimulus independent thought*” (Mason et al., 2007), “*daydreaming*” (Mar, Mason, & Litvack, 2012; Singer, 1966), and “*task unrelated thought*” (Smallwood & Schooler, 2006). Despite subtle conceptual differences (Christoff, 2012), a core characteristic is a state of decoupled attention when the mind wanders, where attention is detached from external toward internal processing (e.g. personal goals and current concerns) (Smallwood & Schooler, 2006). Here, we adopt the umbrella term of mindwandering (hereafter MW) to define this phenomenon.

MW is considered a ubiquitous phenomenon with high intra-individual stability across short and long time periods (Giambra, 1995; Kane et al., 2007). Recently, Killingsworth and Gilbert (2010) showed, using an experience sampling approach, that MW occurs during almost every activity in everyday life. Moreover, Kane et al. (2007) estimated that we spend between 10% and 30% of our daily live experiencing MW. In light of such pervasive occurrence, it has been suggested that MW has several advantageous functions (Baars, 2010). For example, future planning is considered to be one of the most beneficial outcomes of MW (Schooler et al., 2011). Smallwood, Nind and O'Connor (2009) reported that MW involved thinking about the future, rather than about the present or past. Moreover, such future-oriented thought is enhanced by self-reflection (Smallwood et al., 2011) and by priming of personal goals (Stawarczyk, Majerus, Maj, Van der Linden, & D'Argembeau, 2011), while it is reduced by negative mood (Smallwood & O'Connor, 2011). The clear advantage of MW here is to predict possible future events, to achieve better adaptation to the environment, and proactively reduce upcoming distress (Bar, 2009). In keeping with this, MW may also facilitate personally relevant problem solving by manipulating semantic information acquired during external processing (Binder et al., 1999). In other words, during MW it is possible to systemize information which could not be organized and analyzed during stimulus presentation. Finally, creativity (Sio & Ormerod, 2009) and coping (Greenwald & Harder, 1995) have also been linked to MW.

Nevertheless, MW comes also with several downsides which should be taken into account. First, according to the definition of a state of decoupled attention from external stimulation (Smallwood & Schooler, 2006), MW is consistently associated with impaired performance when one is required to accomplish a demanding task (Schooler et al., 2011). For instance, MW leads to reduced reading comprehension (Smallwood, McSpadden, & Schooler, 2008) and attentional failures (Christoff et al., 2009). Interestingly, a recent ERP study demonstrated that during off-task periods both task-related information as well as novel distractors are elaborated to a lesser extent (Barron, Riby, Greer, & Smallwood, 2011). This supports the notion that during MW, attention is not drawn by external interfering stimuli but is actually turned inwards. Moreover, MW is often associated with reduced executive control (Schooler et al., 2011), reflecting either a phenomenon demanding executive resources (Smallwood & Schooler, 2006) or an executive failure (McVay & Kane, 2010). Second, MW is associated with detrimental effects on mood. A recent experience sampling study in 2250 healthy people showed that MW at initial sampling predicted lower mood at subsequent sampling (Killingsworth & Gilbert, 2010). However, it is not clear whether this happened by reducing positive mood, enhancing negative mood, or both. In turn, negative mood induction heightens MW levels (Smallwood, Fitzgerald, Miles, & Phillips, 2009). The latter data suggest a reciprocal influence between MW and mood fluctuations. Third, some evidence supports a specific link between MW and depressive cognitions. In their seminal study, Golding and Singer (1983) reported that MW substantially explained variance in depressive attitudes, namely self-criticism, dependency, and inefficacy. In line with this, clinically and subclinically depressed samples show higher levels of MW (Smallwood, O'Connor, Sudbery, & Obonsawin, 2007; Watts, MacLeod, & Morris, 1988). Fourth, at the level of individual differences, depressive symptoms as well as rumination are worth mentioning. Individual levels of depressive symptoms have been reported to be consistently associated with MW (Smallwood et al., 2003, Study 2, 3) and capable of predicting off-task thinking during a task (Smallwood, O'Connor, & Heim, 2006). Whereas, rumination, defined as "behaviors and thoughts that focus one's attention on one's depressive symptoms and on the implications of those symptoms" (Nolen-Hoeksema, 1991, p. 569), has generally been reported not to predict MW (Smallwood et al., 2003, 2006). Although rumination has been associated theoretically with MW as another form of repetitive thinking (Watkins, 2008), rumination induction compared to distraction did not lead dysphorics to experience increased levels of MW (Lyubomirsky, Kasri, & Keri Zehm, 2003).

So far no studies have explicitly investigated the link between MW and negative cognition. Indeed, most of the available data is correlational where it is difficult to make a directional inference. Interestingly, a specific link between MW and negative thinking can be proposed. As MW is associated with internally-oriented focus (Baird, Smallwood, & Schooler, 2011; Barron et al., 2011; Smallwood et al., 2011), it can heighten self-focus, which has been reliably associated with negative mood (Mor & Winquist, 2002). Moreover, a consistent line of research stressed that during spontaneous thought personal priorities and goals are actively processed (Giambra 1995; Levinson, Smallwood, & Schooler, 2012; Killingsworth & Gilbert, 2010), so that personal concerns may emerge and impact on thinking.

In keeping with this, MW can potentially have either *direct* or *indirect* effects on cognition that may explain its mood dampening effects. That is, it could be that when people's minds wander they are inclined to think in a self-critical and negative way, with MW being *directly* associated with increased negative cognitions. Alternatively, MW can also have an *indirect* effect on negative cognitions through other cognitive mechanisms such as self-focused attention. In this case there would be an increased accessibility of negative cognitions, without an immediate detrimental effect on thinking. To our best knowledge, these after-effects on cognitions have never been investigated.

In the current experiment, MW, operationalized as "*a shift of attention away from a primary task toward internal information*" (Smallwood & Schooler, 2006, p. 946), was induced and measured using a slow-paced Go/NoGo paradigm, the Sustained Attention on Response Task (SART, Robertson, Manly, Andrade, Baddeley, & Yiend, 1997). The execution of the task was pseudo-randomly interleaved by thought probes to determine the presence of mindwandering (MW, from being completely on-task to completely off-task) and the valence of cognitions (from negative to positive) *during* the task, the latter allowing to test the direct effect of MW on cognition. Previous research has extensively shown that SART performance is related to attentional failures in everyday life (ecological validity; Smilek, Carriere, & Cheyne, 2010) and induces MW (Stawarczyk et al., 2011). Alternatively to literature which conceptualizes MW as a categorical phenomenon (Christoff et al., 2009), we adopted a dimensional approach for two reasons. First, capitalizing on the variance at the level of each thought probe by using a Likert scale can provide substantially more information. Second, previous studies found that the neurobiological substrate of MW, namely the Default Mode Network (Gruberger et al., 2011), parametrically interferes with being completely engaged in a task rather than in an "all-or-none" fashion (i.e., Weissman, Roberts, Visscher, & Woldorff, 2006). Consistent with our new approach, recently Prado and Weissman (2011, pp.2281) claimed that: "[…] *in addition to theorizing about discrete on- and off-task states (Smallwood et al., 2008; Christoff et al., 2009), it may be fruitful to conceptualize default-mode interference along a continuum*". For these reasons, we decide to adopt a continuous measure rather than a categorical approach.

To examine the indirect effect of MW, we examined the accessibility of negative thoughts using a Scrambled Sentences Task (SST, Van der Does, 2005; Wenzlaff & Bates, 1998) *before* and *after* MW. This task requires participants to unscramble sentences to form grammatically correct and meaningful statements using five of six displayed words. By reporting the unscrambled sentence that first comes to mind, every sentence is resolved in either a positive or negative manner. In depression-related research, this task has been used extensively and found to be sensitive to fluctuations in the accessibility of negative cognitions (Phillips, Hine, & Thorsteinsson, 2010; Wenzlaff & Bates, 1998). Unlike the standard paradigm, we did not tax participants' executive resources by means of cognitive load (i.e. retaining a six digit number), because we expected that MW would impair mental resources necessary to regulate negative thinking (Smallwood & Schooler, 2006). Finally, depressive symptoms and ruminative thinking were both considered in the analysis in order to investigate the potential effect of individual differences in predicting negative cognitions.

Method

Participants

Eighty undergraduates from Ghent University participated in this study for course credits. One case constituting an outlier (standardized residuals > 3) was dropped, as recommended by Meyers, Gamst, and Guarino (2006), leaving 79 individuals (mean age = 20.3 years, *SD* = 2.6, 75.9% female). All participants signed informed consent. The study was approved by the Ethical Committee at Ghent University.

Materials

Questionnaires. Individual differences in subclinical depressive symptoms and thinking style were considered in this study. Dysphoria and rumination were assessed respectively by the *Beck Depression Inventory – 2nd Edition* (BDI-II; Beck, Steer, & Brown, 1996) and *Ruminative Response Scale - Revised* (RRS-R; Nolen-Hoeksema & Morrow, 1991). As measure of current mood state, we used the *Positive Affect Negative Affect Scale* (PANAS, Watson, Clark, & Tellegen, 1988).

Scrambled Sentences Test (SST). The SST is a paper-and-pencil test which evaluates the activation of negative relative to positive cognitions and includes 3 sets of 20 scrambled sentences (Wenzlaff & Bates, 1998). Each scrambled sentence comprises of six words randomly ordered in an ungrammatical form. Five of the six words from each sentence must be chosen and ordered to form one of two possible sentences. One sentence has a positive outcome and the other has a negative resolution. Participants had to complete each set within 2.5 minutes. All participants completed one sentence set before and one sentence set after the mindwandering phase, and the order of the sets was fully counterbalanced. The main outcome is the ratio of negative sentences to all the total grammatically correct sentences. Although the SST cannot compute statistically independent indexes for negative and positive cognitions, the vast majority of the literature relies on the SST to measure negative cognitions (Phillips et al., 2010). Thus, in relation to the SST we hereafter refer to "negative cognitions", though being aware of the limitations above mentioned. A validated Dutch version of the SST was used (Van der Does, 2005).

Sustained Attention to Response Task (SART). The SART is a Go/No-Go paradigm explicitly aimed to facilitate mindwandering or off-task thought (Robertson et al., 1997; Christoff et al., 2009). Two different kinds of stimuli appeared on the screen. Participants had to respond (pressing a button) to a non-target (e.g. letter “O” – Go stimulus) and withhold the response (not pressing) to a target (e.g. letter “Q” – NoGo stimulus). The SART session consisted of 40 targets (5.5%) and 720 non-targets. Stimulus presentation time and interstimulus interval were both 1250ms. This rate of stimulus presentation was based on previous studies indicating that slow stimulus presentation rate yields greater off-task thought (Jackson & Balota, 2012; Smallwood et al., 2004). Moreover, pseudo-randomly 40 probes consisting of two questions were presented. Participants had to report if either the thought preceding the probe was fully focused on the task or they were experiencing mindwandering (*MW*), and then to rate the valence of these thoughts (*Valence of the Cognitions*). Both questions were answered on a 7-point Likert scale, ranging from 1 = on-task to 7 = off-task for the first, and from 1 = extremely negative to 7 = extremely positive for the second probe. The whole task lasted about 35 minutes.

Design

At the beginning of the experiment, participants were required to fill in current mood state measures (PANAS T1), followed by a measure of the accessibility of negative cognitions (SST T1). Then, individuals underwent the MW phase (SART), after which changes in the accessibility of negative cognitions were assessed again (SST T2). Finally, mood state measures (PANAS T2) and individual differences scales (BDI-II and RRS-R) were administered. Except for specific characteristics, such design mirrors other studies investigating the impact of MW on self-referential thinking (Smallwood et al., 2011, Study 2).

Data-analytic strategy

We first checked the efficacy of our manipulation in inducing MW in participants (MW thought probes and commission errors). To ascertain the effect of time on the distribution of commission errors and responses to the thought probes, we obtained two halves from the SART, both consisting of the same amount of (non-)targets and thought probes (Stawarczyk et al., 2011). We then performed a paired Student's t-test between the first and second half both for MW thought probes and commission errors.

After this manipulation check, we evaluated changes in affect and affective cognitions during the experiment. We first analyzed mood changes (PANAS scales) before and after the SART by means of 2x2 ANOVA (Time and Valence as within-subject factors). Then, we conducted a paired Student's t-test to investigate whether cognitions became more negative (second thought probe) in the second half compared with the first of the SART. We also investigated, by means of a paired Student's t-test, whether there was a change in the accessibility of negative cognitions before and after the SART.

Finally, we ran two multiple linear regression models[2] aiming to investigate whether (i) MW and individual differences could explain the valence of cognitions *during* the SART (direct effect), after controlling for mood changes; (ii) MW and individual differences (BDI-II and RRS-R) could predict the increase of negative cognitions (SST) *after* SART (indirect effect), after controlling for mood changes. We also incorporated into the models the interactions between significant predictors. To do so, we used the Hayes and Matthes' (2009) MODPROBE computational procedures for probing interactions. The MODPROBE macro produces the usual regression output as well as estimates of the effect of the focal predictor variables at values of the moderator variable (for details, see Hayes & Matthes, 2009). According to Cohen, Cohen, West, and Aiken (2003), the predictor variables are mean-centered prior calculating the interaction term. To visualize statistically significant interactions the MODPROBE provides the conditional effects of or simple slopes for the focal predictor at low (one SD below the mean), moderate (sample mean), and high (one SD above the mean) values of the moderator, resulting in three groups of participants.

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[2] The same results reported below were obtained, without dropping the outlying case, by means of robust regression (M-estimation with Huber weighting).

Results

Descriptive statistics and means are provided in Table 1.

Table 1.

Descriptive statistics for the measures used in the study (n = 79)

Task and measure	*Mean*	*SD*	*Range (min. – max)*
Questionnaire – Individual Differences			
BDI-II	8.91	5.95	0 – 28
RRS-R	51.97	13.28	22 – 90
Questionnaire – Mood State			
PANAS positive T1	30.63	5.44	18 – 42
PANAS negative T1	14.31	4.47	10 – 31
PANAS positive T2	24.86	6.46	10 – 41
PANAS negative T2	14.56	3.75	10 – 27
Sustained Attention to Response Task (SART)			
Mindwandering	4.37	0.97	1.60 – 6.15
Valence of the Cognitions	3.84	0.62	1.88 – 5.33
Commission errors	14.37	6.83	2 – 32
Scrambled Sentences Test (SST)			
SST Negative Index T1 (%)	15.95	17.16	0 – 66.67
SST Negative Index T2 (%)	21.16	21.04	0 – 94.74

Note. Higher scores at the *Mindwandering* probe of the SART indicate more off-task focus, while lower scores represent more on-task focus. Higher scores at the *Valence of the Cognitions* probe of the SART indicate more cognitive positivity during the task, while lower scores represent more negative cognitions. *Commission Errors* indicate the number of failures in withholding behavior in response to “Q” targets. The *Negative Index* of the SST paradigm was calculated as the percentage of the ratio between the number of negatively unscrambled sentences and all the unscrambled sentences. Only grammatically correct sentences were included and percentages before (T1) and after (T2) SART paradigm are reported.

Mindwandering: manipulation check

To ascertain the efficacy of our manipulation, we conducted two paired Student’s *t*-tests between the first and second half of the SART. First, concerning the MW probes, analysis revealed a significant increase of MW, $t(78) = 4.95$, $p < .001$, $d =$

.55, with individuals' thoughts being more off-task in the second half (*M* = 4.64, *SD* = 1.21) than in the first (*M* = 4.09, *SD* = 0.94). Moreover, the number of commission errors was significantly different across time, $t(78) = 4.46$, $p < .001$, $d = .50$, with the second half being characterized by more errors (*M* = 8.16, *SD* = 4.00) than the first (*M* = 6.21, *SD* = 3.86). These results confirmed the efficacy of the experimental manipulation, in that being off-task and committing errors increased with time, whereas being fully on-task decreased.

Overall Mood State Changes

To investigate mood changes, a 2x2 repeated measures ANOVA was run on PANAS, with Time (pre vs. post) and Valence (positive vs. negative) as within-subject factors. The analyses revealed main effects of Time, $F(1, 78) = 81.68$, $p < .001$, $\eta^2_p = .51$, and Valence, $F(1, 78) = 311.36$, $p < .001$, $\eta^2_p = .80$. Also a significant Time x Valence interaction was found, $F(1, 78) = 49.71$, $p < .001$, $\eta^2_p = .39$, qualified by a significant reduction of positive mood, $t(78) = 9.45$, $p < .001$, $d = 1.05$, whereas no significant change in negative mood was detected, $t(78) = 0.60$, *p* = *ns*., $d = 0.07$.

Overall Changes in Affective Cognitions

To assess negative cognitions *during* SART, analyses were performed on two halves of paradigm. A paired Student's *t*-test was performed on the *Valence of Cognitions* probe, reporting a significant difference across two SART parts, $t(78) = 3.14$, $p < .002$, $d = 0.35$, with cognitions being more negative/less positive in the second half (*M* = 3.74, *SD* = 0.79) than in the first half (*M* = 3.97, *SD* = 0.57). To assess the accessibility of negative cognitions *after* MW, a paired Student's *t*-test was run on the SST negative index (percentage of the ratio between negatively interpreted scenarios and total number of scenarios) before and after SART paradigm. The analysis revealed a significantly increased accessibility of negative cognitions after the MW-related phase, $t(78) = 3.11$, $p < .01$, $d = 0.35$.

Does mindwandering predict increased negative cognitions (direct effect)?

The possible direct effect of MW in enhancing negative cognitions was explored by adopting a regression approach (for zero-order correlations, see Table 2).

Table 2.

Zero-order correlations between SART, SST and self-report questionnaires (n = 79)

	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) SST Negative Index T1	.71***	-.14	.31**	.21	-.17	-.06	-.17	-.24*	.15	-.21	.06
(2) SST Negative Index T2		.59***	.48***	.34***	.04	-.17	-.14	-.31**	.15	-.37***	.22*
(3) Δ SST Negative Index T2-T1			.32**	.26*	.26*	-.17	.01	-.15	.03	-.28**	.24*
(4) BDI-II				.37***	-.16	-.10	-.19	-.35***	.38***	-.38***	.40***
(5) RRS-R					-.01	-.08	.19	-.06	-.02	-.32**	.21
(6) SART - MW						-.11	.06	-.01	-.13	.03	-.07
(7) SART – Valence of the Cognitions							-.07	.03	-.10	.22*	-.34***
(8) Commission errors								.18	-.09	-.01	.12
(9) PANAS positive T1									-.21	.60***	-.01
(10) PANAS negative T1										.02	.59***
(11) PANAS positive T2											-.05
(12) PANAS negative T2											

Note. ***$p < .001$; **$p < .01$; *$p < .05$. Δ *SST Negative Index T2-T1* = differential score between SST negative indexes after (T2) and before (T1) SART paradigm. Higher scores represent an increase of negative cognitions at time 2, controlling for time 1

The mean *Valence of Cognitions* served as dependent variable, while individual differences (BDI-II and RRS-R) and changes in negative and positive mood (Δ PANAS T2-T1) were entered as predictors in the first step. In the second step, the mean MW probe scores served as predictor[3]. Variance-inflation-factors were all around 1, showing that multicollinearity was not a problem. Analyses revealed that the enhanced level of negative cognitions during MW was not significantly predicted by the model, nor by single predictors (see Table 3).

Table 3.
Summary regression statistics in predicting enhanced negative cognitions during mindwandering (direct effect)

Valence of the Cognitions	Step	Predictor	*B*	*SE B*	*sr*	β
	1	BDI-II	-.01	.01	-.11	-.117
		RRS-R	.00	.00	.05	.058
		Δ PANAS positive T2-T1	.02	.01	.16	.176
		Δ PANAS negative T2-T1	-.03	.02	-.16	-.173
	2	BDI-II	-.01	.01	-.12	-.138
		RRS-R	.00	.00	.05	.064
		Δ PANAS positive T2-T1	.02	.01	.17	.186
		Δ PANAS negative T2-T1	-.03	.02	-.15	-.163
		MW	-.08	.07	-.12	-.127

For the negative cognitions R^2 = .085 for Step 1, *ns*; ΔR^2 = .016 for Step 2, *ns*. *Note*: *sr* = semipartial correlation. *Valence of the Cognitions* = thought probe measuring the valence of the cognitions during SART paradigm. Higher scores represent cognitions more positively than negatively valenced. Δ *PANAS positive T2-T1* and Δ *PANAS negative T2-T1* = differential score between second and first PANAS, respectively either positive or negative. Higher scores represent an increase either of positive or negative mood at time 2, controlling for time 1. Higher scores at the *MW* probe of the SART indicate more off-task focus, while lower scores represent more on-task focus.

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[3] The amount of commission errors was not included in the analysis since this variable was correlated neither with the dependent variable nor with other predictors.

Does mindwandering predict enhanced accessibility of negative cognitions (indirect effect)?

To explore the relation between MW, changes in mood, and accessibility of negative cognitions, we ran a hierarchical regression to investigate whether the magnitude of MW predicts enhanced accessibility of negative cognitions (see Table 4; for zero order-correlations, see Table 2).

Table 4.

Summary regression statistics in predicting enhanced accessibility of negative cognitions after mindwandering (indirect effect)

Δ SST Negative Index T2-T1	Step	Predictor	*B*	*SE B*	*sr*	β
	1	BDI-II	.01	.00	.28	.304**
		RRS-R	.00	.00	.05	.064
		Δ PANAS positive T2-T1	-.01	.00	-.06	-.073
		Δ PANAS negative T2-T1	.01	.00	.16	.176
	2	BDI-II	.01	.00	.32	.355***
		RRS-R	.00	.00	.04	.048
		Δ PANAS positive T2-T1	-.01	.00	-.09	-.097
		Δ PANAS negative T2-T1	.01	.00	.14	.150
		MW	.05	.02	.30	.307**
	3	BDI-II	.01	.00	.33	.370***
		RRS-R	.00	.00	-.02	-.024
		Δ PANAS positive T2-T1	.00	.00	-.06	-.067
		Δ PANAS negative T2-T1	.01	.00	.11	.123
		MW	.04	.02	.16	.270**
		MW x BDI-II	.01	.00	.14	.259*

* $p < .05$; ** $p < .01$; *** $p < .001$. For the increase of negative cognitions $R^2 = .164$ for Step 1, $p < .01$; $\Delta R^2 = .091$ for Step 2, $p < .005$; $\Delta R^2 = .056$ for Step 3, $p < .02$. *Note*: *sr* = semipartial correlation. Δ *SST Negative Index T2-T1* = differential score between SST negative indexes after (T2) and before (T1) SART paradigm. Higher scores represent an increase of negative cognitions at time 2, controlling for time 1. Δ *PANAS positive T2-T1* and Δ *PANAS negative T2-T1* = differential score between PANAS, respectively either positive or negative, after (T2) and before (T1) SART paradigm. Higher scores represent an increase either of positive or negative mood at time 2, controlling for time 1. Higher scores at the *MW* probe of the SART indicate more off-task focus, while lower scores represent more on-task focus. *MW x BDI-II* = interaction between off-task thought and depressive symptoms (both variables were mean-centered prior calculating the product).

The increase of SST negative index *after* MW (post minus pre measure of the ratio between negatively interpreted scenarios and total number of scenarios; Δ SST Negative Index T2-T1) served as dependent variable. In the first step, individual differences measures (BDI-II and RRS-R) as well as changes in positive and negative mood (Δ PANAS T2-T1) *after* MW were entered. Then, in the second step, the mean MW thought probe scores were entered[4], while in the third step, the interaction between MW thought probe and BDI-II was entered. Variance-inflation-factors were all around 1, indicating that multicollinearity was not a problem.

Importantly, the analysis evidenced a significant interaction between MW thought probe and depressive symptoms (Step 3) with respect to the increase accessibility of negative cognitions (b = .01, t(72) = 2.42, p < .02). This interaction is represented in Figure 1. The strength of positive relation between being off-task (MW) and increased accessibility of negative cognitions (Δ SST Negative Index T2-T1) was stronger among those participants with high levels (above 1 *SD*) of depressive symptoms (b = .08, *SE* b = .02, t(72) = 3.90, p < .001, 95% CI = .04; .12) than in individuals with a moderate level (mean) of depressive symptoms (b = .04, *SE* b = .01, t(72) = 2.68, p < .01, 95% CI = .02; .07). Such relation was absent in participants with low levels (below 1 *SD*) of depressive symptoms (b = .001, *SE* b = .02, t(72) = .02, p = ns., 95% CI = -.04; .05). It should be noted that, given the presence of a significant interaction, MW and depressive symptoms (BDI-II) cannot be interpreted as main effects because these are *conditional* effects (Cohen et al., 2003; Hayes & Matthes, 2009).

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[4] Similar results were obtained by adopting a categorical approach. In this case MW probe responses were dichotomized by classifying scores between 1 and 3 as "on-task thought" and scores between 5 and 7 as "off-task thought". Responses scored in the midpoint were excluded (Christoff et al., 2009). Both reduction of on-task thoughts and increase of off-task thoughts emerged as significant predictors for the "*indirect effect*" on negative cognitions.

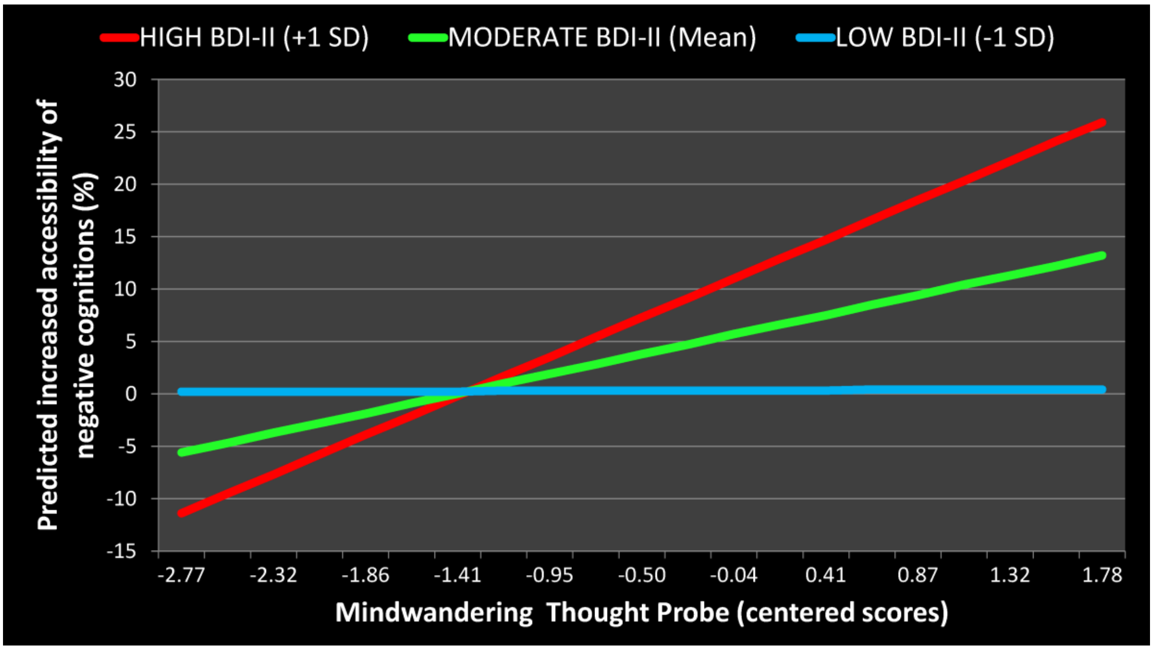

Figure 1. *Effect of the MW on the predicted increase of accessibility of negative cognitions (Δ SST Negative Index T2-T1) at low (below 1 SD), moderate (mean) and high (above 1 SD) levels of depressive symptoms (all the predictors variables were centered prior the analysis).*

Discussion

Research has shown that we spend a great part of our mental life experiencing MW (Kane et al., 2007; Singer, 1966). Interestingly, higher levels of MW are associated with lower mood (Killingsworth & Gilbert, 2010) and negative thinking (Golding & Singer, 1983; Smallwood et al., 2007). We sought to examine the association between MW and negative cognitions, distinguishing between possible direct and indirect effects. To do so, we measured both negative cognitions *during* a MW-related paradigm and accessibility of negative thinking *afterwards*.

In our study, MW predicted heightened accessibility of negative cognition afterwards (*indirect effect*), but only in those with moderate (mean) or high levels (1 *SD* above the mean) of depression. Interestingly, such toxic impact of MW did not emerge in individuals with low levels (1 *SD* below the mean) of depressive symptoms. On the contrary, neither MW nor the level of depressive symptoms had immediate effects on negative cognition (*direct effect*). Interestingly, none of these effects was due to mood changes. These findings are important in understanding the mechanisms through which MW is associated with lower mood and negative cognition in daily life (Golding & Singer, 1983; Killingsworth & Gilbert, 2010; Mar et al., 2012) and bear interesting implications for our understanding of such associations. Several non-mutual exclusive explanations can be proposed for these results.

Recent perspectives claim that during MW (i) attention is mainly focused internally (Baird et al., 2011; Barron et al., 2011; Smallwood et al., 2011) and (ii) personal goals/priorities are actively processed (Levinson et al., 2012; Stawarczyk et al., 2011). On the one hand, internal focus may enhance access to self-focus and self-immersed thinking about one’s future or past, which have both been shown to elicit negative thoughts (Kross, Ayduk, & Mischel, 2005; Mor & Winquist, 2002). On the other hand, the fact that MW negatively impacted on cognitions only in people with significant levels of depression provides preliminary support for a role of personal concerns. Indeed, research has shown that dysphoria is characterized by an elevated level of current concerns (Ruehlman, 1985; Salmela-Aro & Nurmi, 1996).

In light of our results, some broader implications can be derived with regard to the impact of MW on mental life. Consistent with the literature, it seems that MW is not a negative phenomenon *per se*. MW indeed did not impact on thinking directly during off-task thoughts. Moreover, although MW enhanced subsequent accessibility of negative thinking, we have been able to clarify specific conditions in which this detrimental effect occurred. In our study, both elevated levels of depression and being exposed to ambiguous stimuli which can be negatively framed (SST) were necessary to detect the negative effect of MW. We also replicated previous findings showing that rumination is not related with MW (Smallwood et al., 2003, 2006).

Our findings might also be interpreted from a different point of view. That is, the presented results indicate that being fully engaged into a task helps to prevent negative thoughts and promote positive cognitions in individuals with significant levels of depression. This alternative interpretation can be explained in light of theories of mood and well-being, where it is often believed that being concentrated in a task and mindfully attentive to the present moment has positive effects on mood and well-being (Csikszentmihalyi & Figurski, 1982; Keng, Smoski, & Robins, 2011). Moreover, several therapeutic interventions have dysphoric and depressed individuals fully engage in tasks in everyday life in order to distract them from the typical depressive repetitive thinking (Duckworth, Steen, & Seligman, 2005; Hopko, Lejuez, Ruggier, & Eifert, 2003). In keeping with this, the present data indicate that the ability to remain on-task indeed helps to prevent negative thoughts and promote positive cognitions in at-risk individuals.

This study has several limitations. Obviously, it remains to be seen whether these findings in the lab generalize to more naturalistic settings, even if the SART has a good ecological validity (Smilek et al, 2010). Moreover, in our study the amount of commission errors were related neither with the level of MW nor with the other variables implicated in explaining the increase of negative cognitions. Despite the fact the commission errors during SART have been generally reported to be associated with a more direct measure of MW (amount of off-task thoughts; Hu, He, & Xu, 2012; McVay & Kane, 2009), alternative indices of MW during the SART (e.g., RTs) have been proposed as well. It is worth mentioning that sometimes subjective and behavioral markers of MW appeared to be independent while preceding behavioral (e.g. RTs) and neural activity resulted to be correlated (Smallwood et al., 2004, 2008). Such data suggests that both MW-related self-reports and commission errors can be considered markers of MW, with there being a need to further understand when which measures are optimal (Smallwood et al., 2008). In keeping with this limitation, it could be that our definition and operationalization of MW is related to different kinds of undirected thought, even though in real life most of these phenomena tend to overlap (Christoff, 2012). Finally, the procedure we chose to measure the accessibility of negative cognitions (SST) cannot provide orthogonal scores for negative and positive cognitions in that the ratio between both cognitions is mostly used. Thus, it is unclear whether an increased negative ratio indicates enhanced accessibility of negative thoughts or reduced accessibility of positive thoughts. However, it is noteworthy that previous literature adopted the SST as a measure of negative cognitions (Phillips et al., 2010).

In sum, the past years have witnessed increased research interest in examining mental operations of individuals whose attention is decoupled from the surrounding environment (Gruberger et al., 2011; Smallwood & Schooler, 2006). The present findings indicate that there is a reciprocal relation between MW and negative cognitions as previous data suggested (Golding & Singer, 1983; Smallwood et al., 2006, 2007). We now observe that MW shows specificity in heightening accessibility to negative cognitions, and that such relation is mediated by the individual level of depression. As we spend so much time wandering off even when we are required to be engaged, understanding the underlying mechanisms and possible affective consequences of MW may provide important clues about what happens during a substantial part of our daily life.

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CHAPTER 4

The Momentary Self-Focus Inventory (MRSI): Validation and psychometric evaluation[1]

ABSTRACT

Ruminative self-focus is a common emotion regulation strategy that is considered a major risk factor for depression and a number of other emotional disorders. Although measures of trait dispositions to engage in rumination are well-validated, a state measure of ruminative self-focus is lacking. We report on the development and validation of a new self-report measure, the Momentary Ruminative Self-Focus Inventory (MRSI). In five studies, we examined the psychometric properties of the MRSI. In Studies 1, 2, and 3, we report the results of exploratory and confirmatory factor analysis, demonstrating that the 6-item MRSI consists of two related factors. In Study 4 we examined the concurrent validity of the MRSI, showing that scores on the MRSI were positively but modestly related to measures of trait rumination and self-focus. Finally, in Study 5, we provide further validation of the MRSI by demonstrating its sensitivity to an experimental manipulation of ruminative self--focus. Taken together, these findings provide support for the psychometric properties of the MRSI as well as its construct and concurrent validity.

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[1] Based on Mor, N., Marchetti, I., & Koster, E. H. (2013). The Momentary Ruminative Self-Focus Inventory (MRSI): Validation and Psychometric Evaluation. Manuscript submitted to publication.

Introduction

Our unique human ability to reflect on our lives, our behavior and ourselves has important value in learning from failures, making sense of the world and imagining future scenarios. Affect plays an important role in eliciting reflective thinking, as it has been argued that positive affect provides feedback about goal attainment, and negative affect points to a discrepancy between desired and achieved goals (Carver & Scheier, 1998). Negative affect, in particular, enhances reflective thinking in an attempt to understand failures to attain goals or to make satisfactory progress toward them. This understanding is crucial for subsequent behavioral change that would enable goal progress. Despite clear advantages of engaging in reflection, research has indicated that excessive engagement in self-focused thinking can have negative consequences (Mor & Winquist, 2002; Watkins, 2008).

A particularly maladaptive form of self-focus is rumination (Mor & Winquist, 2002; Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). Rumination is defined as "*behaviors and thoughts that focus one's attention on one's depressive symptoms and on the implications of those symptoms*" (Nolen-Hoeksema, 1991, p. 569). Rather than leading to improved self-understanding or problem solving, depressive rumination augments sad mood and negative thinking by focusing attention on current symptoms (Lyubomirsky & Nolen-Hoeksema, 1995). The harmful effects of rumination seem to stem from its evaluative and judgmental nature, rather than from the focus on distress per se (Rude, Maestas, & Neff, 2007).

Different approaches have been used in conceptualizing and measuring rumination. Nolen-Hoeksema's seminal work (1991) has demonstrated that individuals show stable differences in their reactions to negative mood states, and that rumination can be construed as a trait-like response style to distress. Following this work, several questionnaires have been developed to measure trait rumination. The most commonly used measure is the Ruminative Response Scale (RRS; Nolen-Hoeksema & Morrow, 1991), a 22-item scale that assesses typical responses to sad mood that has high internal consistency and acceptable concurrent validity (Butler & Nolen-Hoeksema, 1994; Nolen-Hoeksema & Morrow, 1991). Recent factorial examinations of the RRS have identified two distinct subtypes of rumination (e.g., Treynor, Gonzalez, & Nolen-Hoeksema, 2003; Schoofs, Hermans, & Raes, 2010; Whitmer & Gotlib, 2011). Reflective pondering is a relatively adaptive form of rumination that denotes the degree to which individuals engage in cognitive problem solving to improve their mood, whereas brooding is maladaptive and denotes the degree to which individuals passively focus on symptoms of distress and on the meaning of those symptoms.

Other approaches have focused on the repetitive and perseverative aspects of rumination and demonstrated that rumination serves as a transdiagnostic risk factor for a variety of disorders (e.g., Watkins, 2008). Consistent with these new approaches, the Repetitive Thinking Questionnaire (Mahoney, McEvoy, & Moulds, 2012) and the Perseverative Thinking Questionnaire (Ehring et al., 2011), examine repetitive thinking across disorders. Although these questionnaires do not assess a specific time frame, they have demonstrated good test-retest reliability suggesting that they also tap relatively stable ruminative tendencies.

Some alternative views have suggested that rumination is stress-reactive and may fluctuate from moment to moment (for reviews, see Martin & Tesser, 1996; Smith & Alloy, 2009). Therefore, in addition to measuring stable ruminative thinking, it is also important to examine temporary fluctuations in ruminative self-focus. Whereas trait rumination refers to a habitual and structured maladaptive thinking style, momentary ruminative self-focus refers to a temporary maladaptive cognitive response pattern that is highly dependent on situational cues. Numerous lab-based studies have examined causal effects of ruminative self-focus, demonstrating its negative effects on mood, thought processes, problem solving and goal-oriented behavior, and psychopathology (for a review, see Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). Recent studies have demonstrated meaningful differences between state and trait rumination. For example, Moberly and Watkins (2008), found that momentary rumination (assessed via two items that inquire about the extent to which participants are currently focused on their feelings and problems), predicted subsequent negative affect independently from the prediction of trait rumination. Other studies found interactive effects of momentary and trait rumination. For example, momentary rumination was related to impaired cardiovascular recovery from emotional stress, but only among those who are low in trait rumination (e.g., Key, Campbell, Bacon, & Gerin, 2008). Moreover, some studies have demonstrated poor stability across time of trait rumination (e.g., Kasch, Klein, & Lara, 2001), and recent diary studies have shown significant variation in rumination across days and even hours of the day (e.g., Genet & Siemer, 2012; Takano & Tanno, 2011). Taken together, these findings support the notion of rumination as a transient process that is separate from trait rumination, and underscore the need for a momentary measure of rumination.

Despite increased interest in state rumination, a solid measure of ruminative self-focus, that can assess variations in ruminative responses to experimental inductions of rumination, has not been developed. Such a measure is also important in assessing contextual factors that may contribute to rumination, such as stress (e.g., Zoccola, Dickerson, & Lam, 2012). In early work, Nolen-Hoeksema and colleagues created a daily measure of rumination (Nolen-Hoeksema, Morrow, & Fredrickson, 1993). Later measures of ruminative self-focus address very specific forms of rumination, such rumination following an interpersonal offense (Hatzenbuehler, Nolen-Hoeksema, & Dovidio, 2009; McCullough, Bono, & Root, 2007; Wade, Vogel, Liao, & Goldman, 2008), or have been used in the context of experience sampling and therefore often include a single item or very few items with unknown psychometric properties (Genet & Siemer, 2012; Huffziger, Ebner-Priemer, Zamoscik, Reinhard, Kirsch, & Kuehner, 2013; Moberly & Watkins, 2010; Mor et al., 2010; Roberts, Watkins, & Wills, 2013; Takano, & Tanno, 2011).

The current paper reports on the development and validation of the Momentary Ruminative Self-Focus Inventory (MRSI). The MRSI consists of 6 items measured on a 7-point Likert scale (1 = strongly disagree, 7 = strongly agree). Items on the MRSI were designed based on two available tools, the Situational Self-Awareness Scales (SSAS; Govern & Marsch, 2001), and the lab experimental induction of rumination (Nolen-Hoeksema & Morrow, 1993). The goal in combining items in this way was to capture the main features of momentary ruminative thinking: repetitive and reflective self-focus on one’s symptoms and the possible causes and consequences of these symptoms (Nolen-Hoeksema, 1987, 1991). Because self-focus is a main component of rumination, we included items that assess momentary self-focus. The SSAS is the only questionnaire that assesses spontaneously occurring fluctuations in self-focus (Morin, 2011). It is a 9-item Likert scale that forms three factors: private self-awareness, public self-awareness, and attention to the situation. To create the MRSI, we included the three items that form the private self-awareness subscale. These three items assess one’s current focus on feelings and thoughts as well as momentary reflection on one's life. We designed three additional items by rephrasing as questions items on the rumination induction procedure, which were designed to apply to momentary ruminative thinking. Items on the rumination induction were originally designed to focus one's attention on current feelings and on personal characteristics (Morrow, 1991; Nolen-Hoeksema & Morrow, 1993) and therefore we found them more appropriate as a basis for items on the MRSI than items on trait measures of rumination. We selected items that referred to current focus on feelings and their consequences. We designed the MRSI to be applicable broadly in order to examine momentary ruminative self-focused responses to a variety of events (e.g., stress, criticism, anger, etc.). The last consideration in item selection was to keep the MRSI short, to allow for repeated administration.

We report five studies. In the first study we describe psychometric properties and exploratory factor analysis. In the second and third studies we report confirmatory factor analysis. In the fourth study, we examined the concurrent validity of the MRSI in relation to a number of rumination and self-focus questionnaires. In the final study, construct validity and specificity of the questionnaire were tested by comparing changes in the MRSI following a ruminative versus a non-ruminative self-focus induction.

Study 1: Exploratory Factor Analysis

In this study we examined the factorial structure of the MRSI using Exploratory Factor Analysis (EFA).

Method

Participants and Procedure.

We recruited 234 students at Ghent University (19.77 ± 1.9 years; range 19 – 40; 87.6% female). The MRSI was completed in a group setting.

Results

Descriptive statistics and item correlations for the MRSI items are presented in Table 1.

Table 1.

Descriptive statistics and inter-items correlations (n = 234)

Item	*M*	*SD*	*K*	*SK*	Item 2	Item 3	Item 4	Item 5	Item 6
1. Right now, I am conscious of my inner feelings.	4.96	1.29	.17	-.77	.41**	.53**	.34**	.18*	.23**
2. Right now, I am reflective about my life	4.15	1.58	-.94	-.22		.61**	.47**	.31**	42**
3. Right now, I am aware of my innermost thoughts.	3.53	1.42	-.52	.19			.49**	.40**	.45**
4. Right now, I am thinking about how happy or sad I feel	3.85	1.54	-.86	.02				.38**	.41**
5. Right now, I wonder why I react the way I do	3.29	1.63	-.78	.42					.57**
6. Right now, I am thinking about the possible meaning of the way I feel	3.49	1.56	-.87	.27					

Note. K = kurtosis; SK = skewness.
* *p* < .005. ** *p* < .001

Factor Structure and Internal Consistency. A Principal Axis Factoring (PAF) was conducted on the 6 items using oblique rotation (Oblimin). The Kaiser-Meyer-Olkin measure verified the excellent sampling adequacy for the analysis, KMO = .81 (Field, 2009). KMO values for the individual items were all above .70 (range .76 .83) and are considered good/excellent. Bartletts's test of sphericity ($\chi^2[15] = 447.27$, $p < .001$) indicated that correlations between items were sufficiently large for the PAF. An initial analysis was run to obtain eigenvalues for each factor in the data. In order to get a threshold above which single eigenvalues were considered significant, we ran a Monte Carlo simulation for Parallel Analysis (PA; 6 variables, n = 234, 1000 replications). Six random eigenvalues from this PA (1.22, 1.11, 1.03, 0.95, 0.88, 0.78) were compared to raw eigenvalues produced by the PAF (3.10, 0.99, 0.60, 0.53, 0.41, 0.34). Based on the results of the PA and the scree plot test (Figure 1), a single factor emerged as meaningfully interpretable.

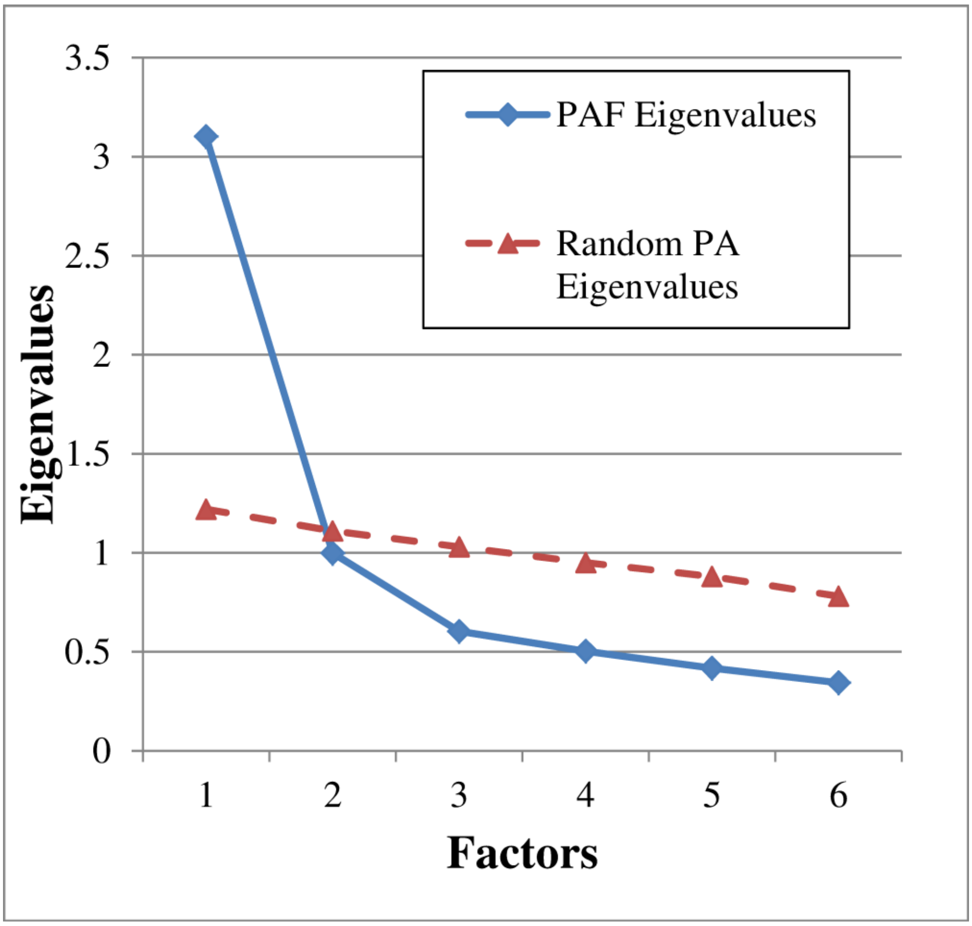

Figure 1. *Scree plot showing the eigenvalues derived from both the Principal Axis Factoring and the Parallel Analysis.*

Table 2 shows the saturations, eigenvalue, explained variance, and Cronbach's alpha associated with the one-factor solution. In keeping with Stevens (2002), if the sample size is larger than 200, only loadings greater than .364 should be interpreted. Thus, in the EFA all of the items of the MRSI loaded significantly on the proposed factor.

Table 2.

Exploratory factor analysis loadings, eigenvalue, explained variance and Cronbach's alpha (n = 234)

Items	Factor Loadings
1	.522
2	.708
3	.810
4	.650
5	.552
6	.636
Eigenvalue	3.103
% of variance	42.67
Cronbach's alpha	.81

Study 2: Confirmatory Factor Analysis

In Study 2, we further examined the stability of the MRSI's unifactorial structure using a Confirmatory Factor Analysis (CFA). Because the MRSI was comprised of items that were designed to tap into both self-focus and rumination, we compared three theoretically-driven models: the unifactorial model that emerged in Study 1 and a two-factor model in which items derived from the SSAS (items 1, 2 and 3) and items derived from the rumination induction (items 4, 5, and 6) form either related or unrelated factors.

Method

Participants and Procedure.

We recruited 100 new students at Ghent University (21.68 ± 1 years; range 20 – 27; 93% female). Again, the MRSI was completed in a group setting.

Data Analysis.

To examine the stability of the single-factor solution derived from EFA, we conducted a CFA on the MRSI using AMOS 7.0 (Arbuckle, 2006). The goodness of fit of tested models was evaluated using the following criteria recommended by Schermelleh-Engel, Moosbrugger, and Müller (2003): the ratio between the chi square and degrees of freedom (χ^2/d.f.) ≤ 3, root mean square error of approximation (RMSEA) ≤ 0.08, comparative fit index (CFI) ≥ 0.95, and Tucker-Lewis Index (TLI) ≥ 0.95. Moreover, we also computed both the Bayesian information criterion (BIC) and the Akaike's information criterion (AIC). Rather than serve to test models, in the sense of hypothesis testing, these indexes are used for model selection. Both BIC and AIC are indeed characterized by combining absolute fit with model parsimony, in that they tend to penalize for adding unnecessary parameters to the model. By comparing BIC and AIC for all the models estimated, the model with the lowest index was selected (Maydeu-Olivares & García-Forero, 2010).

Results

Confirmatory Factor Analysis.

Table 3 reports the goodness-of-fit statistics for the three models that were compared. As can be seen in the Table, the two unrelated factors model (2) did not meet the adopted criteria and did not provide an adequate fit for the data and was excluded. Therefore, the unifactorial (1) and the two related factors model (3) were compared. Although, the latter model seemed to better fit the data based on all of the goodness-of-fit indexes, there were several causes for concern. First, the goodness-of-fit indexes suggested that the model over-fitted and artificially represented the data by adding unnecessary parameters at the cost of parsimony and validity. Specifically, the TLI index was above the threshold of 1, and the normed chisquare (χ^2/d.f.) was smaller than 1. Both conditions are considered cause for concern (Kline, 1998). Moreover, the two related factors proposed by model (3) were highly correlated (r = .81)[2], suggesting that the possible contribution of one factor above and beyond the other factor was negligible given their substantial overlap.

Table 3.

Confirmatory factor analysis goodness-of-fit indicators for three models (n = 100)

Model	BIC	AIC	RMSEA	CFI	TLI	χ^2/d.f.
(1) One-factor	67.94	36.68	.064	.98	.97	1.41
(2) Two unrelated factors	108.99	77.72	.22	.76	.60	5.97
(3) Two related factors	63.83	29.97	.00	1.00	1.04	.49

Note. BIC = Bayesian information criterion; AIC = Akaike's information criterion; RMSEA = root mean square error of approximation; CFI = comparative fit index; TLI = Tucker-Lewis Index; χ^2/d.f. = ratio between chi square and degrees of freedom.

Study 3: Confirmatory Factor Analysis – Further Investigation

Given the lack of clarity regarding the optimal factorial solution, we further investigated the MRSI structure in another independent sample. The aim of this study was to reevaluate the internal structure of the instrument and replicate Study 2, using a larger independent sample. Thus, we compared the same three models: the unifactorial model (1), the two unrelated factors model (2), and the two related factors model (3).

Method

Participants and Procedure.

We recruited 215 new students at Ghent University (21.29 ± 2.9 years; range 17 – 38; 77.7% female). Again, the MRSI was completed in a group setting.

Data Analysis.

We adopted the same analytical strategy and criteria used in Study 2.

Results

Confirmatory Factor Analysis.

Table 4 reports the goodness-of-fit statistics for the three models that were compared. The analysis clearly supported the two related factors solution (3) as the

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[2] The correlation between latent variables is error-attenuated, that is it has been purged from measurement error of the indicators, modeled as error variance

best option, in that it statistically fitted the data as well as it appeared to be the most parsimonious. Moreover, although to a lesser extent than in the previous study, the two factors were still highly correlated (r = .63)[3]. The first factor seems to capture state fluctuations in self-focus (we termed it "Self-focus", MRSI-SF) and reported good/excellent internal consistency (Cronbach's alpha = .78). The second factor seems to measure state ruminative processing (we termed it "Ruminative Processing", MRSI-RP) and showed excellent internal consistency (Cronbach's alpha = .81). Given the statistical and conceptual link between the factors, we summed up the two subscales to obtain a total score (i.e. "Ruminative Self-focus", MRSI), that showed excellent internal consistency (Cronbach's alpha = .82).

Table 4.

Confirmatory factor analysis goodness-of-fit indicators for three models (n = 215)

Model	BIC	AIC	RMSEA	CFI	TLI	χ^2/d.f.
(1) One-factor	163.04	122.59	.21	.81	.68	10.95
(2) Two unrelated factors	145.39	104.94	.19	.85	.75	8.99
(3) Two related factors	86.53	42.71	.07	.98	.96	2.09

Note. BIC = Bayesian information criterion; AIC = Akaike's information criterion; RMSEA = root mean square error of approximation; CFI = comparative fit index; TLI = Tucker-Lewis Index; χ^2/d.f. = ratio between chi square and degrees of freedom.

Discussion: Study 1, 2, and 3

In Study 1, we investigated the factorial structure underlying the six items of the MRSI using an EFA. Our findings provided strong evidence for a unifactorial solution. In Study 2, when adopting a CFA approach, this structure was not fully confirmed in a different sample. Both the unifactorial and the two related factors solutions were found suitable to reflect the factorial structure of the instrument. Finally, in Study 3, CFA that was run in another independent sample confirmed that the two related factors solution provided the best fit for the data and was the most parsimonious model.

Contrary to our initial hypothesis, we found that the MRSI was not unifactorial. This raised the question whether it is possible to disentangle state fluctuations in self-focus from ruminative processing. Theoretically, as ruminative processing is a judgmental and negative form of self-focus (e.g., Watkins, 2008), it is difficult, if not impossible, to disentangle one from the other one. This was confirmed by both our CFA

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[3] see Note 1

analyses where the strength of the relation between the factors suggested substantial overlap (i.e. .81 and .63). As our measure is designed to be used for state measurement which entails manipulating rumination, in most instances both self-focus and ruminative processing will be affected by state. Therefore, in most situations the total score of the MRSI would be the appropriate choice. For these reasons, we advocate the use of the total score, as a sum of both factors. Nevertheless, in an exploratory fashion in the following studies we report statistical analyses for the total score as well as for both subscales.

Study 4: Concurrent Validity

The aim of Study 4 was to investigate the concurrent validity of the MRSI. To this end, we examined the correlations between scores on the MRSI and scores on other measures of rumination and self-focus. We predicted that positive but moderate correlations would emerge between scores on the MRSI and questionnaires that assess trait-like rumination and habitual self-focus. Moreover, following previous findings (Grant, Franklin, & Langford, 2002) and in line with the maladaptive role of ruminative self-focus (Mor & Winquist, 2002), we expected that ruminative self-focus would not be positively associated with a measure of insight that denotes the clarity of understanding of one’s thoughts, feelings, and behavior.

Method

Participants and Procedure.

Most participants from Study 1 (93.6%) were included in this study and were asked to complete additional questionnaires for the purpose of the current study. The sample included 219, but 2 individuals constituting outliers (z score > |3|) on the Private Self-Consciousness Scale or the Insight Scale were excluded, leaving 217 individuals (19.79 ± 1.9 years; range 19 – 40; 87.6% female).

Data Analysis.

In order to examine whether the MRSI total score was correlated with other measures of the same nomological network, such as trait self-consciousness and trait rumination, we ran several Pearson’s correlations. Only among variables that significantly correlated with the MRSI total score, we tested whether there were significant differences in the strength of correlations using the standard *t*-test (Williams, 1959) implemented in the DEPCOR program (Silver, Hittner, & May, 2006). We also examined the correlations between the MRSI subscales and the same constructs, and whether these correlations were significantly different for the MRSI-SF and MRSI-RP subscales of the MRSI.

Materials.

Momentary State Ruminative Self-Focus Inventory (MRSI). In the current study MRSI total score reported excellent levels of internal consistency (Cronbach's alpha = .81). The Self-focus (MRSI-SF) and the Ruminative Processing (MRSI-RP) subscales showed good internal reliability (.76 and .72 respectively).

Ruminative Responses Scale. (RRS; Treynor et al., 2003). The RRS is a 22item self-report questionnaire that assesses trait rumination and consists of items that describe responses to a depressed mood that are focused on the self, symptoms, or consequences of the mood. Participants indicate how often they engage in such responses using a 4-point Likert scale ranging from 1 (almost never) to 4 (almost always). Total RRS scores and subscale scores for reflection and depressive brooding were calculated. The RRS has shown high reliability and validity and has good psychometric properties (Treynor et al., 2003). Internal consistency of the RRS and its subscales in the current study was good to excellent (Cronbach's α = .92 for the total score; α = .79 for the brooding subscale; α = .79 for the reflection subscale).

Private Self-Consciousness Scale. (PrSCS; Fenigstein, Scheier, & Buss, 1975). The PrSCS is a 10-item questionnaire that measures stable individual differences in private self-focus. Participants rate each item on a 5-point Likert scale from 0 (extremely uncharacteristic) to 4 (extremely characteristic). The PrSCS has shown satisfactory reliability, temporal consistency, and factor structure (Fenigstein et al., 1975; Vleeming & Engelse, 1981). In the current study, the internal consistency of the PrSCS was good (Cronbach's α = .85).

Self-Reflection and Insight Scale. (SRIS, Grant et al., 2002). The SRIS is a 20-item self-report scale. It consists of two separate subscales, the Self-Reflection subscale (SRIS-SR) and the Insight subscale (SRIS-IN). The SRIS-SR scale includes 12 items that assess the tendency to think about thoughts, actions, and feelings and evaluate them, whereas the SRISIN includes 8 items that evaluate clarity of experience and self-knowledge. Each item is rated on a 6-point Likert scale ranging from 1 (strongly disagree) to 6 (strongly agree). The SRIS has high internal consistency and internal validity (Grant et al., 2002; Roberts & Stark, 2008). In the current sample, the SRIS-SR and SRIS-IN showed moderate to excellent internal consistency (Cronbach's $\alpha = .91$ for SRISSR; $\alpha = .78$ for SRISIN).

Results

Table 5 depicts descriptive statistics and correlations between the RRS, PrSCS, SRIS and the MRSI. Scores on the MRSI were positively and moderately correlated with scores on both the reflection and the brooding subscales of the RRS and with scores on the PrSCS and the self-reflection subscale of the SRIS. As predicted, the MRSI was unrelated to the insight subscale of the SRIS. Unexpectedly, the analysis also revealed that the MRSI was more strongly correlated with the PrSCS than with brooding (Williams' $t = 1.99$, $p < .05$). No other significant differences emerged between the correlations (p = ns).

Table 5.

Descriptive statistics and intercorrelations for concurrent validity (n = 217)

	M	*SD*	PrSCS	SRIS-SR	SRIS-IN	RRS	Reflection	Brooding
Momentary Ruminative Self-focus Inventory (MRSI)	23.41	6.44	.36*	.34*	.04	.26*	.26*	.21*
Private Self-Consciousness Scale (PrSCS)	23.42	6.05		.74*	-.04	.41*	.46*	.31*
Self-Reflection (SRIS-SR)	52.97	8.52			.05	.38*	.49*	.27*
Insight (SRIS-IN)	31.34	5.43				-.25*	-.09	-.25*
Ruminative Response Scale (RRS)	43.46	11.44					.77*	.84*
Reflection	9.29	3.15						.52*
Brooding	10.57	3.25						

Note. * $p < .001$.

In line with the previous studies, the MRSI-SF (M = 12.73, SD = 3.53) and the MRSI-RP (M = 10.68, SD = 3.80) subscales were significantly correlated ($r = .54$, $p <$

.001)[4]. Table 6 displays the correlations between the subscales and the other trait measures as well as the Williams' standard *t*-test for dependent correlations. Whereas the correlations between the MRSI subscales and self-consciousness and self-reflection did not differ significantly, they did show different patterns of correlations with positive and negative aspects of self-focus. Thus, the MRSI-SF was more strongly correlated with the SRIS Insight subscale than was the MRSI-RP. In contrast, the MRSI-RP correlated more strongly than the MRSI-SF with negative aspects of self-focus, such as trait rumination, ruminative reflection and depressive brooding.

Table 6.

Intercorrelations and Williams' standard t-test for dependent correlations

	MRSI-SF	MRSI-RP	Williams' t
Private Self-Consciousness Scale (PrSCS)	.30***	.34***	ns.
Self-Reflection (SRIS-SR)	.25***	.34***	ns.
Insight (SRIS-IN)	.13*	-.05	$p < .005$
Ruminative Response Scale (RRS)	.16**	.30***	$p < .05$
Reflection	.16*	.29***	$p < .05$
Brooding	.10	.26***	$p < .01$

Note. MRSI-SF = Self-Focus subscale of the MRSI; MRSI-RP = Ruminative Processing of the MRSI
* $p < .05$. ** $p < .01$. *** $p < .001$.

Discussion

In this study, we investigated the concurrent validity of the MRSI as a state measure of ruminative self-focus. The analyses revealed that, in line with our hypotheses, the MRSI was related to stable individual differences in both self-focus and rumination. These correlations were of modest magnitude, supporting the notion that the MRSI measures momentary rumination that only partially mirrors trait disposition. This speaks in favor of considering MRSI as a valuable source of information when

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[4] Please note that this correlation was not estimated in the context of structural equation modeling, so that error measurement was not controlled. Estimated error-attenuated correlation between latent variables was .72.

examining state fluctuations in ruminative self-focus, beyond trait measures. It is also noteworthy that the MRSI was not linked to the clarity of internal experience, an observation that is in line with research that suggests that ruminative self-focus is not associated with beneficial outcomes (Watkins & Teasdale, 2004).

We also found preliminary evidence that the MRSI subscales capture different aspects of ruminative self-focus. In line with the previous factorial analyses, both subscales were equally enrooted in the same overarching construct of self-focus, as measured by the Private Self-Consciousness Scale and the Self-Reflection Scale. Beyond this, the Self-focus subscale seemed also capable of capturing the positive outcomes of self-focus, such as increased clarity of understanding of one’s own inner life. In contrast, the Ruminative Processing subscale was consistently more correlated than the self-focus subscale with trait rumination as well as with ruminative reflection and depressive brooding, that have consistently shown detrimental effects on mental health (Treynor et al., 2003).

Two limitations of study 4 were addressed in study 5. First, we found, unexpectedly, that the MRSI correlated more strongly with PrSCS than with the brooding subscale of the RRS. This pattern of correlations might indicate that the MRSI is not specific to ruminative thinking but rather assesses the broader concept of self-focus. To rule out this possibility, we designed a study in which we manipulated state rumination in one condition and non-ruminative self-focus in another condition. We predicted that if the MRSI is specific to ruminative thinking there would be a significant increase in scores on the MRSI following the rumination condition but not following the non-ruminative self-focus condition. Moreover, in study 4 we did not assess depressive symptoms, a shortcoming that we amended in study 5.

Study 5: Criterion Validity

In the final study, we tested the criterion validity of the MRSI, and examined whether the instrument is sensitive enough to capture experimentally induced momentary fluctuations in ruminative self-focus. To this end, we administered the MRSI prior to and following a rumination induction. To ascertain that the MRSI taps specifically into state rumination rather than self-focus in general, we compared scores on the MRSI when following a ruminative self-focus versus a non-ruminative self-focus control condition. We used the standard rumination induction developed by Nolen-Hoeksema and Morrow (1993). The non-ruminative self-focus was designed to capture one's typical thoughts about day to day self-related topics, but in a non-reflective, repetitive or ruminative manner. Therefore, in this condition participants were asked to focus on daily activities they perform, but not on their emotions or thoughts, and were not asked to reflect on their lives. We expected scores on the MRSI to increase following the ruminative self-focus induction but not following the non-ruminative self-focus induction.

Method

Participants.

We recruited 38 students of Ghent University (21.86 ± 4.1 years; range 18 – 38; 89.5% female). Participants completed the experiment individually.

Measures.

Momentary State Ruminative Self-focus Inventory (MRSI). In both administrations (pre and post experimental manipulation), MRSI Ruminative Self-focus total scores showed good to excellent internal consistency (α = .73 and α = .91, respectively). Acceptable to excellent levels of internal coherence were shown before and after the experimental manipulations in both the Self-focus (i.e., Cronbach's alpha = .63 and .85, respectively) and Ruminative Processing subscale (i.e., Cronbach's alpha = .62 and .84, respectively).

Positive and Negative Affect Scale (PANAS; Watson, Clark, & Tellegen, 1988). State positive and negative mood were measured using the PANAS, which consists of 20 items, half of which measure positive and half, negative mood. Participants rate the extent to which they experience each mood state in that specific moment, using a 5-point scale ranging from 1 (very slightly or not at all) to 5 (very much). The PANAS is reported to have excellent psychometric properties (Watson et al., 1988), and in the current study it showed good to excellent levels of internal consistency (positive mood Cronbach's α = .88 and .92; negative mood Cronbach's α = .87 and .87).

Beck Depression Inventory-II (BDI-II; Beck at el., 1996). Depression was assessed using the BDI-II, a 21-item self-report questionnaire that assesses the severity of a range of affective, somatic and cognitive symptoms. Individuals rate each symptom on a scale ranging from 0 to 3. The reliability and validity of the BDI-II have been well documented (Beck et al., 1996). Internal consistency of the BDI-II in the current study was excellent (Cronbach's α = .91).

Ruminative Responses Scale (RRS; Nolen-Hoeksema & Morrow, 1991). Rumination was assessed using the RRS. Reliability of the RRS and its subscales in the current study was moderate to excellent (Cronbach's α = .92 for the total score; α = .87 for the brooding subscale; α = .71 for the reflection subscale).

Procedure.

Upon arrival at the lab, participants completed the trait and state questionnaires. They were then randomly assigned to one of the two experimental conditions. Participants in the ruminative self-focus condition underwent the standard rumination induction developed by Nolen-Hoeksema and Morrow (1993). They were asked to focus their attention on a series of 45 emotion-focused, symptom-focused and self-focused phrases, each presented on the computer monitor for 15 seconds, for a total of approximately 11 minutes. For example, participants were asked to think about "what your feelings might mean," and "why you react the way you do."

The non-ruminative self-related thinking condition was developed for the purpose of the current study. Participants in this condition were asked to focus on 45 self-related but non-ruminative or emotional phrases, presented on the computer one at a time, for 15 sec each for a total of about 11 minutes. For example, participants were asked to think about "what you had for breakfast", and "the books on your bookshelf."

Immediately following the experimental manipulation, participants completed again the MRSI and the PANAS. Participants were then debriefed about the goals of the study and were paid and thanked for their participation.

Results

Mean scores on the MRSI were subjected to a mixed-design ANOVA with Condition (ruminative self-focus vs. non-ruminative self-related thinking) as between-subject predictor and Time (pre-vs. post-induction) as a within-subject predictor. The analysis revealed a significant main effect of both Condition ($F[1, 36] = 10.08$, $p < .005$, $\eta^2_p = .22$) and Time ($F[1, 36] = 15.34$, $p < .001$, $\eta^2_p = .30$), with the former indicative of higher scores on the MRSI in the ruminative compared to the non-ruminative self-focus condition and the latter being indicative of an overall increase in MRSI scores (M = 22.36, SD = 6.07 for Time 1, and M = 26.15, SD = 8.25 for Time 2). As predicted, these main effects were qualified by a significant Time X Condition interaction ($F[1, 36] = 18.94$, $p < .001$, $\eta^2_p = .34$, see Figure 2). Follow-up paired samples t-tests indicated that MRSI scores increased following the ruminative self-focus induction ($t[18] = 5.38$, $p < .001$, Cohen's $d = 1.20$; M = 23.15, SD = 6.45 for Time 1, and M = 31.15, SD = 5.08 for Time 2), but not following the non-ruminative self-related thinking induction ($t[18] = .34$, p = ns, Cohen's $d = .07$; M =21.57, SD = 5.73 for Time 1, and M = 21.15, SD = 7.84 for Time 2). When BDI-II, Brooding, and increase in negative mood scores (PANAS Negative affect subscale) were entered as covariates, the Time X Condition interaction remained significant ($F[1, 33] = 17.77$, $p =.000$, $\eta^2_p = .35$).

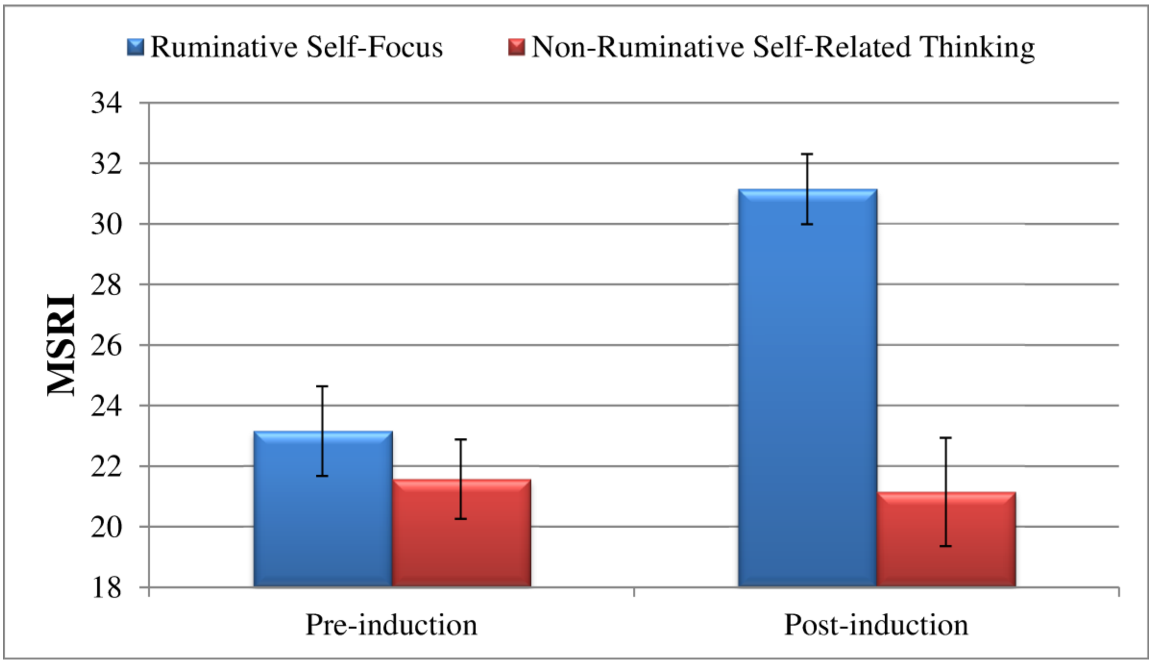

Figure 2. *Mean scores and standard errors for MRSI pre and post conditions (ruminative vs. non-ruminative self-focus induction).*

We also tested whether our inductions led to any significant fluctuations in negative mood. To do so, we performed a mixed-design ANOVA on the mean scores of the negative mood subscale of PANAS, with Condition serving as between-subject predictor and Time as a within-subject predictor. The analysis revealed neither a significant main effect of Time (*F*[1, 36] = 1.95, *p* = ns, η^2_p = .05), nor a significant main effect of Condition (F [1, 36] = .27, p = ns, η^2_p = .01), with the former indicative of no change after both manipulations and the latter being indicative of no overall difference in negative mood between conditions. The Time x Condition interaction was also non-significant (*F*[1, 36] = 1.13, *p* = ns, η^2_p = .03). This pattern of null findings held when controlling for BDI-II and brooding (*F*[1, 34] = 1.29, *p* = ns, η^2_p = .04). These results confirmed that our manipulation selectively induced increased ruminative self-focus without interfering with negative mood.

Finally, we investigated in an exploratory fashion whether the MRSI subscale scores were differentially affected by the manipulations. To do so, we ran a mixed-design ANOVA with Time (pre- vs. post-induction) and Type of processing (self-focus vs. ruminative processing) as within-subject factors and condition (ruminative self-focus vs. non-ruminative self-related thinking) as a between-subject factor. The analysis revealed that the Time X Type of processing X Condition interaction was marginally significant (*F*[1, 36] = 3.16, *p* =.084, η^2_p = .08). However, when BDI-II, brooding, and increase in negative mood scores were included in the model as covariates, the interaction was fully significant (*F*[1, 33] = 5.12, *p* =.05, η^2_p = .13). In order to probe this three-way interaction, we entered the MRSI-SF and MRSI-RP into two separate mixed-design ANCOVAs, with Time as a within-subject factor and Condition as a between-subject factor and with the above mentioned covariates.

When predicting MRSI-SF, the analysis did not reveal a significant main effect of Time (*F*[1, 33] = 1.42, *p* = ns, η^2_p = .04). Moreover, although the Time X Condition interaction was significant (*F*[1, 33] = 7.74, *p* =.01, η^2_p = .19), follow-up repeated measures ANCOVAs indicated that MRSI-SF scores did not increase following either the ruminative self-focus induction (*F*[1, 15] = 2.74, *p* = ns, η^2_p = .15), or the non-ruminative self-related thinking induction (*F*[1, 15] = .04, *p* = ns, η^2_p = .01).

In contrast, when the same analysis was conducted on mean MRSI-RP scores, it revealed a significant main effect of Time (*F*[1, 33] = 7.22, *p* =.01, η^2_p = .18), indicative of an overall increase in MRSI-RP scores (adjusted M = 9.58, StEr = .56 for Time 1, and adjusted M = 11.76, StEr = .53 for Time 2). More importantly, this main effect was significantly qualified by the expected Time X Condition interaction (*F*[1, 33] = 19.91, *p*

=.001, η^2_p = .37). Follow-up repeated measures ANCOVAs indicated that MRSI-RP scores increased following the ruminative self-focus induction (*F*[1, 15] = 7.97, *p* = .01, η^2_p = .37; adjusted M = 9.89, StEr = .90 for Time 1, and adjusted M = 14.68, StEr = .59 for Time 2), but not following the non-ruminative self-focus induction (*F*[1, 15] = .04, *p* = ns, η^2_p = .01; adjusted M = 9.26, StEr = .69 for Time 1, and adjusted M = 8.84, StEr = .84 for Time 2).

Additionally, we explored if and to what extent MRSI and the related subscales at baseline (i.e. before any induction) were significantly correlated with BDI-II scores. The analysis revealed that BDI-II score was correlated with both the MRSI total score (*r* = .33, *p* < .05) and the MRSI-RP score (*r* = .36, *p* < .05), but not with the MRSI-SF (*r* = .21, *p* = ns).

Discussion

This study examined the construct validity of the MRSI by testing fluctuations in scores related to a rumination induction as compared to a control condition. Results indicated that scores on the MRSI fluctuated only in response to the rumination induction but not the non-ruminative self-focus control condition. Scores in the control conditions stayed highly stable. Importantly, we showed that our experimental manipulations selectively induced ruminative processing, rather than negative mood, and were more prominent for scores on the ruminative processing subscale of the MRSI. This pattern of response suggests that the MRSI can be used as a specific tool for assessment of state ruminative self-focus. Furthermore, these observations indicate that the MRSI is suitable for repeated administration and is specifically sensitive to fluctuations in ruminative self-focus. By capitalizing on the previous study, we also explored whether the MRSI subscales differently captured self-focus fluctuations in response to our experimental manipulation. The analysis revealed that ruminative self-focus induction led to significant increase only in the MRSI-RP and not in MRSI-SF. This pattern of results was also confirmed by the differential correlational profile. Depressive symptoms were significantly correlated with the MRSI Ruminative Self-focus total score and the Ruminative Processing subscale, but not with the Self-focus subscale.

General Discussion

The aim of this series of studies was to develop and validate a measure of state ruminative thinking. To this end, we designed the MRSI based on items from a well-established measure of state self-awareness and the standard rumination induction. Studies 1, 2 and 3 examined the factorial structure of the MRSI. These studies demonstrated that a two related factors solution provides a good fit for the data, and that the use of the total score and the subscale scores can be considered adequate. Study 4 provided further support for the utility of the MRSI by demonstrating that it correlates modestly with trait measures of self-focus and rumination. Study 4 also provided further evidence that the two subscales, Self-focus and Ruminative Processing, capture different aspects of momentary ruminative thinking. Whereas the Self-focus subscale was related to increased clarity of understanding of one’s own inner life, the Ruminative Processing subscale was more strongly associated with negative aspects of ruminative thinking, such as depressive brooding. Finally, Study 5 demonstrated the sensitivity of the MRSI to experimental manipulations of ruminative thinking. Taken together these findings demonstrate the usefulness of the MRSI as a state measure of ruminative self-focus.

Ruminative self-focus is an important construct that plays a central role in theories of self and affect regulation (e.g., Nolen-Hoeksema et al., 2008; Martin & Tesser, 2006; Ehlers & Clark, 2000). Ruminative thinking in response to a stressful event or in response to negative mood is thought to contribute to the development or maintenance of various forms of psychopathology (Nolen-Hoeksema & Watkins, 2011; Smith & Alloy, 2009). However, a psychometrically sound measure that allows to assess fluctuations in ruminative self-focus and that differentiates between state and trait rumination, has been lacking. Until now, measures have either focused on specific and narrow forms of state rumination (e.g., McCullough et al., 2007; Wade et al., 2008), or have used a very limited number of items (e.g., Genet & Siemer, 2012; Moberly & Watkins, 2010; Takano & Tanno, 2012). Initial evidence, gleaned from experience sampling research suggests that dispositional ruminative tendencies are associated with momentary levels of ruminative thinking. The findings we report in Study 4 add to this work, indicating that trait rumination and momentary ruminative self-focus are interlinked, but are not the same. It may be argued that the small sizes of the correlations between the MRSI and the RRS may raise concerns for the conceptual validity of the MRSI. However, the magnitude of these correlations is similar to that found between the RRS and momentary rumination measured in experience sampling designs (e.g., Huffziger et al., 2013; Moberly & Watkins, 2010). Similarly, the MRSI correlated more strongly with the Private Self-Consciousness scale than with the Brooding rumination subscale, but the findings of Study 5 confirm that the MRSI is uniquely responsive to ruminative thinking rather than reflective self-focus. Together, these findings further differentiate between state and trait rumination, and substantiate the specificity of the MRSI to momentary ruminative thinking.

Although prior work has clearly differentiated between subtypes of trait rumination (Treynor et al., 2003), this distinction was not applied to designing the MRSI. The reason for this is that at brief durations it is more difficult to disentangle more and less adaptive aspects of rumination. Instead, we included items related to both self-focus and ruminative processing. The findings regarding the distinctiveness of subtypes of state rumination are mixed across our five studies. On the one hand, whereas the correlation between the reflection and brooding subtypes of trait rumination is generally modest, the correlation between the two subtypes comprising the MRSI is so high that it is difficult to disentangle one from the other. On the other hand, despite the strong correlation between the two factors of the MRSI, they did show differential correlation patterns with positive and negative aspects of trait rumination and with depression, and they responded differentially to a rumination induction. In sum, given this lack of clarity, we spur for further investigations to highlight the specific features of state self-focus and state rumination from both the methodological and conceptual point of view.

The MRSI is also important because it can allow researchers to test causal links between rumination and factors that are either thought to lead to ruminative thinking or are considered outcomes of rumination. As the results of Study 5 indicate, the MRSI can be used as an effective manipulation check, allowing researchers to assess reliably the effects of experimental manipulations of rumination. Moreover, recent theories of rumination suggest that cognitive factors, particularly biases and deficits in executive functions, have a causal role in rumination (e.g., Koster, De Lissnyder, Derakshan, & De Raedt, 2011). However, empirical evidence for these models often relies on correlational designs that assess the link between trait rumination and cognitive biases (e.g., Bernblum & Mor, 2010; De Lissnyder, Derakshan, De Raedt, & Koster, 2011). Alternatively, some researchers have pointed to the cognitive consequences of rumination (e.g., Philippot & Brutoux, 2008; Watkins & Brown, 2002). Thus, the MRSI can serve as an important tool in establishing the causal direction of the link between cognitive biases and ruminative thinking.

Recent research has attempted to elucidate contextual factors that can heighten or reduce rumination. For example, studies demonstrated that a critical and evaluative social environment was associated with increased rumination (Zoccola et al., 2012), whereas activating a mental representation of an attachment figure following recall of upsetting memories reduced rumination (Selcuk, Zayas, Günaydin, Hazan & Kross, 2012). In these studies, rumination was assessed using thought records and adhoc measures. Using a standard selfreport measure can assist in understanding the conditions that foster or inhibit rumination.

Although we believe that the studies described here provide good empirical support for the use of the MRSI, we acknowledge several limitations of this research. First, the relative lack of diversity in our samples may temper the generalizability of the findings. Therefore, future research should examine the MRSI in additional samples, and particularly in clinical samples. Second, we did not assess test-retest reliability for the MRSI. Given significant within-day and across-day fluctuations in ruminative self-focus (e.g., Moberly & Watkins, 2008), it is important that future research assess the temporal stability of the MRSI. Third, although we assessed the convergent validity of the MRSI by examining its correlations with similar constructs, our assessment of links between the MRSI and psychopathology was limited to depression (as measured by the BDIII). Future research should broaden the assessment of correlates of the MRSI as well as assess discriminant validity by investigating its links with purportedly unrelated constructs. Finally, we did not assess links between changes in mood and scores on the MRSI. Because rumination both increases negative mood and is elicited by negative mood, future research should assess the effects of a mood induction on ruminative thinking as measured by the MRSI. In sum, the results of the studies described here, provide preliminary evidence for the utility of the MRSI as a measure of momentary ruminative self-focus. The MRSI may be useful in studies that assess causal links between rumination and associated factors and contextual factors that affect rumination, in experience sampling research that examines within person fluctuations in rumination, and in research on the interplay of stable trait tendencies and situational factors that affect negative thinking in psychopathology.

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CHAPTER 5

Rest-related dynamics of risk and protective factors for depression: A behavioral study[1]

ABSTRACT

Resting state provides an important condition to study depressogenic cognition as neuropsychological studies have associated rest with heightened self-related processing. We examined outside the fMRI scanner relationships between rest-related internal focus, cognitive reactivity (vs. mindfulness), rumination, and negative mood in an undergraduate sample (N=80). We tested a theory-based (Marchetti et al., 2012) effect by which, in presence of cognitive risk (vs. protective) factors, internal focus lowers mood via ruminative self-focus. Such effect was detected in individuals with high cognitive reactivity, whereas brooding only showed an incremental effect. On the contrary, this dynamic was not significant in individuals with low cognitive reactivity, despite the level of brooding, or high mindfulness. These results provide an important window on risk for depressogenic thought during resting state.

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[1] Based on Marchetti, I., Koster, E. H. W., & De Raedt, R. (2013). Rest-related dynamics of risk and protective factors for depression: A behavioral study. *Clinical Psychological Science, 1*(4), 443-451. doi:10.1177/2167702613489668

“A mind quite vacant is a mind distress’d”

- William Cowper (1731 – 1800)

Introduction

Resting state is defined as a state of relaxed wakefulness during which one is not actively engaged in any task, but one’s mind is free to wander off. Despite such apparent idleness, our mind is constantly active and tends to gravitate towards internally-originated scenarios (e.g. daydreaming, involuntary autobiographical memories, etc.). In recent years, neurobiological research has confirmed such notion, highlighting that several large-scale neural networks intensively perpetuate their activation during rest (Broyd et al., 2009). Neuroimaging studies indicate that resting state (i.e. people quietly lie in the scanner with eyes closed) is associated with a neural network which shows a tight temporally synchronized co-activation of brain areas (Fox et al., 2005), the so-called Default Mode Network (DMN; Raichle et al., 2001). The DMN consists of two highly linked sub-networks showing anticorrelated activation, namely the Task Negative Network (TN) and the Task Positive Network (TP) (Broyd et al., 2009). TN is comprised of brain areas that are typically active during rest, such as medioprefrontal cortex and posterior cingulate (Raichle et al., 2001).

Interestingly, several psychological functions have been proposed to be embedded in the TN, such as autobiographical recalling, future prospection, self-referential thinking, and associative processing (Buckner et al., 2008). Broadly speaking, TN is thought to subserve *internal focus*, during which internally-generated information dominates (Fox et al., 2005) and self-related processing occurs (Northoff, 2012). TP consists of brain areas (e.g. dorsolateral prefrontal cortex and inferior parietal cortex) that are particularly active during non-specific task engagement, such as attention demanding tasks (Corbetta & Shulman, 2002). For these reasons, TP is the putative neural substrate of external attentional focus (Fox et al., 2005). In sum, the DMN is a resting state network comprising highly anticorrelated oscillations between internal and external focus. Given the pivotal role of the DMN in both self-related internal focus and task-related engagement, DMN aberrations could play a major role in psychopathology (Broyd et al., 2009). For instance, increased TN activation during rest is found in depression and schizophrenia (for a review see, Whitfield-Gabrieli & Ford, 2012). In depression, there is emerging data on the association between TN and maladaptive self-related processing, such as rumination (Berman et al., 2011). However, to date resting state studies have mostly examined isolated risk factors. Recently a comprehensive theoretical framework has been proposed relating various cognitive risk factors for depression to the DMN (Marchetti, Koster, Sonuga-Barke, & De Raedt, 2012). The authors proposed that impaired attentional control, rumination, and cognitive reactivity are outcomes of DMN dysfunctions. The present study examines resting state in relation to rumination and cognitive reactivity at the behavioral level[2].

Rumination has been defined as "*repetitively focusing on the fact that one is depressed; on one's symptoms of depression; and on the causes, meanings, and consequences of depressive symptoms*" (Nolen-Hoeksema, 1991, p.569). The deleterious impact of rumination may not derive from attention to distress per se, but from internally-oriented attention that is negative, evaluative, and judgmental (Rude, Maestas, & Neff, 2007). Indeed, recent literature shows rumination to have its neural roots in increased TN activation during rest (Hamilton et al., 2011). Mainly, brooding - the most maladaptive form of rumination (i.e. passively focusing on the presence and meaning of symptoms of distress; Treynor, Gonzalez, & Nolen-Hoeksema, 2003)-, is related to TN during rest (Berman et al., 2011). On the contrary, reflection (i.e. the degree to which individuals engage in problem solving to improve mood), considered as the more adaptive form of rumination, is negatively associated with temporal dominance of TN over TP (Hamilton et al., 2011). In sum, Marchetti et al. (2012) proposed that during rest increased TN activity is specifically associated with higher levels of maladaptive rumination (i.e. brooding).

The second rest-related risk factor is cognitive reactivity, namely fluctuations in the activation of negative self-attitudes in response to stressors (Butler, Hokanson, & Flynn, 1994). The ease by which negative self-related thinking is triggered is accounted for by the Differential Activation Hypothesis (DAH; Teasdale, 1988). In brief, the DAH postulates that depressive episodes strengthen associative links between negative self-schemata, negative mood, and negative thinking, so that even mild stressors can activate a negative cascade in self-attitudes, depressive thinking, and related behavioral outcomes (e.g., depressive withdrawal). However, cognitive reactivity has been recently

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[2] Impaired attentional control will not be considered here as it is proposed to specifically occur in the transition between rest and task.

conceptualized as a process which can be observed also in at-risk individuals who never suffered from clinical depression (Moulds et al., 2008). Crucial for our study, the construct of cognitive reactivity assumes the existence of negative self-schemata, which are “latent but reactive” (Segal & Shaw, 1986). Once activated negative schemata can bias self-related processing in a maladaptive way. In keeping with this, Marchetti et al. (2012) hypothesized that during rest increased TN activity could neurobiologically support such “latent but reactive” negative self-schemata. Although there is some overlap between brooding and cognitive reactivity, brooding is considered part of stable tendency to ruminate (Treynor et al., 2003) whereas cognitive reactivity is clearly defined in relation to the encounter of stress (Teasdale, 1988).

Related to the association between TN and cognitive reactivity, Marchetti et al. (2012) also proposed an inversed relation between mindfulness and TN. Mindfulness is a mindset characterized by weak connections between the self and negative thoughts and feelings (Segal, Williams, & Teasdale, 2002), associative connections that are the very core of the construct of cognitive reactivity. Recent studies confirmed this notion, showing that mindfulness and cognitive reactivity are negatively correlated and that after a mindfulness training negative effects of cognitive reactivity decrease (e.g. Kuyken et al., 2010). Moreover, high levels of dispositional mindfulness have been associated with decreased rest-related activation (Way, Creswell, Eisenberger, & Lieberman, 2010). In sum, individuals with high level of mindfulness may, during rest, have a reduced likelihood for self-attitudes and negative feelings and thoughts to occur, which mirrors the process of cognitive reactivity in a protective manner.

In our study, we aimed to investigate depression-related cognitive processes that are subserved by the DMN through a behavioral resting state paradigm. It has been argued by Broyd et al. (2009) that DMN research is crucial in discerning the pathogenesis of psychiatric disorders and that the DMN may become valuable in differential diagnosis. Moreover, insight into maladaptive cognitive processes during rest can provide new opportunities for clinical interventions. We opted for a behavioral resting state approach as, compared to fMRI research, it has larger ecological validity. That is, fMRI scanner background noise impacts on cognitive control (Hommel, Fischer, Colzato, van den Wildenberg, & Cellini, 2012), and suppresses TN activation in a nonlinear way (Gaab, Gabrieli, & Glover, 2008), making any conclusion potentially confounded in a non-controllable fashion. To overcome these limitations, we used a validated behavioral paradigm which allows making inferences on the underlying neural activity (Vanhaudenhuyse et al., 2011). Specifically, we asked participants to rest for about 25 minutes, keep their eyes closed, and avoid any structured thinking. They were then pseudo-randomly probed during this resting state about the level of internal and external focus. Crucially, in this paradigm event-related higher levels of internal focus have been mirrored by higher activation of TN brain areas, such as medioprefrontal cortex and posterior cingulate cortex, while more externally-oriented focus has been related to increased activation at level of TP (i.e. inferior frontal gyrus and inferior parietal cortex). Moreover, internal and external focus showed the anticorrelated pattern typically occurring at the neurobiological level between TN and TP. Also the frequency of the switching internal-external focus has been reported to be in the same range (<0.1Hz) of DMN fluctuations (Vanhaudenhuyse et al., 2011). Compared with standard fRMI studies, our paradigm has the advantage to be noise-free and in turn immune from the biasing effect of constant auditory stimulation. The resting periods in between thought probes (mean ~19 sec), were chosen to be sufficient to elicit consistent DMN activation (Gaab et al., 2008) and for participants to experience wandering thoughts (Flavell, Green, & Flavell, 2000).

We hypothesized that during rest increased levels of internal focus would be the ideal condition for rumination-like analytical process to occur and, in turn, detrimentally impact on mood. In other words, given the tendency of internal focus towards self-related content, higher accessibility of self-salient information could facilitate comparative and judgmental processing (Teasdale, 1999), which elicits negative mood (Mor & Winquist, 2002). In accord with our neurobiological framework (Marchetti et al., 2012), we expected that negative effects of internal focus on mood via contribution of ruminative self-focus would occur only in individuals with high levels of habitual brooding tendencies and/or cognitive reactivity. In keeping with this, we also predicted the absence of this effect in individuals who adopt a mindful perspective towards their thoughts. Moreover, we hypothesized that internal focus would only lead to lower mood when self-related information was processed in a ruminative way. Otherwise self-related internal focus was not expected per se to lower mood.

Method

Participants

Eighty-two undergraduates participated in this study. Two cases constituting an outlier (z point > 3) were dropped, leaving 80 individuals (mean age=20.5 years, *SD*=4.5, 80% female). The study was approved by the local Ethical Committee.

Materials

Trait and state questionnaires

Depressive symptoms level was measured by the Beck Depression Inventory 2nd Edition (BDI-II; Beck, Steer, & Brown, 1996), whereas trait rumination was assessed by the Ruminative Responses Scale (RRS; Treynor et al., 2003). Then cognitive reactivity and mindfulness levels were measured respectively by the Leiden Index of Depression Sensitivity – Revised (LEIDS-R; Van der Does & Williams, 2003) and the Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003).

Two state measures were acquired. Specifically, state mood was assessed by the Positive Affect Negative Affect Scale - State (PANAS – State; Watson, Clark, & Tellegen, 1988), whereas state levels of ruminative self-focus were evaluated by the recently validated 6-item Momentary Ruminative Self-focus Items (MRSI; Mor, Marchetti, & Koster, in preparation). Ruminative self-focus is defined as a temporary maladaptive analytical process, characterized by “thinking about” experience (Teasdale, 1999).

Resting state paradigm

Attentional dynamics during rest were studied by means of a validated paradigm (Vanhaudenhuyse et al., 2011). At the start of the procedure, participants received the following instruction: “*During the next 25 minutes, we ask you to keep your eyes closed and to avoid prolonged structured thinking, such as counting or singing. When you hear a beep, please use the keyboard to communicate the intensity of ‘external awareness’ and ‘internal awareness’ ongoing prior to the beep. ‘External’ is here defined as the perception of environmental sensory stimuli (e.g. auditory, visual, olfactory, or somesthetic). ‘Internal’ here refers to all environmental stimuli independent thoughts (e.g. inner speech, autobiographical memories, or wandering thoughts)*”. All participants were instructed to respond by using button presses from 1 = absent to 7 = maximal. After a training phase of 11 attention probes, the experiment phase consisted of 66 attention probes. Interstimulus interval was randomized between 11.3 and 26.8 sec.

This paradigm generates two main variables, “internal focus” (i.e. “internal awareness”) and “external focus” (i.e. “external awareness”). For both internal and external focus, the mean scores across 66 attention probes were computed. Notably, in our study internal and external focus were significantly anticorrelated (r=-.42, *p*<.001).

Design

Participants filled in current mood state measures (PANAS-t0), followed by the state measure of ruminative self-focus (MRSI-t0). Then, individuals underwent the resting state phase, after which both measures of ruminative self-focus and mood were re-administered (respectively MRSI-t1 and PANAS-t1). Finally, questionnaires for individual differences in depressive symptoms, rumination, cognitive reactivity, and mindfulness (BDI-II, RRS, LEIDS-R, and MAAS) were administered.

Data-analytic strategy

We tested the hypothesis that higher levels of *internal focus* (focal predictor) could predict *increased ruminative self-focus* (intervening variable) after the experimental paradigm which in turn could explain *higher levels of negative mood* (outcome variable) (Figure 1B, C). Note that we had theoretical reasons to hypothesize neither total (path *c*, Figure 1A) nor direct (path *c’* Figure 1B, C) contribution of the focal predictor on the outcome variable. This type of statistical model is defined as *indirect effect model* (Mathieu & Taylor, 2006). Additionally, we expected the indirect effect to vary across different levels of moderator(s), namely either cognitive reactivity and habitual brooding (Figure 1B) or mindfulness (Figure 1C). To test such *conditional indirect effect*, we performed all the analyses with Hayes’ (2012) PROCESS macro for SPSS (for more details see the Supplemental Online Material).

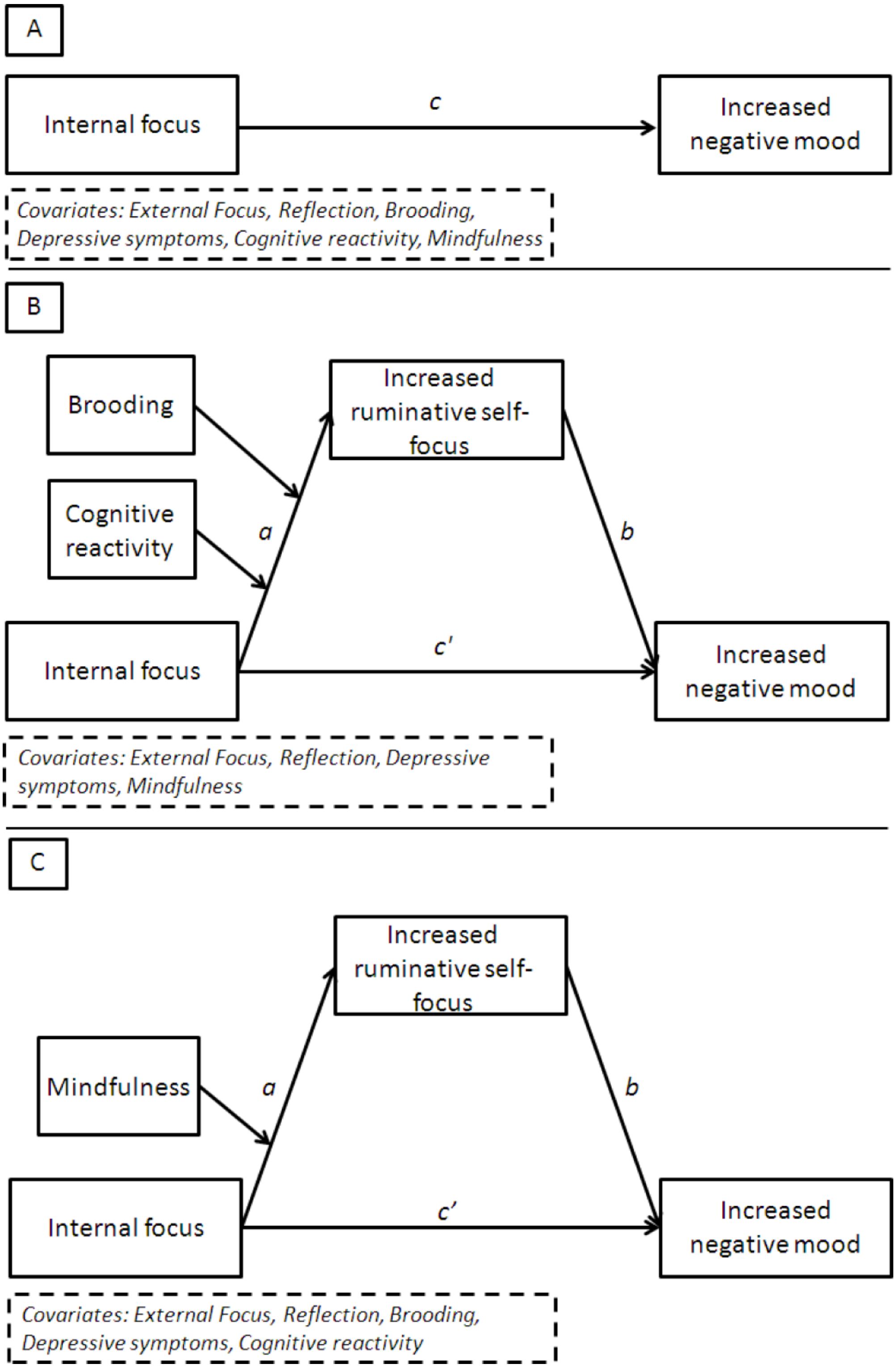

Figure 1. *Hypothesized conditional indirect effect models. 1A represents the total effect of internal focus in predicting increased negative mood (path c). 1B represents the model for cognitive risk factors, that is both the direct effect (path c') and conditional indirect effect per different levels cognitive reactivity and brooding (path axb) are depicted. 1C represents the model for protective factor, that is both the direct effect (path c') and conditional indirect effect per different levels of mindfulness (path axb) are shown.*

Results

Descriptive statistics, Pearson's correlations, and Cronbach's alphas are provided in Table 1.

First, we tested the significance of the indirect effect of internal focus (focal predictor) on increase of negative mood (outcome variable) through contribution of increased ruminative self-focus (intervening variable), across different levels of cognitive risk factors, namely cognitive reactivity and trait brooding (Figure 1B). In order to remove noise variance unrelated to the focal predictor, we included individual scores on dispositional mindfulness, reflection, depressive symptoms, and external focus during the task as covariates[3].

Table 2 (upper part) shows that the investigated indirect effect is always significant (i.e. bootstrap CIs do not contain zero), with the only exception of low levels of cognitive reactivity. Moreover, inspection of the conditional indirect effect coefficients allows inferring that brooding has a smaller impact compared with cognitive reactivity; nevertheless given a certain level of cognitive reactivity, higher levels of brooding contribute to a stronger indirect path. Furthermore, the conditional effect of internal focus per either cognitive reactivity or brooding (path *a*) *positively* predicts increased ruminative self-focus (respectively β=.28 and β=.05), which in turn (path *b*) *positively* explains the increase of negative mood (β=.24) (see Table S1 in Supplemental Material). On the contrary, the total effect of internal focus in predicting increased negative mood (Figure 1A, path *c*), after controlling for the variables implicated in the previous model, is not significant (see lower part Table S1); neither is the direct effect (Figure 1B, path *c'*) (middle part Table S1). To summarize, higher levels

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[3] Mindfulness is considered to negatively mirror cognitive reactivity as it also emerged in the correlational analysis (r=-.42). By controlling for mindfulness, we were able to estimate the particular effect of cognitive reactivity above and beyond mindfulness. For the same reason, we included reflection. Despite their positive relation, reflection and brooding have been reported to show an opposite relationship in relation to the TN at neurobiological level (Berman et al., 2011; Hamilton et al., 2011). This observation was confirmed by the opposite role of both reflection and brooding in predicting the increase of ruminative self-focus (see upper part Table S1). Moreover, individual level of dysphoria was included given its well-established contribution to rumination and negative mood. Importantly, none of the covariates, except for external focus (r=-.42), was significantly correlated with the focal predictor, a condition which makes such statistical controlling fully appropriate (Miller & Chapman, 2001). External focus was included as covariate to ensure that findings obtained for internal focus were not due to dynamics related to external focus of attention.

Table 1.

Mean, standard deviation and Cronbach's alpha (n = 80)

	M	*SD*	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) Internal Focus	4.86	0.93	-.42***	.46***	.03	.36***	.11	-.07	.02	-.13	.01	-.13	.02	-.10	-.01
(2) External Focus	2.88	0.84	-	-.09	.08	.00	.05	.18	.23*	.18	.06	.16	.02	.01	-.03
(3) Δ MRSI t1-t0	2.30	4.85		-	-.15	.59***	.25*	-.01	.19	-.05	.06	-.18	.17	.00	.05
(4) MRSI-t0	23.31	5.54			(.68)	.71***	-.09	.30**	.23*	.34***	.34***	.22*	.35***	.26**	-.04
(5) MRSI-t1	25.61	6.80				(.79)	.10	.24*	.33***	.25*	.32*	.05	.41***	.21	.00
(6) Δ PANAS negative t1-t0	-1.05	3.23					-	-.43***	.36***	-.11	-.07	-.05	-.15	-.21	.07
(7) PANAS negative-t0	14.28	4.14						(.80)	.69***	.51***	.20	.06	.31**	.17	-.07
(8) PANAS negative-t1	13.23	4.02							(.81)	.43***	.15	.02	.19	.01	-.02
(9) BDI-II	9.41	6.53								(.87)	.31*	.20	.28**	.27**	-.16
(10) RRS Total	45.27	12.23									(.91)	.69***	.80***	.66***	-.13
(11) RRS Reflection	10.18	3.81										(.82)	.32**	.38***	.00
(12) RRS Brooding	10.45	3.50											(.78)	.60***	-.20
(13) LEIDS-R	42.61	16.54												(.88)	-.42***
(14) MAAS	3.75	0.61													(.78)

Note. ****p* < .001. ***p* < .01. **p* < .05. The values between parentheses are Cronbach's alphas. Δ *MRSI t1-t0* = differential score between MRSI indexes after (t1) and before (t0) rest-related paradigm. Higher scores represent an increase of ruminative self-focus at time 2, controlling for time 1. Δ *PANAS negative t1-t0* = differential score between PANAS negative indexes after (t1) and before (t0) rest-related paradigm. Higher scores represent an increase of negative mood at time 2, controlling for time 1.

of internal focus during rest predict increased levels of negative mood via contribution of increased ruminative self-focus. This condition holds only for moderate and high levels of cognitive reactivity, whereas the contribution of brooding, although still in line with our hypothesis, is smaller.

Table 2.

Conditional indirect effect of internal focus on the increase of negative mood across low (-1 SD), medium (M) and high (+1) levels of cognitive reactivity and brooding via increased ruminative self-focus (upper part); conditional indirect effect across low (-1 SD), medium (M) and high (+1) levels of mindfulness (lower part)(n = 80)

Cognitive reactivity	Brooding	Conditional indirect effect	Boot SE	Boot LL CI 95%	Boot UL CI 95%
Low	Low	.16	.15	-.02	.65
	Medium	.21	.16	-.02	.66
	High	.26	.28	-.11	1.11
Medium	Low	.39	.29	.01	1.15
	Medium	.44	.24	.01	.96
	High	.49	.29	.03	1.20
High	Low	.62	.45	.03	1.91
	Medium	.66	.39	.01	1.58
	High	.71	.39	.01	1.55

Mindfulness	Conditional indirect effect	Boot SE	Boot LL CI 95%	Boot UL CI 95%
Low	.74	.36	.13	1.55
Medium	.49	.23	.09	1.02
High	.25	.23	-.06	.92

Second, we tested the significance of the indirect effect of internal focus (focal predictor) on the increase of negative mood (outcome variable) through contribution of increased ruminative self-focus (intervening variable), across different levels of mindfulness as protective factor (Figure 1C). Here we included the following covariates: external focus, depressive symptoms, brooding, reflection, and cognitive reactivity. Table 2 (lower part) shows that the investigated indirect effect is always significant, with the exception of high levels of mindfulness. As hypothesized, the conditional effect of internal focus moderated by mindfulness (path *a*) *negatively* predicts increased ruminative self-focus (β=-.18), which in turns (path *b*) *positively* explains the increase of negative mood (β=.30) (see Table S3). On the contrary, neither the total effect (path *c*) nor the direct effect (path *c'*) of internal focus significantly predicted increased negative mood, after controlling for variables included in the conditional indirect effect model (see middle and lower part Table S3). To summarize, higher levels of internal focus during rest positively predict increased levels of negative mood via contribution of increased ruminative self-focus. This condition does not hold for individuals showing high levels of dispositional mindfulness.

Discussion

Rest is increasingly being the focus of intense research and several neurobiological abnormalities have been reported during resting state in psychopathology (Whitfield-Gabrieli & Ford, 2012). Resting state provides an interesting condition to study depressive cognitive risk factors and protective factors (Marchetti et al., 2012) as behavioral and neuropsychological studies have associated rest with heightened levels of self-related processing (Northoff, 2012). Nevertheless, little is known about depressogenic cognitive processes during rest. Therefore, we adopted a behavioral noise-free paradigm to study cognitive processes that influence mood during resting state. The main finding of our study is that there is an indirect effect of internal focus on negative mood through ruminative self-focus when individuals have moderate to high cognitive reactivity, whereas brooding seems to have only an incremental effect. This indirect path is not significant in individuals with low cognitive reactivity (regardless of brooding levels), or high mindfulness levels.

The significant indirect path indicates that internally focused attention is a condition that can facilitate judgmental and analytical thinking, which subsequently heightens negative mood. This is in line with theories relating self-focused attention to negative mood and depression (Ingram, 1990). It is noteworthy that internal focus during rest did not overlap with state ruminative self-focus, as these two variables were only moderately correlated.

Crucially, our data strongly indicates that there are individual differences in the affective consequences of being internally focused during rest (i.e. *conditional* indirect effect). On the one hand, cognitive reactivity levels strongly determined the strength by which internal focus predicted worsening in mood via ruminative self-focus. On the other hand, brooding appears to have only an incremental effect in that, given a certain level of cognitive reactivity, brooding augmented the indirect effect without actually influencing individuals with low levels of cognitive reactivity. It is noteworthy that we have been able to specify the contribution of cognitive reactivity above and beyond maladaptive rumination, as shown in previous research (Moulds et al., 2008). Although being highly correlated (r=.60), these two constructs show a hierarchical asymmetry in moderating the indirect effect, with cognitive reactivity dominating over brooding.

Our study also shows individual difference variables that have a protective effect in such contexts. Individuals with high levels of mindfulness did not experience a worsening in mood. The construct of mindfulness is thought to represent weakened links between the self, (negative) thinking, and (negative) feelings (Way et al., 2010), and in turn to conceptually oppose cognitive reactivity (Marchetti et al., 2012, Raes et al., 2009). Correlational analysis confirms this hypothesis, showing that mindfulness negatively correlates only with cognitive reactivity, but not with brooding[4]. A possible explanation for this result is that, despite the emergence of self-related material during rest, mindful individuals are capable of not engaging in a self-judgmental loop.

Why is this study of resting state of theoretical and clinical importance? Typically during rest when there is time for self-reflection, individuals experience the most negative thoughts. However, such conditions have so far rarely been investigated in lab contexts. The current paradigm used is highly promising to further study rest-related phenomena in psychopathology, with a strong link to rapidly advancing DMN research (Whitfield-Gabrieli & Ford, 2012). Although the current paradigm is less informative about the neural mechanisms, it is noteworthy that resting state as studied through this behavioral paradigm has a larger ecological validity than studies using fMRI. By capitalizing on this, we aimed to bridge the extant gap between clinical theories and

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[4] This pattern holds even after controlling for brooding (r_p=-.382, *p*<.001), on the contrary the relation between brooding and mindfulness is reduced to zero after controlling for cognitive reactivity (r_p=.07, *p*=ns).

basic neuroscience. Second, our findings provide evidence for interplay between cognitive risk as well as protective factors. In line with a recent proposal (Marchetti et al., 2012), we could relate different aspects of depression risk to resting state and DMN. Especially observing these relations in a sample of healthy, non-depressed participants suggests that there are strong relations between resting state, negative thinking, and negative mood which can turn toxic even in individuals with limited levels of psychopathology. Therefore, it is conceivable that clinically depressed individuals during rest might show stronger effects. Our findings can also account for the clinical observation that task engagement can lift negative mood (Hopko, Lejuez, Ruggiero, & Eifert, 2003). Finally, in relation to clinical interventions, mindfulness has promising effects in decreasing cognitive risk factors (Ma & Teasdale, 2004). Given the high frequency of (short) resting state phases in everyday life, it appears important for at-risk individuals (e.g., remitted depressed individuals) to develop mindful skills which can protect them from negative consequences associated with rest.

Our study has limitations. First, despite a strong link has been established between internal/external focus and the DMN activity during rest (Vanhaudenhuyse et al., 2011), in our study we can only indirectly relate our results to activity of underlying neural mechanisms. Second, our study is correlational in nature so no conclusions can be drawn regarding causal relationships. Therefore, future studies should further investigate the reported effects by directly manipulating the degree of internal focus during rest. Third, the presence of probes during the task might have influenced the investigated phenomenon. However, previous research on mindwandering has shown that assessment of mindwandering using thought probes generates similar results as and, sometimes, better than retrospective reports (Hurlburt & Melancon, 1987).

To conclude, we found that internal focus has a detrimental effect on negative mood through ruminative self-focus only when individuals have moderate to high cognitive reactivity, whereas this is not the case in low cognitive reactivity or high levels of mindfulness. Resting state clearly is a pivotal moment where negative cognitions can creep up on individuals. Our study attempted to bridge the literature on cognitive and neural mechanisms involved in resting state, which increases our understanding of risk as well as protective influences.

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Supplemental Material

Data-analytic strategy

In our study, we aimed at testing a specific statistical model where only the indirect effect (*axb*) is expected to be significant, neither the total (*c*) nor the direct effect (*c'*) is expected to be significant. *Indirect effect model* is a term which has been proposed to differentiate from full and partial meditational models where significant either total or direct effects are expected (Preacher & Hayes, 2008). In keeping with the guidelines proposed by Mathieu and Taylor (2006), we first tested the statistical significance of the indirect effect, operationalized as the product of path *a* and *b*. We then tested the null total effect of the focal predictor on the outcome variable without taking into account the contribution of the intervening variable (Figure 1A). We also tested the null effect of the direct path (*c'*), namely the contribution of the focal predictor on the outcome after controlling for the intervening variable. When these three conditions were satisfied, we could test whether the relation between the focal predictor and the outcome is due to an indirect effect through the contribution of the intervening variable (Hayes, 2009; Hayes, Preacher, & Myers, 2011; Mathieu & Taylor, 2006). Nevertheless, the test of the *indirect effect model* was performed on data that were only partially structured to be temporally consistent with the proposed underlying process, with the intervening variable (increased ruminative self-focus) and the outcome variable (increased negative mood) being measured at the same time. In order to control for the alternative indirect path (reversed model), the data were subjected to an analysis in which the increased negative mood served as intervening variable and the enhanced ruminative self-focus as outcome. If the results of this reversed model were also significant, caution would be warranted (Kenny, 2012).

To test the statistical significance of the indirect effect (path *axb*), according to Preacher and Hayes' recommendations (2008) we adopted the nonparametric bootstrapping approach. Compared with the causal steps approach (Baron & Kenny, 1986) or the Sobel test (Sobel, 1982), bootstrapping is considered the most powerful approach and free from unrealistic assumptions, such as the multivariate normality in data distribution (Bollen & Stine, 1990; Hayes, 2009). Specifically, bootstrapping circumvents this problem by relying on confidence intervals (CIs) for the determination of the indirect effect instead of the traditional *p*-value approach that uses standard errors (MacKinnon, Lockwood, & Williams, 2002). According to Preacher and Hayes (2008), to test the significance of the indirect effect (path *axb*) we estimated 10000 bootstrap bias-corrected 95% CIs, and if they did not contain zero they were considered significant. Crucially, to determine the significance of the indirect effect (*axb* path) we evaluated only the bootstrap CIs without considering the significance of path *a* and *b*, as recommended by Hayes (2009, 2012). Regressions weights for both path *a* and *b* were computed only to clarify the direction of the influence of the focal predictor over the intervening variable (path *a*) and the intervening variable over the outcome variable (path *b*).

Furthermore, we put forward the indirect effect to vary across different levels of the moderator(s), either cognitive reactivity and brooding (Figure 1B) or mindfulness (Figure 1C). For both models, we estimated different *conditional indirect effects* of the focal predictor over the outcome variable at low (one SD below the mean), moderate (sample mean), and high (one SD above the mean) values of the moderator(s). Following Cohen, Cohen, West, and Aiken (2003), both the focal predictor and the moderator(s) were mean-centered prior calculating the interaction term(s).

Additional Analyses

We tested the reversed models, where increased negative mood acts as intervening variable and increased ruminative self-focus acts as outcome variable, by estimating the indirect effect. Specifically, we ruled out the statistical significance of the reversed models for both cognitive risk factors (TableS2, upper part) and protective factor (TableS2, lower part).

Table S1.

Summary regressions for the total and direct effect of internal focus over increased negative mood conditioned to cognitive reactivity and brooding via increased ruminative self-focus (n = 80)

Δ MRSI t1-t0	Predictor	*B*	*SE B*	β	R^2
	BDI-II	-.01	.07	-.01	
	Reflection	-.37	.13	-.29**	
	Brooding	.35	.16	.25*	
	LEIDS-R	.03	.04	.09	
	MAAS	1.59	.86	.20	
	External focus	1.01	.62	.17	
	Internal focus	2.76	.54	.53***	
	Internal focus x LEIDS-R (*a*)	.08	.04	.28*	
	Internal focus x Brooding (*a*)	.08	.21	.05	.401***
Δ PANAS negative t1-t0	Predictor	*B*	*SE B*	β	R^2
	BDI-II	-.05	.06	-.11	
	Reflection	.00	.10	.00	
	MAAS	.22	.60	.04	
	External focus	.44	.48	.11	
	Internal focus (*c'*)	.13	.48	.04	
	Δ MRSI t1-t0 (*b*)	.16	.08	.24	.086
Δ PANAS negative t1-t0	Predictor	*B*	*SE B*	β	R^2
	BDI-II	-.03	.06	-.06	
	Reflection	.04	.11	.05	
	Brooding	-.05	.13	-.06	
	LEIDS-R	-.03	.03	-.17	
	MAAS	-.12	.68	-.02	
	External focus	.48	.49	.13	
	Internal focus (*c*)	.52	.44	.15	.073

Note. ****p* < .001; ***p* < .01; **p* < .05. Δ *MRSI t1-t0* = differential score between MRSI indexes after (t1) and before (t0) rest-related paradigm. Higher scores represent an increase of ruminative self-focus at time 2, controlling for time 1. Δ *PANAS negative t1-t0* = differential score between PANAS negative indexes after (t1) and before (t0) rest-related paradigm. Higher scores represent an increase of negative mood at time 2, controlling for time 1.

Table S2.

Conditional indirect effect of internal focus on the increase of ruminative self-focus across low (-1 SD), medium (M) and high (+1)levels of cognitive reactivity and brooding via increased negative mood (reversed model) (upper part); conditional indirect effect across low (-1 SD), medium (M) and high (+1) levels of mindfulness (reversed model) (lower part)(n = 80)

Cognitive reactivity	Brooding	Conditional indirect effect	Boot SE	Boot LL CI 95%	Boot UL CI 95%
Low	Low	-.03	.19	-.51	.31
	Medium	.11	.23	-.21	.78
	High	.26	.37	-.24	1.37
Medium	Low	.01	.21	-.34	.53
	Medium	.16	.18	-.03	.72
	High	.30	.30	-.06	1.18
High	Low	05	.31	-.43	.92
	Medium	.20	.24	-.05	.97
	High	.34	.31	-.02	1.20
Mindfulness		**Conditional indirect effect**	**Boot SE**	**Boot LL CI 95%**	**Boot UL CI 95%**
	High	.27	.26	-.05	.98
	Medium	.16	.19	-.08	.74
	Low	.06	.26	-.42	.68

Table S3.

Summary regressions for the total and direct effect of internal focus over increased negative mood conditioned to mindfulness via increased ruminative self-focus (n = 80)

Δ MRSI t1-t0	Predictor	*B*	*SE B*	β	R^2
	BDI-II	-.00	.08	-.01	
	Reflection	-.28	.14	-.22*	
	Brooding	.26	.17	.19	
	LEIDS-R	.01	.04	.05	
	MAAS	1.30	.89	.16	
	External focus	.88	.63	.15	
	Internal focus	2.52	.57	.48***	
	Internal focus x MAAS (*a*)	-2.00	1.15	-.18	.335***
Δ PANAS negative t1-t0	Predictor	*B*	*SE B*	β	R^2
	BDI-II	-.02	.06	-.05	
	Reflection	.09	.10	.11	
	Brooding	-.12	.13	-.13	
	LEIDS-R	-.03	.03	-.16	
	External focus	.32	.48	.08	
	Internal focus (*c'*)	.02	.48	.00	
	Δ MRSI t1-t0 (*b*)	.20	.09	.30*	.135
Δ PANAS negative t1-t0	Predictor	*B*	*SE B*	β	R^2
	BDI-II	-.03	.06	-.06	
	Reflection	.04	.11	.05	
	Brooding	-.05	.13	-.06	
	LEIDS-R	-.03	.03	-.17	
	MAAS	-.12	.68	-.02	
	External focus	.48	.49	.13	
	Internal focus (*c*)	.52	.44	.15	.073

Note. ***$p < .001$; **$p < .01$; *$p < .05$. Δ *MRSI t1-t0* = differential score between MRSI indexes after (t1) and before (t0) rest-related paradigm. Higher scores represent an increase of ruminative self-focus at time 2, controlling for time 1. Δ *PANAS negative t1-t0* = differential score between PANAS negative indexes after (t1) and before (t0) rest-related paradigm. Higher scores represent an increase of negative mood at time 2, controlling for time 1.

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CHAPTER 6

Self-generated thoughts and depression: From daydreaming to depressive symptoms[1]

ABSTRACT

Human minds often engage in thoughts and feelings that are self-generated rather than stimulus-dependent, such as daydreaming. Recent research suggests that under certain circumstances, daydreaming is associated with adverse effects on cognition and affect. Based on recent literature about the influence of resting mind in relation to rumination and depression, this questionnaire study investigated mechanisms linking daydreaming to depressive symptoms. Specifically, an indirect effect model was tested in which daydreaming influences depressive symptoms through enhancing self-focus and ruminative thought. Results were in line with the hypothesis and several alternative pathways were ruled out. The results provide initial supportive evidence that daydreaming can influence depressive symptoms through influences on self-focus and rumination. Further research should use prospective or experimental designs to further validate and strengthen these conclusions.

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[1] Based on Marchetti, I., Van de Putte, E., & Koster, E. H. W. (2014). Self-generated thoughts and depression: From daydreaming to depressive symptoms. *Frontiers in Human Neuroscience*, *8*:131. doi: 10.3389/fnhum.2014.00131

All the daydreams are ego-centred. […]
Each of the daydreams is like a little play, whose hero is the dreamer himself
G. H. Green (1923, pp. 27-28)

Introduction

It often happens that one's mind drifts away from what one is doing or that one's attention fluctuates inward during rest. For instance, in everyday life it is a common experience, while reading a book, not to be able to recall the last page, or during a long train ride, to spend a large part of time being unaware of the other passengers. In other words, there is ample evidence that human mind often focuses on mental contents arising independently from the direct environment or the task at hand (Smallwood, 2013; Smallwood & Schooler, 2006). Consequently, this specific process has been defined "self-generated thought" (SGT; Smallwood, 2013).

Throughout decades, SGT has been operationalized in different ways (Callard, Smallwood, Golchert, & Margulies, 2013), by focusing either on its independence from the ongoing task (i.e., stimulus-independent thought; Mason et al., 2007) or the internal rather than external source of information (i.e., spontaneous thought; Christoff, Gord, & Smith, 2011). We here choose to operationalize SGT as "daydreaming" (Klinger, 2013), which is a comprehensive phenomenon that, beyond (i) being based on SGT, gathers all the mental states sharing crucial characteristics, such as (ii) the same neurobiological substrate (Stawarczyk, Majerus, Maquet, & D'Argembeau, 2011), and (iii) similar subjective content (Smallwood & Schooler, 2006). By doing so, we have multiple advantages, such as being allowed to capitalize on previous literature (Klinger, 1971, 1990, 2009, 2013) and the related instruments of measurement (Giambra, 1980; Singer & Antrobus, 1970, 1972).

Daydreaming is conceived as "*nonworking thought that is either spontaneous or fanciful*" (Klinger, 2009, pp. 226) and it is considered the default mode of the mind (Mason et al., 2007; Klinger, 1971). This definition includes SGT unrelated to the task at hand, also known as mindwandering (Smallwood & Schooler, 2006), as well as instances when the mind wanders toward fanciful topics during rest (Klinger, 1971). The value of this definition has been confirmed recently by studies showing that daydreaming is enrooted in a specific large-scale neurobiological network (Christoff et al., 2009; Mason et al., 2007) known as the Default Mode Network (DMN). The DMN is a neural network that is highly active during rest and less active, if not deactivated, during intense task engagement (Raichle et al., 2001). This network has been associated with a list of mental functions that are characterized by an internal focus, among which daydreaming seems to play a major role. Mason and colleagues (2007) have shown that when participants' minds drifted away from a well-practiced task, high levels of DMN activation were observed. Interestingly, the activation levels of DMN hub areas were correlated with a well-established self-report measure of daydreaming, the Daydreaming Frequency Scale (DDFS, Singer & Antrobus, 1970).

As mental baseline, daydreaming is a frequent phenomenon. Estimates suggest that we spend 30-50% of our mental activity during waking hours in thoughts that are neither related to what we are doing at that moment nor to the immediate surrounding environment (Franklin et al., 2013; Killingsworth & Gilbert, 2010; Klinger & Cox, 1987/1988). In light of this ubiquity, it would be hard to believe that SGT does not serve specific functions, be it adaptive or maladaptive (Klinger, 1996, 2013). Although rarely studied until recently, the benefits of SGT are increasingly being reported in regard to different domains (Mooneyham & Schooler, 2013), for instance creative thinking (Baird et al., 2012), autobiographical planning (Smallwood et al., 2011), and delaying gratification (Smallwood, Ruby, & Singer, 2013). Nevertheless, several costs of SGT have been documented as well. Daydreaming, and specifically the mindwandering subtype, has been shown to detrimentally impact on reading comprehension (Franklin, Smallwood, & Schooler, 2011), sustained attention (Smallwood et al., 2004), and working memory (McVay & Kane, 2012).

In line with these findings, daydreaming, especially if characterized by negative cognitions, has been associated with symptoms of psychopathology, such as depression, schizophrenia, anxiety, and dissociation (Andrews-Hanna, Smallwood, & Spreng, in press; Klinger, Henning, & Janssen, 2009). What also confirms the potentially toxic role of daydreaming is that its neurobiological substrate has been consistently found to be affected in major psychopathology, such as schizophrenia and depression (Whitfield-Gabrieli & Ford, 2012).

Depression is an important context within which to investigate the clinical impact of daydreaming, as this disorder involves spending much time in inactivity, after which higher levels of depressed mood and lower levels of mastery and pleasure are shown (Martinsen, 2008). In line with this, many studies have indeed reported a clear and direct relation between daydreaming and depressive symptoms (Epel et al., 2012; Golding & Singer, 1983; Stawarczyk, Majerus, Van der Linden, & D'Argembeau, 2012). For instance, Giambra and Traynor (1978) have shown that the frequency of and the tendency to be absorbed by daydreaming, especially if negatively valenced, correlated with three different measures of depression. Recently, Meyer, Finucane, and Jordan (2011) confirmed this finding, reporting that the tendency to engage in daydreaming was predicted by both the severity of current depressive symptoms and the likelihood of former depressive episodes. Furthermore, in a laboratory setting, individuals with subclinical levels of depression exhibited more accessible periods of mindwandering while encoding verbal material, greater attentional control failures, and higher physiological response than euthymic individuals (Smallwood, O'Connor, Sudbery, & Obonsawin, 2007).

Nevertheless, other studies did not support this link between depression and daydreaming in the same clear way, but proposed a more specific relation. Deng, Li, and Tang (2012) reported that levels of depressive symptoms correlated only with the rate of episodes of mindwandering that occurred without the participant's awareness of being off task (e.g. "zoned out"), but not with those episodes of which a participant was aware (e.g. "tuned out"). Moreover, Marchetti, Koster, and De Raedt (2012) showed that individuals' levels of depressive symptoms were not correlated with mindwandering, but the former moderated the latter in predicting the accessibility of negative thinking. In keeping with this result, Smallwood, O'Connor, and Heim (2004/05) also reported that the rate of being off task correlated with individuals' mean scores of depression, but only in high ruminators and not in low ruminators.

This inconsistency in findings highlights the need to clarify the mechanism(s) through which daydreaming can lead to negative outcomes. Shedding light on the underlying process could indeed help understand what conditions increase the likelihood of negative outcomes related to daydreaming. Recently, Marchetti, Koster, Klinger, and Alloy (under review) proposed a comprehensive model that could explain the depressogenic role of daydreaming via contribution of multiple cognitive risk factors, such as rumination. In keeping with this, Marchetti, Koster, and De Raedt (2013) demonstrated in a laboratory setting that higher levels of internal focus during resting state predicted increased levels of state rumination that, in turn, explained a temporary worsening in mood. This model specifically held in individuals at-risk for depression. The authors speculated that being internally focused during rest could facilitate the emergence of self-related material that is the ideal condition for rumination to occur (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). Rumination, in turn, has been consistently found to enhance depressive symptoms (Aldao, Nolen-Hoeksema, & Schweizer, 2010). Literature consistently reports that during SGT external information is processed to a lesser extent (Barron, Riby, Greer, & Smallwood, 2011; Smilek, Carriere, & Cheyne, 2010), and the train of thoughts is largely insulated (Smallwood et al., 2012). Such reduced processing of external distractions could augment repetitive thinking (Nolen-Hoeksema et al., 2008).

In the current study, we aimed to test the indirect effect hypothesis that: (a) during daydreaming, self-related material would be significantly present in individuals' awareness; (b) being self-focused during SGT would spur ruminative processing of the emerged material; (c) a rigid and judgmental evaluation of internal material would lead to depressive symptoms. Given the inconsistent findings mentioned above, we did not make any *a priori* hypothesis about a direct association between daydreaming and depressive symptoms. Our study contributes to this research field in different ways. Importantly, by testing this model, we can further specify the mechanisms through which daydreaming is toxic and detrimental for mental health. Moreover, by relying on self-report questionnaires, our study may complement previous research that, although methodologically rigorous, suffers from suboptimal ecological validity, such as fMRI or specific laboratory contexts.

Therefore, we administered several trait questionnaires to measure individual levels of daydreaming (vs. mindfulness), self-focus, rumination, and depressive symptoms. Importantly, the scale we adopted as a measure for spontaneous cognitions, the Daydreaming Frequency Scale (DDFS), was previously used in both neurobiological and behavioral studies that confirmed its solid relation with the DMN (Mason et al., 2007) and rest-related phenomena, such as mindwandering (Mrazek, Smallwood, &

Schooler, 2012; Stawarczyk et al., 2012). Moreover, in order to evaluate the specific role of daydreaming in predicting depressive outcomes, we controlled for dispositional level of mindfulness. Mindfulness has been defined in different ways, but here we focused on the perspective that defines mindfulness as sustained nondistraction from here and now (Brown & Ryan, 2003). By partialling it out, we could establish the specific role of daydreaming above and beyond the potential confound of mindfulness.

Method

Participants

We recruited 117 native Dutch-speaking students at Ghent University (mean age 21.51 ± 3.04, range: 20 – 46, F: 116 and M: 1[2]). This study was approved by the Ethical Committee of the faculty of Psychology and Education of Ghent University.

Design

The questionnaires were completed in a group setting. The order of the questionnaires was counterbalanced[3].

Materials.

Daydreaming Frequency Scale (DDFS; Singer & Antrobus, 1970). The DDFS is one of the scales forming the Imaginal Processes Inventory. It consists of 12 items used to assess the frequency of daydreaming. Respondents rate each item on a 5-point Likert scale. Previous studies have reported good to excellent psychometric properties (Singer & Antrobus, 1970). For instance, both the English and the French version have been found to be unifactorial with substantial loading of each item (Singer & Antrobus, 1970; Stawarczyk et al., 2012). The instrument also has excellent six to eight years test-retest reliability (r = .76) and internal consistency (Cronbach's alpha = .91) (Giambra, 1980). In the current study, the original 12 items were translated from English to Dutch independently by two native Dutch speakers with excellent knowledge of academic

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[2] All the analyses reported in this study did not substantially change after excluding the only male participant.

[3] Another trait questionnaire of self-focus, the Private Self-Consciousness Scale (PrSCS, Fenigstein, Scheier, & Buss, 1975), was also administered. The analysis did not change substantially when the PrSCS was used. For sake of brevity, these results were not reported.

English. Importantly, one of the translators was one of the authors of this study (E. K.), whereas the other translator was not involved in this research. Discrepancies between these two versions were discussed until a satisfactory version was found. In this study, excellent internal consistency was observed (Cronbach's alpha = .91).

Self-Reflection and Insight Scale (SRIS; Grant, Franklin, & Langford, 2002). The SRIS is a 20-item self-report questionnaire, consisting of two independent subscales, the Self-Reflection subscale (SRIS-SR) and the Insight subscale (SRIS-IN). The SRIS-SR scale includes 12 items and measures the tendency to self-focus, that is to think about one's own thoughts, actions, and feelings and evaluate them. The SRIS-IN consists of 8 items that assess clarity of experience and self-knowledge. Each item is measured on a 6-point Likert scale ranging from 1 (strongly disagree) to 6 (strongly agree). The SRIS has high internal consistency and internal validity (Grant et al., 2002; Roberts & Stark, 2008). The Dutch version of the questionnaire had good psychometric properties (Sauter, Heyne, Blöte, Windenfelt, & Westenberg, 2010) and in the current sample, the SRIS-SR and SRIS-IN showed excellent internal consistency (Cronbach's α = .94 for SRIS-SR; α = .82 for SRIS-IN).

Ruminative Responses Scale (RRS; Treynor, Gonzalez, & Nolen-Hoeksema, 2003). The RRS is a 22-item self-report questionnaire that measures habitual tendency to ruminate and consists of items that describe responses to depressed mood that are focused on the self, symptoms, or consequences of this mood. Participants rate to what extent they usually engage in such responding using a 4-point Likert scale ranging from 1 (almost never) to 4 (almost always). Total RRS scores and subscale scores for reflection and depressive brooding were also calculated. The RRS has shown high reliability and validity and has good psychometric properties (Treynor et al., 2003). The Dutch version of the instrument also has good reliability and satisfactory validity (Raes, Hermans, & Eelen, 2003). Internal consistency of the RRS and its subscales in the current study was good (Cronbach's α = .93 for the total score; α = .77 for the brooding subscale; α = .74 for the reflection subscale).

Beck Depression Inventory 2nd Edition (BDI-II; Beck, Steer, & Brown, 1996). The BDI-II is a 21-item self-report questionnaire, which assesses the severity of affective, somatic and cognitive symptoms of depressive phenomenology. Individuals rate each symptom on a scale ranging from 0 to 3. The Dutch version of the BDI-II we used has acceptable reliability and validity (Van der Does, 2002). In our study, the BDI-II had excellent internal consistency (Cronbach's alpha= .85).

Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003). The MAAS is a self-report 15-item questionnaire. Participants are required to rate each item on a 6-point Likert type scale, ranging from 1 (almost always) to 6 (almost never). The MAAS evaluates mindfulness as attention and awareness towards emotions, thoughts, sensations, and situations. Higher scores on the MAAS reflect higher levels of dispositional mindfulness. The Dutch translation of the MAAS was made available by the authors of the original instrument and in our study we found excellent internal consistency (Cronbach's alpha= .81).

Data-analytic strategy.

We first investigated the psychometric properties of the Dutch version of the Daydreaming Frequency Scale (DDFS). Initially, we checked the single item features and internal consistency through item analysis and Cronbach's alpha respectively. We then carried out an Exploratory Factor Analysis (EFA) on the Pearson's correlation matrix by means of Principal Axis Factoring (PAF) with oblique rotation (Oblimin) to highlight the factorial structure of the instrument. According to established guidelines (Zwick & Velicer, 1986), we retained the number of factors suggested by the scree plot (Cattell, 1966; see Figure 1), the Parallel Analysis (PA; Horn, 1965; see Figure 1), and the Minimum Average Partial Correlation statistic (MAP; Velicer, 1976). The analyses were carried out with IBM SPSS 19 and FACTOR 8.02 (Lorenzo-Seva & Ferrando, 2006).

We then checked the descriptive statistics and Pearson's correlations among all the variables measured in this study. Spearman's rank correlation coefficient was computed when necessary. Data were transformed to either obtain normally distributed variables or correct for outliers (z point > 3). No participants were excluded.

According to our hypothesis (see Figure 2A), we first tested whether trait *daydreaming* could explain higher levels of *self-focus* (path a_1), which in turn was expected to account for higher levels of *brooding* (path a_3). The final output of this serial mediation model was individual levels of *depressive symptoms* (path b_2). We did not have a specific hypothesis regarding either the total (path *c*) or the direct (path *c'*) effect of daydreaming with depressive symptoms. According to Mathieu and Taylor's

(2006) guidelines, if the indirect effect was found significant, we could refer to this as an *indirect effect model* only if both the total and direct effect were null. If one or both of these two latter effects were found significant, we should speak of either *full* or *partial mediation model* (Preacher & Hayes, 2008). Given that daydreaming and mindfulness are thought to represent negatively related constructs, with the former capturing the tendency of the mind to drift away and the latter the tendency to be aware of the present moment (Deng et al., 2012; Mrazek et al., 2012), we always included the mindfulness as a covariate in all the models in which daydreaming was the focal predictor in order to establish its contribution above and beyond mindfulness[4].

In our study, the total effect (path *c*) was computed as the regression coefficients of daydreaming and mindfulness predicting depressive symptoms, while none of the intervening variables were included in the model. According to the mediation theory (Hayes, 2013), it was possible to decompose the total effect in two main parts, that is the direct effect (path *c'* with depressive symptoms being regressed on daydreaming, self-focus, brooding, and mindfulness) and the total indirect effect. The latter could, in turn, be decomposed into three specific indirect effects where daydreaming influenced depressive symptoms via: (i) self-focus (path a_1b_1); (ii) brooding (path a_2b_2); self-focus and brooding serially (path $a_1a_3b_2$). By definition, the sum of the direct effect and the total indirect effect equates to the total effect of daydreaming on depressive symptoms.

To test the significance of both the total and specific indirect effects, we adopted the bootstrapping approach (Preacher & Hayes, 2008). Compared with the causal steps approach (Baron & Kenny, 1986) or the Sobel test (Sobel, 1982), bootstrapping is considered the most powerful approach, to be free from unrealistic assumptions (i.e., normal distribution of the indirect effect), and to have better control on Type I error (Hayes, 2009, 2013). In line with Preacher and Hayes' recommendations (2008), to test the significance of the indirect effects, we estimated 10000 bootstrap bias-corrected 95% confidence intervals (CIs), and if they did not contain zero they were considered significant. The core hypothesis we tested was the model whereby daydreaming influences depressive symptoms via self-focus and brooding serially (path

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[4] All the analyses reported did not substantially change after excluding MAAS as covariate

$a_1a_3b_2$). However, in order to rule out alternative paths belonging to the same statistical model, we also estimated the other specific indirect effects (Hayes, 2013), where the intervening variables were introduced one at a time, that is either path a_1b_1 or path a_2b_2. In order to clarify the direction of the indirect effects, we also estimated each single path (e.g. a_1, a_2, a_3, b_1, and b_2) using an ordinary least squares regression. Finally, in adherence with Mathieu and Taylor's guidelines (2006), we tested both the direct (path c') and the total effect (path c).

Given that our study was purely cross-sectional, we tried to rule out two other serial indirect effects that would work against our main hypothesis. In the first alternative model, we substituted brooding with the reflection subscale of the RRS as the second intervening variable. Although both reflection and brooding are essentially forms of self-focus and self-referential thinking, reflection is known not to lead to negative outcomes, such as depressive symptoms (Nolen-Hoeksema et al., 2008). We thus expected the model, in which daydreaming influences depressive symptoms via self-focus and reflection, not to be significant. The second alternative model proposes that self-focus leads to increased daydreaming, which in turn could explain depressive brooding and depressive symptoms. Self-focus induction indeed has been reported to influence the tendency of the mind to drift away from external reality toward the inner mental world (Smallwood et al., 2011). However, it is difficult to explain how and why daydreaming, after being purged of its self-related component, could lead to rumination. Therefore, we anticipated this model would not be significant either.

All the analyses were carried out with IBM SPSS 19 and the macro PROCESS 2.03 (Hayes, 2013).

Results

Preliminary analysis: Psychometric properties of the Daydreaming Frequency Scale (DDFS)

We evaluated the psychometric properties of the Dutch version of the DDFS on the total sample. The inter-item correlation matrix showed that all the DDFS items were positively correlated, mean r = .47 (range: .17 - .84), as well as the mean-corrected item-total correlation was r = .65 (range: .51 - .79). Cronbach's alpha revealed excellent internal consistency (α = .91), which was not improved by item deletion. Before conducting the Principal Axis Factoring (PAF) on the 12 items, we checked the assumptions through the Kaiser-Meyer-Olkin criterion (KMO = .91) and the Bartlett's test of sphericity ($\chi^2[66] = 773.28$, $p < .001$), which highlighted sufficient sample size and data quality (Gorsuch, 1983).

The scree plot inspection (see Figure 1), the Parallel Analysis (PA; Figure 1), and the Minimum Average Partial Correlation test (MAP, average partial correlation = .331) strongly supported the one-factor solution, which explained 51.93% of the variance in the unrotated matrix. All the items loaded on the factor substantively, that is ≥ .54 (range: .54 - .84). According to Stevens (2002), for sample sizes of 100 subjects, only loadings greater than .51 should be interpreted.

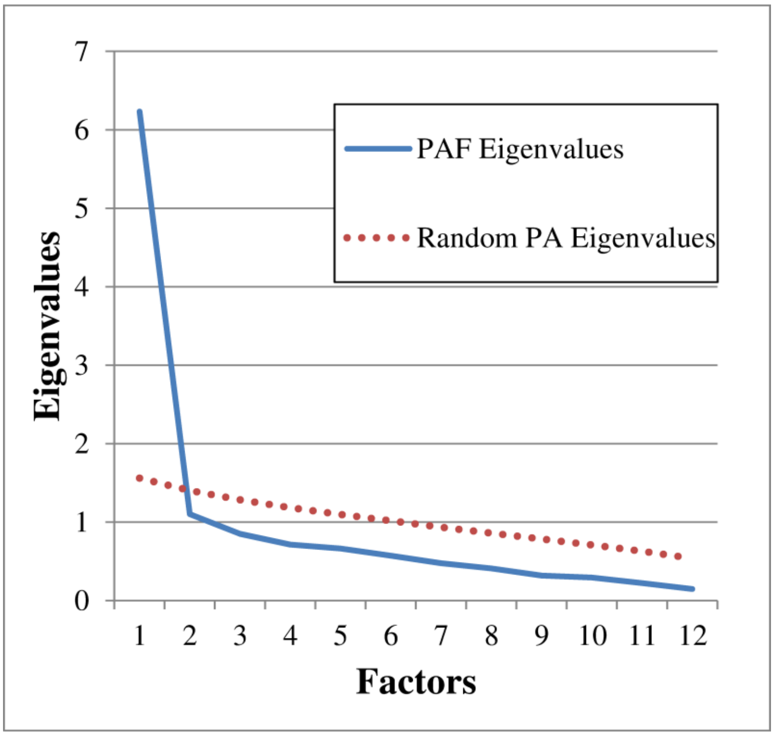

Figure 1. *Scree plot showing the eigenvalues derived from both the Principal Axis Factoring (PAF) and the Parallel Analysis (PA). PAF eigenvalues: 6.23, 1.10, .85, .71, .66, .57, .47, .41, .32, .29, .22, .15. Random PA eigenvalues (12 variables, n = 117, 1000 replications): 1.56, 1.40, 1.28, 1.18, 1.09, 1.01, .93, .85, .78, .70, .62, .53.*

In sum, we confirmed that the Dutch version of the DDFS is unifactorial and all the items significantly represent the underlying factor. We thus adopted the sum of the 12 DDFS items as our main variable in this study.

Descriptive statistics and correlational analysis

Means, standard deviations, Cronbach's alphas and correlations between the questionnaire measures are reported in Table 1.

Table 1.

Means, standard deviations, Cronbach's alpha, and Pearson's correlations (n = 117)

	M	*SD*	*SK*	*K*	*Min – Max*	DDFS	SRIS-SR$_a$	SRIS-IN	RRS$_a$	Brooding$_a$	Reflection	BDI-II$_a$	MAAS
DDFS	36.19	8.49	.04	-.48	18 - 58	(.91)	.21*	-.21*	.24**	.21*	.17$_s$	.12	-.25**
SRIS-SR	51.39	9.91	-.70	.00	23 – 68		(.94)	-.12	.42***	.40***	.55$_s$***	.15	.13
SRIS-IN	31.66	5.9	-.41	.02	15 - 44			(.82)	-.21*	-.18	-.06$_s$	-.28**	.39***
RRS	39.41	10.92	1.01	1.28	22 – 79				(.93)	.88***	.73$_s$***	.36***	-.01
Brooding	9.48	3.04	.84	.73	5 – 19					(.77)	.56$_s$***	.38***	.01
Reflection	7.98	2.6	1.14	.96	5 - 16						(.74)	.13$_s$	.07$_s$
BDI-II	8.56	6.46	1.41	2.47	0 – 34							(.85)	-.25**
MAAS	4.17	.59	-.38	.14	2.53 – 5.47								(.81)

Note. *$p < .05$. **$p < .01$. ***$p < .001$. The values between parentheses are Cronbach's alphas. *SK* = skewness. *K* = kurtosis. *DDFS* = Daydreaming Frequency Scale. *SRIS-SR* = Self-reflection scale of the Self-reflection and Insight Scale. *SRIS-IN* = Insight scale of the Self-reflection and Insight Scale. *RRS* = Ruminative Response Scale – total score. *BDI-II* = Beck Depression Inventory 2nd Edition. MAAS = Mindful Attention Awareness Scale.

a = data transformed to either obtain normally distributed variables or correct for outliers (z point > 3)

s = Spearman's rank correlation coefficient

In line with our hypothesis, daydreaming frequency was positively correlated with self-focus measured with the self-reflection scale (SRIS-SF). Daydreaming was also correlated with rumination, and specifically with depressive brooding, but not with reflection. In line with a previous study and current theoretical perspectives (Marchetti et al., 2013; Marchetti et al., under review), daydreaming seems to be a phenomenon during which evaluative and judgmental self-referential thinking occurs. This was also supported by the negative relationship between the insight scale (SRIS-IN) and daydreaming. Daydreaming seems not to be beneficial with regard to the clarity of reflection and self-understanding; on the contrary, it may impair these processes. In sum, although daydreaming is focused on the daydreamer's narrative self (e.g. action, feelings, past events, etc.), it is not associated with any immediate beneficial outcome, rather it is the ideal condition for detrimental ruminative self-focus to occur. Moreover, daydreaming was independent from depressive symptoms, whereas it was negatively correlated with being aware at the present moment. It is noteworthy that this modest negative relation between daydreaming and mindfulness has been reported previously in other studies (i.e. r = -.237; Mrazek et al., 2012). Importantly, not only does this result confirm a previous finding (Mrazek et al., 2012), but also it provides information about the divergent validity of the Dutch version of the DDFS.

Mediation analysis

In accordance with Mathieu and Taylor's guidelines (2006), we first tested the significance of the main indirect effect of interest, namely that daydreaming would explain the levels of depressive symptoms via self-focus and brooding levels serially (path $a_1a_3b_2$; Figure 2).

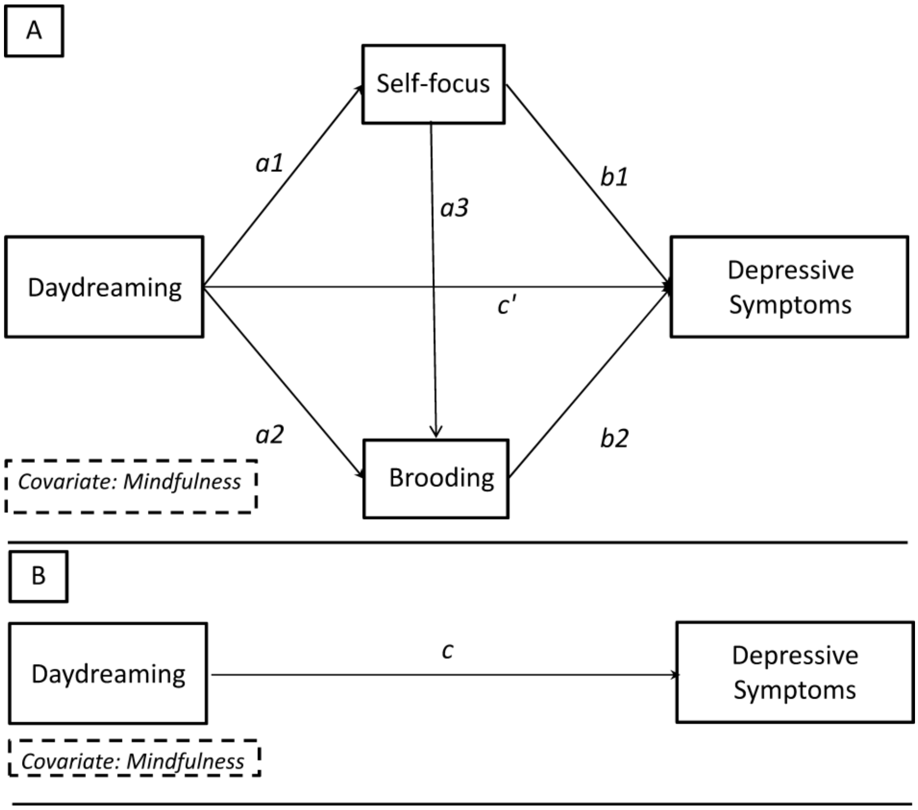

Figure 2. *Theoretical path diagram showing the multiple serial mediation model. Path c: total effect. Path c': direct effect. Path $a_1a_3b_2$: specific indirect effect of interest.*

Table 2 shows that this three-step indirect effect was indeed statistically significant (path $a_1a_3b_2$ = .0014; boot 95% CI LL = .0004, boot 95% CI UL = .0036). Moreover, all the single paths of this effect were in the expected direction (Table 3).

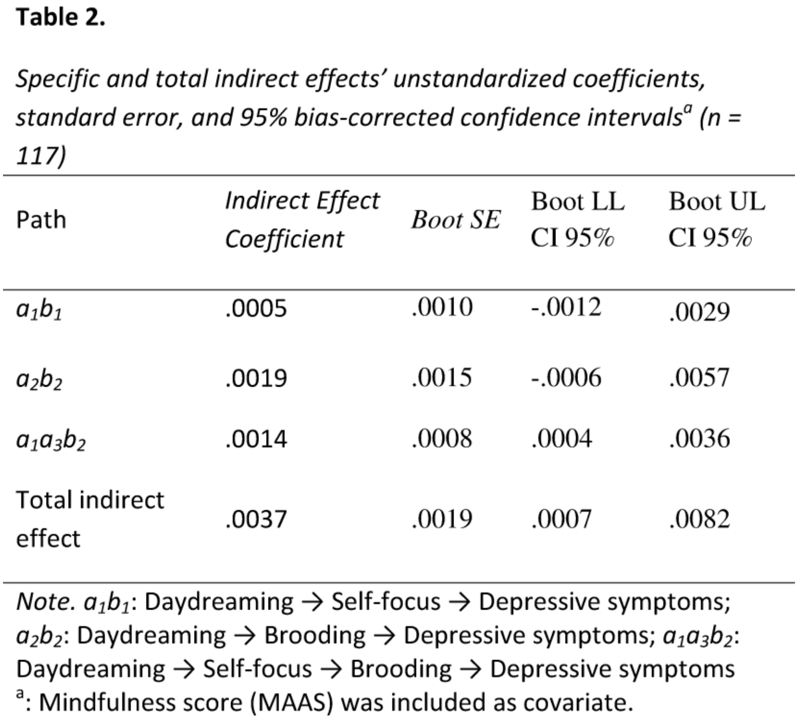

Table 2.

Specific and total indirect effects' unstandardized coefficients, standard error, and 95% bias-corrected confidence intervals^a (n = 117)

Path	*Indirect Effect Coefficient*	*Boot SE*	Boot LL CI 95%	Boot UL CI 95%
a_1b_1	.0005	.0010	-.0012	.0029
a_2b_2	.0019	.0015	-.0006	.0057
$a_1a_3b_2$	.0014	.0008	.0004	.0036
Total indirect effect	.0037	.0019	.0007	.0082

Note. a_1b_1: Daydreaming → Self-focus → Depressive symptoms; a_2b_2: Daydreaming → Brooding → Depressive symptoms; $a_1a_3b_2$: Daydreaming → Self-focus → Brooding → Depressive symptoms
^{a}: Mindfulness score (MAAS) was included as covariate.

Table 3.

Total (c) and direct (c′) effects' unstandardized coefficients, unstandardized path coefficients, standard errors, and p-values (n = 117)

		Consequent														
Antecedents	Path	Self-focus (SRIS-SR)			Path	Brooding			Path	Depressive symptoms (BDI-II)			Path	Depressive symptoms (BDI-II)		
		Coefficient	*SE*	*p-value*		*Coefficient*	*SE*	*p-value*		*Coefficient*	*SE*	*p-value*		*Coefficient*	*SE*	*p-value*
Daydreaming (DDFS)	a_1	.0366	.0132	< .01	a_2	.0076	.0051	*ns*	c'	-.0012	.0034	*ns*	c	.0024	.0035	*ns*
Self-focus (SRIS-SR)		-	-	-	a_3	.1492	.0352	< .001	b_1	.0127	.0252	*ns*		-	-	-
Brooding		-	-	-		-	-	-	b_2	.2493	.0625	< .001		-	-	-
Mindfulness (MAAS)		.4057	.1911	< .05		-.0068	.0733	ns		-.1472	.0487	< .005		-.1286	.0515	< .01
(Constant)		-6.0386	1.0382	< .001		3.2459	.4450	< .001		.8184	.3588	< .001		1.3262	.28	< .001
		R^2 = .079, $F(2, 114)$ = 4.869, $p < .01$				R^2 = .180, $F(3, 113)$ = 8.249, $p < .001$				R^2 = .210, $F(4, 112)$ = 7.458, $p < .001$				R^2 = .066, $F(2, 114)$ = 4.044, $p < .05$		

Note. All the coefficients are unstandardized.

Indeed, daydreaming positively predicted self-focus (path a_1 = .036), which, in turn, positively predicted brooding (path a_3 = .149). Finally, brooding positively predicted depressive symptoms (path b_2 = .249). It is noteworthy that the simpler alternative indirect paths were both not significant. The indirect effect whereby daydreaming influences depressive symptoms only via self-focus failed to reach statistical significance (path a_1b_1 = .0005; boot 95% CI LL = -.0012, boot 95% CI UL = .0029). So did the other alternative path, whereby daydreaming predicts depressive symptoms via brooding levels (path a_2b_2 = .0019; boot 95% CI LL = -.0006, boot 95% CI UL = .0057). In sum, the three-step indirect effect was the only statistically significant effect, and, despite that it consisted of two intervening variables, it was parsimonious too, in that simpler models did not explain the data satisfactorily (see Figure 3).

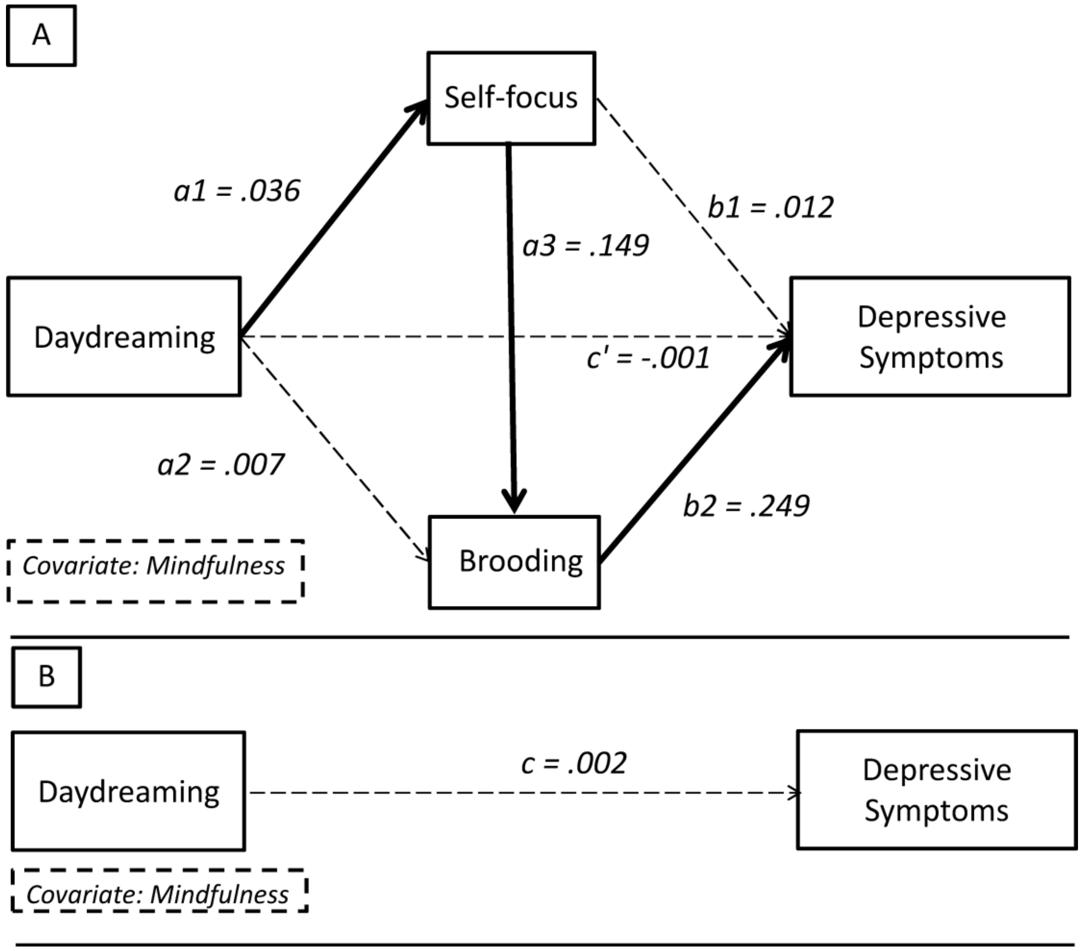

Figure 3. *Statistical diagram with path coefficients. Total effect: c = .002. Direct effect: c' = -.001. Specific indirect effect of interest:* a_1a_3b *= .036(.149).249 ≈ .0014. Bold paths are statistically significant, while dashed paths are not significant.*

We then tested both the total (path *c*) and the direct (path *c′*) effect using the OLS regression approach. Table 3 shows that both unstandardized coefficients were not significant. We can thus conclude that the hypothesized serial (indirect) effect model was supported and that daydreaming seems to explain depressive symptoms only via the contribution of both self-focus and depressive brooding.

Additional analysis

We also explored two alternative models that were in contrast to our main hypothesis. We investigated whether the same three-step indirect effect was statistically significant, after removing brooding and including reflection as the second intervening variable. Given the unclear link between reflection and depression (Nolen-Hoeksema et al., 2008), we expected this model would not be significant. In keeping with this, Table 4 shows that this alternative model was in fact not statistically sound (path $a_1a_3b_2$ = .0005; boot 95% CI LL = -.0004, boot 95% CI UL = .0021).

Table 4.

Specific and total indirect effects' unstandardized coefficients, standard errors, and 95% bias-corrected confidence intervals[a] *(n = 117)*

Path	*Indirect Effect Coefficient*	*Boot SE*	Boot LL CI 95%	Boot UL CI 95%
a_1b_1	.0014	.0013	-.0005	.0047
a_2b_2	.0004	.0007	-.0003	.0025
$a_1a_3b_2$	.0005	.0006	-.0004	.0021
Total indirect effect	.0022	.0014	.0001	.0056

Note. a_1b_1: Daydreaming → Self-focus → Depressive symptoms; a_2b_2: Daydreaming → Reflection → Depressive symptoms; $a_1a_3b_2$: Daydreaming → Self-focus → Reflection → Depressive symptoms
[a]: Mindfulness score (MAAS) was included as covariate.

By capitalizing on the literature (Smallwood et al. 2011), we also put forward that self-focus could lead to a habitual tendency to daydream that in turn could explain depressive symptoms via the contribution of brooding. In contrast, our main hypothesis argued that daydreaming would lead to depressive brooding only via the self-referential focus of task-free mental activity. Because of this, we expected that this alternative model would not reach significance. Table 5 shows indeed that self-focus fails to explain depressive symptoms via daydreaming and brooding serially (path $a_1a_3b_2$ = .0028; boot 95% CI LL = -.0003, boot 95% CI UL = .0113).

Table 5.

Specific and total indirect effects' unstandardized coefficients, standard errors, and 95% bias-corrected confidence intervals (n = 117)

Path	*Indirect Effect Coefficient*	*Boot SE*	Boot LL CI 95%	Boot UL CI 95%
a_1b_1	.0025	.0047	-.0054	.0139
a_2b_2	.0373	.0141	.0143	.0695
$a_1a_3b_2$	.0028	.0027	-.0003	.0113
Total indirect effect	.0426	.0151	.0169	.0762

Note. a_1b_1: Self-focus → Daydreaming → Depressive symptoms; a_2b_2: Self-focus → Brooding → Depressive symptoms; $a_1a_3b_2$: Self-focus → Daydreaming → Brooding → Depressive symptoms

Discussion

SGT and mental phenomena that are based on it, such as daydreaming, are increasingly attracting scholars' attention (Andrews-Hanna et al., in press; Klinger, 1971, 1990, 2009, 2013; Smallwood, 2013; Smallwood & Schooler, 2006) given their ubiquitous impact on mental life. Interestingly, daydreaming has been associated with increased depressive symptoms and negative cognitions (Meyer et al., 2011; Smallwood et al., 2007), although findings are mixed. Here we sought to examine some of the pathways that could potentially explain why and how daydreaming leads to depressive outcomes and, in turn, account for the inconsistency reported in the literature.

In our study, we found that levels of daydreaming and depressive symptoms were statistically independent. However, according to the previous studies and a recent theoretical framework (Marchetti et al., 2013; Marchetti et al., under review), daydreaming did predict depressive outcomes, but only to the extent to which self-focus and brooding were involved too. In other words, during SGT, our attention tends to be focused on internal scenarios related to our self and self-related goals (Diaz et al., 2013; Klinger, 2009; Northoff et al., 2006). This enhances the chance of ruminating on the (lack of) progress in salient goal-striving (Klinger, 2013; Koster, De Lissnyder, Derakshan, & De Raedt, 2011). Unfortunately, such a passive and self-critical evaluation has consistently been reported to be depressogenic (Aldao et al., 2010). It is also noteworthy that, in line with these results, daydreaming was negatively correlated with both mindfulness and the clarity of self-knowledge. That is, people who reported experiencing daydreaming generally did not benefit from being aware of the present moment nor did being self-focused lead them to a better understanding of themselves.

On the one hand, these findings are important because they convey a plausible nomological model suggesting possible directional links between crucial constructs in depression, such as daydreaming, self-focus, and brooding. It is also noteworthy that the proposed model could bridge the gap between cognitive and neurobiological science, in that the hypothesis tested in this study is compatible with evidence derived from both research fields. As mental baseline, daydreaming is considered the quintessential outcome of the DMN (Mason et al., 2007), while self-focus has been robustly associated with a specific DMN subnetwork, Cortical Midline Structures (CMS; Northoff et al., 2006). Unsurprisingly, both rumination and clinical depressive status, too, have been linked with higher levels of DMN functional connectivity during resting state (Greicius et al., 2007; Berman et al., 2011, Zhu et al., 2012). Therefore, the model tested in this study holds promise for guiding future neuroimaging studies where trait rumination could be associated with specific dynamics of neural activation of DMN-related brain regions (i.e., Granger causality test; Hamilton, Chen, Thomason, Schwartz, & Gotlib, 2011).

On the other hand, we believe that our study not only replicated previous findings, but also complements these research lines that may suffer from suboptimal ecological validity. Both fMRI investigations and experimental studies usually require individuals to rest in conditions that are far from those usually experienced. For instance, recent methodological studies highlight the detrimental impact of the scanner background noise on the neural activation of DMN and resting state (Gaab, Gabrieli, & Glover, 2008; Hommel, Fischer, Colzato, van den Wildenberg, & Cellini, 2012; Rondinoni, Amaro, Cendes, dos Santos, & Salmon, 2013). On the contrary, in our study we did not impose any artificial condition, but we simply investigated stable and long-term dispositions through self-report. By doing so, we may have been able to track specific mechanisms that are more likely to mirror what happens in everyday life, although future experience sampling studies are warranted.

This study has several limitations that we want to acknowledge. First, the research design is totally self-report based and methodologically cross-sectional, so that no cause-effect claims can be made. Nevertheless, to partially mitigate this flaw, we ruled out four alternative models. Not only did this support our hypothesis, but it also confirmed the validity of the model, in that no redundant variable was detected. Apparently, both self-focus and maladaptive rumination were necessary components for daydreaming to impact on depressive symptoms. However, in order to be able to further validate the model, behavioral high-risk longitudinal designs are warranted (Alloy, Abramson, Raniere, & Dyller, 1999). Second, we acquired information only about the frequency of daydreaming and not on its specific content. According to recent perspectives on SGT (Smallwood & Andrews-Hanna, 2013), a factor implicated in the impacting of daydreaming on well-being is its specific content, either positive vs. negative, or past- vs. future-oriented (Klinger et al., 2009; Ruby, Smallwood, Engen, & Singer, 2013). Accordingly, future studies should include additional significant variables in order to better specify under which circumstances daydreaming leads to depressive outcomes and, most importantly, when this is not the case. Third, according to our hypothesis aiming at clarifying the role of daydreaming in depression, we did not take into account the possibly positive effects of SGT. For instance, previous research has indeed reported that DDFS is positively correlated with creative thinking (Baird et al., 2012) and neurobiological evidence suggests that SGT could facilitate social cognition (Schilbach et al., 2012; Schilbach, Eickhoff, Rotarska-Jagiela, Fink, & Vogeley, 2008). So, we cannot exclude that possible positive effects due to SGT did go unnoticed in our study.

In sum, the clinical importance of resting state and rest-related phenomena is increasingly being stressed by both researchers and clinicians (Rosner, Lyddon, & Freeman, 2004; Whitfield-Gabrieli & Ford, 2012), with different models being proposed (i.e. Andrews-Hanna et al., in press; Marchetti et al., under review; Marchetti, Koster, Sonuga-Barke, & De Raedt, 2012). In our study, we confirmed a plausible mechanism recently proposed by Marchetti and colleagues (2013), whereby daydreaming is supposed to impact on depression via contribution of both self-focus and rumination. However, we are not claiming here that daydreaming is negative *per se*. On the contrary, we have been able to clarify a specific mechanism where self-focus seems to be pivotal (Green, 1923). This also implies that, in individuals with a different style, daydreaming might have different effects, such as in those who tend to be more other-focused than purely self-focused during free thinking (Mar, Mason, & Litvack, 2012; Marchetti & Koster, 2014).

In conclusion, daydreaming is a very fluid and complex mental activity. Theoretical and empirical efforts are necessary to highlight both the negative and positive consequences of such a pervasive phenomenon that occupies a vast part of our mental life.

Conflict of Interest Statement

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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CHAPTER 7

Wandering in the dark: Daydreaming and vulnerability to mood disorders[1]

ABSTRACT

There is increasing research interest in mental functioning that is unrelated to task activity, termed daydreaming. Daydreaming is an umbrella term for processes such as mindwandering, involuntary autobiographical memory, and fantasy. A substantial literature elucidates adaptive and maladaptive consequences of daydreaming. In this theoretical framework, we propose that, apart from its positive functions, daydreaming provides a crucial context for cognitive vulnerability in individuals who are at risk to develop mood disorders. Given that daydreaming tends to focus on unattained personal goals and evaluate the discrepancy between current and desired status (Klinger, 1971, 2013a), daydreaming potentiates in vulnerable individuals at least four cognitive risk factors for depression, including rumination, hopelessness, low self-esteem, and cognitive reactivity, and reduces levels of protective factors, such as mindfulness. We also propose that stress could intensify the impact of daydreaming on depression. Finally, we describe how daydreaming could enhance the likelihood of developing mania. The evidence for this framework is reviewed and we discuss theoretical and clinical implications of our proposal.

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[1] Based on Marchetti, I., Koster, E. H. W., Klinger, E., & Alloy, L. B. (2014). Wandering in the Dark: Daydreaming and Vulnerability to Mood Disorders. Manuscript submitted to publication.

> *"The fact that the body is lying down is no reason*
> *for supposing that the mind is at peace.*
> *Rest is* […] *far from restful"*
> Lucius A. Seneca (~60 A. D.)

Introduction

Daydreaming is a very frequent and ubiquitous phenomenon. Although modern life is considered busy and hectic with little spare time, estimates consistently suggest that we spend up to half of our waking hours thinking of and reflecting upon topics that are unrelated to the task at hand or the surrounding environment (Killingsworth & Gilbert, 2010). Moreover, daydreaming has been robustly associated with both emotional consequences, half of them negative ones (Killingsworth & Gilbert, 2010, for a critique see Klinger, 2013b), as well as personality traits that have been implicated in risk for psychopathology, such as neuroticism or openness to experience (Zhiyan & Singer, 1996-1997). Notwithstanding these findings, so far only a few theoretical efforts have attempted to understand whether and how daydreaming impacts mental health and what role it may play in major psychopathology (e.g., Klinger 1996a), such as mood disorders, including major depression and bipolar disorder.

There are good reasons to examine daydreaming in relation to mood disorders. Negative self-evaluative thought is a hallmark characteristic of major depression, which most frequently arises when one is not fully engaged in a task. As depression has been associated with lower levels of behavioral activation (Mazzucchelli, Kane, & Rees, 2009), there is ample opportunity to engage in daydreaming. Indeed, rest or low demanding tasks are typical conditions known to induce daydreaming (Antrobus, Singer, & Greenberg, 1966; Klinger, 2013a). Moreover, considering that in the US more than 32 million adult individuals have been estimated to be clinically depressed (Kessler et al., 2003) for a total cost of about $83 billion to society (Greenberg et al., 2003), with similar estimates being reported for Europe (Gustavsson et al., 2011), it is timely to elucidate the mechanism through which daydreaming impacts mood, cognition, and depressive symptoms.

Daydreaming as a mental function that potentiates cognitive risk factors for depression

In our framework (Figure 1), we propose that during daydreaming - defined as the mind drifting away from external reality in a spontaneous or fanciful way - individuals focus mostly on their unattained personal goals and evaluate the discrepancy between their current and desired status (Klinger, 1971, 2009, 2013a). Importantly, the same mechanism based on goal-discrepancy that is dominant during daydreaming is also extensively implicated in well-established cognitive risk factors for depression, such as (i) *rumination*, (ii) *hopelessness*, (iii) *low self-esteem*, and (iv) *cognitive reactivity*.

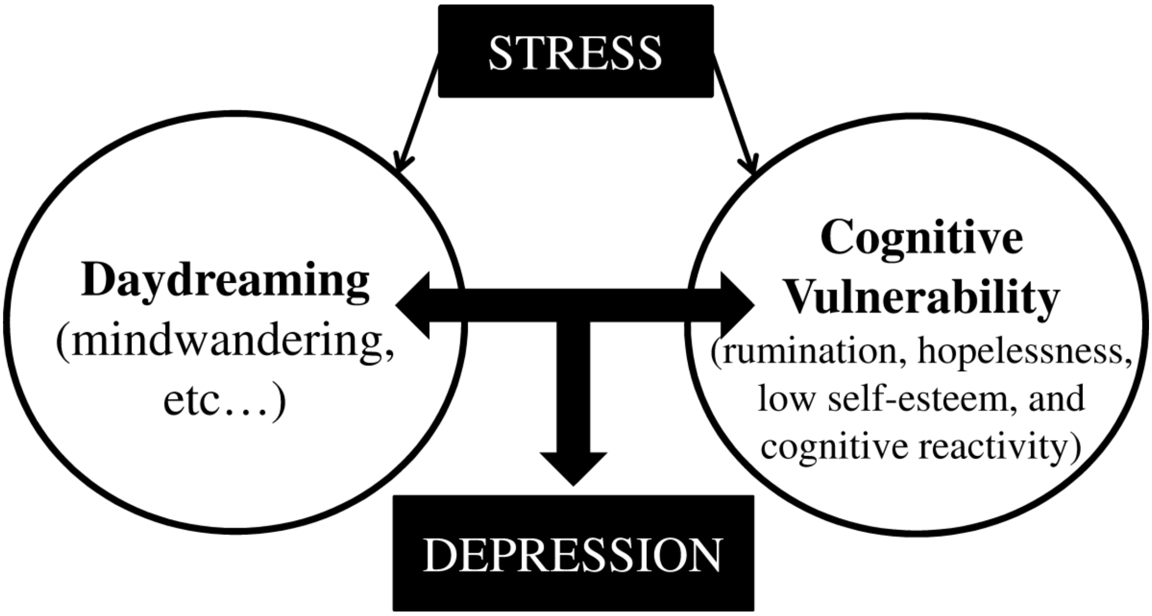

Figure 1. *Theoretical framework – daydreaming and cognitive risk factors for depression*

Crucially, we propose that in individuals who are either dysphoric or vulnerable to depression, daydreaming potentiates the aforementioned risk factors which subsequently leads to depressive symptoms. According to early and recent perspectives on resting state (Harmelech & Malack, 2013; Varendonck, 1921), daydreaming is thought to recapitulate the habitual mindset of the daydreamer, such as the personal thinking style, and to maintain these habits. Consequently, we suggest that individuals with elevated levels of depressive thinking experience a depressogenic style of daydreaming that ends up worsening both their mood and cognitions which, in turn, lead to concurrent and future depressive symptoms. On the contrary, in individuals who do not show this depressive style, daydreaming is not expected to be maladaptive, rather providing benefits, such as creative problem solving and autobiographical planning (Mooneyahm & Schooler, 2013).

Importantly, the cognitive risk factors that we link to daydreaming emerged from independent theories of depression and are to a large extent investigated independently. In our view, these different cognitive risk factors can be associated with the mental state of daydreaming, which potentiates them and provides a prominent context in which these risk factors influence mental health. We also propose that daydreaming, especially when characterized by negative content, could reduce the individual's ability to be attentive to the present moment and adopt a non-judgmental attitude with regard to his/her negative thoughts and emotions; that is, daydreaming could reduce *mindfulness*. Moreover, from a vulnerability-stress perspective, we highlight that daydreaming may interact with *stress* in a way that hinders emotional recovery and exacerbates negative outcomes.

Resting state and daydreaming (i.e., mindwandering) are the focus of intense efforts at the level of both behavioral and neuroscience research (Broyd et al., 2009; Buckner, Andrews-Hanna, & Schachter, 2008; Smallwood & Schooler, 2006). Therefore, our framework is informed by new developments in cognitive as well as neurobiological studies. The necessity to integrate these different perspectives has been stressed in the context of depression (e.g., Disner, Beevers, Haigh, & Beck, 2011; Marchetti, Koster, Sonuga-Barke, & De Raedt, 2012). To do so, first, we describe the current understanding of daydreaming, and specifically its functional and neural characteristics. Second, we review the literature that links daydreaming to depression and depressive symptoms. Third, we propose theoretical and empirical links between daydreaming and the aforementioned risk factors (i.e., rumination, hopelessness, low self-esteem, and cognitive reactivity) as well as its interaction with mindfulness and stress. Fourth, we discuss preliminary findings associating daydreaming and mania. Finally, we suggest future directions to guide new research and discuss the implications of our framework for clinical interventions.

Daydreaming

Definition and methodological issues

It is a common experience that the content of thought is often unrelated to the surrounding environment or any external stimulus. For instance, while reading a book, we may suddenly realize that we are unable to remember what we have been reading; or during a train ride, we may spend a large part of time in wandering thoughts, being unaware of what happens around us. As clearly emerges from these examples, the phenomenology of undirected thoughts is varied and quite difficult to define precisely. Consequently, different terms have been proposed across decades, such as mindwandering, spontaneous thought, stimulus-independent thought, task-unrelated thought, to mention some. Although tentative taxonomies have been proposed to account for subtle differences among these mental states (e.g., Stawarczyk, Majerus, Maj, Van der Linden, & D'Argembeau, 2011), all of these phenomena are characterized by roughly similar subjective reports (Singer & McCraven, 1961; Stawarczyk, Majerus, Maj, et al., 2011) as well as by the same neural substrate (Stawarczyk, Majerus, Maquet, & D'Argembeau, 2011). Here we use an umbrella term that represents all of these mental states, namely *daydreaming* (Singer, 1966; Smith, 1904; Klinger, 1971, 1990, 2009; Varendonck, 1921).

Daydreaming is defined as "*nonworking thought that is either spontaneous or fanciful*" (Klinger, 2009, pp. 226). Crucially, this definition suggests that daydreaming is a nonworking, noninstrumental type of thinking that does not intentionally serve any specific function, such as calculating. Furthermore, this definition of daydreaming encompasses different types of thoughts, such as spontaneous thinking that is unrelated to the current task at hand, or volitional fanciful thinking during periods of relaxed wakefulness. Although these phenomena share many features, an experience sampling study shows they can be differentiated and independent (Klinger & Cox, 1987-1988). In sum, the adopted definition of daydreaming is a broad one (Klinger, 2009), as it maps on to different types of mental activity that are likely to switch from one to another in the normal flow of thoughts (Pope, 1977, as cited in Klinger, 2013a). Given this, to provide a comprehensive framework and strengthen the theoretical foundations of our model, we capitalize on and integrate different research lines, such as (i) *mindwandering*, (ii) *involuntary autobiographical memories*, and (iii) *fantasy*.

Mindwandering is probably the largest component of daydreaming (Klinger, 2009), and is defined as “*a shift of attention away from a primary task toward internal information*” (Smallwood & Schooler, 2006, pp. 946), that is, attentional decoupling from external reality in favor of internal self-generated information. Although many ways have been proposed to capture this phenomenon, mindwandering mainly has been measured in relation to three functions: reading, working memory, and sustained attention (for a review, see Mooneyham & Schooler, 2013). Of particular interest is the latter domain wherein the individual usually undergoes a slow-paced task (i.e., GO/NOGO), such as the Sustained Attention to Response Task (SART; Robertson, Manly, Andrade, Baddeley, & Yiend, 1997). During the SART, the participant is asked to respond by pressing a button to frequent non-target stimuli and to withhold a response to infrequent target stimuli. Often the SART also involves intra-task thought probes about specific qualitative features, such as the type of attentional focus (off- vs. on-task) just before the probe.

Involuntary autobiographical memories are personal memories that arise spontaneously without any attempt to intentionally retrieve them (Berntsen, 2009), and by definition, they belong to the superordinate category of daydreaming (Johannessen & Berntsen, 2010). In daily life, involuntary memories are experienced often, especially during periods of non-engagement and in response to either external or internal cues, such as casual stimuli from the external world or accidental thoughts (Berntsen, 2009). In cognitive research, two methods are used most often to investigate this phenomenon: naturalistic diary studies and experimental paradigms of sustained vigilance (Berntsen, 2009).

Fantasy is defined as “*report of mentation other than orienting responses to, or scanning of, external stimuli, or operant activity, such as problem-solving in a task situation*” (Klinger, 1971, pp. 9-10). This definition includes inner experiences, such as daydreams in layman’s terms and reveries, but it excludes intentional activities, such as writing or working. Fantasy has been investigated by means of different methodologies mainly developed in the 1960s and 1970s, which are still used today (for a review see, McMillan, Kaufman, & Singer, 2013). Here, we mainly focus on two methods that are of particular interest for us, that is, self-report questionnaire assessment and thought probing, either online or retrospective, during periods of relaxed wakefulness.

The principal self-report questionnaire for a comprehensive assessment of fantasy is the Imaginal Processes Inventory (IPI; Antrobus, Singer, Goldstein, & Fortgang, 1970). The IPI consists of 344 items comprising 28 scales measuring the frequency, the style, and the content of inner experience, such as emotional content, sexual content, visual imagery, acceptance, and distractibility. However, given its length and the time necessary for its administration, the 12-item subscale about the frequency of daydreaming (Daydreaming Frequency Scale, DDFS) is increasingly adopted instead of the long form of the IPI (Mason et al., 2007; Stawarczyk, Majerus, Van der Linden, & D'Argembeau, 2012). It is also noteworthy that the DDFS measures the frequency of daydreaming, but neither its content nor its emotional valence (e.g. "*I daydream many different times during the day*"). Factor analysis of the IPI revealed three second-order factors that could represent a reasonably comprehensive assessment of fantasies and daydreams, but in a shorter form. The Short Imaginal Processes Inventory (SIPI; Huba, Aneshensel, & Singer, 1981) consists of three 15-item scales measuring specific styles of daydreaming, such as positive-constructive daydreaming (i.e., "*My daydreams often leave me with a warm, happy feeling*"), guilty-dysphoric daydreaming (i.e., "*In my fantasies, a friend discovers I have lied*"), and poor attentional control (i.e., "*I have difficulties maintaining concentration for long periods of time*").

As an alternative to retrospective self-report assessment, more direct evaluation of inner experience during periods of relaxed wakefulness has been proposed, such as online thought probes. During resting periods, thought probes are administered to investigate the specific content of ongoing mental activity (Roberts, Watkins, & Wills, 2013) and its attentional focus (Marchetti, Koster, & De Raedt, 2013). Moreover, after-rest retrospective methods have been proposed recently using self-report questionnaires (Diaz et al., 2013; Smallwood, O'Connor, & Heim, 2004-2005).

In sum, daydreaming includes a variety of different mental activities that are differently conceptualized, but all share similar features, in which most of them arise in contexts with low or no task demands. We capitalize on these different research lines in order to increase the ecological validity of our model and provide a broad framework that can account for undirected mental activity in everyday life.

Daydreaming as mental baseline

In his groundbreaking work in the 1970s, Klinger (1971) tentatively proposed that daydreaming is the mental baseline from which the mind departs every time a task must be accomplished, and to which it returns whenever not fully and actively engaged. In other words, daydreaming is supposed to be the mind's *default mode* (Klinger, 2009). Later, this speculation turned out to be farsighted, as at least two major findings have converged on this point confirming its validity.

First, daydreaming is thought be frequent and to occupy up to half of our mental activity during waking time (Franklin et al., 2013; Killingsworth & Gilbert, 2010; Klinger & Cox, 1987-1988), with about 2000 out of 4000 daily thoughts dedicated to daydream-like thoughts (Klinger, 1990). Second, daydreaming has been strongly associated with a specific neural network, the Default Mode Network (DMN; Figure 2).

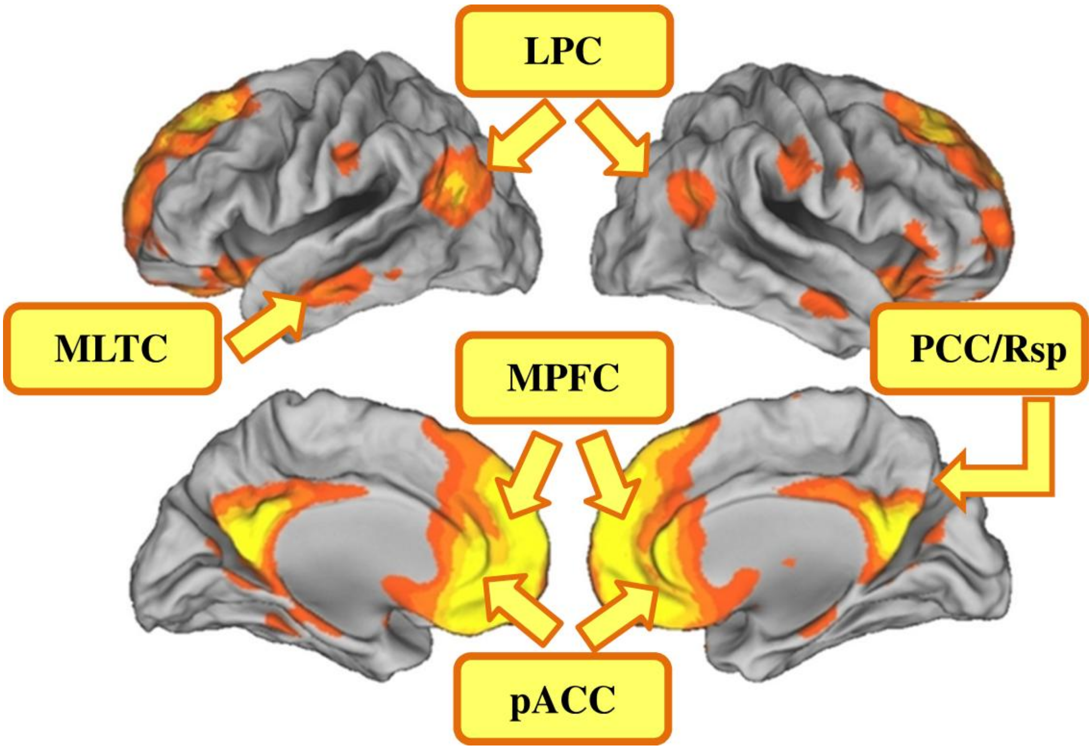

Figure 2. *Spatial distribution of BOLD signal fluctuations at rest, representing major areas of the Default Mode Network (DMN). MPFC: medioprefrontal cortex; pACC: perigenual anterior cingulate cortex; PCC: posterior cingulate cortex; Rsp: retrosplenial cortex; MLTC: mediolateral temporal cortex; LPC: lateral parietal cortex. Reproduced and adjusted with permission from Wang, Norton, Hutchison, Ives, & Mirsattari (2012) (permission by Dr. Seyed M. Mirsattari).*

The DMN is a large-scale network that has been reported to be highly active during rest and less active (if not deactivated) during external attention-demanding tasks (Raichle et al., 2001). It comprises different brain areas, such as the medioprefrontal cortex (MPFC), the perigenual anterior cingulate cortex (pACC), the posterior cingulate cortex (PCC), the retrosplenial cortex (Rsp), the precuneus, along with more lateralized areas, such as the lateral parietal cortex (LPC), the mediolateral temporal cortex (MLTC) and (para)hippocampal formation (Broyd et al., 2009; Buckner et al., 2008). These areas not only show a similar pattern of activation and deactivation, but also their low-frequency oscillations are usually temporally synchronized (i.e. *functional connectivity*; Buckner et al., 2008). Importantly, Mason et al. (2007) reported that when participants' minds drifted away from a practiced task, high levels of BOLD signal were detected in the DMN. Moreover, the activation levels of the DMN hubs were correlated with daydreaming in daily life, as measured with the DDFS (mean of the mean correlations across six areas = .58; mean of the peak correlations = .72).

In sum, cognitive, behavioral, and neuroimaging findings support Klinger's (1971) hypothesis that daydreaming serves as a mental baseline. Undirected thinking is an extremely frequent phenomenon that occurs whenever the mind is not engaged in a task or drifts away during ongoing external activity.

Basic properties of daydreaming

Daydreaming is characterized by several features, some of which are of crucial interest for their clinical impact, in that daydreams are usually (i) self-focused, (ii) sensitive to temporality, and (iii) emotionally valenced.

Daydreams mostly tend to be focused on the daydreamer's self. This feature was already highlighted by a classic study, as Green (1923) maintained that "[…] *all the daydreams are ego-centred.* […] *Each of the daydreams is like a little play, whose hero is the dreamer himself*" (pp. 27-28). This claim has been confirmed by recent studies. For instance, Diaz et al. (2013) demonstrated that self-focused thinking is an important component of internal mentation during a 5-minute resting state phase, in both ecological (i.e. at home) and fMRI contexts. Moreover, a recent experience sampling study in an Asian sample highlighted two important features of daydreaming (Song & Wang, 2012). First, daydreaming is likely to be a universal phenomenon (Klinger, 2009), as similar results in terms of frequency, triggers, and contents were reported in a non-Western sample. Second, they found that daydreaming provided a context in which the self-concept is actively processed (Song & Wang, 2012). Finally, at the neurobiological level, specific DMN areas lying on the brain midline, such as the MPFC and the PCC, have been directly involved with self-processing (for a recent meta-analysis, see Qin & Northoff, 2011).

Daydreaming also appears to be sensitive to time and temporal self-projection. Most studies report a prospective bias toward the future (Baird, Smallwood, & Schooler, 2011; Song & Wang, 2012; Stawarczyk, Majerus, Maj, et al., 2011). Interestingly this tendency is sensitive to manipulation, as both self-reflection and personal goal processing can strengthen this propensity for future-related thoughts (Smallwood et al., 2011; Stawarczyk, Majerus, Maj, et al., 2011), whereas negative mood induction leads to self-projection in the distant past (Poerio, Totterdell, & Miles, 2013; Smallwood & O'Connor, 2011). However, a closer look at the data also indicates that about 40% of daydreaming centers around the present, that is the very recent past or immediate future (Andrews-Hanna, 2012). Interestingly, Spreng and Grady (2010) showed that autobiographical memory and future prospection share the same neurobiological substrate, such as the ACC, the PCC, and hippocampal and parahippocampal formations.

Emotionality and daydreaming have been shown to influence each other reciprocally and in a complex way (Varendonck, 1921). Experimental manipulations for increasing negative mood enhance levels of mindwandering (Smallwood, Fitzgerald, Miles, & Phillips, 2009; but see Seibert & Ellis, 1991), whereas an experience sampling study suggested that being off-task might enhance future levels of unhappiness (Killingsworth & Gilbert, 2010, but see Klinger, 2013b, and Poerio et al., 2013). Moreover, although people mostly tend to think about positive things during mindwandering (Killingsworth & Gilbert, 2010; Song & Wang, 2012), they nevertheless on average report concurrent lower levels of positive mood (Franklin et al., 2013). Importantly, these mood effects have been confirmed cross-culturally in a Chinese sample (Song & Wang, 2012). Finally, a recent experience sampling study reported that, although mindwandering is usually triggered by prior negative mood (i.e. sadness), only negatively valenced mindwandering predicts subsequent negative mood, and not mindwandering *per se* (Poerio et al., 2013). Interestingly this finding held even after controlling for mood prior to mindwandering. In other words, negative mindwandering seems to potentiate and amplify previous negative mood. Although more research is needed, (negative) daydreaming often appears to lead to negative short- and long-term emotional consequences. From a neurobiological standpoint, a recent meta-analysis compared brain activity in tasks involving emotional and socio-cognitive processing as well as task-related BOLD signal decreases in the DMN (Schilbach et al., 2012). The analysis provided compelling evidence that these three domains are all subserved by the DMN, mainly the dorsal MPFC (DMPFC) and the PCC. Thus, the mental functions subserved by the DMN are likely to be emotional in nature.

Daydreaming as a default goal reminder mechanism

What is the function of daydreaming? As an answer to this question, Klinger (2009) proposes that daydreaming is the residue of prospective goal-directed actions that are as yet uncompleted, especially if they are blocked but not yet relinquished. Let us explain this in greater detail. Goal pursuit is the key factor on which individual action is based. This process begins with commitment to a specific goal (e.g., finding a new job) and it ends with either its attainment or relinquishment (i.e., getting a new job vs. giving up looking for new employment). The time between the beginning and the end of goal pursuit is where *current concerns* arise (Klinger, 1971, 2009). This is a latent state (i.e. "having a goal"; Klinger, 2009, pp. 229) that sensitizes the individual to any information that could result in advancement of the goal-striving process (Figure 3). In other words, the current concern is the representation of the discrepancy between the actual state and the desired outcome state, and it promotes the processing of information relevant to moving toward the latter.

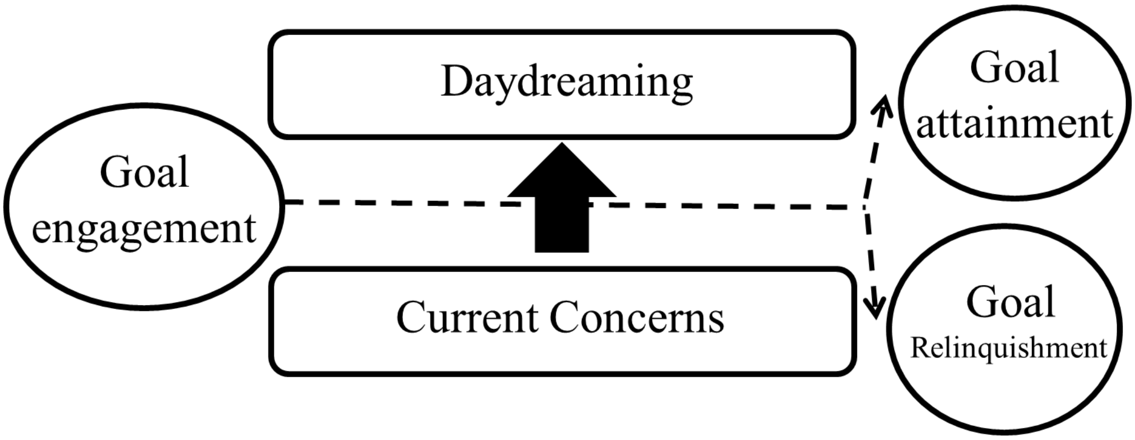

Figure 3. *Current concerns theory (Klinger, 1971)*

From these ideas, it follows that daydreaming serves as a *default reminder mechanism* regarding an individual's agenda of goals (Klinger, 2013a, b). The benefit derives from the fact that, when not engaged in immediate and pressuring tasks, one's mind gravitates overtly or covertly toward unaccomplished goals that (i) have not been relinquished, and (ii) are still relevant. Without a mechanism based on prospective memory, it would be impossible to advance long-term goals, as they imply a long and time-based sequence of rather complex actions. As individuals are usually committed to multiple and sometimes opposite goals, no particular current concern consistently influences and dominates mental activity, but rather the plethora of current concerns do so (Klinger, 1971). Moreover, different goals are organized into hierarchies, in which the higher-order goals are more central for the self (Carver & Scheier, 1998). Consequently, highly emotionally pressing and self-salient current concerns are posited to compete for mental space and hence hinder full engagement in tasks— the phenomenon of mindwandering (Klinger, 2009).

It is now comprehensible why daydreaming is self-focused, temporally sensitive, and emotionally valenced. Current concerns are likely to gravitate towards higher-order and self-salient goals, as suggested also from cognitive and neuroimaging literature (Qin & Northoff, 2011; Song & Wang, 2012). Moreover, current concerns are posited to be relevant here and now, as they are likely to be related to the immediate present or the upcoming future. In keeping with this, the temporal focus of undirected thought is indeed the present time (i.e., recent past and immediate future) along with a prospective bias for the future (Baird et al., 2011). Finally, although the content of daydreaming often depicts positive and desirable events (i.e., desired state), this is frequently associated with a worsening in mood (Song & Wang, 2012), as daydreaming reminds one of what has not yet been attained. Nevertheless, as a consequence of this hypothesis, if specific daydreams are helpful for reaching goals, the associated emotion should be positive as a marker that the attainment of the goal is likely. Franklin et al. (2013) recently reported that, although mental drifting is characterized by concurrent lower positive mood, off-task periods classified either as "interesting" or "useful" are associated with more positive mood. This clearly supports the conclusion that the content of mindwandering can lead to different outcomes and effects, either positive or negative.

In support of these proposals, a large literature directly links current concerns to daydreaming (Andrews-Hanna, 2012; Antrobus et al., 1966; Klinger, 1971, 2009; Poerio et al., 2013; Stawarczyk, Majerus, Maj, et al., 2011). Gold and Reilly (1985-1986) showed that 64.5% of daydreaming clearly reflected individuals' current concerns. In line with this finding, Johannessen and Berntsen (2010) reported that about half of the involuntary (and voluntary) memories were related to one or more of five current concerns previously listed by the experimental participants. Finally, at the neural level, Christoff, Gordon, Smallwood, Smith, and Schooler (2009) reported that task-unrelated thoughts during the SART were not only supported by higher levels of DMN activation, but also by increased activity of areas that are usually responsive to task engagement and goal pursuit, such as the dorsolateral prefrontal cortex (DLPFC). Although the DLPFC contribution was present only during off-task periods that occurred unnoticed by the individuals (i.e., zone-out), this may represent effort, perhaps unconscious, to address unresolved issues and unattained goals during task-unrelated thoughts (Christoff et al., 2009; see Discussion).

In sum, daydreaming is vital as it reminds and maintains active in the mind important goals in order to increase the chance to attain them (Klinger, 2013a). Daydreaming also has been associated with other positive functions, such as future planning, creative incubation, memory consolidation, self-awareness, and moral reasoning, to mention some (for two excellent reviews, see McMillan et al., 2013; Mooneyham & Schooler, 2013). Nevertheless, even highly adaptive mechanisms may sometimes trigger and support maladaptive functions, and daydreaming is no exception (Klinger, 1996a). Given the reduced mental control exerted and the focus on unattained goals, undirected thinking is the ideal context in which pre-existing negative cognitions can be recapitulated and impact mental functions and mood (Klinger, 2009; Varendonck, 1921).

Daydreaming and Major Depression

Throughout decades, the clinical impact of daydreaming did not go unnoticed. For instance, Beck (1971/2004) claimed that "[…] *the pathognomonic* [day]*dream* *dramatizes the way the individual sees himself, his world, and his future*” (pp.31). It is not surprising that the link between depression and daydreaming has been highlighted by several authors (Segal, 1996; Teasdale & Barnard, 1993), given the fact that undirected thoughts are intertwined with self-focus, emotions, time perspective, and motivation. All these factors have been found to be abnormal in depression; for instance, increased self-focus has been strongly associated with negative mood and depression (Mor & Winquist, 2002).

Consistently, the literature reports a marked association between daydreaming and depression (Deng, Li, & Tang, 2012; Epel et al., 2013; Golding & Singer, 1983; Johannessen & Berntsen, 2010; Meyer, Finucane, & Jordan, 2011; Stawarczyk et al., 2012). For example, higher levels of depressive mood have been associated with a greater rate of commission errors during the SART (Farrin, Hull, Unwin, Wykes, & David, 2003) and more accessible periods of mindwandering while encoding verbal material (Smallwood, O’Connor, Sudbery, & Obonsawin, 2007). Furthermore, Johannessen and Berntsen (2010) showed that the proportion of involuntary memories with reference to current concerns was highly correlated with levels of depression (r = .61). Finally, depressed patients compared with healthy participants have higher levels of DMN functional connectivity during rest, specifically at the level of subgenual cortex (i.e., a ventral part of the MPFC [VMPFC]), thalamus, the orbitofrontal cortex, and the precuneus (Greicius et al., 2007; Whitfield-Gabrieli & Ford, 2012).

Daydreaming and Cognitive Risk Factors

In our framework, we propose that in individuals who are at-risk for depression (i.e., characterized by high levels of cognitive risk factors and/or subclinical depressive symptoms), daydreaming maintains and exacerbates four major cognitive risk factors for depression, namely *rumination*, *hopelessness*, *low self-esteem*, and *cognitive reactivity* (Figure 1). As described above, daydreaming has been convincingly linked to depression and depressive symptoms; nevertheless, a comprehensive theoretical explanation that accounts for this relationship is lacking. We suggest here that, given its focus on emotionally toned goal-discrepancy, daydream content influences and is influenced in turn by depressive risk factors, thus forming positive feedback loops. This upward spiral between undirected thought as a forum and cognitive vulnerability that supplies depressive content and expands the space for undirected thought is likely to account for both concurrent and future depressive symptoms.

The proposal is that daydreaming *per se* is not depressogenic but, given its specific content (Smallwood & Andrews-Hanna, 2013), it can potentiate pre-existing vulnerability to depression. Empirical research supports our hypothesis. On the one hand, in individuals who are at risk for depression, frequent daydreaming is likely to carry and maintain depressive content. In line with this, , Giambra and Traynor (1978) reported that the frequency of daydreaming and mindwandering correlates positively with scores on three different questionnaires for depression. Additionally, significant positive correlations were found with absorption in and frightened reactions to daydreaming as well as with the tendency to experience daydreams characterized by feelings of guilt and fear of failure. This supports our hypothesis that in individuals who already are vulnerable to depression, daydreaming maintains and probably worsens this condition. On the other hand, in individuals who are at low risk for depression, negative consequences related to daydreaming are not expected to occur. For instance, Marchetti, Koster, and De Raedt (2012) reported that off-task thoughts (i.e., mindwandering) predicted subsequent increased accessibility of negative thoughts *only* in individuals with medium or high levels of depressive symptoms, whereas euthymic individuals did not show this toxic effect. Moreover, Andrews-Hanna et al. (2013) recently reported that the content and the features of everyday thoughts are specifically related to well-being. Depression and negative affect seem to be associated with thoughts characterized by self-salience and negative valence, whereas mindful individuals define their everyday thoughts as more concrete, less personally salient, and more positive. Thus preliminary evidence converges on the idea that daydreaming tends to be characterized by negative mood and depressogenic cognitions only in those who already show vulnerability to depression.

We start by discussing empirical evidence for the proposed link between daydreaming and cognitive risk factors for depression. Moreover, in order to increase the nomological validity of our framework, we will also highlight the negative relationship between (negatively toned) daydreaming and mindfulness, a well-established protective factor against depression. Finally, by adopting a vulnerability-stress perspective, we propose that daydreaming is a phenomenon sensitive to stress and stressful life events, in that higher stress leads to enhanced and more detrimental daydreaming.

Rumination

Rumination is a form of repetitive self-focus that leads to and exacerbates depression (Nolen-Hoeksema, Wisco, & Lyubomisrky, 2008; Spasojevic & Alloy, 2001). Despite its major role in emotional disorders, rumination has been conceptualized in different ways, such as trait vs. context-dependent, process vs. content, or triggered by negative mood vs. goal nonattainment (Smith & Alloy, 2009).

The most influential theory is the response styles theory (RST), which defines rumination as "*behaviors and thoughts that focus one's attention on one's depressive symptoms and on the implications of those symptoms*" (Nolen-Hoeksema 1991, pp. 569). According to this theory, individuals react to negative mood by initiating ruminative processing with the aim to enhance their self-understanding. Unfortunately, rather than providing beneficial effects, rumination leads to a paradoxical increase of negative mood that perpetuates repetitive negative thought (Lyubomirsky & Nolen-Hoeksema, 1995). The Ruminative Response Scale (RRS) is the principal tool for the assessment of rumination according to the RST (Nolen-Hoeksema & Morrow, 1991), and factor analysis highlighted two ruminative subtypes that are worth mentioning (Treynor, Gonzalez, & Nolen-Hoeksema, 2003). First, reflective pondering is considered the more adaptive form of rumination as it reflects the extent to which individuals try to improve their mood by engaging in active problem-solving. Second, depressive brooding is considered the more detrimental form of rumination, as it represents passively focusing on symptoms of distress and their meaning.

Daydreaming has been proposed as a context in which rumination can freely occur and detrimentally impact mental functioning (Klinger, 2013a). First, daydreaming is characterized by higher levels of self-focus (Song & Wang, 2012) and, second, it seems to be associated with higher likelihood of negative mood and less positive mood (Franklin et al., 2013; Smallwood et al., 2009). According to the RST, both self-focus and negative mood are pivotal elements that trigger the ruminative spiral.

Several empirical findings indicate a direct link between daydreaming and rumination. In a questionnaire study, it has been reported that a higher frequency of daydreaming, as measured with the DDFS, predicted increased levels of depressive symptoms via mediation by both self-focus and depressive brooding serially (Marchetti, Van de Putte, & Koster, under revision). In other words, during daydreaming individuals tend to focus on themselves and this is the ideal condition for depressive brooding to occur, which, in turn, is a well-established antecedent for depression. Such a toxic effect of daydreaming was not found when reflective pondering served as mediator. Moreover, Marchetti, Koster, et al. (2013) recently showed that higher levels of internal focus during rest predicted increased levels of ruminative self-focus and negative mood in individuals at risk for depression. Finally, Berman et al. (2011) reported that during the resting state, the strength of functional connectivity between the subgenual cortex and the PCC correlated with the total score on the RRS (r = .68) in both depressed and healthy individuals. Interestingly, this effect was mainly driven by depressive brooding (r = .41) and not by reflective pondering (r = -.12).

Compared with the RST, rumination is conceptualized in a broader way by control theories, such as the goal progress theory (GPT), that defines ruminative thinking as "*a class of conscious thoughts that revolve around a common theme and occur in the absence of immediate environmental demands requiring the thoughts*" (Martin & Tesser, 1996, pp. 7). This definition shares many similarities with daydreaming, as both entail that thinking gravitates towards a common theme (i.e., a current concern) and it does not serve any immediate function in relation to the external world (i.e., nonworking and noninstrumental thought). Additionally, GPT speculates that rumination is triggered and maintained by contextual factors, such as the lack of or too slow progress toward goal attainment. Interestingly, Martin, Shrira, and Startup (2004) point out that rumination results from failure to achieve higher-order goals, thus suggesting that individuals ruminate on personally relevant and self-salient themes as is true for current concerns.

Although no attempt has been made to directly investigate the relationship between the GPT's type of rumination and daydreaming, a recent study tried to integrate different theories of rumination and mindwandering (Roberts et al., 2013). Participants were cued about either important unresolved or resolved goals and then underwent a task conducive to mindwandering, that is a SART with specific thought probes modified for capturing rumination-like thoughts on personal goals. Consistent with GPT, cueing unresolved goals led to more frequent mindwandering on personal issues than focusing on personally-relevant but resolved goals (17.5% vs. 3.4%). However, RST was also supported, as reporting ruminative task-unrelated thoughts was a function of the trait tendency to engage in rumination, as measured with the RRS. Specifically, the interaction between the type of manipulation (i.e., cueing resolved vs. unresolved goals) and brooding explained a significant amount of variance in ruminative thoughts during SART (18.9%), whereas reflection did not contribute to this interaction. Interstingly, cueing unresolved goals led to an increase of daydream-like state rumination *only* in individuals with high levels of brooding. In contrast, those with low levels of brooding did not report any increase of state rumination after focusing on unresolved goals and, in turn, were immune from any toxic effect related to daydreaming.

Consistently, the reviewed studies permit the inference that negatively toned daydreaming is strongly related to rumination. In fact, daydreaming provides cognitive, emotional, and motivational effects that are the ideal context for rumination to occur. The theory of current concerns (Klinger, 1971, 1977, 2013a; Klinger & Cox, 2011) provides an explanation for the emergence of rumination. First, thematically homogeneous daydream segments are usually brief, with a median estimated duration of 5 s and a mean estimated duration of 14 s (Klinger, 1978), meaning that content keeps shifting. Ordinarily, these shifts are toward content that may be associated with the previous segment but can run the gamut of an individual's more pressing goals. There is reason to believe that these shifts are directed by emotional reactions to external and internal cues (Klinger, 1996b, 2013a). Certainly the extent to which a cue is related to a current concern is strongly correlated with the extent to which it elicits emotional responses (e.g., Bock & Klinger, 1986; Nikula, Klinger, & Larson-Gutman, 1993). It is therefore easily inferable that when an individual has emotionally highly potent concerns and has mentally wandered into processing one of them, the subsequent associated segments that these mental cues elicit will have a high probability of remaining in the same or closely related content area, whether that is, for example, bereavement over a major actual loss or fear of such a loss, or problems with self-regard. Such strongly emotional concerns would have the capacity to lock the train of thoughts into a thematically narrow content channel— i.e., rumination.

There are also contextual factors that facilitate the ruminative component of undirected thought. For example, during rest or task-unrelated thought, the information coming from the external world is processed to a lesser extent (Barron, Riby, Greer, & Smallwood, 2011), so that the chance to be distracted from the ruminative train of thoughts is reduced. Distraction has been suggested as a possible way to decrease repetitive thinking and reduce its negative effects (Nolen-Hoeksema et al., 2008).

In sum, we hypothesize that daydreaming frequency in interaction with rumination, especially brooding, will predict concurrent and future depressive symptoms. We also hypothesize that negatively-valenced daydreaming (i.e., guilty-dysphoric) will have a more detrimental impact on mental health (see, Klinger, Henning, & Janssen, 2009).

Hopelessness

Hopelessness is considered a proximal sufficient cause of depression (Abramson, Metalsky, & Alloy, 1989; Abramson et al., 2002), as high levels of this risk factor have been associated with both concurrent and future depressive symptoms (Alloy & Clements, 1998; Alloy, Abramson, Whitehouse, & Hogan, 2006; Metalsky & Joiner, 1992). Hopelessness is defined as “*an expectation that highly desired outcomes will not occur or that highly aversive outcomes will occur coupled with an expectation that no response in one's repertoire will change the likelihood of occurrence of these outcomes*” (Abramson et al., 1989, pp. 359). Although this definition suggests that the perceived likelihood of negative future scenarios is a key feature of hopelessness, only a specific type of future negative outcomes is believed to lead to depression. The nonoccurrence of desirable scenarios impacts mental functioning and mood only to the extent to which the individual is committed to reach those outcomes and thinks they are “in the realm of possibility”. This specific feature clearly mirrors the current concerns theory (Klinger, 1971, 1975, 1977; Klinger & Cox, 2011), as both theories suggest that people commit themselves to specific goals and remain “concerned” until either reaching or abandoning them (Abramson et al., 1989). It is noteworthy that the process of abandoning goals entails a gamut of negative consequences, ranging from negative affect (i.e., disappointment) to major depression. While missing a goal that is not central for the self likely leads to minor consequences, abandoning important goals may be perceived as a stressful life event.

In our framework, we propose that during daydreaming one is constantly reminded of current concerns. This discrepancy between actual and desired states of goal pursuit, especially if emotionally-pressing and negatively valenced, can easily lead to (i) expectations about negative future scenarios and (ii) the belief that one has no control over the expected outcomes (i.e., helplessness; Seligman, 1975). Several findings support this hypothesis. First, a diary study investigated the relation between involuntary mental time travel, such as autobiographical memories and future projection, and daydreaming style (Finnbogadóttir & Berntsen, 2013). In that study, involuntary negative future projections were correlated with guilty-dysphoric daydreaming (r = .46), whereas positive-constructive daydreaming was correlated with involuntary positive autobiographical memories (r = .47). Consistent with this finding, increased rest-related activity in the VMPFC, a key area of the DMN, has been found to be correlated with scores on the Beck Hopelessness Scale (BHS; Beck, 1988) in both depressed and healthy individuals (Grimm et al., 2008; Wiebking et al., 2011). It is noteworthy that most of the items of the BHS specifically measure an individual's tendency to envision a negative and hopeless future (i.e., "*My future seems dark to me*", "*All I can see ahead of me is unpleasantness rather than pleasantness*"). Second, research has robustly associated learned helplessness and mindwandering (for a review, see Mikulincer, 1996). Learned helplessness, introduced in the learned helplessness theory (Seligman, 1975) and later incorporated into the hopelessness theory (Abramson et al., 1989), deals with performance deficits induced by unsolvable problems (a helplessness induction) (Seligman, 1975). Mikulincer (1989) reported that being exposed to unsolvable problems leads to worse performance in a search task in individuals who habitually engage in mindwandering or in those who show more mindwandering after the helplessness induction.

In sum, daydreaming provides a key context for thoughts and feelings of hopelessness. Negative daydreaming often consists of negative future scenarios, as is true for persons with high levels of hopelessness. Moreover, facing unsolvable problems has been consistently reported to be conducive to mindwandering, in that during off-task thought individuals are likely engaged in processing self-generated thoughts (Mikulincer, 1996). Consequently, in our model, we propose that self-reported and behavioral measures of daydreaming are, for vulnerable individuals, significant predictors of both concurrent and future depressive symptoms. We expect this effect to be moderated by hopelessness/helplessness. Finally, we anticipate this effect to be stronger for guilty-dysphoric daydreamers.

Low Self-Esteem

Self-esteem is defined as a positive or negative attitude toward the self (Rosenberg, 1965) and it has been found to predict subjective well-being over time (Schimmack & Diener, 2003). Low self-esteem is considered a key feature in depression (for a review, see Ingram, Miranda, & Segal, 1998) and therefore a crucial component in the cognitive theory of depression (i.e., negative self-schemata; Beck 1967; Clark et al., 1999). The evaluative component of self-esteem is thought to stem from a comparative process between the “actual self”, that is the current self-representation, and the “ideal self”, that is the representations of the personal characteristics that an individual aspires to have (Higgins, 1987). The underlying assumption of this model is that the ideal self serves as both a motivational incentive for future behavior (i.e., a goal) and as the standard to be attained, relevant to judging goal-progress (Zentner & Renaud, 2007). From this, it follows that individuals with low levels of self-esteem are expected to show larger actual-ideal self-discrepancy, in that the current self is far removed from the desired self. Consistent with this, research shows that depressed or dysphoric individuals report larger self-discrepancy on both explicit and implicit measures (Moretti & Higgins, 1999; Remue, De Houwer, Barnes-Holmes, Vanderhasselt, & De Raedt, 2013).

In our framework, we propose that during daydreaming the comparative process influencing self-esteem is active. In other words, the ideal self would represent a higher-order goal (i.e., having a better self-concept) to which individuals are powerfully committed. The larger the discrepancy between the current state and desired state (i.e., actual-ideal self-discrepancy), the more pressing and probably more negatively valenced daydreaming about it becomes in turn.

For decades, this idea has been supported. In his pioneering work, Rosenberg (1965) reported that in a sample of about 3000 adolescents, only 13% of individuals with high self-esteem defined themselves as frequently engaged in daydreaming. On the contrary, 60% of individuals with low self-esteem reported being habitual daydreamers. In other words, self-esteem and daydreaming are negatively correlated. Interestingly, this notion was supported by a recent study in which both behavioral and self-reported measures of mindwandering were negatively correlated with a questionnaire on self-esteem (*r* ranging from -.16 to -.29; Mrazek et al., 2013). Moreover, higher levels of self-discrepancy have been associated with negatively valenced daydreaming. Gough, Fioravanti, and Lazzari (1983) reported that individuals with larger self-discrepancy were characterized by high levels of daydreaming, self-concern, and persistent ruminative thoughts, as measured with the California Q-Set (Block, 1961). Recently, Klinger et al. (2009) showed that mismatch between the current and the ideal self correlates with the guilty-dysphoric daydreaming style. Finally, at the neurocognitive level, Disner et al. (2011) proposed that, among other areas, the MPFC plays an important role in supporting negative self-schemata that likely result in negative self-esteem. In keeping with this, Frewen, Lundberg, Brimson-Théberge, and Théberge (2013) reported that the VMPFC is associated, perhaps uniquely, with negative self-esteem in women.

In sum, the reviewed literature suggests that individuals with low self-esteem are more likely to daydream as an attempt to address the discrepancy between their current and desired self-image. In our model, we propose that daydreaming frequency could predict both current and future depressive symptoms with moderation by self-esteem (i.e.. when self-esteem is low). Complementary to this hypothesis, we anticipate that guilty-dysphoric daydreaming could predict depressive symptoms synchronously and over time.

Cognitive Reactivity

Cognitive schema theory has been one of the dominant models of depression during the last forty years (Beck, 1967; Clark et al., 1999). This theory proposes that information processing is guided by individual’s schemata, conceived as memory structures that represent information about the self, the world, and the future. Depression is hypothesized to be characterized by negative schemata that lead to specific ways of misprocessing information, such as attentional, interpretation, and memory biases (Everaert, Koster, & Derakshan, 2012). However, mere presence of depressive schemata is not expected to significantly impact mental functioning, unless schemata are activated by relevant stimuli (Beck, 1967).

This vulnerability-stress perspective with negative schemata as a vulnerability factor has been addressed under the notion of cognitive reactivity. Teasdale (1988) proposes that after multiple depressive episodes, the strength of the associative network between the self, negative thinking, and negative mood is intensified. Consequently, priming any element of the network will putatively activate the network itself. Cognitive reactivity therefore represents the fluctuations of negative self-attitudes in reaction to stressors, even if these are mild (Butler, Hokanson, & Flynn, 1994). Typically, priming negative mood has been shown to efficaciously activate negative schemata (for a review see Scher, Ingram, & Segal, 2005); however, inducing self-focus has also been found to activate them (Hedlund & Rude, 1995). Importantly, several longitudinal studies have shown that the interaction between stress and cognitive reactivity predicted depression (Hankin, Abramson, Miller, & Haeffel, 2004; but see Barnett & Gotlib 1990), and Segal et al. (2006) reported that mood-induced cognitive reactivity could predict relapse in remitted depressed individuals over 18 months (but see, van Rijsbergen et al., 2013). It is worth highlighting that, although originally developed to account for depressive recurrence, cognitive reactivity recently has been conceptualized as a fundamental mechanism present also in non-clinical populations. For instance, Van der Does and Williams (2003) developed the Leiden Index for Depression Sensitivity – Revised (LEIDS-R) that investigates the tendency to engage in negative self-attitudes in response to low mood, rather than depressed mood, in both clinical and non-clinical individuals.

How is cognitive reactivity linked to daydreaming? These two phenomena share many similarities. For instance, manipulations involving either negative mood or self-focus can trigger both daydreaming (Smallwood et al., 2009; Smallwood et al., 2011) and cognitive reactivity (Hedlund & Rude, 1995; Scher et al., 2005). Moreover, Segal (1996) speculated that intensity and intrusiveness of negative mindwandering (i.e. depressive cognitive interference) is a function of associative strength of the depressive network. In other words, the tighter the depressive network is, the more negative and more difficult to control daydreaming becomes (Teasdale & Barnard, 1993). In line with this, it is reasonable to expect that an individual with high levels of cognitive reactivity experiences daydreaming as more ruminative and hopelessly focused on goal-discrepancy. Confirming this hypothesis, a recent study showed that higher levels of internal focus during rest predicted increased levels of state rumination and negative mood in individuals with medium or high levels of cognitive reactivity (Marchetti, Koster, et al., 2013). However, as we predict in our model, the rest-related toxic effect was not detected in individuals at low risk for depression, that is with low levels of cognitive reactivity.

At the neurobiological level, a recent theoretical proposal directly linked the DMN with cognitive reactivity (Marchetti et al., 2012). Confirming this association, Zamoscik, Ebner-Priemer, Huffziger, Kirsch, and Kuehner, (2013) documented that individuals characterized by high levels of cognitive reactivity (i.e. remitted depressed individuals) reported increased functional connectivity between the PCC and the parahippocampal gyrus during recall of a negative autobiographical memory compared with healthy controls. The increased connectivity predicted increased ruminative daydreaming during daily life.

In sum, daydreaming and cognitive reactivity share many theoretical similarities, as both seem to be triggered by the same factors, such as negative mood and self-focus. Nevertheless, only a few studies have investigated this relationship and more efforts in this regard are warranted. We propose that the habitual tendency to daydream could predict concurrent and future depressive symptoms, but moderated by individuals' levels of cognitive reactivity, whereas a main effect is expected for guilty-dysphoric daydreaming.

Mindfulness

Mindfulness is considered a powerful protective factor against depression (Ma & Teasdale, 2004). Despite the lack of agreement about its definition (Grossman & Van Dam, 2011), two key features of mindfulness are (i) sustained attentiveness to the present moment (Wallace & Shapiro, 2006) and (ii) receptive and non-judgmental attitude toward inner experience (Kabat-Zinn, 1994). Considering the features of daydreaming, the relationship between undirected thought and mindfulness are worth examining. First, daydreaming *per se* implies by definition a mental drift from the here-and-now reducing awareness of the surrounding environment (Smallwood & Schooler, 2006). Thus, it seems reasonable to hypothesize that daydreaming and mindfulness represent divergent constructs, although not fully opposite as both rely on self-awareness to a certain extent. In fact, research showed that mindful observing of inner experience is positively correlated with self-awareness (Evans, Baer, & Segerstrom, 2009). Second, both daydreaming and mindfulness imply that the individual frequently attends to his/her own inner experience, but the relative attitude toward mental events seems crucial in leading to either positive or negative consequences. Whereas mindfulness requires a non-judgmental experiencing of thoughts and emotions, such acceptance is not an intrinsic feature of daydreaming. We here speculate that during daydreaming, the pre-existing attitudes toward mental events are recapitulated and maintained during undirected thought. Consequently, individuals characterized by one or more of the aforementioned cognitive risk factors are likely to actively maintain these detrimental cognitions during mindwandering and, in turn, report lower levels of mindfulness. In line with this, we also suggest that during guilty-dysphoric daydreaming the mental attitude is strongly evaluative and judgmental.

Evidence deriving from questionnaire, experimental, and neuroimaging studies confirms our hypothesis that daydreaming and mindfulness are negatively related. Mrazek, Smallwood, and Schooler (2012) reported that multiple markers of mindwandering during the SART were negatively correlated with dispositional mindfulness (*r* ranging from -.18 to -.22). Interestingly, the same negative relation also was reported between dispositional mindfulness, as measured with the Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003), and the tendency to engage in daydreaming (*r* = -.23). These findings have been replicated by several researchers. For instance, Deng et al. (2012) reported that mindfulness was negatively related with the rate of commission errors during the SART, whereas Stawarczyk et al. (2012) and Marchetti, Van de Putte, et al. (under revision) confirmed the small to moderate negative correlation between the DDFS and the MAAS. Finally, Way, Creswell, Eisenberger, and Lieberman (2010) have shown that increased resting state activity in the MPFC and PCC was negatively correlated with individuals' MAAS scores.

In sum, findings confirm that daydreaming and mindfulness are contrasting constructs, with higher levels of daydreaming implying lower levels of mindfulness and vice versa. Nevertheless these two constructs are not opposite as they are negatively correlated with only small to moderate magnitude. This modest link could be accounted for by the fact that both phenomena seem to partially rely on the same functions, such as self-awareness (Evan et al., 2009). However, whereas mindful awareness is characterized by a non-judgmental attitude toward the self, guilty-dysphoric daydreaming is likely to stimulate a ruminative tendency to process self-salient goal discrepancy. Future research should clarify the exact relation between different styles of daydreaming, and not only its frequency, and mindfulness.

Stress as negative daydreaming amplifier

The interaction between stress and cognitive risk factors is of importance for theories that focus on the etiology of depression. Stress is thought to activate negative schemata that would otherwise remain dormant (Beck, 1967; Clark et al., 1999). Stress can initiate a domino effect that leads to negative affect and depressive symptoms. In line with the vulnerability-stress model, the interaction between cognitive vulnerabilities and stress predicts future depressive symptoms (Metalsky & Joiner, 1992).

It has been proposed that daydreaming increases by stress, as the latter could potentiate the processing of current concerns (Klinger, 2013a). Confirming this point, a study showed that frequency of current concern-related thoughts is influenced by stress in the form of blocked goals (i.e., unexpected difficulties in pursuing the goal; Klinger, Barta, & Maxeiner, 1980). More recently, two recent cross-sectional studies reported a significant correlation between mindwandering and perceived stress, as measured with the Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermelstein, 1983). Epel et al. (2013) found that the tendency to engage in mindwandering was highly correlated with perceived stress (r = .53). Although with smaller magnitude, Mrazek et al. (2013) also found significant correlations between self-reported mindwandering, task-unrelated thoughts during SART, and the PSS (r range between .20 and .30).

However, we propose that stress not only enhances the *frequency* of daydreaming but also influences the *content* of daydreaming by making undirected thought gravitate towards negative and depressogenic topics. In other words, stress is thought to induce and/or magnify negative daydreaming (i.e., guilty-dysphoric style) even in individuals who generally do not engage in this detrimental type of daydreaming. This, in turn, hinders post-stress emotional recovery. Thus, the occurrence of (negative) daydreaming is a maladaptive way to cope with stress. In line with our hypothesis, Stawarczyk, Majerus, and D'Argembeau (2013) demonstrated that an increase of stress-related negative mood correlated with task-unrelated thoughts in a subsequent SART. More importantly, that study found that the amount of stress-focused thoughts during the experimental paradigm predicted persistence of negative mood, suggesting that negative mindwandering hinders adaptive adjustment. Similarly, Poerio et al. (2013) reported that prior negative mood leads to negatively valenced mindwandering, that predicted negative mood after 15 minutes, even after controlling for negative mood at baseline. Finally, a couple of early studies documented that engaging in daydreaming as a form of coping strategy leads to undesirable consequences. Tanck and Robbins (1979) reported that the habit of daydreaming in reaction to stress correlated with depressive symptoms, while Pytkowicz, Wagner, and Sarason (1967) showed that, after anger induction (i.e., insults), being allowed to engage in fantasy led to reduced anger toward the experimenter but increased self-awareness and self-recrimination. This effect was particularly evident in individuals who habitually engage in daydreaming.

In sum, we propose that stress interacts with daydreaming in two ways. First, stress increases frequency of daydreaming. Second and more importantly, stress influences content of undirected thought, in that it introduces negative and depressogenic elements into one's train of thoughts, which hinder emotional recovery from stress. Moreover, we speculate that stressful life events, in contrast with mild and transitory negative emotions, play a key role in powerfully impacting one's thinking style.

Daydreaming and Bipolar Disorder

Bipolar disorder (BD) is a severe mental illness characterized by recurrent episodes of depression and (hypo)mania (Goodwin & Jamison, 2007). Interestingly, BD and mania have been associated with highly ambitious, or even unrealistic, goals as well as with an increased engagement in goal-striving (Alloy, Urosevic, et al. 2012).

Moreover, life events related to goal-striving and achievement can trigger manic symptoms (Nusslock, Abramson, Harmon-Jones, Alloy, & Hogan, 2007).

According to our model, it is reasonable to suggest that daydreaming supports this risky goal-striving mechanism in individuals who suffer from or are at risk for bipolar disorder. Under certain circumstances, constant reminders of highly ambitious goals during daydreaming could enhance efforts for their achievement and, in turn, result in a hypomanic or manic episode.

Although understudied, the relation between daydreaming and mania is supported by early and recent studies. For instance, Smith (1933) showed that 11 out of 26 BD patients reported daydreaming frequently and 17 of them claimed that the topic of their daydreams was about improbable events. More recently, an 11-year longitudinal study investigated a large sample of 559 unipolar depressed individuals who later developed bipolar disorder (Akiskal et al., 1995). In that study, the tendency to engage in daydreaming by unipolar patients predicted those who later developed a manifest bipolar disorder. Finally, a study (Meyer et al., 2011) of a non-clinical sample documented that higher levels of habitual daydreaming were predicted by higher scores on the Hypomanic Personality Scale, a measure of BD-related risk (Eckblad & Chapman, 1986).

We propose that, in individuals at risk for mania, daydreaming triggers and, perhaps, contributes to maintaining manic phases. In more detail, we expect this effect to be driven by both high frequency of undirected thought and a specific daydreaming style envisioning grandiose success and the attainment of unrealistic goals.

Discussion

Daydreaming is a complex neurocognitive phenomenon that serves essential functions in goal pursuit during periods of low or no engagement in external tasks (Klinger, 1971, 2009). By doing so, daydreaming plays an important role in maintaining plans for non-immediate goals (Klinger, 2013a). Nevertheless, the very same mechanism also is associated with undesirable side-effects (Klinger, 1996a). Based on the extant literature deriving from questionnaire, behavioral, and neuroimaging studies, we argue that frequent daydreaming is a process potentiating cognitive risk factors for mood disorders in vulnerable individuals. The continuous goal-discrepancy addressed during daydreaming ends up perpetuating and probably boosting rumination, hopelessness, low self-esteem, and cognitive reactivity in individuals who already show these traits (Figure 1). We also propose that high levels of (negative) daydreaming reduce the tendency to mindfully attend to the present, a mental attitude known to protect from psychopathology (Ma & Teasdale, 2004). Moreover, stress is expected to interact with daydreaming by intensifying its occurrence, imbuing it with negative and depressive content, and hindering subsequent emotional recovery. In sum, our framework predicts that daydreaming may help account for both concurrent and future depressive symptoms. This effect is expected to be potentiated in reaction to stressful life events.

However, daydreaming is a complex phenomenon, comprising different characteristics and styles that we want to discuss in relation to our framework. Consistent findings strongly support that the guilty-dysphoric type of daydreaming is likely to lead to psychopathological consequences. When characterized by feelings of guilt, hostility, fear of failure, grandiose success, and frightened reactions to it, daydreaming has been robustly associated with a variety of psychopathological symptoms (Klinger et al., 2009), among which depression plays a major role (Giambra & Traynor, 1978). These findings may account for the association between guilty-dysphoric daydreaming with depressive symptoms.

It is perhaps less intuitive that frequent daydreaming *per se* represents a condition potentially enhancing the likelihood of developing depression in those who are vulnerable to mood disorders. In our view, during daydreaming depressogenic themes are recapitulated and magnified in those who already have a thinking style prone to depression, whereas this is not the case for individuals who are less disposed toward depression. Preliminary findings support this idea, as negative consequences related to daydreaming are consistently reported in individuals who already show a predisposition to depression (Andrews-Hanna, et al., 2013; Marchetti, Koster, et al., 2012, 2013; Roberts et al., 2013). In sum, a novel hypothesis that we propose in our framework is that excessive engagement in daydreaming potentiates and probably accelerates a depressogenic spiral in those who are already at risk for depression.

Finally, although positive-constructive daydreaming is not the main focus of this article, it is worth briefly discussing its possible impact on mental health as well. This specific style of undirected thought is characterized by a feeling of playfulness, wishful imagery, creativity, and planning, and it has been proposed as the quintessential adaptive form of daydreaming (McMillan et al., 2013). Unfortunately, several findings render doubtful that this form of daydreaming is always adaptive. The literature on the relationship between positive-constructive daydreaming and depressive symptoms is mixed. On the one hand, Giambra and Traynor (1978) reported both negative or non-significant relationships between this daydreaming style and depressive symptoms. On the other hand, both positive and negative associations have been documented when gender was taken into account (Golding & Singer, 1983), and a study reported that positive-constructive daydreaming was positively related to depressive symptoms (r = .28) (Segal & Lynn, 1992-1993). Finally, positive-constructive daydreaming can lead to serious health consequences in cancer patients. Jensen (1987) showed that positive-constructive daydreaming positively predicted neoplastic growth in women with breast cancer at follow-up about 600 days after first assessment. Taken together, these findings suggest that indulging in positive daydreaming can, under certain circumstances, enhance the likelihood of developing mental distress, such as when positive fantasies are unrealistic and characterized by low expectations of reaching the fantasized goal (Oettingen, 2012). Hence, more thorough investigation of the clinical impact of positive daydreaming is warranted.

In our model, we also briefly described the possible role of habitual daydreaming with regard to mania. We propose that frequent daydreaming, especially if characterized by positive emotionality and topics of unconstrained and grandiose success, could trigger (hypo)manic phases in individuals who are already at risk for bipolar disorder. In line with current theorizing (Alloy & Abramson, 2010; Holmes, Geddes, Colom, & Goodwin, 2008), we argue that in individuals with a dysregulated tendency to engage in goal-striving, the constant reminder of (unrealistic) goals could spur an upward spiral that leads to mania.

Clinical Implications

Our theoretical framework of daydreaming and its role in mood disorders points to a number of clinical implications. First, daydreaming could be useful diagnostically. Daydreaming has been proposed to recapitulate the behavioral, cognitive, and emotional repertoire of the daydreamer (Varendonck, 1921). Interestingly, a similar hypothesis has been proposed recently with regard to resting brain. That is, patterns of spontaneous correlations in the DMN are believed to represent *a priori* cognitive patterns active in daily life (Harmelech & Malach, 2013). Taken together, these theories consider daydreaming (and the related neural substrate) as highly informative about the daydreamer's functioning, rather than as random and meaningless mental activity. Therefore, such a valuable source of information could be used for individual's assessment. For instance, by measuring the frequency of daydreaming as well as its specific style/content, it would be possible to acquire useful information concerning the person's cognitive-emotional structure. Indeed, the informativeness of daydreaming has not gone unnoticed, as both psychodynamic therapy and cognitive therapy have supported its use (Beck, 1971/2004; Shedler, 2010).

Given the data provided, it is clear that excessive levels of daydreaming should be the target of clinical interventions for individuals who are at risk for or already show a mood disorder. To do so, several therapeutic tools are available, such as mindfulness training (Mrazek et al., 2012), behavioral activation (Mazzucchelli et al., 2009), and SSRIs (Schupak & Rosenthal, 2009). We also propose that daydreaming could reduce well-being by allowing and intensifying distressing thoughts. In this regard, standard psychological therapies, by addressing and confronting personal goals, are probably capable of modifying the content of maladaptive undirected thought. For instance, cognitive therapy directly addresses personal core themes, such as feelings of guilt and unworthiness, and challenges related assumptions and beliefs (Beck, 1967). By doing so, cognitive therapy manipulates the salience of maladaptive current concerns and reduces their likelihood to be recapitulated in daydreams. Moreover, specific therapeutic tools have been developed to target maladaptive motivational patterns with the aim to reduce commitment to unrealistic and self-destructive goals and redirect the person toward more realistic and adaptive goals (Cox & Klinger, 2011). This motivational change is likely to lead to more adaptive forms of daydreaming that are less susceptible to foster depressive outcomes.

In the context of depressive disorders, several additional interventions may exert beneficial effects through reducing the amount of daydreaming or the salience of negative thoughts during daydreaming. Provided that depression is often associated with inactivity and reduced levels of engagement in activities (Martinsen, 2008), interventions aimed at re-engagement and activation are crucial to reduce the amount of time spent daydreaming. There is extensive evidence for the efficacy of behavioral activation and other forms of re-activating individuals (e.g., physical exercise; Mazzucchelli et al., 2009). Another class of interventions is aimed at reducing the salience of negative self-evaluative thoughts. Well-known therapies include mindfulness based cognitive therapy (Ma & Teasdale, 2004) and acceptance and commitment therapy (Hayes, Strosahl, & Wilson, 1999) where individuals learn to relate differently to their negative thoughts. Similarly, specific treatment has been developed to reduce levels of ruminative thought that include reducing levels of evaluative thinking (Watkins et al., 2012).

Limitations

Notwithstanding the consistency of the reviewed literature, we acknowledge several limitations that should be the focus of further study. First, studies associating daydreaming and cognitive risk factors for depression are mostly correlational, with neither experimental manipulation nor longitudinal tracking being used. So, although we propose a bidirectional link in the form of positive feedback between undirected thought and vulnerability to mood disorders, it should be noted that this mutual influence is tentative. To the best of our knowledge, no study so far has directly ruled out the possibility of causation between daydreaming and cognitive risk factors. Therefore, future studies should clearly address this issue and explore whether any direct causal link can be highlighted. Furthermore, it is also possible that the relationship between the tendency to engage in undirected thought and vulnerability to mood disorder could be influenced, if not caused, by a third factor, such as a genetic predisposition or personality factors.

Second, daydreaming shares some features with other clinically relevant constructs, a fact that might make it difficult to identify its specific contribution. For instance, daydreaming and dissociation are both characterized by the tendency to ignore the surrounding environment to focus internally. However, important differences should be noted between these constructs. For instance, during dissociative states the boundaries between fantasy and reality are substantially weakened and the sense of a coherent self is somewhat reduced. On the other hand, these features are not representative of daydreaming. Notwithstanding this, the current operationalizations of these two constructs tend to partially overlap. Klinger et al., (2009) demonstrated that different measures of daydreaming, including the SIPI, are significantly correlated with a standard measure for dissociation, namely the Curious Experiences Scale (Goldberg, 1999). Importantly, all the daydreaming styles correlated significantly with dissociation scores, with positive-constructive daydreaming surprisingly playing a leading role (*r* = .47). Thus, a limitation of our model is that the reviewed findings might partially map onto the undesired contribution of dissociation. The available psychometric ways to acquire information on daydreaming are probably not sufficiently precise to draw final conclusions. Experience sampling methods using probes are probably superior but also more labor-intensive. This research area would benefit from future efforts to develop unconfounded methods that are both valid and cost-effective.

Future research

We believe that our framework paves the way to several future studies. First, a powerful method to test our longitudinal predictions is the behavioral high-risk design (Alloy et al., 2006; Alloy, Bender, et al., 2012). This specific longitudinal design entails recruiting individuals who do not show significant levels of the criterion of interest (i.e., depression) and show either high or low levels of a vulnerability factor (i.e., daydreaming frequency plus cognitive vulnerability and/or guilty-dysphoric style of daydreaming). By doing so, the hypothesized influence of daydreaming and cognitive vulnerability to lead to depressive symptoms could be evaluated by means of multiple assessments across time.

Second, a possible further theoretical integration could be proposed with regard to psychobiological motivational systems. The Behavioral Inhibition System/Behavioral Activation System (BIS/BAS) model suggests that two main dimensions account for human functioning (Gray, 1994). The BAS system is proposed to regulate approach-/reward-related behavior, whereas the BIS system is thought to be triggered by inhibition- and withdrawal-related stimuli (Gray, 1994). Interestingly, these two dimensions have been found to correlate with lateralized frontal alpha rhythm asymmetry during resting state (Coan & Allen, 2003). It is also noteworthy that BIS/BAS imbalance has been implicated in both depression and mania (Abramson et al., 2002; Alloy & Abramson, 2010). Thus, future studies should explore the possible interplay among the DMN, frontal alpha asymmetry, and daydreaming in individuals with mood disorders.

Third, both theoretical considerations and recent findings have associated daydreaming with a variety of psychiatric symptoms (Klinger, 1996a; Klinger et al., 2009). Nevertheless, a broader model that could account for the role of daydreaming in major psychopathology, including also anxiety, emotional, psychotic, and personality disorders, is lacking. Future studies should shed light on this intriguing topic.

Conclusion

Daydreaming is considered the mental state from which we depart for engaging in activity and to which we return after completing or abandoning a task. During this period of inattentiveness for any task or the surrounding environment, the mind is far from just calmly resting. Solid empirical findings and theorizing based on them suggest that, while daydreaming, the mind actively processes unattained personal goals toward which the daydreamer is powerfully committed. Although this mechanism provides clear advantages in terms of enhanced likelihood of reaching important goals, daydreaming also perpetuates cognitive risk factors in individuals who are already vulnerable to depression. By reviewing the extensive literature we have highlighted what we could term the “dark side” of daydreaming and mindwandering. Many findings indeed report that well-known mechanisms leading to depression, such as rumination, hopelessness, low self-esteem, and cognitive reactivity, are consistently associated with daydreaming and are likely to exacerbate negative mood. In conclusion, although consistent findings highlight its fruitful role, daydreaming is not immune from leading to twisted effects in individuals already vulnerable to mood disorders. Hence, we argue for considering daydreaming and the individual's dominant daydreaming style as important factors for both research and clinical practice.

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CHAPTER 8

Brain and intersubjectivity: A Hegelian hypothesis on the self-other neurodynamics[1]

Introduction

Human beings live in a social context, where interacting with others is crucial for survival, and having a clear representation of both the "self" and the "other" is needed (Baumeister, 2011). Interestingly, neuroscience has traditionally adopted a Cartesian perspective by which the self is a solipsistic and self-sufficient unit, fundamentally unrelated to the other individuals' representation. Since the last decade, however, neuroscience is increasingly promoting research about how the "self" and the "other" are processed and represented at both intra- (Decety & Sommerville, 2003; Denny, Kober, Wager, & Ochsner, 2012; Molnar-Szakacs & Uddin, 2013; Wagner, Haxby, & Heatherton, 2012) and inter-brain level (Dumas, Martinerie, Soussignan, & Nadel, 2012; Dumas, Nadel, Soussignan, Martinerie, & Garnero, 2010). Nevertheless, the specific way whereby neural self-other representations co-occur and exert influence on each other in order to promote higher-order functions necessary for social functioning remains largely unclear. We propose that the philosophical theory of *intersubjectivity* (Hegel, 1807/1977) could integrate neuroscience findings and, in turn, shed new light on the self-other dynamics at neurobiological and cognitive level.

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[1] Based on Marchetti, I., & Koster, E. H. W. (2014). Brain and intersubjectivity: A Hegelian hypothesis on the self-other neurodynamics. *Frontiers in Human Neuroscience, 8*(11). doi: 10.3389/fnhum.2014.00011

Hegel and self-other dynamics

Philosophy has intensively studied the interaction between the self and other, terming sometimes their interplay as *intersubjectivity*. In 1807, the German philosopher, Georg Wilhelm Friedrich Hegel, published the *Phenomenology of Spirit* (Hegel, 1807/1977), where he thoroughly investigated the progressive steps that from a relatively simple form of thinking, such as *consciousness*, lead to higher-order functions, such as *self-consciousness*.

According to Hegel, *consciousness* is the mental function that accounts for ordered experience and which provides us with a unified experience of reality, instead of a chaotic flow of meaningless information. By means of consciousness, we are therefore able to represent and process in a meaningful way the stimuli that fall in our phenomenal space. Recent theoretical efforts have associated this crucial mental function with specific brain dynamics: rest-stimulus interaction at the level of cortical and subcortical midline regions (Northoff, 2012).

Compared with earlier philosophers, Hegel took the notion of consciousness one step further. In line with his idealistic assumptions, he proposes that the mind actively "constructs" the objects of our knowledge, with no need for the latter to rely on cognitively inaccessible external entities. Earlier thinkers, such as Immanuel Kant, had indeed argued that these founding external entities were not comprehensible to our mind (i.e. thing-in-itself or *noumenon*) (Kain, 2005). Although his theory probably qualifies Hegel as one of the first radical constructivists, it also raises a fundamental question. If neither based on external reality nor on itself, on what is our self-consciousness based? Hegel (1807/1977) clearly answers that "*Self-consciousness exists in and for itself when, and by the fact that, it so exists for another; that is, it exists only in being acknowledged*" (paragraph 178) (Hegel, 1807/1977). Three elements are noteworthy here. First, Hegel proposes a condition of necessity in the self-other dyad, with each pole needing to be *recognized* by the other one (i.e. *mutual recognition* or *intersubjectivity*). Second, both the self and the other maintain their specific identity without merging into an undifferentiated matrix (Coelho & Figueiredo, 2003), in that the other is recognized as a separate subjectivity with whom a shared subjective state is possible (i.e. *recognition of the other*). Third, the self, at least in part, exists insofar as being constructed by the other that *recognizes* it back (i.e. *recognition of the self*).

Without the other, the self lacks a fundamental reference to contrast itself with, and, in turn, it is bound not to emerge in the biological and psychological context (Baumeister, 2011). Importantly, a simple object fundamentally lacks self-consciousness and as such it is not eligible to recognize one's self as this would lead the latter to become "*a motionless tautology of I am I*" (paragraph 167) (Hegel, 1807/1977). In other words, if the other's recognition is lacking, I can experience events and objects (i.e. consciousness), but I cannot experience myself as a self-conscious agent (i.e. self-consciousness).

From the intersubjective perspective, the "other" is necessary. Not only must the other be physically present with its own body (Mead, 1934/2009; Russon, 1997), but the other must also recognize the subject as an intentional and self-conscious self (Kain, 2005). In order to process such fundamental but complex input, the brain is expected to be properly equipped to detect recognition by others.

Intersubjectivity, Default Mode Network, and Mirror Neuron System

How may Hegelian intersubjectivity inform our knowledge of the brain and, in turn, account for our social functioning? Intersubjectivity could shed light on recent neuroimaging findings by integrating two of the most active research lines in neuroscience, the Mirror Neurons System (MNS) and the Default Mode Network (DMN).

In the social context, the perception of a meaningful and goal-directed action leads to specific neural activation, regardless whether the action is performed by the subject itself or it is observed being performed by another actor (Iacoboni et al., 1999). The MNS has indeed been consistently associated with this function whereby the other's instrumental behavior is neuronally represented in the observer by means of a motor resonance mechanism. In other words, a significant gesture is encoded also in the observer's brain within its own motor schemata and this helps qualify the person of the observer as a (potentially) active and goal-directed actor. On the contrary, immobile objects or aimless actions do not elicit a similar response in the MNS (Preston and De Waal, 2002). Interestingly, already in the 1930's George Herbert Mead, a sociologist deeply influenced by Hegel's theory, stressed the importance of this "*conversation of gestures*" between individuals as the first step leading to higher levels of self-consciousness (Markova, 1990; Mead, 1934/2009). The MNS can therefore be considered as a neural tool that bridges the gap between the self and the other at the level of lower-order physical representation (Rizzolatti & Sinigaglia, 2010).

The DMN, a neural network highly active during rest, has been associated with psychological representing of others, that is mentalizing (Schilbach et al., 2012; Van Overwalle & Baetens, 2009). This cognitive ability to adopt someone else's perspective and internally represent mental states of others (i.e. beliefs, intentions, and goals) implies that we subsume the cognitive representation of other's mental activity into ours to some extent. Interestingly, while the MNS relies on the perception of other's embodied actions, mentalizing requires the ability to extract and understand goals and intentions of others. The latter implies that the other is recognized as an agent. Therefore, the DMN seems to subserve the mechanism through which the other psychologically resonates into one's mind as an intentional being (Molnar-Szakacs & Uddin, 2013).

As intersubjectivity is emerging as a promising perspective in neuroscience (Allen & Williams, 2011), we contend that it can meaningfully integrate these findings. Our Hegelian model suggests that it is the long-term interaction between the pre-reflective "*I*" (i.e. consciousness) and the other's representation, both at physical (Mead, 1934/2009; Russon, 1997) and psychological (Kain, 2005) level, that gives rise to a self-reflective "*I*" (i.e. self-consciousness). Hence, a self-conscious individual is capable not only of processing internal/external stimuli, but also of actively reflecting upon herself, which creates a network of information related to the self, such as attributes, beliefs, and traits (Baumeister, 2011).

In neurocognitive terms, we could say that self-awareness is the product of *interactions* between both lower- and higher-order functions, such as motor resonance and mentalizing subserved by the MNS and DMN, respectively. Crucially, this neural cooperation has been recently confirmed by a meta-analysis showing that self-specific activity emerges as interaction between the DMN (i.e., perigenual anterior cingulate cortex [pACC] and posterior cingulate cortex [PCC]), and MNS (i.e., left anterior insula [lAI] and right inferior frontal gyrus [rIFG]) (Qin & Northoff, 2011). Moreover, mentalizing about the self and other is associated with similar neurocircuitry, yet, the brain seems to be capable of distinguishing between them without equating one to the other (Lombardo et al., 2010).

In sum, Hegel's model of mutual recognition converges with neuroscience findings in that in order to understand ourselves we must rely on the same mechanisms that we use for understanding others. Self and other representations are strictly bond without one dissolving into the other (Coelho & Figueiredo, 2003; Lombardo et al., 2010). Notwithstanding this, the representation of others' minds and actions shapes our own mind, as both motor resonance mechanism (i.e., MNS) and mentalizing (i.e., DMN) are necessary to support and maintain the self-reflective self (Lombardo et al., 2010; Qin & Northoff, 2011, Sandrone, 2013). It is noteworthy that a similar hypothesis has been recently proposed by Timmermans, Schilbach, Pasquali, and Cleeremans (2012). The authors propose that a set of neurobiological prediction-based mechanisms support our constant attempt to model other's mind and the related social interaction. Importantly, the very same mechanism is proposed to be crucial for developing self-consciousness too.

The master-slave dynamics in the brain

Representation of the self and other is associated to a large extent with the same neural circuitry (Lombardo et al., 2010), and *mutual recognition* of self and other is required (Hegel, 1807/1977; Kain, 2005). However, this double bind implies a fragile equilibrium between the two components of the dyad. What if, for instance, the self fails to recognize the other? What if mutual recognition is deficient (Williams, 1997)?

Hegel (1807/1977) addresses this point by introducing the famous literary example of the master-slave dynamic, as follows. Given a couple of peers, one of the two could desire to undermine equilibrium by overpowering the other. Hence, one would become the "master" while the other becomes the "slave". However, the situation is bound to turn out paradoxical. By not considering the other a full self-consciousness (i.e. objectification), the master prevents the slave from recognizing it back. Consequently, the master hinders the process of mutual recognition upon which it itself relies in order to emerge as a self-conscious individual. In cognitive terms, we could say that the individual enhances the threshold to receive the recognizing input that could structure it as self-conscious.

From this, several hypotheses derive. First, objectifying the other (i.e., negating its status of human being) leads, to a certain extent, also to a self-objectification, as the source of recognition is now lacking. Second, objectifying the other is expected to impact on the DMN and/or the MSN, the neurobiological systems maintaining self-consciousness. Preliminary findings support these hypotheses. First, being subjected to ostracisim (i.e., seeing the status of human being negated) leads the victims to judge both themselves and the ostracizer(s) less human (Bastian & Haslam, 2010). Second, actively engaging in ostracism makes the ostracizer feel less related to human beings (Legate, DeHaan, Weinstein, & Ryan, 2013). Third, a recent study showed that inducing participants to consider other human beings as objects leads to decreased activity of the DMN (Jack, Dawson, & Norr, 2013).

Concluding remarks

Hegel's theory of intersubjectivity seems capable of shedding new light on the complex interaction between the self and the other at both neural and cognitive level. The interplay between the DMN and the MNS in supporting self-awareness may indeed be interpreted fruitfully by reintroducing the concept of *mutual recognition*.

Importantly, new hypotheses can be derived from the classic work of Hegel in order to better account for the interaction between DMN and MNS in both healthy and clinical samples. For instance, major psychopathologies characterized by abnormal self-other dynamic, such as schizophrenia, autism, and depression (Billeke, Boardman, & Doraiswamy, 2013; Crespi & Badcock, 2008; Gallese, Rochat, & Berchio, 2013; Mehta, Basavaraju, Thirthalli, & Gangadhar, 2012; Northoff, 2007), represent key areas to test the explanatory power of the intersubjective theory. Finally, our neurophilosophical framework could be fruitfully integrated in a new branch of social neuroscience, namely the two-person neuroscience (Schilbach et al., 2013). By focusing on the neurocognitive basis of the interaction between two individuals, two-person neuroscience is developing new experimental paradigms and innovative methods to analyze real-time two-brain interplay, such as simultaneous neuroimaging recording or, so-called, hyperscanning (Babiloni & Astolfi, 2012; Dumas, 2011). In sum, we argue that the integration of our Hegelian neurophilosophical approach and two-person neuroscience holds promise to convey innovative future perspectives in the field of social neuroscience.

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CHAPTER 9

General discussion

Although the layman's perspective often contrasts task engagement with resting state (i.e., daily business vs. time of leisure, or *negotium* vs. *otium*), rest is far from being a passive state. In fact, current research highlights that (i) the resting mind is actively engaged in generating streams of information not related to external stimuli (i.e., self-generated thought [SGT], Smallwood, 2013), and (ii) the brain at rest consumes about 20% of all the energy of the body, whereas task-evoked brain activity accounts for just an increased 2% compared with baseline (Clarke & Sokoloff, 1999).

SGT is increasingly considered as a cornerstone of human thought, in that it shows specific characteristics that impact the (healthy) functioning of the mind, such as its contents tends to be (i) centered on the daydreamer's self (Diaz et al., 2013), (ii) sensitive to temporality (Smallwood et al., 2011), and (iii) emotionally valenced (Killingsworth & Gilbert, 2010). Moreover, SGT is (iv) extremely frequent (Killingsworth & Gilbert, 2010), and (v) it is mostly supported by the Default Mode Network (DMN; Christoff et al., 2009; Mason et al., 2007). Notwithstanding all these specific features, SGT has rarely been investigated in relation to psychopathology (i.e., Klinger, 1996), and only recently this topic has attracted systematic research (Andrews-Hanna, Smallwood, & Spreng, in press). Considering that aberrant self-focus, time perspective, and negative mood are all hallmarks of negative mood disorders (i.e., Nolen-Hoeksema, Lyubomirski, & Wisco, 2008), depression seems be the ideal context where to investigate the plausible contribution of SGT and DMN to increase pathogenic risk.

In this doctoral project, we aimed at highlighting the plausible contribution of SGT in promoting, maintaining, and supporting vulnerability to depression, by adopting a neurocognitive and neurophilosophical approach.

Main contributions and findings of the doctoral research project

This doctoral research project mainly focused on two research lines that influenced and inspired each other, that is (i) the theoretical development of models and hypotheses on the clinical role of both SGT and DMN, and (ii) the empirical evaluation of those models.

Theoretical contributions

Three theoretical models have been developed at the beginning and end of the PhD research. In **chapter 2** we proposed a neurocognitive framework where specific DMN-related aberrations, such as hyperconnectivity and aberrant rest-to-task transition indexes (i.e., TN-persistence and TP-deficiency), are proposed to account for recurrence in depression via contribution of well-established cognitive risk factors, such as rumination, cognitive reactivity, and impaired attentional control. This framework has several strengths that we would like to stress. For instance, it integrates two extensive literatures, namely psychological (cognitive) vulnerability to depression and neural networks in depression. Moreover, it specifically focuses on the still understudied field of recurrent depression, where the key component to tackle is the mechanism leading to resurgence of depressive symptoms, rather than the first onset of depressive disorder. Finally we proposed that taking into account multiple cognitive risk factors could be an optimal way to address the topic of vulnerability to depression.

In **chapter 8**, we extended the perspective on the depressogenic role of resting state by shifting the main focus from neurobiology to *cognitive psychology*. In this chapter, we argued that SGT could represent a phenomenon, surprisingly underestimated, that could not only prevent the extinction of depression, but also promote and accelerate the depressive downward spiral in those who are already susceptible to depression. In this novel theoretical framework, by relying on an extensive literature that spans many decades, we intensified our efforts to include multiple cognitive risk factors simultaneously. We indeed considered rumination, cognitive reactivity, hopelessness, low self-esteem, and low mindfulness. We also more explicitly included the impact of stress in heightening the risk to depression. Finally, preliminary, but promising, evidence for the role of SGT for mania has been summarized.

Finally in **chapter 9**, a short and preliminary model is described where, by adopting a Hegelian perspective (Hegel, 1807/1977), we proposed that the neurocognitive representation of the self-other dyad is necessary for the development of higher-order functions, such as self-consciousness. Within the new direction of two-person social neuroscience (Schilbach et al., 2013), we proposed possible interaction between the DMN and the Mirror Neurons System (MNS) in supporting self-consciousness. Moreover, by applying the philosophical *master-slave* paradigm (Hegel, 1807/1977), we derived specific hypotheses and preliminary supporting evidence was reviewed.

Empirical contributions

In chapter 3 to chapter 6, we showed a series of multiple studies where we highlighted the depressogenic role of SGT. In **chapter 3**, we reported that mindwandering, a specific type of SGT defined as "*a shift of attention away from a primary task toward internal information*" (Smallwood & Schooler, 2006, pp. 946), predicts increased negative (relative to positive) thought after a long period of mindwandering, whereas no direct link between mindwandering and worsening in mood was reported. Interestingly, the negative effect of mindwandering was significant only in individuals with medium or high levels of depressive symptoms, whereas individuals with low levels of depression were immune from this toxic effect.

In **chapter 5**, we tested the specific role of rest in leading to momentary negative effects. By capitalizing on the hypothesis developed in chapter 2, we investigated whether internal focus during resting state could lead to state negative effects in individuals with high levels of both brooding and cognitive reactivity. The analysis revealed that resting state does lead to worsening in mood via contribution of increased state rumination, as measured with the Momentary Ruminative Self-Focus Inventory (MRSI) that we developed in **chapter 4**. Interestingly, in line with the hypothesis, the negative effect of resting state was significant in individuals with medium or high levels of cognitive reactivity, or medium or low levels of mindfulness, whereas this was not the case in individuals at low risk for depression (i.e., low levels of cognitive reactivity or high levels of mindfulness). Brooding appeared to contribute only to a limited extent.

In **chapter 6**, we reported a cross-sectional questionnaire study where we investigated the possible depressogenic role of the habitual tendency to engage in daydreaming. In this study we have been able to test a multiple serial mediation model where daydreaming explained depressive symptoms, but only to the extent that also trait self-focus and brooding were involved too. Importantly, daydreaming *per se* was not related to depression.

Theoretical implications

The main theoretical implication of this doctoral research project is that resting state *per se* is not depressogenic, but that, under certain circumstances, it may lead to depressive symptoms. Both our theorizations (Marchetti, Koster, Klinger, & Alloy, under review; Marchetti, Koster, Sonuga-Barke, De Raedt, 2012) and empirical findings (Marchetti, Koster, De Raedt, 2012, 2013; Marchetti, Van de Putte, Koster, 2014) support the claim that high levels of SGT and high levels of DMN activity could facilitate the development of major depression and depressive symptoms, but only in those who are already at risk to experience depression.

We indeed documented that mindwandering and internal focus during resting state conveyed negative outcomes, but only in individuals who were vulnerable, that is characterized by noticeable levels of depressive symptoms, cognitive reactivity, brooding, and low levels of mindfulness. It is important to mention that, although SGT was often found to predict depression (i.e., “main effect”), we always found that specific individual differences could modulate the main effect of SGT (i.e., “interaction”). A similar interpretation can be proposed for our questionnaire study (i.e., **chapter 6**) where daydreaming influenced concurrent levels of depressive symptoms, but only via both self-focus and brooding, whereas daydreaming could be associated with other non-depressogenic paths not taken into account in the study.

At the neurobiological level, we proposed that abnormally elevated levels of DMN could enhance the likelihood of developing future depressive episodes in remitted depressed individuals. Interestingly, this hypothesis has been substantially confirmed by two recent studies (Nixon et al., 2014; Zamoscik, Huffziger, Ebner-Priemer, Kuehner, &

Kirsch, 2014). For instance, Zamoscik et al. (2014) showed that, during sad mood provocation, increased PCC-PHG connectivity was found in the at-risk group and not in the healthy groups and this index correlated with state measures of rumination and negative mood and follow-up measures of depression and brooding after 6 months. Importantly, these findings held only in the vulnerable group (i.e., remitted depressed individuals), and not in the healthy group.

In sum, this doctoral project highlighted that individual differences are crucial factors that must be considered in order make meaningful claims on the adaptive or maladaptive role of both SGT and DMN. Consequently, it is not in line with the empirical findings to affirm that SGT and resting state *always* lead to psychopathological outcomes[1]. By adopting the same perspective, it is questionable to claim that SGT is *always* positive and constructive (McMillan, Kaufman, & Singer, 2013). To our knowledge, no attempt has been made to validate the absence of any possible moderator that could either mitigate or nullify, if not revert, the documented positive outcomes of SGT and DMN, such as increased creativity and empathy (Baird et al., 2012; Rabinowitz & Heinhorn, 1984). Future studies should address this issue.

Finally, although the list of possible moderators is virtually infinite, recent theoretical efforts have shed light on the crucial factors responsible for adaptivity and maladaptivity of SGT and DMN, such as time perspective, intrapsychic intersubjectivity, and psychological vulnerability to mood disorders (Andrews-Hanna, Smallwood, & Spreng, in press; Marchetti & Koster, 2014; Marchetti et al., under review; Mason, Brown, Mar, & Smallwood, 2013; Smallwood & Andrews-Hanna, 2013). Future studies should validate these theory-driven hypotheses in order to better specify which individual differences modulate the impact of both SGT and DMN on individual well-being.

Clinical implications

Several clinical implications can be derived from this research project. As we have already described them extensively in **chapter 7**, we will here report the two major clinical aspects of our project.

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[1] For instance, Cronbach (1963) warned future teachers that excessive charges could induce psychosis in their students via frequent engagement in daydreams.

First, there is a quite unanimous consensus that when SGT is characterized by negative and depressogenic cognitions (i.e., rumination), it should be the target of specific clinical interventions aiming at changing its content (Marchetti et al., under review; Smallwood & Andrews-Hanna, 2013). In line with our theoretical papers and previous empirical findings (Giambra & Traynor, 1978; Marchetti et al., 2014; Klinger, Henning, & Janssen, 2009), it is very likely that individuals characterized by vulnerability to depression experience more negative, self-defeating, and hopelessness-focused SGT compared to resilient individuals. In other words, the content of SGT is recognized to play a major role in leading to either positive or negative outcomes (Poerio, Totterdell, & Miles, 2013). Accordingly, specific therapeutic interventions should be adopted to modify the depressogenic core of SGT, to reduce commitment to unrealistic and self-destructive goals and redirect the person toward more realistic and adaptive goals (Cox & Klinger, 2011).

Second, in individuals who are prone to develop depression, excessive daydreaming could represent a factor magnifying the vulnerable status. In turn, the therapeutic goal should be not only the change maladaptive cognitive content (see above), but also to reduce the frequency of SGT. In other words, high levels of SGT could represent in vulnerable individuals a condition of risk that should be avoided. However, we fully acknowledge that this point is controversial in the literature with opposite positions being taken. For instance, Watkins (2008) claimed that "[…] *the goal of therapy for people with unconstructive repetitive thinking should not be to reduce their repetitive thinking but rather to shift them to more constructive forms of repetitive thinking*" (pp. 194), and more recently Smallwood and Andrews-Hanna (2013) proposed that "[…] *mind-wandering is a heterogeneous, rather than a homogeneous state, and thus it might not make sense for intervention studies to seek to reduce self-generated thought per se. Instead techniques could focus on changing the* content *of the experience that is disruptive to an individual's health and well-being without impacting upon the obvious benefits that self-generated thought conveys to the individual*" (pp. 4).

On the other hand, a recent study showed that high levels of SGT is positively correlated with the number of specific steps generated in the context of social problem solving, but negatively correlated with the overall efficiency of the solution proposed (Ruby, Smallwood, Sackur, & Singer, 2013). The authors interpret these findings by suggesting that the relation between SGT and social problem solving may take the form of a Yerkes-Dodson relationship, with high levels of SGT being detrimental to individual's well-being. Finally, they suggest that "[b]*y restraining the mind's habitual tendency to wander, interventions that emphasize being in the moment may help individuals gain a degree of control over SGT which may in turn allow them to employ this basic capacity for conscious thought to generate solutions in a more efficient manner*" (pp. 8).

In sum, SGT is a pervasive and very frequent phenomenon. However, whether its frequency should be targeted by specific clinical interventions, is still topic of debate and future studies should explicitly address this issue, with both experimental and longitudinal studies.

Limitations

There are a number of limitations to this doctoral research project that deserve some consideration. To begin with, almost all the findings reported in this dissertation mainly rely on introspection, as only information accessible to consciousness has been acquired. For instance, in **chapter 5**, the paradigm adopted to measure attentional focus during resting necessarily relies only on the introspective skills of participants, which have been questioned about their validity and reliability. It is indeed possible that individual differences in regard to their access to internally generated information could have impacted self-reports. In order to partially mitigate this aspect, we preferred probe-based state measures rather than retrospective measures. Although usually adopted, the latter have been found to distort the frequency of recollections in thinking, especially in regard to negatively valenced thoughts (Hurlburt & Melancon, 1987). Moreover, we preferred a probe-caught methodology (i.e., random thought probes delivered by the experimenter) over self-caught methodology (i.e., information being reported when the individual is meta-aware of being off-task), in order to reduce the impact of meta-awareness on individual self-reports (Smallwood & Schooler, 2006). However, future studies should prefer a multi-method approach where self-reported information is corroborated with neurophysiological indexes, such as BOLD signal, alpha rhythm, or pupil dilation (Schooler & Schreiber, 2004).

Second, in our project we focused mostly on specific SGT-related characteristics, such as self-focus, while other important features have not extensively taken into account. Recently, the *content regulation hypothesis* has indeed stressed a primary role played by time perspective in regard to SGT-related affective consequences, where retrospective bias is mainly associated with negative consequences and prospective bias leads to positive outcomes (Smallwood & Andrews-Hanna, 2013). In our project, we mainly included time perspective in **chapter 7**, where we put forward the self-projections in gloomy and dreadful future scenarios is a hallmark of hopelessness. So contrary to the content regulation hypothesis (Smallwood & Andrews-Hanna, 2013), we suggest a more nuanced interpretation of the contribution of time perspective in leading to either costs or benefits.

Third, the main focus of this dissertation is the impact of SGT and DMN on depression, while related psychopathological constructs have not been taken into account, such as anxiety. It is indeed well-established that both depression and anxiety share important characteristics, such as general distress (Clark & Watson, 1991). This implies that future studies and theoretical ponderings should clarify to what extent the reported findings are specifically attributable to (the “pure” contribution of) depression and to what extent they are due to a general common factor. However, this research intention raises conceptual and methodological obstacles, in that the most often used measures for depression and anxiety tend to substantially co-vary and, in turn, hinder any statistical attempt to distinguish one factor above and beyond the other one.

Future challenges and research directions

Although the field of resting mind and brain is exponentially burgeoning, this research line is still at its very infancy. For instance, there is no consensus on the terminology to adopt with different taxonomies being proposed (Smallwood, 2013). This lack of established boundaries and methodologies, on the other hand, implies that there is still much room for theoretical and empirical exploration. In what follows, we will provide some avenues for new studies that might contribute to a better understanding of SGT, DMN, and their impact on mental functioning and well-being.

First, a promising future direction for the study of SGT and DMN is considering resting state as intrinsically social. Several pieces of evidence indeed support this claim. At the cognitive level, a huge community-based survey (n>17000) reported that about 75% of daydreams involve mental social interaction (Mar, Mason, & Litvack, 2012). Moreover, a recent experimental study reported that the other-referential processing is a fundamental mechanism of SGT, perhaps even more than self-referential processing (Ruby et al., 2013). Finally, at neurobiological level, two meta-analyses confirmed that the DMN substantially overlaps with the neural network active during social cognition (Schilbach et al., 2012; Schilbach, Eickhoff, Rotarska-Jagiela, Fink, & Vogeley, 2008). In sum, it is plausible to speculate that the human mental baseline is intrinsically social (i.e., intrapsychic intersubjectivity; Coelho & Figueiredo, 2003), where the processing of the self-other dynamic is vital. Recently, we indeed proposed that the balance of the self-other representation is a crucial mechanism, whereas its disequilibrium could represent an important and still understudied mechanism for psychopathology (Marchetti & Koster, 2014).

Second, considering its intrinsically private nature, SGT seems to be the ideal candidate for an in-depth Husserlian phenomenological analysis, where the specific characteristics of consciousness during SGT are considered. According to the most recent directions in phenomenology and philosophy of mind (Gallagher & Zahavi, 2012), at least five core features of any perceptive processing are worth being evaluated carefully, namely (i) its *intentionality*, (ii) its *gestalt character*, (iii) its *perspectival incompleteness*, (iv) its *phenomenal* and (v) *temporal character*. To our knowledge, this specific investigation on the phenomenology of SGT has never been carried out, although it could plausibly provide meaningful elements for the understanding of resting state in both healthy and non-healthy individuals. In regard to depression, Northoff (2012) recently claimed that "*One question in this context* [depression] *may also be how the resting state's spatiotemporal structure and its alterations may be mirrored in and correspond to the changes in the spatial and temporal features of the patients' consciousness of themselves and the world including of time and space. That though requires a much more detailed phenomenological in-depth analysis and a corresponding neuroscientific investigation*" (pp. 9). We fully agree with this position.

Third, although SGT (and the underlying neurobiological substrate) is a phenomenon located in time, little attempts have been made so far to capture this temporal unfolding. Most of the studies indeed elaborate the general pattern of performance (i.e., average and standard deviation), whereas a specific framework that could account for this feature of SGT is still lacking. In this regard, we think that a promising and viable option is adopting the theoretical and analytical framework termed Dynamical System Theory (DST). In DST, the values of the variables at one time (t) are modeled as functions of the same variables earlier (t-1) (Vallacher, Coleman, Nowak, Bui-Wrzosinska, 2010), and, by doing so, it is possible to benefit from important analytical tools, such as “trajectory” (i.e., time-series), “attractor” (i.e., convergence of time-series in a specific state), and “entropy” (i.e., absence of attractor) (Granic & Hollenstein, 2003). This could provide us with information about the structural and temporal unfolding of SGT (Koster, Fang, & Marchetti, in press).

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NEDERLANDSTALIGE SAMENVATTING

Onderzoek geeft aan dat we een groot gedeelte van de tijd niet mentaal bezig zijn met taakgerichte activiteiten of de ons direct omringende informatie: vaak zijn we aan het dagdromen, fantaseren en aan het nadenken over onszelf (Killingsworth & Gilbert, 2010). Dit type gedachten die ongerelateerd zijn aan onze directe omgeving wordt benoemd als Zelf-Gegenereerde Cognitie (ZGC; Smallwood, 2013). Het afgelopen decennium is er een sterke interesse ontstaan in ZGC vanuit cognitief en neurowetenschappelijk onderzoek. Deze interesse is voor een groot deel te wijten aan de boeiende ontdekking (Raichle, 2001) dat wanneer mensen zich in een “rusttoestand” bevinden er een specifieke activatie plaatsvindt van een netwerk van verschillende hersengebieden die gedeactiveerd zijn wanneer mensen bezig zijn met taken (o.a. mediale prefrontale cortex en posterieure cingulate cortex). Dit netwerk noemt men Default Mode netwerk (DMN) of het rustnetwerk. Hierbij is er een grote interesse ontstaan naar de functies van dit rustnetwerk waarbij theorieën stellen dat dit netwerk geassocieerd is met mentale processen zoals autobiografisch geheugen, zelfprojectie en zelfreflectie (Buckner, Andrews-Hanna, & Schacter, 2008).

De afgelopen jaren is er toenemende aandacht voor cognitie in rust en DMN bij psychopathologie (Andrews-Hanna, Smallwoord, & Spreng, in press). Met name bij majeure depressie, een belangrijke en veelvoorkomende vorm van psychopathologie, lijken er verstoringen van cognitie tijdens rust. In hoofdstuk 2 presenteer ik een nieuw theoretisch kader omtrent heroptredende depressie, cognitie in rust en cognitieve risicofactoren voor depressie. Het centrale idee van dit hoofdstuk is dat het DMN een belangrijke rol kan spelen bij verschillende cognitieve risicofactoren voor depressie, zoals ruminatie (depressief piekeren), aandachtsproblemen en cognitieve reactiviteit (verhoogde toegankelijkheid van negatieve gedachten). Er is uitgebreide evidentie dat elk van deze cognitieve risicofactoren een rol kunnen spelen bij de etiologie en instandhouding van depressie. Echter, het huidige theoretische kader is het eerste model waarbij deze risicofactoren geïntegreerd worden en gekoppeld aan de neurobiologische bevindingen bij depressie. Dit hoofdstuk speelt een belangrijke rol bij het genereren van specifieke voorspellingen die in het vervolg van het doctoraat werden getoetst.

In **hoofdstuk 3** gingen we na of én op welke wijze ZGC gerelateerd is aan negatieve stemming. Op grond van het model in hoofdstuk 2 ontstond de hypothese dat ZGC ofwel een directe invloed heeft op stemming of dat dit effect verloopt via een verhoogde toegankelijkheid van negatieve cognities (cognitieve reactiviteit). Bij een studentenpopulatie (n = 79) bevroegen we emotionele gedachten gedurende een Sustained Attention to Response Taak (SART, een volgehouden aandacht taak) die ZGC induceert en we onderzochten de toegankelijkheid van negatieve cognities middels de Scrambled Sentences Taak (SST). De resultaten toonden dat bij proefpersonen met verhoogde depressie scores, een sterkere aanwezigheid van ZGC tijdens de SART geassocieerd was met een verhoogde toegankelijkheid van negatieve cognities.

In de daaropvolgende studie (**Hoofdstuk 5**) beoogden we de relatie tussen interne aandacht, ruminatie en negatieve stemming verder na te gaan. In een rustsituatie in het lab bestudeerden we de relatie tussen rust-gerelateerde interne aandacht, cognitieve reactiviteit, ruminatie en negatieve stemming in een steekproef van studenten (n = 80). Hierbij testten we de voorspelling van het model dat in aanwezigheid van cognitieve risicofactoren, interne aandacht leidt tot verhoogde niveaus van toestandsruminatie wat een leidt tot een meer negatieve stemming. Om toestandsruminatie te meten werd in **Hoofdstuk 4** een nieuwe vragenlijst gevalideerd. De voorspelde relaties werden getoetst binnen een indirect conditioneel model en werden bevestigd. Deze relaties gingen niet op wanneer er geen verhoogd cognitief risico was op voorhand of wanneer mensen hoog in mindfulness waren.

In **Hoofdstuk 6** werd nagegaan of we dezelfde relaties terugvonden wanneer de studie niet in het lab werd uitgevoerd maar wanneer proefpersonen bevraagd werden middels vragenlijsten. Opnieuw vonden we grotendeels dezelfde relaties in een indirect effect model waarbij dagdromen (als proxy van ZGC) een invloed heeft op depressieve symptomen via het verhogen van zelf-gerichte aandacht en ruminatie (brooding). Verder onderzoek met prospectieve en experimentele designs is aangewezen om deze relaties en conclusies en verder te valideren en te verstevigen.

Op basis van de bevindingen uit de eerdere hoofdstukken, biedt **Hoofdstuk 7** een nieuwe theoretische visie op ZGC. In dit hoofdstuk stellen we dat ZGC de ideale context vormt waarbinnen cognitieve factoren bij at-risk populaties de ruimte hebben om een negatieve invloed uit te oefenen. Aangezien dat ZGC veelvuldig gericht is op onbereikte persoonlijke doelen en de discrepantie tussen de huidige en gewenste toestand (Klinger, 1971, 2013), kan dit direct gerelateerd worden aan vier gekende cognitieve kwetsbaarheidsfactoren: ruminatie, hopeloosheid, laag zelfwaarde gevoel en cognitieve reactiviteit. Eveneens kan stress de invloed van ZGC op depressieve symptomen versterken. Deze nieuwe conceptualisatie van de relatie tussen ZGC, cognitieve risicofactoren en depressie heeft belangrijke theoretische en klinische implicaties.

Tot slot, wordt in **Hoofdstuk 8** de koppeling gemaakt tussen Hegel's concept van intersubjectiviteit - waarbij de relatie tot de ander een cruciale status heeft bij de vorming van ons zelfbewustzijn – en verschillende neurobiologische onderzoekslijnen naar de verwerking van observaties van anderen (binnen het mirror neuron systeem) en het proces van mentalisatie binnen het DMN. Vanuit deze koppeling wordt de hypothese afgeleid dat cognitie tijdens rust op *onszelf in relatie tot anderen* gericht is. Deze conceptualisatie leidt tot interessante nieuwe onderzoeksmogelijkheden naar het bestuderen van cognitie in rust bij depressie waar interpersoonlijke problemen een belangrijke rol spelen bij een substantieel deel van de depressieve populatie.

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