Mindwandering heightens the accessibility of negative relative to positive thought

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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.

Keywords: mindwandering, negative cognitions, mood, depression, individual differences

"*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)

1. 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 and 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.

2. Method

2.1. 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.

2.2. 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.

2.3. 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).

2.4. 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[1] 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.

3. Results

Descriptive statistics and means are provided in Table 1.

3.1. 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.

3.2. 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, $t(78) = 0.60$, $p = ns.$, $d = 0.07$.

3.3. 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, $t(78) = 3.11$, $p < .01$, $d = 0.35$.

3.4. 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). 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[2]. 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).

3.5. 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). 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[3], 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 Fig. 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).

4. 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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Footnotes

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

[2] 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.

[3] 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 Captions

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).

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	5 – 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.

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											

***$p < .001$; **$p < .01$; *$p < .05$. 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

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.

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).

Figure
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