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A closer look at the relationship between the default network, mind wandering, negative mood, and depression

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Abstract By a systematic analysis of the current literature on the neural correlates of mind wandering, that is, the default network (DN), and by shedding light on some determinative factors and conditions which affect the relationship between mind wandering and negative mood, we show that (1) mind wandering per se does not necessarily have a positive correlation with negative mood and, on the higher levels, depression. We propose that negative mood as a consequence of mind wandering generally depends on two determinative conditions, that is, whether mind wandering is with or without meta-awareness and whether mind wandering occurs during high or low vigilance states; (2) increased activity of the DN is not necessarily followed by an increase in unhappiness and depression. We argue that while in some kinds of meditation practices we witness an increase in the structure and in the activity of the DN, no increase in unhappiness and depression is observed.

Keywords Attention · Depression · Cognitive control · Mood · Regulation · Default network · Mind wandering · Meditation

Introduction

The discovery of the default network (DN hereafter) as the neural correlate of mind wandering has been marked as an important finding in neuroscience. Such a finding is a result of examining rest control conditions during functional imaging studies (Raichle et al., 2001). Now we know that during resting state that the brain performs no demanding task, the activity of the DN increases (Raichle et al., 2001; Raichle & Snyder, 2007).

To date, many studies have been conducted regarding mind wandering and its functions. These studies demonstrate that mind wandering is related to both adaptive and maladaptive functions. There have also been informative review articles investigating the relationships between mind wandering and adaptive and maladaptive functions; review articles such as Andrews-Hanna (2012), Smallwood and Andrews-Hanna (2013), Mooneyham and Schooler (2013), and Schooler et al. (2014), to cite but a few. In this article, we particularly focus on one of the important maladaptive functions of mind wandering, that is, negative mood, and conditions under which such a maladaptive function occurs.

Apart from adaptive functions attributed to the activity of the DN and mind wandering, which will be addressed briefly in Section 2, evidence shows that under certain conditions the activity of the DN and the occurrence of mind wandering may have an emotional cost, such as creating negative mood. Although the relationship between mind wandering and negative mood is often unclear and complex, there have been several studies which shed light on such a relationship. For example, in a well-received paper by Killingsworth and Gilbert (2010), they claim that mind wandering causally increases negative mood.

In this regard, as we will see, generally two different claims have been proposed: (1) there may be a positive correlation between the occurrence of mind wandering and unhappiness or negative mood, and (2) increased activity of the DN can be positively correlated with depression.

In this article, by a systematic analysis of the current literature on the structure and functionality of the DN, we examine

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the relationship between the DN, mind wandering, and negative mood at greater depth. We also argue that none of the above claims can be valid unconditionally. We will try to distinguish conditions under which mind wandering is or is not followed by negative mood. In each case, we investigate the corresponding neural correlates. In doing so, we introduce different and somewhat new factors and conditions which can affect the relationship between mind wandering and negative mood. This may distinguish the present work from previous studies that address the same topic.

In Section 3, based on the studies on the neural correlates of mind wandering in opposite states, that is, mind wandering with meta-awareness versus without meta-awareness, on the one hand, and mind wandering during high vigilance versus during low vigilance state (EEG based) on the other, we show that for mind wandering to be accompanied by subsequent negative mood, some other factors and conditions must be taken into play. In Section 4, we argue that some kinds of meditation practices can prevent negative mood despite the presence of mind wandering. More importantly, we show that although some sorts of meditative practices, such as mindfulness-based stress reduction (MBSR), make structural and functional increases in the DN, they are not accompanied by negative mood and depression.

Figures 1 and 2 summarize the arguments of this article. Figure 1 illustrates that the occurrence of mind wandering during periods of high vigilance and/or mind wandering without meta-awareness leads to more attention and monitoring processes, especially conflict monitoring. These monitoring processes, in turn, increase the likelihood of negative mood. By meta-awareness we mean a re-representation of conscious contents (Braboszcz, Hahusseau, & Miles, 2010; Smallwood & Schooler, 2006), that is, the ability to consider the content of mental state carefully (Smallwood, McSpadden, & Schooler, 2007). Despite the presence of mind wandering during meditation, the absence of conflict monitoring makes it less likely for negative mood to emerge. In other words, meditation can be considered a third state of mind wandering which does not give rise to negative mood.

Figure 2 illustrates that frontoparietal control network (FPCN) activity and metacognition can affect the consequence of increased DN activity in terms of negative mood. By metacognition we refer to "the ability to reflect upon, comment about, and report a variety of mental states…[or in general] cognition about cognition" (Fleming, Dolan & Frith, 2012, p. 1280). Metacognition includes a variety of executive functions (Christoff, Gordon, Smallwood, Smith, & Schooler, 2009; Fleming et al., 2012; Fox & Christoff, 2014). It can occur in the absence of meta-awareness (Schooler, 2002). During increased DN activity, metacognitive processes can lead to different consequences. If these processes occur during high vigilance states of mind wandering and/or in the state of mind wandering without meta-awareness, they give rise to negative mood. However, if they occur in the state of meditation, no negative mood or depression arises.

Default network, mind wandering, their functions and relations

Studies on the anatomy of the DN (Andrews-Hanna, Reidler, Sepulcre, Poulin & Buckner, 2010; Andrews-Hanna, Smallwood, & Spreng, 2014; Buckner, Andrews-Hanna, & Schacter, 2008) show that the DN consists of dissociated subsystems interacting via hubs. The DN includes a medial temporal subsystem comprising the hippocampus, the parahippocampal cortex, the retrosplenial cortex (RSC), the posterior inferior parietal lobe, the ventromedial prefrontal cortex (vmPFC), and a dorsal medial subsystem that includes the dorsal medial PFC (dmPFC), the temporoparietal junction (TPJ), the lateral temporal cortex, and the temporal pole. The posterior cingulate cortex (PCC hereafter) and the anterior medial prefrontal cortex (amPFC hereafter) are regarded as the hubs of the DN as they have intense connections with other parts of the network (Andrews-Hanna et al., 2014). While the hubs of the DN probably play a role in constructing personal meaning, the medial temporal subsystem is involved in mental simulation. The dorsal medial subsystem may be involved in mentalizing and conceptual processing (Andrews-Hanna et al., 2014).

There is a growing body of evidence (e.g., Andrews-Hanna, 2012; Andrews-Hanna, Reidler, Huang, & Buckner, 2010; Christoff et al., 2009; Gruberger, Simon, Levkovitz, Zangen, & Hendler, 2011; Smallwood, 2013; Smallwood, Brown, Baird, & Schooler, 2012) that the DN is critically involved in mind wandering. Also, several studies (Christoff et al., 2009; Fox, Spreng, Ellamil, Andrews-Hanna & Christoff, 2015; Gruberger et al., 2011) show that mind wandering may include executive functions such as memory, planning, and computing. Some findings confirm the activation of executive networks and the DN during mind wandering (Christoff et al., 2009; Gruberger et al., 2011). A recent meta-analysis (Fox, Spreng, Ellamil, Andrews-Hanna, & Christoff, 2015) demonstrates that mind wandering consistently recruits many regions of the frontoparietal control network (FPCN hereafter), including the dorsal anterior cingulate cortex, right rostrolateral/dorsolateral prefrontal cortex, right anterior inferior parietal lobule, and precuneus.

Adaptive functions of DN activity and mind wandering

Based on some observations on the content of mind wandering[1] and its frequency in everyday life, some researchers have

[1] The term *mind wandering* in this article refers to spontaneous thought, stimulus independent thought, task-unrelated thought, and self-generated thought. In the literature, these terms are often used interchangeably. In a recent study, Christoff, Irving, Fox, Spreng, and Andrews-Hanna (2016) introduced a framework to define and understand mind wandering more precisely. The introduction of such a framework roots in their belief that research on this topic has overlooked the dynamic nature of mind wandering and "most research has instead used the terms 'mind wandering' and 'spontaneous' as loose synonyms for 'task-unrelated' or 'stimulus-independent'" (Christoff et al., 2016, p. 727).

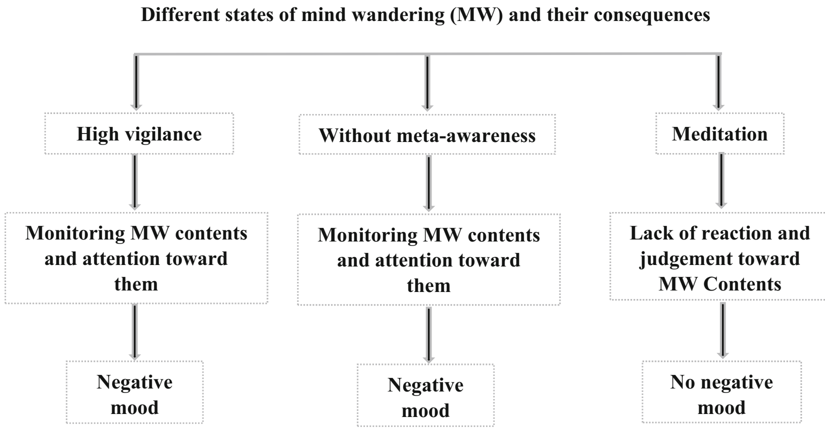

Fig. 1 The role of monitoring processes during mind wandering in subsequent negative mood. The figure shows three different states of mind wandering. As we will see in Section 3.2, the occurrence of high vigilance mind wandering and/or mind wandering without meta-awareness can lead to more attention and monitoring processes (specifically conflict monitoring) toward the content of mind wandering, which may ultimately result in negative mood. However, as discussed in Section 4, probably due to the lack of reaction to and judgment of the content of mind wandering, the occurrence of mind wandering during meditation does not lead to negative mood. It should be noted that mind wandering during high vigilance stages can be with or without meta-awareness of mind wandering itself. Also, mind wandering during high vigilance stages can be a subtype of mind wandering without meta-awareness. So, it is possible that mind wandering during high vigilance and mind wandering without meta-awareness sometimes overlap. Both of the latter two states of mind wandering correlate with negative mood through mediatory monitoring processes

hypothesized that spontaneous cognition has an adaptive function (Andrews-Hanna, 2012; Andrews-Hanna et al., 2010; Baars, 2010; Corballis, 2013; Gruberger et al., 2011; Raichle & Snyder, 2007; Raichle et al., 2001). It is claimed that DN activity may be necessary for well-being and happiness too (Berridge, 2003; Berridge & Kringelbach, 2008, 2011; Kringelbach & Berridge, 2009, 2010). Also, some studies show that there is a relation between mind wandering and positive mood (Franklin et al., 2013; Ruby, Smallwood, Engen, & Singer, 2013).

According to these observations, self-generated thought has demonstrable benefits such as enhancing creativity and helping self-memories to consolidate. Self-generated thought is also related to skills such as planning and delaying gratification (Mooneyham & Schooler, 2013; Smallwood & Andrews-Hanna, 2013). Spontaneous repetition of conscious thoughts may play an important role in problem solving and learning (Baars, 2010; Gruberger et al., 2011). Some researchers have attributed an evolutionary role to DN activity (Raichle et al., 2001) and mind wandering (Corballis, 2013).

DN activity (as the neural correlate of mind wandering) may also be necessary for happiness and well-being. Berridge and Kringelbach (2011) argue that well-being or happiness consists of at least two components: hedonia (positive affect or pleasure) and eudaimonia (a sense of meaningfulness of life). Some scholars believe that hedonia corresponds, at least psychologically, to a state of pleasure (Berridge & Kringelbach, 2011). Well-being involves both hedonia and Eudaimonia, although they are very different concepts.

As to the role of the default network in eudaimonic happiness, it is proposed that eudaimonic happiness may be a result of interactions between hedonic circuits and the DN. DN's functions may be important for higher pleasures and meaningful aspects of happiness (Kringelbach & Berridge, 2009, 2010). There is an overlap between key regions of the DN and the hedonic network, such as the anterior cingulate cortex and orbitofrontal cortex (Beckmann, Johansen-Berg, & Rushworth, 2009; Berridge & Kringelbach, 2008; Kringelbach, 2005; Kringelbach & Rolls, 2004; Peciña, Smith, & Berridge, 2006). Such regions have a relatively high density of opiate receptors (Willoch et al., 2004) and are implicated in pleasure-related cognitive functions such as monitoring, learning, and memory (Kringelbach, 2005). On the other hand, all brain structures that are targets of the treatments of pathological mood disorders either are a part of the brain's default network or have close connections to the hedonic network (Davidson et al., 2002). For example, mindfulness-based cognitive therapy for depression may recruit the default network to improve happiness via a link to hedonic circuitry (Berridge & Kringelbach, 2011).

In sum, it seems that happiness is a result of an interplay between higher pleasures, positive appraisals of life meaning and social connectedness. Such an interplay occurs through interactions between the default network and pleasure networks (Berridge, 2003; Berridge & Kringelbach, 2008, 2011; Kringelbach & Berridge, 2009, 2010).

Furthermore, some studies show that mind wandering may be associated with positive mood (Ruby et al., 2013; Franklin et al., 2013). Franklin et al. (2013) show that the presence of interesting thoughts during mind wandering increases positive

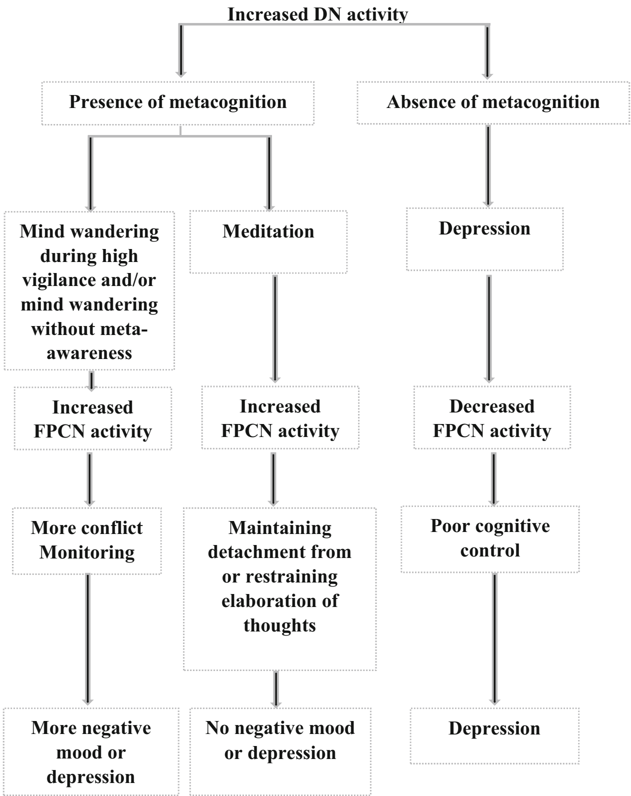

Fig. 2 The role of frontoparietal control network (FPCN) activity and metacognition in negative mood or depression during different states of increased default network (DN) activity. Increased activity of the FPCN in the presence of metacognition along with increased DN activity may lead to different consequences in terms of subsequent changes in negative mood. It seems that if during increased DN activity executive resources become engaged in functions such as conflict monitoring, FPCN activity can result in negative mood or depression. However, if executive resources become engaged in functions such as maintaining detachment from or restraining elaboration of thoughts, despite increased DN activity, negative mood or depression will not occur. Finally, the lack of metacognition and decreased activity in the FPCN along with increased DN activity may be accompanied by negative mood and depression, probably due to poor cognitive control

mood. Also, Ruby et al. (2013) demonstrate that thoughts related to future and self also increase positive mood. To summarize, DN activity and mind wandering have adaptive and useful functions.

Despite such helpful roles they play in our life, some researchers argue that mind wandering has an emotional cost in terms of its correlation with unhappiness and negative mood (Killingsworth & Gilbert, 2010; Marchetti, Koster & De Raedt, 2012; Mor & Winquist, 2002; Mrazek, Phillips, Franklin, Broadway & Schooler, 2013; Perkins, Arnone, Smallwood, & Mobbs, 2015; Poerio, Totterdell, & Miles, 2013; Smallwood, Fitzgerald, Miles & Phillips, 2009; Stawarczyk, Majerus, & D'Argembeau, 2013). There are also some studies which address the role of the DN in depressive disorders (e.g., Berman et al., 2011; Hahn et al., 2012; Kaiser, Andrews-Hanna, Wager & Pizzagalli, 2015; Marchetti, Koster & De Raedt, 2013; Marchetti, Koster, Sonuga-Barke, & De Raedt, 2012; McCabe & Mishor, 2011; Piguet et al., 2016; Posner et al., 2013; Simon & Engström, 2015). In the next sections, we delve deeper into the nature of such a correlation.

Mind wandering, the DN, negative mood, and depression

In this section, we first address the relationship between mind wandering, negative mood, and depression in general. Then, in further exploration of such a relationship, we introduce some determinative factors and conditions which can particularly affect the relationship between mind wandering, unhappiness and negative mood.

Mind wandering and the DN are correlated with negative mood and depression

It seems that mind wandering and negative mood are correlated positively. However, the direction of the relationship is unclear. Some researchers propose that there may even be a third variable as the common cause of mind wandering and negative mood (Mason, Brown, Mar, & Smallwood, 2013). Regarding the direction of the relationship, two groups of ideas are distinguishable. One group argues that negative mood can be a precursor of mind wandering (Poerio et al., 2013; Smallwood et al., 2009; Stawarczyk et al., 2013). The other group suggests that mind wandering is antecedent of negative mood (Killingsworth & Gilbert, 2010; Marchetti, Koster, & De Raedt, 2012; Mor & Winquist, 2002; Mrazek et al., 2013; Perkins et al., 2015). In this article we address the ideas proposed by the latter group.

Mind wandering may also be a precursor for depressive rumination (Hamilton et al., 2011; Murphy, Macpherson, Jeyabalasingham, Manly, & Dunn, 2013). It is probably the thinking style which can increase the likelihood and the intensity of depression and excessive ruminations predisposed to the increased risk of depression (Nolen-Hoeksema, 2000; Nolen-Hoeksema & Morrow, 1993; Nolen-Hoeksema, Morrow, & Fredrickson, 1993). Correlational examinations (Giambra & Traynor, 1978; Stawarczyk, Majerus, Van Der Linden, & D'Argembeau, 2012) demonstrate that the frequency of mind wandering in everyday life is associated with the higher levels of depression. Therefore, mind wandering is correlated with negative mood as well as depression.

Such a correlation, on the neural level, suggests that the activity of the DN (as the neural correlate of mind wandering) may have positive correlation with negative mood. Various studies have focused on the role of the DN in depressive disorders. These studies show that depression is related to the increased activity and connectivity of the DN (e.g., Berman et al., 2011; Hahn et al., 2012; Kaiser et al., 2015;

Marchetti et al., 2012; Marchetti et al., 2013; McCabe & Mishor, 2011; Piguet et al., 2016; Posner et al., 2013; Simon & Engström, 2015). For example, some researchers (Marchetti et al., 2012; Marchetti et al., 2013) argue that rumination and cognitive reactivity, as two kinds of cognitive risk factors for depression, are outcomes of DN dysfunctions. They have shown that rumination and cognitive reactivity are related to increased DN functional connectivity. Posner et al. (2013) have found that at the baseline, compared to healthy individuals, patients with dysthymic disorder (DD) increase DN connectivity. Also, they showed that antidepressant drugs can normalize increased baseline connectivity in the DN of patients with dysthymic disorder. Given that alteration in DN connectivity is observed in patients with DD and/or with major depressive disorder (MDD), Posner et al. (2013) speculate that increased DN connectivity may cause vulnerability for developing MDD. Also, by showing increased dorsal medial prefrontal cortex connectivity (dmPFC) in depression, McCabe and Mishor (2011) suggest that the DN may be a target for antidepressant drug treatment. Their data show that antidepressant drugs can decrease the elevated resting state functional connectivity. This has been observed in depressed patients independently of the mood change and in areas that mediate reward and emotional processing in the brain.

The above observations suggest a correlation between mind wandering, negative mood and depression. It seems that increased activity of the DN may be a hallmark of depression. In the next section, we discuss conditions under which mind wandering may or may not lead to negative mood or depression.

Important factors and conditions affecting the relationship between mind wandering and negative mood

There are factors which influence the relationship between mind wandering and negative mood. Here, according to the content-regulation hypothesis (Smallwood & Andrews-Hanna, 2013), a key factor is the content of mind wandering (Andrews-Hanna et al., 2013; Poerio et al., 2013; Ruby et al., 2013). This hypothesis suggests that the "relationship between self-generated thought and psychological wellbeing depends on assessing how individuals regulate the content of their mental experiences so as to maximize thoughts with a productive outcomes, and minimize those which are detrimental to their happiness or other life outcomes" (Smallwood & Andrews-Hanna, 2013, p. 4). For example, Ruby et al. (2013) show that thoughts about future and self are linked to the subsequent positive mood and thoughts about past and others are linked to the subsequent negative mood. Also, Franklin et al. (2013) show that the presence of interesting thoughts during mind wandering increases positive mood.

Similarly, Gruberger et al. (2013) show that the relationship between mind wandering and negative mood can be affected by some factors and conditions but, contrary to the previous studies, they do not take the content of mind wandering into account. By comparing negative affect, as a consequence of mind wandering, across two groups, that is, high-vigilance and low-vigilance individuals during rest, they argue that rest related negative affect (RRNA) is not necessarily an outcome of mind wandering and may be a phenomenon of its own.

Gruberger et al. (2013) calculated the vigilance level of each participant after 15-minute resting-state simultaneous fMRI-EEG scans. Then, they divided participants into two groups: high and low vigilance.[2] They used an algorithm (Olbrich et al., 2009) which included five stages of vigilance, based on EEG markers, from the most alert to the lowest vigilance levels before sleep onset. Affective assessment was performed before and after scans. Their experiment confirms the hypothesis that the availability of attentional resources is a necessary condition for rest related negative affect and low attentional resources during rest will create less negative affect. Their findings show that negative affect does not rise when levels of vigilance decrease whereas in participants who were vigilant during rest, negative affect rises. Given that mind wandering occurred in both groups, they argue that negative affect is a result of heightened attention toward mind wandering processes. Their findings can provide a basis for suggesting a mechanism in which when vigilance is maintained, individuals attend to mind wandering more and therefore there is more self-monitoring, while during lowered vigilance, although mind wandering occurs, there are no monitoring processes, resulting in reduced negative affect.

Regarding underlying mechanisms of RRNA on the neural level, only in the high vigilance group there was a significant increase in functional connectivity (FC) levels between ventral anterior cingulate cortex (ACC), a region in the DN associated with emotional processing, and dorsal ACC, a region in the executive network associated with monitoring of self and other's behavior. These heightened FC levels further correlate with reported negative affect among high vigilance group (Gruberger et al., 2013). Similarly, the results of a meta-analysis show that major depressive disorder is associated with increased functional connectivity within the DN (as mentioned earlier), and increased FC between frontoparietal control network and regions of the DN that may "reflect ongoing rumination or an underlying bias for control systems to allocate resources toward internal thoughts at the cost of getting

[2] It should be noted that vigilance levels of participants did not increase during the 15-minute rest scan. There was a significant decline in vigilance level (between the baseline and the 15-minute rest scans) in some participants. Thus they were considered as low vigilance group. Other participants who indicated no such decline and retained high vigilance levels were considered as high vigilance group.

engaged in the external world" (Kaiser et al., 2015, p. 2). These are the hallmarks of depression.

The findings of Gruberger et al. (2013) can be interpreted that retaining high-vigilance levels during mind wandering causes negative mood. However, there can be other possible interpretations. For example, in healthy individuals, EEG-vigilance stages are associated with some indicators of ANS (autonomous nervous system) activity such as heart rate. High EEG-vigilance stages are associated with high heart rate. Although there is no agreement on the direction of causal relationship between high EEG-vigilance and ANS activity (Arns, Gunkelman, Olbrich, Sander, & Hegerl, 2011; Olbrich et al., 2011), it is possible that higher ANS activity during experiment leads to higher vigilance. The higher ANS activity may result from some states of participants such as negative affect and/or anxiety (Brown, Barton & Lambert, 2009; Huang et al., 2015; Olbrich et al., 2016). It is also possible that a third factor causes negative mood in participants. High vigilance can be related to individual and environmental factors that modulate brain arousal such as sleep deficits, consumption of substances that affect vigilance (e.g., caffeine, nicotine), and disease-related factors (Hegerl, Sander, & Hensch, 2016). As discussed below, although none of the above alternative interpretations can be rejected, Gruberger et al. (2013) still believe that vigilance can be considered as a mediating factor for negative affect.

As we mentioned earlier, Gruberger et al. (2013) performed affective assessment before and after scans. Given that an increase in negative affect from baseline was observed among high vigilance group but not in low vigilance group and there were no significant differences at baseline between the two groups in terms of negative affect, it can be concluded that "the rise in negative affect following rest was dependent on a maintained level of vigilance: when vigilance was diminished, negative affect level did not increase." (Gruberger et al., 2013, p. 6). This idea can be supported by some studies which demonstrate that affective disorders are linked to the regulation of EEG-vigilance. According to these studies, disturbed vigilance regulation is related to the pathogenesis of affective disorders (Hegerl & Hensch, 2014; Sander, Hensch, Wittekind, Böttger, & Hegerl, 2015) and it is believed that symptoms of depression are the autoregulatory mechanisms for reducing levels of vigilance (Arns et al., 2011; Hegerl et al., 2016).

Apart from Gruberger et al.'s (2013) research, we could not find any studies in which the mediatory role of vigilance states with regard to the effects of mind wandering on negative mood is examined. However, the latter research alone can still be inspirational to conduct two research projects that explore (1) the relationships between vigilance states and negative mood/depression, and (2) the role of monitoring processes and dACC in negative mood/depression. In what follows, we discuss studies which confirm the worthiness of such research projects.

First, some studies suggest that different types of vigilance regulation are linked to psychopathological syndromes confirming the idea that there is a relation between EEG vigilance stages and major depressive disorder (Hegerl & Hensch, 2014; Hegerl, Wilk, Olbrich, Schoenknecht & Sander, 2012; Olbrich et al., 2012; Schmidt et al., 2016). For example, in line with the assumption that the most stable EEG vigilance regulation patterns are markers of depression, Olbrich et al. (2012) observed an increased number of high EEG vigilance stages in individuals with major depressive disorder compared to healthy controls. They argue that withdrawal and sensation avoidance in depression is a reaction to be chronically in high vigilance state. Hegerl et al. (2012) demonstrate that a hyperstable vigilance regulation is observed in individuals with major depressive disorder in which, as one of its characteristics, there is missing or delayed decline in vigilance. The results of their study confirm that during rest, compared to control group, depressed patients show less and delayed declines to lower vigilance stages. They also noted that hyperstable vigilance regulation could be related to constant inner tension and inability to relax observed in depressed patients. Schmidt et al. (2016) also reached a similar result. Their study supported the idea of hyperstable vigilance regulation in depression. They demonstrate that depressed individuals show fewer declines to lower EEG vigilance stages and mostly are in the high EEG vigilance stages.

Here, alpha wave (8–12 Hz) can be a reliable measure of vigilance (e.g., De Gennaro, Ferrara, & Bertini, 2001; De Gennaro et al., 2005; Olbrich et al., 2009). So, an increase in alpha wave in the frontal lobe is known as a marker of decreased vigilance (De Gennaro et al., 2005; Olbrich et al., 2009). The relation between high EEG vigilance and depression can also be indicative of the relation between frontal alpha asymmetry and depression (Allen & Reznik, 2015; Cantisani et al., 2015; Choi, Chi, Chung, Kim, Ahn & Kim, 2011; Jesulola, Sharpley, Bitsika, Agnew, & Wilson, 2015; Vogt, Schneider, Brümmer, & Strüder, 2010). The difference between electrical activity in the left and right frontal lobes during rest under EEG assessment, that is, frontal lobe asymmetry (FLA) (Henriques & Davidson, 1990, 1991, 1997; Jesulola et al., 2015), may be a neurophysiological biomarker of depression risk (Allen & Reznik, 2015; Gollan et al., 2014; Stewart, Bismark, Towers, Coan & Allen, 2010). It is proposed that electrical activity in the left prefrontal cortex is related to approach behaviors, that is, engagement with pleasant stimuli (Davidson, 1998), and activation of the right prefrontal cortex is related to withdrawal behaviors, that is, disengagement with or avoiding aversive stimuli (Sutton & Davidson, 1997). Thus, hypoactivation of the left frontal lobes is associated with some symptoms of depression, for example, anhedonia (Trew, 2011), and hyperactivation of the right prefrontal regions is associated with hypervigilance, behavioral inhibition, and withdrawal (Sutton & Davidson, 1997). Depressed individuals show relatively greater electrical activity in the right frontal lobe than in the left frontal lobe (Allen, Urry, Hitt & Coan, 2004; Baehr, Rosenfeld, Baehr & Earnest, 1998; Carvalho et al., 2011; Deslandes et al., 2008; Gotlib, Ranganath, & Rosenfeld, 1998; Henriques & Davidson, 1990).

In the above studies, measurement of the differences between electrical activity across frontal lobes in depressed persons is described in terms of alpha power so that high alpha power is indicative of less overall electrical activity (hypoactivation) while low alpha power is indicative of greater overall electrical activity (hyperactivation) (Cook, O'Hara, Uijtdehaage, Mandelkern & Leuchter, 1998; Laufs et al., 2003). Therefore, it can be hypothesized that EEG asymmetry in depression is accompanied by lesser alpha power in the right frontal lobe and greater alpha power in the left frontal lobe.

In sum, taking into consideration that right frontal lobe plays an active role in withdrawal behaviors and becomes more active (lesser alpha power) in depression, it can be concluded that frontal alpha asymmetry is probably associated with an important aspect of all depressive behaviors, that is, withdrawal from uncontrollable aversive stressors (Cantisani et al., 2015; Jesulola et al., 2015). In line with these observations, some studies show that changing frontal asymmetry by repetitive transcranial magnetic stimulation (rTMS) and neurofeedback training can be an effective treatment for major depressive disorder (Baehr et al., 1998; Choi et al.,2011; Mantovani, Aly, Dagan, Allart & Lisanby, 2013; Noda et al., 2013; Peeters, Oehlen, Ronner, van Os, & Lousberg, 2014). Also, it is demonstrated that meditation therapy and mindfulness-based cognitive therapy can have positive effects on depression, mostly by increasing left frontal activity (Barnhofer, Chittka, Nightingale, Visser, & Crane, 2010; Barnhofer et al., 2007; Keune, Bostanov, Hautzinger, & Kotchoubey, 2013; Moynihan et al., 2013).

Secondly, as we saw, Gruberger et al. (2013) suggest that more monitoring processes are associated with more negative mood. They also emphasize the role of dACC in such association. In what follows, we discuss studies which confirm and support the latter claims.

Several studies have shown that, first, dACC activity is correlated with conflict detection (Botvinick, Braver, Barch, Carter, & Cohen, 2001; Botvinick, Cohen, & Carter, 2004; Botvinick, Nystrom, Fissell, Carter, & Cohen, 1999; Cohen, Botvinick, & Carter, 2000; Egner & Hirsch, 2005); second, conflict is aversive (Hajcak & Foti, 2008; Lindström, Mattsson-Mårn, Golkar, & Olsson, 2013; Spunt, Lieberman, Cohen, & Eisenberger, 2012); and third, conflict arouse negative affect (e.g., Botvinick, 2007; Braem et al., 2016; Elliot & Devine, 1994; Inzlicht, Bartholow, & Hirsh, 2015). As to the relationship between conflict and negative affect, for example, an early proposal on the negative nature of cognitive dissonance holds that cognitive dissonance is experienced as a negative state (Elliot & Devine, 1994). Later on, studies on cognitive and affective neuroscience provided additional support for the emotional cost of conflict (Botvinick, 2007), even in conflicts that carry low inconsistency and are not a threat to goals (Proulx, Inzlicht, & Harmon-Jones, 2012). For instance, performing experimental tasks which involve conflict (e.g., Stroop task) produces a state of negativity in participants (Dreisbach & Fischer, 2012; Fritz & Dreisbach, 2013). Performing such tasks is related to emotional primitives[3] such as increasing the activity of sympathetic nervous system (Critchley et al., 2003; Hoshikawa & Yamamoto, 1997) including heart rate and blood pressure. Finally, as noted earlier, dACC activity is correlated with conflict detection. Studies on the role of dACC in negative affect (Koban & Pourtois, 2014; Shackman et al., 2011) suggest a functional overlap between conflict and negative affect (Inzlicht et al., 2015).

In addition to the two research projects mentioned above, the findings of Gruberger et al. (2013) on monitoring processes during mind wandering and their effect on negative affect confirm the role of attention and meta-awareness in affective processing.

As to the relationship between meta-awareness and mind wandering, we now know that individuals generally do not know "when" mind wandering occurs. Only after a certain period of time they realize that their minds wandered. This realization is called "meta-awareness," a re-representation of conscious contents (Braboszcz, Hahusseau, & Miles, 2010; Smallwood & Schooler, 2006). Meta-awareness refers to the ability to consider the content of mental state carefully (Smallwood, McSpadden, & Schooler, 2007). Different studies (e.g., Deng, Li, & Tang 2014; Smallwood, McSpadden, & Schooler, 2007) have compared the differences between mind wandering with meta-awareness and mind wandering without meta-awareness from different perspectives. For example, Smallwood et al. (2007) show that in the context of task performance, the occurrence of mind wandering without meta-awareness during the task is associated with greater behavioral cost such as rapid and careless task performance. Deng et al. (2014) show that mind wandering in the absence of meta-awareness is associated with higher levels of negative mood.

In addition to the studies accomplished on the differences between mind wandering with and without meta-awareness, combining two studies conducted by Christoff et al. (2009) and Deng et al. (2014) shows that, similar to the results of Gruberger et al. (2013), negative affect is a result of *heightened* attention and more monitoring of the content of mind wandering.

[3] Which are "the most basic and simple building blocks of emotion, including changes in core affect, physiology, and subjective conscious experience" (Inzlicht et al., 2015, p. 1).

One of the aims of the study of Christoff et al. (2009) was to examine the relationship between meta-awareness and the neural recruitment associated with mind wandering. According to their assessment, mind wandering in the absence of meta-awareness was associated with strong activation of the executive network (dorsal ACC and dorsolateral PFC) and the default network (ventral ACC, posterior cingulate/ precuneus and temporoparietal cortex). Also, mind wandering with meta-awareness was associated with similar but weaker activation in those networks. They did not observe any brain regions being significantly more activated during mind wandering with meta-awareness than during mind wandering without meta-awareness. Regarding the role of executive recruitment during mind wandering, Christoff et al. (2009) argue that executive recruitment can reflect the process of detecting conflict within the content of mind wandering itself. In line with this interpretation, some evidence shows that dACC activity, which is stronger during mind wandering without meta-awareness, is correlated with conflict detection (Botvinick et al., 1999; Botvinick et al., 2001; Botvinick et al., 2004; Cohen et al., 2000; Enger & Hirsch, 2005). Similarly, Fox et al. (2015) consider the role of executive control regions during mind wandering in guiding, evaluating and selecting among many spontaneous thoughts, memories and imaginations made conscious by the DN.

As we saw, it is likely that conflict detection and monitoring the content of mind wandering occur more when the person does not have meta-awareness of his own mind wandering. On the other hand, Deng et al. (2014) propose that mind wandering without meta-awareness may be associated with higher levels of negative mood. So we can suggest that monitoring mind wandering contents and attention toward them, as results of activity in the executive control regions or FPCN, are possibly related to higher levels of negative mood. This further corroborates Gruberger et al.'s (2013) assumption that rest-related negative affect may be a phenomenon of its own and is not merely a simple or unavoidable outcome of mind wandering. Here, it should be noted that some researchers make a distinction between meta-awareness of the content and meta-awareness of the process of mind wandering. We can have meta-awareness of the contents of mind wandering without meta-awareness of the process of mind wandering itself (Christoff et al., 2009; Schooler, 2002). Also, it is possible that some cognitive processes, such as monitoring processes, occur in the absence of meta-awareness (Schooler, 2002). Monitoring of desired goals in social situations (Bargh, 1997) and monitoring processes for finding mental contents that indicate failure of achieving a desired state (Wegner, 1994) are two instances of monitoring processes without meta-awareness. It is even possible to perform a task without meta-awareness (Mrazek et al., 2013). By taking such possibilities into consideration, the observation that more self-monitoring and more attention toward the content of mind wandering can occur during mind wandering without meta-awareness may not be implausible or contradictory anymore.

Thus far in this section we have supported two proposals according to which mind wandering per se does not lead to negative affect (e.g., Gruberger et al., 2013) and meta-awareness can be related to the effects of mind wandering (Christoff et al., 2009; Deng et al., 2014). Given that mind wandering and meta-awareness can co-occur during meditation practices (Fox & Christoff, 2014), the question arises whether meditation can prevent negative affect despite the presence of mind wandering (regardless of its content), and if so, how?

Also, given that mind wandering may not be directly related to negative affect but executive control regions or FPCN may play a role in negative mood as well as depression (as we have seen earlier in this section), another question is under what conditions would increased activity and connectivity in the DN not lead to increasing depression? In the next section, we will address these questions.

Meditation, mind wandering, and the DN

Attention regulation is a critical component and a common feature of all meditative practices. Meditative styles can be placed on a continuum, from focused to unfocused practices, depending on how attention is directed (Braboszcz et al., 2010; Lutz, Slagter, Dunne, & Davidson, 2008). In this article, we deal with the focused attention and mindfulness meditation.

In focused attention (FA) techniques, individuals try to keep continuous sustained attention on a given object, for example, breath or body sensations, a repeated sound or word (mantra) or a mental image. This technique narrows meta-awareness so that the mind only focuses on one object. If during practice distraction occurs, such as mind wandering, the individual tries to redirect attention toward the selected object of meditation (Braboszcz et al., 2010).

In mindfulness techniques, that is, so called open-monitoring (OM) or insight meditation, contrary to the previous technique, individuals practice to expand meta-awareness with no given object to focus on (except meta-awareness itself). In mindfulness meditation, individuals allow any feeling or sensation to arise in consciousness while simultaneously maintaining nonreactive meta-awareness to what is being experienced (Braboszcz et al., 2010). So, the goal of mindfulness practice is to enable individuals (1) to acknowledge all incoming thoughts, feelings, and emotions from moment to moment and to direct the attentional focus on all such mental states without focusing on any of them (meta-awareness) and (2) to openly accept and approve thoughts, feelings, and emotions without reaction and attachment to them, that is, by only observing the content of awareness without any interpretation or judgment of the moment to moment experience. In this technique, to minimize engaging in deliberate thinking processes, the meditator does not make any attempt to control the stream of thoughts (acceptance) (Braboszcz et al., 2010; Maron-Katz, Ben-Simon, Sharon, Gruberger, & Cvetkovic, 2014; Teper & Inzlicht, 2013). In sum, "open monitoring practices, sometimes referred to as 'choiceless awareness,[4] ' involve an open, receptive, non-judgmental attitude toward any and all experience, regardless of origin (external/sensory or internal/mental) and affective tone (positive, negative, or neutral)" (Fox et al., 2014, p. 53).

Contrary to the idea of some researchers (Murphy et al., 2013) who claim that mind wandering and mindfulness are mutually exclusive concepts, it has been argued that these are two very different but not opposite states of consciousness (Braboszcz et al., 2010). So, they can occur simultaneously.[5]

The beneficial effects of mindfulness meditation on mood and negative affect are due to the absence of reaction to mind wandering even if the content is negative. As some researchers (Marchetti et al., 2013) demonstrate, dispositional mindfulness negatively correlates with cognitive reactivity. There is no negative correlation between dispositional mindfulness and rumination. According to this result, Marchetti et al. (2013) argue that despite the emergence of self-related thoughts during rest, mindful individuals are not engaged in a self-judgmental loop and in cognitive reactivity levels which are associated with worsening of the mood. There are some other studies (Frewen, Evans, Maraj, Dozois, & Partridge, 2008) which confirm the above idea by showing that although highly mindful individuals are not immune to negative thinking, their ability to not react to negative thoughts or to let go without suppressing such thoughts can reduce the frequency of negative automatic thinking.

To sum up, harmful effects of mind wandering on mood are not caused by the mere presence of mind wandering itself but by reacting to and judging its content.

Mindfulness meditation is similar to other types of meditation, including acem meditation and transcendental meditation in which participants do not resist the generation of thoughts in the mind and allow them to pass freely through consciousness (Gutierrez, Fox, & Wood, 2015).

Considering the role of the DN in mind wandering, the question will be: What is the effect of meditation practices on DN activity? And more importantly, given that the inability to suppress DN activity is associated with depression (Anticevic et al., 2012; Sood & Jones, 2013), is it possible for an increased activity of the DN *not* to be followed by depression? And if yes, how? In what follows, we address these questions.

[4] Here, the term "awareness" refers to meta-awareness too.

[5] The claim of Murphy et al. (2013) that mind wandering and mindfulness are mutually exclusive concepts is originally adopted from Kabat-Zinn (1994).

Meditation and the DN

In general, meditation causes two kinds of neurophysiological changes in the body: state changes and trait changes. Trait changes are created over a long time and persist even when the person is not engaged in meditation. For example, a regular practice of open-monitoring meditation with focusing on internal and external sensations increases the thickness of the cortex in somatosensory areas of the brain (Braboszcz et al., 2010).

Meditation also affects some brain networks, particularly the DN. Several studies (e.g., Brewer et al., 2011; Sood & Jones, 2013; Taylor et al., 2011) indicate that differential activation and connectivity of the DN can be considered as neural mechanisms underlying mindfulness training. Functional magnetic resonance imaging (fMRI) studies demonstrate differences in DN activity between experienced meditators and beginners. For example, Brewer et al. (2011) show that across three types of meditation practices, including mindfulness practices, the hubs of the DN (the PCC and mPFC) are less active in meditators than in control group. They found that in meditators there is increased connectivity between the DN and brain structures such as the dorsal anterior cingulate and dorsolateral prefrontal cortices (conflict monitoring and cognitive control) (Brewer et al., 2011). Also, a comparison between experienced meditators and beginners during their mindfulness practice as they viewed negative, positive, and neutral pictures showed relatively greater mPFC deactivation in the experienced than in the beginner meditators. This may reflect the fact that individuals with extensive meditation experience have relatively greater acceptance toward affective states. They are also less engaged in appraisal and thought-related processes. This is consistent with descriptions of mindfulness meditation in which the individual accepts his sensations, emotions, and thoughts rather than controlling or changing them. Compared to beginner meditators, mindfulness practice leads to a relative deactivation of another brain area in experienced meditators, that is, PCC (Taylor et al., 2011). Also, during the processing of negative and positive emotional stimuli, mindfulness causes a relative deactivation of amygdala in beginners compared to experienced meditators. An interpretation of the above observation can be that individuals with extensive mindfulness training allow themselves to fully experience their emotional responses, and there is an accepting perspective toward such experiences. Thus, while experienced meditators may have amygdala reactivity to emotional stimuli in the mindful state, mPFC deactivations during mindfulness practices indicate that mindfulness alters what happens after amygdalar response of meditators. This leads to a decreased subjective emotional intensity (Taylor et al., 2011).

Interestingly, contrary to what was stated above regarding the beneficial effects of meditation on mood due to reduced DN activity during meditation, it can be shown that some meditation practices even increase DN activity and connectivity, however, without leading to unhappiness or negative mood. The latter idea has not been dealt with sufficiently in the current literature despite the fact that during the last decade we have seen exponential growth of research on the relation between the DN and mind wandering, negative mood, and depression. The reason is that only a few studies have focused on the state changes when contrasting meditation with various control tasks in the same practitioners. Most of the studies have been focusing on the trait differences in the brain activity arising from meditation, often showing more decreased DN activation in experienced meditators than beginners (Xu et al., 2014). It should be noted that methodological differences in meditative and control tasks, the employment of different strategies or cognitive processes, the level or type of expertise in meditators, and participant characteristics can lead to contradictory results (Taylor et al., 2011; Wang et al., 2014). In general, the relationship between the type of practice and the number of years of experience is too complex to let us strictly conclude that meditation reduces mind wandering and DN activation (Xu et al., 2014). There is convincing evidence which shows that meditation practices increase DN activity, as we will see in what follows.

In some meditation practices, spontaneous flow of inner experiences is considered as a part of the meditation process. For example, Xu et al. (2014) investigated the state effects of nondirective meditation compared to either rest or concentrative practicing in experienced participants in acem meditation. Compared to rest, nondirective meditation increased activation within all regions of the DN, including the ventral medial prefrontal cortex, the posterior cingulate/retrosplenial cortex, the inferior parietal lobe, the lateral temporal cortex, the dorsal medial prefrontal cortex, and the hippocampal formation. Also, by comparing brain activity of a group of participants during two conditions, eyes-closed rest and transcendental meditation (another form of nondirective meditation), Travis, Haaga, Hagelin, Tanner, Arenander, Nidich and Schneider (2010) show that during transcendental meditation there is greater activation in areas that overlap the DN. Manna et al. (2010) investigated the differences between open-monitoring (OM) and focused attention (FA) meditation. They observed that compared to FA, there was an increase in the activation of the precuneus during OM. Also, they found that compared to novices, expert practitioners' patterns of brain activity during OM were similar to their normal resting state activity. They concluded that with extended practice, the state of nonjudgmental meta-awareness, or "mindfulness," becomes intrinsic or default mode of the brain activity.

As we mentioned earlier, mPFC is a central DN component and some studies (e.g., McCabe & Mishor, 2011; Wang et al., 2015) show that increased activity and connectivity in dmPFC is observed in depression. This region plays an important role in the treatment of mood disorders because it is extensively involved in the processing of negative emotion and self-reflection. Wang et al. (2015) show that the use of antidepressants causes changes in resting state functional connectivity. Their work also show that reductions in functional connectivity of the dmPFC significantly correlate with symptomatic improvement.

However, through meditation, an increase in the activity of the central DN component can also happen without causing negative mood or depression. For example, some studies (e.g., Engström & Söderfeldt, 2010; Hölzel et al., 2007; Jang et al., 2011) show that meditation practices can increase mPFC activity and connectivity. According to Hölzel et al. (2007), meditators show stronger activations in the dmPFC compared to controls. Given that the mPFC is activated in emotional processing and might be involved in the cognitive aspects of emotional processing, such as paying attention to emotion or identification of emotions, they argue that mPFC is activated when subjects internally attend to their emotional state. They assume that stronger dorsal mPFC activation in meditators implies that meditators are engaged more strongly in emotional processing which in turn illustrates their better ability for emotion regulation. Jang et al. (2011) show that during rest, meditation practitioners of "brain-wave vibration meditation" (meditative movement) have greater functional connectivity within the DN in the medial prefrontal cortex area than a control group. Their results suggest that long-term meditation practice may be associated with functional changes in regions involved in internalized attention even when meditation is not being practiced. Another study (Engström & Söderfeldt, 2010) shows that compassion meditation in experienced meditators is accompanied by a large significant activation in the left medial prefrontal cortex, which plays an important role in empathy.

Furthermore, meditation is related to the structure of the DN regions. Findings of structural MRI studies show greater gray matter (GM) volume or more dense DN regions in meditators than novices (Wang et al., 2014). The precuneus/posterior cingulate cortex (PCC), lateral temporal cortex (LTC), lateral parietal cortex (LPC), parahippocampal gyrus (PHG), and thalamus are included in such DN regions (Hölzel et al., 2008; Leung et al., 2013; Luders, Toga, Lepore, & Gaser, 2009). Density in gray matter is associated with performance abilities and increase in gray matter concentration may be indicative of improved functioning in the relevant area (Hölzel et al., 2011). For example, Hölzel et al. (2008) show that compared to nonmeditators, meditators increase gray matter concentration in regions in the right hippocampus as well as in parahippocampal region. The hippocampus in meditative experiences is involved in modulating cortical arousal and responsiveness. The hippocampus also modulates the activity of amygdala and is involved in attentional and emotional processes. The parahippocampal region is involved in emotional memory and sensory functions (Hölzel et al., 2008).

Mindfulness-based stress reduction (MBSR), which is widely used in mindfulness training, improves symptoms of some disorders such as anxiety and depression. The results of analyses of a study performed by Hölzel et al. (2011) confirm that MBSR is accompanied by increases in gray matter concentration within the left hippocampus and the PCC. The PCC is related to assessing the relevance or significance of a stimulus for oneself and may particularly be important for the integration of self-referential stimuli in the emotional and autobiographical context of one's own person. These functions are also observed in mindfulness practice which involves the introspective observation of phenomenal experiences. The structural increases in gray matter concentration might then be related to the repeated activation of the PCC during mindfulness practice.

As seen, there is evidence supporting the idea that increased activity in the DN is not necessarily followed by unhappiness or negative mood. One explanation can be that the simultaneous presence of metacognition along with mind wandering during meditation (Fox & Christoff, 2014) prevents negative mood and depression despite increased activity in the DN. Some studies (Fox & Christoff, 2014; Tang, Hölzel, & Posner, 2015) show that metacognitive brain regions such as the rostrolateral/dorsolateral prefrontal cortex have greater activation during meditation. This is in line with the claim of some researchers such as Fox et al. (2015) concerning the role of hyperactivity of the DN in some disorders. They note that "over activation of the DN regions in isolation, with minimal or attenuated activation of the executive areas, might characterize dysfunctional forms of spontaneous thought, such as depressive rumination" (Fox et al., 2015, p. 8). Similarly, a meta-analysis conducted by Kaiser et al. (2015) shows that increased connectivity within the DN, which may be indicative of rumination, and reduced connectivity within the FPCN, which may be indicative of poor cognitive control, are observed in major depressive disorder. According to these observations, it seems that increased activity of the DN may be a common factor between some meditation practices and depression, and decreased activity of the FPCN may be related to harmful effects of overactivation of the DN. So, it seems legitimate to claim that on the neural level a distinction can be made between DN/FPCN activities across two states where mind wandering is present, that is, depression and meditation that have different effects on our well-being and mood. On the other hand, based on what was proposed earlier on the possible role of the executive areas or FPCN in negative mood and depression (Section 3.2), it seems that the mere activation in the executive areas does not play an important role in preventing negative mood and depression. A critical factor in creating or preventing negative mood and depression has to do with the type of the operation that executive areas perform. For example, if during mind wandering the FPCN is recruited to more conflict monitoring (see Section 3.2), it cannot prevent negative mood. Taking the latter idea into account, another legitimate claim is that some conditions cannot be distinguishable on the neural level but on the cognitive and behavioral level. In such cases, what may solely determine the consequence of a neural activation and provide a context in which a neural pattern of activity represents useful or nonuseful cognition are cognitive and behavioral goals of the individual.

Furthermore, when it comes to the role of FPCN activity during meditation, Fox and Christoff (2014) argued that the suppressant role of metacognitive functions in interactions between metacognition and mind wandering[6] is only one side of the coin. They believe that the suppressant mind-wandering–metacognition interaction is observed in the focused attention meditation because the role of metacognition primarily is to detect lapses of attention and then to redirect attention toward a chosen object. But "during mindfulness meditation the role of metacognition is to maintain detachment from or restrain elaboration of thoughts and sensory input, and further to regulate arousal so that one does not become over-involved emotionally" (Fox & Christoff, 2014, p. 305). Although mindfulness practice does not reduce the occurrence of spontaneous thoughts, an open and nonjudgmental metacognitive stance will finally result in greater flexibility (both cognitively and emotionally) and in more adaptive behavioral responses (Fox & Christoff, 2014).

To recapitulate, increased activity and connectivity in the DN by itself does not necessarily lead to depression. A determinant factor regarding the effects of such an increase can be how the individual encounters the situation.

Conclusion

This article was an attempt to shed more light on some determinative factors and conditions that play important roles in the relationship between the DN, mind wandering, negative mood, and depression but have not been given enough attention in the current literature.

It seems that factors such as EEG vigilance stages and the state of meta-awareness during the occurrence of mind wandering can affect the relationship between mind wandering and negative mood. These factors possibly affect the extent of monitoring processes, in particular, conflict monitoring. Therefore, negative affect can be prevented despite the presence of mind wandering even if its content is negative. This can be observed during mindfulness meditation. By taking the above factors and conditions into account, we will have a better understanding of why in the DN research we sometimes encounter inconsistent results. Highlighting such factors and conditions also prevents us from proposing generalized

[6] According to the standard view, "metacognition serves to correct the wandering mind, suppressing spontaneous thoughts and bringing attention back to more 'worthwhile' tasks" (Fox & Christoff, 2014, p. 293).

statements regarding the effects of the activity (or hyperactivity) of the DN and will draw our attention toward the role of other brain networks. This may lead to targeting depression from a new angle other than the suppressant role of therapeutic interventions on DN activity. To explore whether unhappiness or depression occurs as a result of an increase in the structure and functionality of the DN, then, we should always consider DN activity in the context of such determinant factors and conditions.

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