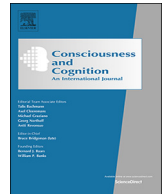




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Who is prone to wander and when? Examining an integrative effect of working memory capacity and mindfulness trait on mind wandering under different task loads

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ABSTRACT

We proposed an integration hypothesis of mind wandering in which the tendency of mind wandering is only related to working memory capacity (WMC) when a self-regulation process is required (i.e., under a high task load); however, this tendency is related to mindfulness regardless of task load. A within-group experiment with 160 participants was conducted. Task load was manipulated as high or low using modified 0-back and 2-back tasks, during which participants' self-caught mind wanderings and the types of mind wandering (aware vs. unaware; intentional vs. unintentional) were measured. The results supported our hypothesis that WMC was negatively associated with mind wandering only in demanding tasks, and mindfulness scores were negatively associated with mind wandering across tasks. Furthermore, we also determined how WMC and the mindfulness trait were related to different types of mind wandering. Theoretical implications were discussed.

1. Introduction

Mind wandering is a mental state that people often experience while they are shifting attention from an ongoing task toward internal thoughts, which results in them decoupling from the outside world (Schooler et al., 2011; Smallwood & Schooler, 2006; Smallwood, 2013; Smallwood, Beach, Schooler, & Handy, 2008). Under this loose definition, studies have reported that mind wanderings may arise from various causes (Kane & McVay, 2012; McVay & Kane, 2010; Smallwood, 2013; Thomson, Besner, & Smilek, 2015), how likely they are to occur across contexts and people (Smallwood & Andrews-Hanna, 2013), and whether they are intentional or if the individual is aware (Schooler et al., 2011; Seli, et al., 2017; Seli, Risko, & Smilek, 2016). To integrate the influences of various factors and to improve understanding of the regulatory effect of task load on mind wandering, this study examined how people's tendencies toward mind wandering were associated with their working memory capacity (WMC) and mindfulness tendencies across different levels of task load. This study also determined whether different types of mind wandering (aware or unaware mind wandering, and unintentional or intentional mind wandering) could be predicted using these three factors.

1.1. WMC and mind wanderings

Because WMC is a measure of mental capacity and indicates some aspects of executive function, which are relevant to goal

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maintenance and distractor inhibition (Cowan, 2017; Engle, 2002; Kane, Conway, Hambrick, & Engle, 2008; McCabe, Roediger, McDaniel, Balota, & Hambrick, 2010), WMC has unsurprisingly been considered a potentially vital factor in the tendency toward mind wandering. Indeed, some researchers have reported that people with high WMC tend to experience fewer mind wanderings than those with low WMC in laboratory situations (Kane & McVay, 2012; McVay & Kane, 2009). Robison and Unsworth (2015) also reported that people with high WMC were more resistant to mind wandering and external distraction during a reading comprehension task under silent and noisy conditions, respectively.

However, other evidence complicates matters. Kane (2007, 2017) investigated participants' mind-wandering tendencies in their everyday lives and revealed a negative relationship between WMC and mind wandering only existed during tasks that participants wanted to concentrate on. In addition, our recent study (Ju & Lien, 2016) indicated that the relationship could be altered depending on what was focused on. When our participants were instructed to focus on a mental image, their mind-wandering tendency was negatively correlated with their WMC, as demonstrated by other studies. However, this relationship ceased if they were asked to concentrate on their breathing. Evidence was even obtained of an inverse relationship: those with high WMC experienced more mind wandering than those with low WMC when completing a visual search task or breath-aware task (Levinson, Smallwood, & Davidson, 2012). In summary, evidence on the relationship between WMC and mind wandering is inconsistent. In addition, the past studies have not specified the amount of effort that the task required or that participants put into the task.

1.2. Modulatory effect of task load on the relationship between WMC and mind wandering

Rummel and Boywitt (2014) further integrated these findings and argued that people with high WMC have superior cognitive flexibility to modulate mind wandering in adaptation to task load. They found that, with marginal significance, participants' WMC was negatively correlated with their mind wandering tendency under a high-load condition and positively correlated under a low-load condition. That is, when the task load was increased, those with high WMC exhibited a greater magnitude of mind wandering reduction and less impairment of task performance than those with lower WMC. Rummel and Boywitt (2014) thus argued that those with high WMC were more capable of self-regulating mind wandering to be more adaptive to a change in task load than those with low WMC. Their findings integrate two opposing claims regarding WMC and mind wandering: WMC is required to prevent mind wandering when the task at hand is demanding (Kane et al., 2007; McVay & Kane, 2010) or to allow an individual to maintain mind wandering when the task is undemanding (Smallwood & Schooler, 2006; Smallwood, 2013).

Randall, Oswald, & Beier (2014) conducted a meta-analysis to examine the moderating effect of task complexity (i.e., task demand) on the relationship between mind wandering and WMC. They classified the tasks used in studies as "more complex" or "less complex" according to consistency between input and output, and number of distinct acts and dimensions of information to be coordinated for the task. For example, reading comprehension tasks or assessments of complex cognitive abilities (e.g., WMC tasks) were classified as "more complex tasks" (i.e., high-load tasks), and the go/no-go task, sustained attention to response task, choice reaction time task, and Stroop-task were classified as less complex tasks (i.e., low-load tasks). Their findings confirmed that people with more mental resources (i.e., higher WMC) are more capable of resisting mind wanderings in general but provided no support for their claim that greater task complexity could magnify the negative relation between WMC and mind wandering. Randall et al. attributed the failure to find a moderating effect to the small number of effects available and the overall small size of correlation, and thus called for more experimental settings in which task demand was directly manipulated.

1.3. The integration hypothesis: taking the mindfulness trait into account

To account for the aforementioned inconsistent findings, we proposed an integration hypothesis of mind wandering which takes people's endogenous tendency to generate task-unrelated thoughts into account in addition to their self-regulating abilities involving WMC. Specifically speaking, as a task becomes more difficult, an individual must exert more effort on controlling mind wandering to maintain task performance if he or she is motivated to do so, which yields a relatively robust negative relation between WMC and mind wandering in demanding situations. However, the need for top-down control decreases and the regulation process triggered by the demand of the task diminishes when the task is easy. In this situation, we predict the occurrence of task-unrelated thought is in accordance with the endogenous tendency of mind wandering and is likely to be decoupled from WMC. Rummel and Boywitt (2014) observed that the numbers of mind wanderings reported by their participants were positively correlated across low-load and high-load conditions, which indicated that a trait-like tendency of mind wandering exists.

A person's mindfulness trait could be a useful and sensible index for this tendency. In psychology, the mindfulness trait usually refers to a tendency to focus on a task at hand and be aware of the present moment, although measures of mindfulness traits may include different aspects of this tendency (e.g., Baer et al., 2008; Brown & Ryan, 2003; Walach, Buchheld, Buttenmüller, Kleinknecht, & Schmidt, 2006). Evidence indicates that peoples' mindfulness scores are associated with their tendency toward mind wandering in several ways. For example, mindful people scored lower on a daily mind-wandering questionnaire than those who were less mindful (Carciolo, Song, Du, Wang, & Zhang, 2017). Similarly, laboratory studies have demonstrated that participants with higher mindfulness scores had fewer mind wanderings during a sustained attention task, with mind wandering measured using the probe-caught method (Carciolo et al., 2017; Mrazek, Smallwood, & Schooler, 2012). Notably, these studies did not manipulate the task load and used tasks usually considered undemanding; thus they did not address the modulatory role of task load on the relationship between mindfulness and mind wandering.

We suggest that the mindfulness trait may influence one's tendency toward mind wandering in two ways. First, mindful people may be better at detecting off-task thoughts, an aspect of meta-awareness, and thus have a higher chance of directing themselves back

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