Mind-wandering and task stimuli: Stimulus-dependent thoughts influence performance on memory tasks and are more often past- versus future-oriented

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ABSTRACT

Although many studies have indicated that participants frequently mind-wander during experimental tasks, relatively little research has examined the extent to which such thoughts are triggered by task stimuli (stimulus-dependent thoughts; SDTs) versus internally triggered (stimulus-independent thoughts; SITs). In the current experiment, we assessed differences in the frequency and characteristics of SDTs and SITs, as well as their associations with subsequent memory in young adults. Whereas frequency of SDTs (but not SITs) increased in a task with more meaningful stimuli, frequency of SITs (but not SDTs) increased in an easier task. Furthermore, only SDTs were more likely to be past- versus future-oriented. Finally, frequency and vividness of SDTs during a shallow, but not a deep, incidental encoding task both correlated with later memory performance for word stimuli. These results suggest that SDTs differ from SITs in several important ways.

1. Introduction

Participants experience a variety of thoughts that are not directly relevant to performing an ongoing experimental task (mind-wandering; Smallwood & Schooler, 2015). Many studies have now examined the frequency and cognitive consequences of mind-wandering during numerous tasks, such as those indexing episodic encoding, sustained attention, and reading comprehension (for reviews, see Mooneyham & Schooler, 2013; Randall, Oswald, & Beier, 2014; Smallwood & Schooler, 2015). In the current experiment, we focus on one aspect of mind-wandering that has received relatively little attention in the literature: whether it is triggered by a task stimulus (stimulus-dependent thought; SDT; e.g. the word "apple" triggering a thought about going to the supermarket) or internally-triggered (stimulus-independent thought; SIT). Note that our use of the terms SDT and SIT differs another usage of these terms as specifying whether a thought is about immediate perceptual input or not (e.g., Teasdale et al., 1995). That is, in the current paper, an SDT is defined as a thought that was cued by a task stimulus, irrespective of whether that stimulus is still present in the environment when a participant is having it.

Whether defined with respect to its relation to current perceptual input or cueing, mind-wandering is primarily thought of as reflecting SIT. For instance, Stawarczyk, Majerus, Maj, Van der Linden, and D'Argembeau (2011) defined mind-wandering as thoughts whose content is decoupled from stimuli present in the environment and unrelated to the activity being carried out at the moment of its occurrence. Similarly, Smallwood and Schooler (2015) defined mind-wandering as a shift in the contents of thought away from an ongoing task and/or from events in the external environment to self-generated thoughts and feelings, where self-

generated thoughts refer to thoughts that arise from intrinsic changes within an individual rather than extrinsic changes cued from perceptual events in the external environment. Moreover, mind-wandering is often studied using tasks devoid of meaningful stimuli. For instance, the sustained attention to response task (SART; Robertson, Manly, Andrade, Baddeley, & Yiend, 1997), one of the most commonly used tasks in the mind-wandering literature, uses the digits 1–9 as stimuli. Because digits are relatively meaningless stimuli, they are unlikely to themselves trigger thoughts, and it is thus a safe assumption that most mind-wandering episodes measured in this task are SITs.

Although many theoretical accounts of mind-wandering emphasize its independence from the environment, other authors such as Klinger (2013) have put more emphasis on the importance of external cues in triggering mind-wandering episodes. Specifically, Klinger (2013) argued that an individual's current goals/concerns sensitize them to respond to cues associated with those concerns. Concern-related cues receive automatic priority for cognitive processing, and these cues may in turn trigger concern-related though segments.

Several studies have provided evidence consistent with the idea that environmental stimuli can trigger mind-wandering episodes. For instance, McVay and Kane (2013) had participants complete a questionnaire in which they described their personal goals and concerns across several life domains. In a second session, participants performed a modified version of the SART, during which they had to respond to lowercase words and withhold their response to uppercase words. Unbeknownst to the participants, some words in the SART were designed by the experimenter to reflect the participants' previously reported concerns (e.g. the words INCREASE – FACIAL – HAIR for the concern "I want to grow a beard"). The authors observed a small increase in self-reported mind-wandering episodes following concern-related versus concern-unrelated words, suggesting that concern-related task stimuli can increase mind-wandering episodes (see Klinger, 1978 for similar results). In another study (Plimpton, Patel, & Kvavilashvili, 2015), dysphoric and non-dysphoric controls performed a vigilance task in which they had to respond to slides depicting arrangements of black vertical lines and withhold their response to slides depicting black horizontal lines. The slides also included short phrases (e.g., "friendly boss", "missed opportunity", "crossing the road") that participants were told to ignore. Eighty-six percent of task-unrelated thoughts in controls (83% in dysphorics) were reported to have identifiable triggers. Of these, 85% percent in controls (and 89% in dysphorics) were judged as having been triggered by the word cues, suggesting a strong influence of task stimuli on task-unrelated thought content (see Mazzoni, Vannucci, & Batool, 2014 for similar results). Moreover, task-unrelated thoughts were more likely to be past-oriented than present-oriented or future-oriented in this study. Lastly, in a daily-life experience sampling study (Song & Wang, 2012), 88% of mind-wandering episodes were reported to have an identifiable trigger: 49% were internally triggered whereas 51% were externally triggered. Collectively, these studies suggest that environmental stimuli regularly trigger mind-wandering episodes.

Although the aforementioned studies suggest that a large number of mind-wandering episodes are SDTs, these studies did not assess whether SDTs differ in any meaningful way from SITs. We addressed this gap in one of our recent studies (Maillet & Schacter, 2016). Specifically, we reasoned that one of the main differences between SDTs and SITs may lie in the extent to which they benefit later memory for incidentally encoded task stimuli. That is, because SDTs are thoughts that are triggered by specific stimuli, these thoughts may sometimes improve people's memory for the stimuli that elicited the thoughts in the first place (e.g. "I remember seeing the word 'elephant' because, when I initially saw it, I had a thought about the last time I saw one at the zoo") (Gardiner, Ramponi, & Richardson-Klavehn, 1998; Selmeczy & Dobbins, 2014). On the other hand, because SITs are thoughts that are unrelated to (i.e., were not triggered by) encoding stimuli, they may have either no effect, or be detrimental to later retrieval decisions. For example, many studies have indicated that greater mind-wandering during intentional encoding tasks (which presumably primarily reflected SITs) is negatively related to retrieval performance (e.g., Maillet & Rajah, 2013, 2016; Smallwood, Baracaia, Lowe, & Obonsawin, 2003; Thomson, Smilek, & Besner, 2014).

To test these hypotheses, Maillet and Schacter (2016) measured the frequency of SDTs and SITs during an incidental encoding task for word-picture pairs in young and older adults. Older adults experienced an increase in SDTs, but a decrease in SITs compared with young adults. Moreover, in older adults only, the frequency of SDTs during incidental encoding was positively correlated with later memory performance. SIT frequency was not correlated with memory performance in either age group. Thus, consistent with the notion that SDTs may facilitate the ability to remember stimuli that were responsible for eliciting the SDTs, we found a positive correlation between encoding SDTs and memory performance in older adults. However, this finding was not observed in young adults. This result suggests that memory retrieval in older adults, relative to young adults, may rely more heavily on thoughts and feelings elicited during encoding than on other features such as perceptual details, as previously established in studies examining the characteristics of retrieved memories (Hashtroudi, Johnson, & Chrosniak, 1990; Hashtroudi, Johnson, Vnek, & Ferguson, 1994). In addition to observing differences in how SDTs and SITs relate to later memory as a function of age, we found that, across age groups, SDTs and SITs differed in their temporal orientation: whereas SITs were more likely to be future-oriented relative to SDTs, SDTs were more likely to be past-oriented than SITs.

In summary, the findings from Maillet and Schacter (2016) suggest three ways in which SDTs and SITs differ. First, the frequency of SDTs and SITs is differentially associated with age. Second, some of the characteristics of SDTs and SITs may differ (e.g. the temporal nature of the thoughts). Third, SDTs and SITs may differentially affect later memory for triggering stimuli (i.e. in older, but not young, adults, SDTs correlated with memory performance). Although the foregoing research has shed some light on SDTs and SITs, our current knowledge of the nature and the characteristics of SDTs and SITs, the ways in which they are modulated by task conditions, and how they impact subsequent memory, remains modest. In the current experiment, we expand on this initial research examining SDTs and SITs in young adults. Specifically, in Experiment 1, we assess how a manipulation of stimulus meaningfulness affects the frequency of SDTs and SITs, and whether SDTs and SITs differ in characteristics other than temporality (i.e., their relation to current concerns, meta-awareness, and vividness). In Experiment 2, we assess the association between the frequency of SDTs and SITs and subsequent memory performance for words encoded in a shallow and deep encoding condition.