Influencing the Occurrence of Mind Wandering While Reading

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Abstract

The current concerns hypothesis suggests that directing attention towards unfulfilled plans of the individual prior to a task would result in more off-task thoughts (or mind wandering). In this experiment, participants were asked to read a scientific text and self-report instances of mind wandering by indicating when they were experiencing task-unrelated thoughts (TUTs) or task-related interferences (TRIs). Prior to reading, participants in the individual plans experimental condition were asked to reflect upon their short-term plans by making a “to do” list while participants in a control condition were asked to make a list of the components of an automobile. In support of the current concerns hypothesis, directing attention towards the short-term plans resulted in significantly more TUTs, but not TRIs. Furthermore, participants in the individual plans condition had significantly lower scores on an assessment of reading comprehension, and this relationship was mediated by the frequency of TUTs.

Keywords: Mind Wandering, Attention, Current Concerns, Reading, Comprehension
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1. Introduction

“As one reads a dialogue of Plato, one’s mind often wanders far from the printed page; indeed, this happens so frequently that there is created a feeling of difficulty in concentrating the attention on the dialogues...” – Marion Jewitt Austin; The Classical Journal (1922)

If you have ever had the opportunity to read Plato, then you may have experienced it as described above. It is not uncommon to “zone out” or mind wander while doing any task. Mind wandering is defined here as an involuntary attentional shift away from the primary task towards internal thoughts unrelated to the task (Smallwood, McSpadden, & Schooler, 2007; Smallwood & Schooler, 2006). The study of mind wandering, while not new, has recently received an increased amount of attention and has yielded several important insights (McVay & Kane, 2010; Mooneyham & Schooler, 2013; Smallwood, 2013; Smallwood, Fishman, & Schooler, 2007; Szpunar, Moulton, & Schacter, 2013). For example, the occurrence of mind wandering has been shown to differ depending on the complexity of the task (Smallwood & Andrews-Hana, 2013). Many studies have placed individuals in situations that are minimally or moderately taxing of executive resources and assessed the amount and content of mind wandering episodes (e.g., Baird, Smallwood, & Schooler, 2011; Smallwood, Nind, & O’Connor, 2009). These experimental situations are analogous to our everyday routines in that we are not constantly engaged in tasks that require deep levels of attention (Smallwood & Andrews-Hana, 2013). Assessing mind wandering in such contexts has helped to identify and explain how internally-influenced thought fluctuates and acts to aid in mental activities, such as future planning towards unfulfilled goals (Baird et al., 2011; Mooneyham & Schooler, 2013; Stawarczyk, Majerus, Maj,
Van der Linden, & D’Argembeau, 2011). However, mind wandering is not exclusive to minimally demanding tasks. Mind wandering also occurs during complex tasks such as reading and can be detrimental to comprehension (Feng, D’Mello, & Graesser, 2013; Schooler, Reichle, & Halpern, 2004).

What is it that we are thinking about when the mind wanders? One theory posits that mind wandering is an act of our mind defaulting to a baseline condition (Christoff et al., 2009; Killingsworth & Gilbert, 2010; Klinger, 1971; Mason, Bar, & Macrae, 2007; Mason, Norton, Van Horn, Wegner, Grafton, & Macrae, 2007; Raichle et al., 2001, Raichle & Snyder, 2007; Smallwood, 2010). That is, our mind never stops producing thought; it is only when a task demands our attention that the mind is consumed by the external task-related stimuli. When executive control fails to suppress off-task baseline thoughts, the default or baseline thoughts emerge into consciousness and direct attention away from external stimuli (McVay & Kane, 2010). This view is consistent with the Global Workspace Theory of Consciousness (Baars, 1988; 2005), which posits that coalitions of unconscious processes continually compete to gain access to the conscious global workspace, which is a limited resource. Thus, mind wandering would occur when baseline or off-task thoughts win the competition for consciousness, due to their inherent relevance and/or failure of being suppressed (Smallwood, 2010).

If baseline thought consists of information regarding something one did or something one needs to do, then it would stand to reason that off-task thoughts will likely be directed towards that information. In line with this, Klinger (1978, 1999) posited that off-task thoughts would have a high propensity to be about concerns of the individual (i.e., current concerns). The current concerns hypothesis suggests that personally relevant information (e.g., unfulfilled goals) constitutes the majority of baseline thoughts. Correlational studies have provided evidence to
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support this theory through experience-sampling methods. For example, instances of mind wandering have been shown to have a high likelihood to include thoughts pertaining to personal goals or things that need to get done (Klinger, Barta, & Maxeiner, 1980; McVay, Kane, & Kwapil, 2009). Based on the above discussion, a straightforward prediction of the current concerns hypothesis is that cueing current concerns would act to influence the amount of off-task thought.

There has been one successful attempt to influence mind wandering by cuing the current concerns of the individual during a task (McVay & Kane, 2013). McVay and Kane (2013) induced mind wandering while participants engaged in the perceptual version of the Sustained Attention to Response Task (SART; McVay & Kane, 2009), where participants viewed words and made judgments (i.e., identify words presented in lower case only). Two days prior to engaging in the SART, participants completed a personal concerns inventory. The SART was then personalized for each participant by inserting words from the concerns inventory into the SART as target stimuli to act as cues to trigger off-task thoughts. The cues were comprised of word triplets that reflected the personal goals that the individual reported (e.g., WASH – TWO – PETS). As a control, yoked goals that were not expressed by the participants were also presented as SART stimuli (e.g., CLOSE – WOODEN – DOOR). Across four experiments, there was an overall significant yet subtle effect of participants reporting more instances of mind wandering when cued with information regarding their current concerns ($M = .46$) compared to the control condition ($M = .43$) (see Table 1 for effect size).

Studies that have attempted to manipulate mind wandering by influencing the attention of the individual prior to a task have been successful in influencing the content of mind wandering but not the overall amount. For example, Smallwood, Schooler, Turk and colleagues (2011)
placed pre-task focus on the autobiographical information of the individual. Participants were placed into one of four conditions in which they either rated themselves, a friend, or an arbitrary political figure on a scale for personal attributes (vs. a no rating control condition) prior to engaging in a choice reaction time task. The focus on the individual rather than others did have an influence on the types of mind wandering reported; there was a higher propensity to have thoughts regarding the future compared to the past. However, there were no statistically significant differences in overall mind wandering when comparing the condition where participants rated themselves (30%) to the no rating control condition (34%). A similar trend was found for a working memory task (rate self = 25%, control = 27%).

More in line with the current concerns hypothesis, Stawarczyk and colleagues (2011) placed an emphasis on the goals of the individual prior to engaging in the SART (Robertson, Manly, Andrade, Baddeley, & Yiend, 1997). Participants in one condition wrote an essay on a current project and their plans required for completion of that project. In a control condition, participants were asked to produce a set of directions from their current location to a distant location. Compared to the control condition, there were more future related thoughts for those who wrote about their current plans, but there were no statistically significant differences in overall mind wandering reports (i.e., current plans = 22%, control = 19%).

Based on the results of these studies, we conclude that the influence of current concerns on mind wandering has yielded mixed results (see Table 1 for the effect sizes of the aforementioned studies). The content of mind wandering has been successfully influenced (i.e., thoughts related to the future), but these studies did not show a difference in the overall amount of mind wandering. When cueing current concerns during a task, the influence was slight, which is somewhat surprising considering the shallow nature of the task and the very personalized
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materials. Considering that the aforementioned studies failed to produce a meaningful effect, another study is warranted. Aside from these simple lab-based cognitive tasks that are moderately demanding of attention, is it possible to influence the occurrence of mind wandering during more complex tasks like reading without resorting to explicit personalized cues?

In line with this question, Masicampo and Baumeister (2011) were interested in the extent to which unfulfilled goals influenced the intrusion of off-task thought during reading. In one condition, participants were asked to describe two important tasks or errands that needed to be completed and explain their importance and consequences of non-completion. In a second condition, participants did the same, but they also made a detailed plan to complete the tasks. As a control, participants were asked to describe two tasks that were recently completed and explain what the consequences of non-completion would have been. The logic behind their manipulation was motivated by the idea that the mind keeps unfulfilled goals active (Klinger, 1975; Zeigarnik, 1938) and they will persist in the mind until completed. Activating goals prior to reading would influence attention during reading to be directed towards those goals. In addition, they also predicted that making a plan to achieve these goals might reduce the thoughts related to them.

Participants read a 3,200 word excerpt from a mystery novel and were prompted to report instances of mind wandering at four time points while reading. Their results showed that participants in the unfulfilled plans condition did retrospectively report significantly more off-task thoughts compared the other conditions. However, there were no significant differences among conditions with regard to the amount of mind wandering reports during reading. Specifically, when considering the average number of mind wandering reports of each condition (of four possible reports) neither the plan ($M = .78$) or no plan ($M = 1.49$) conditions significantly differed from the control conditions ($M = 1.25$) (see Table 1 for effect size).
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We hypothesize that there are multiple potential reasons for the lack of a significant effect in the Masicampo and Baumeister (2011) experiment. One pertains to the design of the experiment, which allowed for the focus of goals to be prevalent in all three conditions prior to reading. Second, participants were only probed four times while reading a relatively short passage (3,200 words). The low number of opportunities to assess mind wandering may have been the reason for the low number of mind wandering reports. Furthermore, the placement of mind wandering probes during a complex task like reading limits the number of instances of mind wandering that can be recorded. Probing mind wandering during reading may also draw the reader’s attention back to the task which has the potential to reduce instances of reporting mind wandering when probed. In addition, when probed, participants were asked to make a choice between “…very much paying attention to the story” or “…my attention was elsewhere.” This could be problematic as Stawarczyk et al. (2011) suggests that disruptions of information processing could also occur due to an appraisal of the task being performed; thus, not necessarily an off-task thought, but not paying attention to the content either. For example, the internal thought could still be task-related, but the processing of information may still be inhibited (i.e., a task-related interference: Smallwood, Obonsawin, & Heim, 2003). What follows is the identification of three types of disruptions as reported in Stawarczyk et al. (2011): (1) Stimulus independent thoughts that are decoupled from the stimuli of the current task and task-unrelated in that they are unrelated to the current activity (i.e., TUTs), (2) Stimulus independent and task-related interferences (i.e., TRIs) such as an appraisal of the task (e.g., wondering how much more there is to be read), and (3) Sensory related perceptions that are irrelevant external distractors (EDs) such as a noise that attracts attention. It might be the case that the Masicampo
and Baumeister (2011) failed to find an effect because they did not consider the different types of disruptions that could have occurred.

In this research, we tested the current concerns hypothesis by manipulating the focus of attention between conditions prior to reading and assessed self-reports of mind wandering. We directed attention towards individual plans (IP) by asking participants to make a list of the things they need to accomplish in the immediate future (i.e., short term goals). Once the individual’s thought is directed towards their immediate future, it should become the focus of attention and, presumably, be salient prior to reading. Participants were randomly placed in one of two conditions where they were either asked to make a list of the things that they need to do in the next week (i.e., IP condition) or they were asked to make a list of the components of a car (i.e., control condition).

While reading, participants were instructed to self-report the moment they realized that they were not thinking about the content of the text they were reading. We asked for self-reports as opposed to the more traditional probing method of mind wandering (e.g., Smallwood & Schooler, 2006) because we were interested in the individual’s metacognitive awareness of mind wandering (Schooler, Reichle, & Halpern, 2004). Furthermore, the probe method has the potential to interrupt the comprehension process (i.e., when participants report “no” to the probes). Additionally, participants were asked to report whether they were thinking about thoughts that were unrelated to the current task (i.e., TUTs) or if the thoughts that they were reporting were task related interferences (i.e., TRIs) as defined above. We conducted a pilot study and found that EDs were rarely reported as types of mind wandering. For the purposes of this study we chose to focus on TUTs and TRIs. The lack of reporting EDs here is in contrast to previous studies and may be due to the differences associated with the reporting method (i.e., the probe method may be more conducive to this kind of conscious experience compared to the self-report method employed here). To our knowledge, this was the first study of assessing ED’s using the self-caught method for mind wandering reporting.
This design allows for multiple predictions. First, by placing the individual in a situation where their plans are salient, we expect that there will be more TUTs in the IP condition compared to the control condition because the default or baseline thought of those in the IP condition will likely consist of their upcoming plans. As such, the focus on the plans would act to distract attention from the reading task if executive resources fail to suppress the information activated by making a “to do” list. No predictions are made regarding the TRIs because the current concerns hypothesis does not predict an inflation or suppression of task-related interferences. Second, we expect that reading comprehension will differ between conditions in that those in the IP condition will have lower performance on a comprehension assessment compared to the control condition as it has been documented that there is a negative relationship between mind wandering and comprehension (Feng et al., 2013; Schooler et al., 2004; Smallwood, McSpadden, & Schooler, 2008; Szpunar et al., 2013). Further, we expect that task-unrelated thoughts will mediate the relationship between the IP condition and reading comprehension.

Our experiment differs from previous endeavors in a few salient aspects. First, of the four studies mentioned above, only one attempted to influence mind wandering during reading (Massicampo and Baumeister, 2011). While we are also interested in mind wandering during reading, our methodology differs from theirs in that we have incorporated a self-caught method of reporting mind wandering as opposed to the probe-caught method. The probe caught method has been extensively validated in numerous studies that have tracked mind wandering that require sustained amounts of attention, working memory tasks, and reading. We chose the alternative self-caught method to circumvent the possibility that the probing during reading because (1) we were interested in the metacognitive awareness of mind wandering and (2) the
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probe caught method limits the instances and the locations where mind wandering could be detected. Second, while Stawarczyk et al. (2011) considered the distinction between TRIs and TUTs while reporting mind wandering during an attention task, Massicampo and Baumeister (2011) did not distinguish between these types of off-task thoughts during reading. Unlike the previous studies, the current study asked participants to make this distinction when reporting mind wandering during reading. Third, we asked participants to simply list goals or “immediate plans” as opposed to reflecting on how to achieve their goals prior to a task as was done in both the Stawarczyk et al. (2011) and the Masicampo and Baumeister study (2011). We did this because we were interested in whether or not reflecting on goals related to the immediate future (i.e., current concerns) would have an influence on mind wandering during reading as the current concerns hypothesis suggests. Lastly, we compared our immediate plans condition to a control condition where the task did not involve goals (i.e., list components of an automobile). As stated above, the lack of significant mind wandering differences between conditions in the Masicampo and Baumeister (2011) could have been because all participants were asked to focus on either completed or not completed goals.

2. Method

2.1 Participants

One-hundred forty college students from a private Midwestern university (n = 98) and a public university in the southern United States (n = 42) participated for partial course credit (62% female; average age = 20.2 years). There was no statistical age difference between the two schools (private $M = 19.65$; public $M = 21.25$), $t(137) = .51, p = .61$. There were no statistical differences between the two population regarding the gender ratio (private $M = 65%$ female; public $M = 57%$ female), $t(137) = .82, p = .44$. The sample size was selected in an attempt to
detect a moderate effect of condition \((f = .25)\) with a statistical power of .80 and a two-tailed alpha of .05. The G*Power (Faul, Erdfelder, Lang, & Buchner, 2007) was used for the requisite computation.

2.2 Materials

2.2.1 Text

The reading task involved reading an excerpt from a book on a scientific topic which there would likely be little familiarity. The excerpt was taken from a book entitled *Soap-bubbles and the Forces which Mould Them* (Boys, 1895). The text contained roughly 5700 words taken from the first 35 pages of the first chapter of the book. All images were removed as well as any reference to the images within the text after assuring that this did not impede comprehension. Beyond these modifications, the text was exactly the same as the originally published version.

2.2.2 Measures.

Prior research has shown that negative mood can trigger mind wandering (Smallwood, Fitzgerald, Miles, & Phillips, 2009). Placing the focus on any individual plans may foster a state of anxiety, which is a negative affective state. To ensure that mood was not an extraneous variable, we measured affect both prior to and after the reading task with the Positive and Negative Affect Scale (PANAS; Watson, Clark, & Tellegen, 1988). The measure consisted of 20 words that describe different emotions. Participants rated the extent to which they felt that emotion on a scale of 1 (not at all) to 5 (extremely).

An experimenter generated posttest assessment was used to assess comprehension. The assessment consisted of twelve multiple choice questions regarding text content with four answer options: the correct answer and three foils\(^2\). See Appendix A for sample question.

\(^2\) Prior to the start of data collection the posttest was pilot tested on participants without prior exposure to the text and this resulted in chance performance.
2.3 Design and Procedure

All instructions and experimental materials were administered via computer. Participants were first given the following instructions regarding reporting mind wandering during reading: “Your primary task is to read the text in order to take a short test after reading.” Participants were then explicitly instructed to report a TRI while reading if they were “thinking about the task itself but not the actual content of the text.” Participants were asked to report a TUT if they were “thinking about anything else besides the task” (see Appendix B for full instructions). The instructions also emphasized that the participants should be as honest as possible when reporting mind wandering and that the results will have no influence on their scores on the test or their progress in the study. Participants were instructed to report mind wandering by pressing specific labeled keys on the keyboard.

Participants were then randomly placed in one of two list making conditions (i.e., IP or control conditions). Randomization was successful as there were no significant differences between groups with regard to age, \( t (137) = 1.01, p = .32 \), or gender, \( t (137) = 1.18, p = .24 \). Participants in the IP condition were instructed to “Please take a few minutes and think about your upcoming plans. In the space below please write out a ‘to do’ list of the things that you have to do in the next five days. Please try to be as complete as possible.” In the control condition, participants were instructed to “Please take a few minutes and think about your knowledge of the automobile. In the space below please write a list of the features that define a car. Please try to be as complete as possible and list as many features that you can think of.” Participants in both conditions were allotted three minutes to make their lists.

Participants then completed an assessment of affect by completing the PANAS (pre reading). Participants were then asked to read the text (57 pages with approximately 100 words
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per page) on a computer screen. Participants proceeded through the text by pressing the “right arrow” key, and self-reported their instances of mind wandering while reading. Participants could only navigate forward through the text. When they pressed a key to indicate mind wandering, a tone sounded to inform them that their response had been recorded. After the reading portion was completed, participants completed the post reading assessment of affect by completing the PANAS measure again. Lastly, participants completed the posttest comprehension assessment, upon which they were fully debriefed.

3. Results

Table 2 gives descriptive statistics by condition for key variables. All reported analyses are ANCOVAs and control for differences among sampled populations by using school identification as a covariate. All reported means are covariate adjusted and a two-tailed alpha of .05 is adopted. As recommended by Simmons, Nelson & Simonsohn (2011), we report the statistical information for analogous ANOVAs in Appendix C for each of the following ANCOVAs reported here. To alleviate any concerns that the covariate of school would interact with the independent variable of condition, the reported ANOVAs in Appendix C include school identification as grouping factor in addition to condition. There was only one instance where school and condition resulted in a significant interaction (see below). To address any concerns of any extraneous variables we first conducted a manipulation check and then considered other possible confounds.

3.1 Manipulation Check

All participants did comply with the instructions of the list making tasks for each of the conditions. Participants in the control condition produced lists of the components of a car. Those lists consisted of items such as brakes, tires, windows, and fender. Participants in the IP
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condition produced a “to do” list. Those lists consisted of items such as study for physics, get groceries, do laundry. We were specifically concerned that one condition would produce more items than in the IP condition because presumably it would be easier to list the car components compared to producing a “to do” list.

The control condition did produce significantly more items ($M = 19.40$, $SD = 7.6$) than the IP condition ($M = 11.83$, $SD = 4.7$), $F(1, 139) = 51.97$, $p < .001$, $MSE = 38.6$, $\eta^2 = .27$. As stated above, the analogous ANOVA is reported in Appendix C. For this analysis, there was a significant interaction between school identification and condition, $F(1, 139) = 5.18$, $p = .02$, $MSE = 37.3$, $\eta^2 = .03$. Both schools produced an equivalent amount of items in the control condition (public = 19.28, $SD = 1.3$; private 19.38, $SD = .89$), $F(1,136) = .005$, $p = .001$. The public school produced significantly fewer items in the IP condition (8.1, $SD = 3.1$) than the private school (13.35, $SD = 8.55$), $F(1,136) = 10.6$, $p = .001$. However, both of the populations produced significantly more items in the control condition vs. the IP condition (Public: $F(1,136) = 34.9$, $p < .001$; private: $F(1,136) = 23.78$, $p < .001$). To alleviate any possibility that this difference may have had an impact on attention during reading, the amount of items produced in the list making task was used as a covariate in all analyses.

3.2 Potential Confounding Variables

We then considered the results of the affect assessment. As discussed above, negative mood has been found to be associated with increased mind wandering (Smallwood et al., 2009). Placing participants in a context that focuses on their individual unfulfilled plans may foster a state of anxiety. To ensure that affect was not an extraneous variable, we measured affective state at two points: prior to reading immediately after the list making task and immediately after reading. The PANAS measure provided an indication of positive (Cronbach’s alpha: pre reading
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= .88; post reading = .85) and negative affect (Cronbach’s alpha pre reading = .82; post reading = .72). Scores were calculated for each participant by computing an average response score for both positive and negative affect prior to reading, but after the target manipulation (i.e., pre PANAS), and after reading the text (i.e., post PANAS). The computed score reflected the average response on a five point scale for items related to either positive or negative affect. Prior to reading, there was no significant difference of positive affect between the IP condition (M = 2.45, SD = .61) and the control condition (M = 2.35, SD = .83), F(1, 139) = .018, p = .89, MSE = 4.4, η² = .001. There was also no significant difference of negative affect, F(1, 139) = 1.16, p = .28, MSE = 1.6, η² = .001, (IP = 1.41, SD = .41, control = 1.34, SD = .39). An assessment of post reading PANAS scores produced similar results. There was not a significant difference of positive affect between the IP condition (M = 1.59, SD = .48) and the control condition (M = 1.51, SD = .56), F(1, 139) = .64, p = .43, MSE = 2.6, η² = .001. There was also no significant difference of negative affect, F(1, 139) = .09, p = .77, MSE = 1.5, η² = .001 (IP = 1.44, SD = .40, control = 1.41, SD = .38). Mood was not an extraneous variable; there were no differences between groups prior to reading, or after, for positive or negative affect.

We were also concerned that any differences in mind wandering may have been due to reading time differences between conditions. All participants read 57 pages with roughly 100 words on each page. On average, participants read for 28 minutes (control = 27.1, SD = 8.1, IP = 28.2, SD = 9.1) with no significant differences between conditions, F(1, 139) = 1.03, p = .31, MSE = 70.7, η² = .001. As such, reading time was not considered an extraneous variable.
3.3 Mind Wandering Reports

Participants reported mind wandering on an average of 18 pages. TUTs and TRIs were calculated and a proportion score was computed for each participant. Proportion scores reflected the number of instances of each type of report divided by the number of pages (i.e., 57)\(^3\).

There were significantly more reports of TUTs for the IP condition compared to the control condition, \(F(1, 139) = 10.03, p = .002, \text{MSE} = .02, \eta^2 = .07\). There was no significant difference between conditions for TRIs, \(F(1, 139) = 2.88, p = .09, \text{MSE} = .02, \eta^2 = .02\). Without controlling for the number of items produced during list making and school, the differences between conditions for TRIs were smaller (see Table 2) and the ANOVA was not close to reaching significance \((p = .20\); see Appendix C) suggesting that there was indeed no effect of condition on TRIs. Five participants did not report mind wandering. An analysis of the data after removing those participants produced similar results (TUT, \(F(1, 134) = 8.83, p = .004, \text{MSE} = .02, \eta^2 = .06\); TRI, \(F(1, 134) = 2.17, p = .14, \text{MSE} = .01, \eta^2 = .02\)). Thus, making the plans of the individual salient prior to reading increased the propensity to mind wander about thoughts unrelated to the task, but had no significant influence on task-related interferences.

3.4 Patterns of Mind Wandering Reports Over Time

The current concerns hypothesis does not make any predictions regarding the time course of mind wandering. However, we were interested in assessing the patterns of TUTs over time during reading. The text was dissected into four sections and TUTs were computed as a proportion of reports for each section. An ANCOVA revealed that there was a significant interaction between condition and text section, \(F(3,405) = 4.28, p = .005, \text{MSE} = .05, \eta^2 = .03\). Figure 1 illustrates the trends by condition. Post-hoc pairwise comparisons with a Bonferroni

\(^3\)Participants could self-report report multiple instances of mind wandering per page. Multiple self-reports for a single page was rare and when it did occur we only considered the initial report for the purposes of analysis.
adjusted alpha to correct for Type I error were used to assess differences between conditions (i.e., alpha of .05 divided by the number of comparisons (i.e., 4) = Bonferroni adjusted alpha of .0125). There was no difference of TUTs between conditions for the initial portion of the text ($F(1,135) = .482, p = .49, d = .007$), but there were more TUTs for those in the IP condition during the second ($F(1,135) = 10.64, p = .001, d = .44$), the third ($F(1,135) = 10.49, p = .002, d = .41$) and the fourth sections ($F(1,135) = 7.46, p = .007, d = .25$) when compared to the control condition. Initially, no differences in condition were observed for TUTs. Thus, it seems that over time the attention drifted from the task towards TUTs when the pre-task focus was directed towards the immediate plans of the individual. The same analysis of TRIs (see Figure 2) resulted in a non-significant interaction between condition and text section, $F(3,405) = .935, p = .42$, $MSE = .01, \eta^2 = .001$.

3.5 Comprehension Assessment

The control condition significantly outperformed the IP condition on the comprehension assessment, $F(1,139) = 5.24, p = .02, MSE = .03, \eta^2 = .04$. The overall reports of mind wandering were negatively and significantly correlated with performance on the comprehension measure ($r = -.23, p = .007$). The reports of TUTs were also significantly, negatively correlated with comprehension ($r = -.22, p = .008$). The reports of TRIs were negatively correlated with comprehension but not significantly ($r = -.16, p = .07$). These results are consistent with previous endeavors that have assessed mind wandering and comprehension. For example, Smallwood, McSpadden, and Schooler (2008) found a significant negative correlation between overall instances of off-task thoughts and a reading comprehension assessment ($r = -.28$).

As reported above, placing participants in a context that makes their individual plans salient has a negative direct effect on comprehension. We conducted a mediation analysis to
assess the extent to which the relationship between context and comprehension is influenced by TUTs. The amount of TUTs that occurs during a task should have an indirect effect on this relationship because more TUTs would lead to lower comprehension (see Figure 3). That is, producing a list of individual plans should influence the occurrence of TUTs during reading which would then influence comprehension. The method proposed by Preacher and Hayes (2004, 2008) suggests that the requirement to demonstrate that mediation is present is to test the significance of the indirect effect by using a bootstrapping method. This method is a more powerful alternative to the traditional Baron and Kenny (1986) method that is traditionally used to assess the significance of mediation (Hayes, 2009). Unstandardized indirect effects were computed for each of 5000 bootstrapped samples using the PROCESS macro for SPSS (Preacher & Hayes, 2004; 2008). The relationship between condition (control = 0, IP = 1) and performance on the comprehension assessment was mediated by task-unrelated thoughts. As Figure 3 illustrates, the standardized regression coefficient between condition and TUTs ($a = .09, p = .002$) was statistically significant as was the standardized regression coefficient between TUT and comprehension ($b = -.22, p = .03$). The standardized indirect effect of $a \times b$ was -.01 with a 95% confidence interval of -.048 to -.003. According to Preacher and Hayes, the fact that the CI does not overlap zero is taken as evidence for a significance indirect effect. Therefore, the relationship between condition and comprehension was mediated by TUTs.

4. Discussion

The current concerns hypothesis suggests that the content of mind wandering is likely to be consumed with thoughts related to unfulfilled goals of the individual (Klinger, 1999; Smallwood, 2010, 2013). Previous research has shown that it is possible to manipulate the content of mind wandering (i.e., temporal focus) by influencing the mental focus of the
individual prior to a task (Smallwood et al., 2009; Stawarczyk et al., 2011). However, the pre-task manipulations of those studies did not have an influence on the overall amount of mind wandering. McVay and Kane (2013) did manipulate mind wandering by cuing the current concerns of the individual during an attention task, but the magnitude of the differences between conditions was rather small (see Table 1) and the primary task (i.e., SART) was altered to be made personally relevant to the individual. Taking a different approach from prior studies, we were interested in increasing the amount of task-unrelated thoughts (TUTs) that occur during reading. To do this, we placed individuals in a context where the focus was on their upcoming plans (i.e., current concerns), and compared the occurrence of mind wandering to a control condition. Our experimental design differed from previous studies that intended to manipulate mind wandering in that (1) we employed a self-caught methodology as opposed to the standard probe-caught method, (2) we distinguished task-unrelated thoughts and task related interferences during reading, and (3) we attempted to manipulate mind wandering by asking to focus on current concerns (i.e., immediate future goals) prior to a reading task without asking for plans to complete the goals and compared to a condition were goals were not made salient.

Our first major finding was that the focus on the individual plans (IP) influenced the types of thoughts that occurred such that there was a higher propensity to report thinking about TUTs for the IP condition compared to a control condition ($d = .64$). There was not a significant difference between the two conditions for the reports of TRIs. When the focus, prior to reading, is placed on plans of the individual (which include unfulfilled goals) these thoughts become highly salient in the baseline or default network and become prevalent when attention drifts from the reading. This suggests that the act of priming current concerns prior to reading may have acted to attract attention away from the task towards the internally generated thought. The
analysis of the patterns of mind wandering over time provides further support for this idea by illustrating that the occurrence of TUTs was higher for the IP condition compared to the control condition after the initial portion of the task. The finding that the beginning of the text produced no differences between conditions regarding the amount of TUTs is potentially due to the nature of starting a new task in that the novelty of the reading task initially reduced or eliminated any potential difference between conditions. The differences manifested as the reading continued and those in the IP condition eventually exhibited a higher propensity to shift attention away from reading.

In line with previous mind wandering research (Feng et al., 2013 Schooler et al., 2004; Smallwood et al., 2008; Szpunar et al., 2013), our data also show that mind wandering was associated with poor comprehension. For those in the IP condition, increased reports of TUTs were related to lower comprehension scores. The participants in the control condition, who were not made to think about their individual plans prior to the task, performed better on the comprehension assessment ($d = .46$). The test of the indirect effects showed that the TUTs mediated the relationship between considering future plans and comprehension.

To our knowledge, this is the first experiment to successfully manipulate the occurrence of mind wandering during reading and to show the mediating effect of mind wandering on the relationship between focusing on the current concerns of the individual and reading comprehension. Considering that mind wandering has been found to be detrimental to learning in many scenarios (Szpunar et al., 2013), it would be beneficial to identify situations that would promote more learner engagement by reducing the propensity to mind wander.

This experiment was not without limitations. We selected reading material that was outdated and that the readers would likely not be familiar with. This may have inflated mind
wandering reports especially considering that participants read for roughly half of an hour. This was similar to a real-world context in that it is often the case where learners are asked to read texts on unfamiliar topics. However, future research would benefit from investigations that use alternate materials with the current design. An additional limitation is that this experiment does not reveal the content of mind wandering thoughts beyond the distinction of task-unrelated thoughts and interferences. It would be beneficial for future research to investigate precisely how thinking about current concerns influences the types of thoughts that occur during a task such as reading. Furthermore, the influence of current concerns, as it was defined here, is related to personal goals. It would be informative for future research to investigate whether the current concerns hypothesis extends beyond goals to other concerns such as things that have happened in the immediate past that could still be concerning (i.e., poor grade on an exam recently). Lastly, this experiment took place in a laboratory setting. It would be interesting for future investigations to incorporate this design in other naturalistic settings to assess the ecological validity of the influence of mind wandering.

In conclusion, it is not uncommon for people to generate “to do” lists or think about the immediate future. In fact, it is highly probable that our baseline or default thought activity is directed towards goals that need to be accomplished (Spreng et al., 2010). Our data show how this simple, everyday task influences mind wandering during a reading. We are not claiming that this is the cause of all instances of mind wandering. We do, however, take stock in the claim that this is one possible mechanism that results in an increased amount of task-unrelated thoughts, at least with the materials used for this experiment.
Acknowledgements

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Table 1.

*Estimated effect sizes for studies that assessed mind wandering differences between experimental and control conditions.*

<table>
<thead>
<tr>
<th>Study</th>
<th>Manipulation</th>
<th>Effect Sizes</th>
<th>Total N</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>McVay and Kane (2013)</td>
<td>Personalized vs. non-personalized SART</td>
<td>$d = .23^*$</td>
<td>251</td>
<td>SART</td>
</tr>
<tr>
<td>Smallwood et al. (2011)</td>
<td>Pre-task: Rate self vs. no rating</td>
<td>$d = .14$</td>
<td>28</td>
<td>CRT</td>
</tr>
<tr>
<td>Stawarczyk et al. (2011)</td>
<td>Pre-task: List current project along with plans for completion vs. list directions</td>
<td>$d = .04$</td>
<td>46</td>
<td>SART</td>
</tr>
<tr>
<td>Masicampo &amp; Baumeister (2011)</td>
<td>Pre-task: List tasks that need completion and:</td>
<td></td>
<td></td>
<td>Reading</td>
</tr>
<tr>
<td></td>
<td>-Plan vs. Control</td>
<td>$d = .34$</td>
<td>73</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-No plan vs. Control</td>
<td>$d = .17$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: SART = Sustained Attention to Response Task; CRT = Choice Reaction Time Task
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Table 2

Average proportion of mind wandering reports (overall and by type) and comprehension performance by condition (with standard deviations in parentheses).

<table>
<thead>
<tr>
<th></th>
<th>Covariate Adjusted Mean</th>
<th>Unadjusted Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Individual Plans (N = 71)</td>
<td>Control (N = 69)</td>
</tr>
<tr>
<td>Mind Wandering Reports</td>
<td>.38 (.23)</td>
<td>.25 (.23)</td>
</tr>
<tr>
<td>Task Unrelated Thought (TUT)</td>
<td>.22 (.15)</td>
<td>.13 (.15)</td>
</tr>
<tr>
<td>Task Related Interference (TRI)</td>
<td>.16 (.12)</td>
<td>.12 (.12)</td>
</tr>
<tr>
<td>Comprehension Assessment</td>
<td>.46 (.18)</td>
<td>.54 (.18)</td>
</tr>
</tbody>
</table>

Note: All covariate adjusted means are adjusted for school identification and the number of items produces during the list making tasks.
Figure 1. Average proportion of task-unrelated thought (TUTs) for each section of the text by condition with error bars representing 95% confidence intervals. All reported means are covariate adjusted for school identification and the number of items produces during the list making task.
Figure 2. Average proportion of task-related interference (TRIs) for each section of the text by condition with error bars representing 95% confidence intervals. All reported means are covariate adjusted for school identification and the number of items produces during the list making task.
Figure 3. Standardized regression coefficients for the relationship between condition placement and comprehension as mediated by reports of task-unrelated thoughts. Condition is coded as: 0 = control condition and 1 = IP condition.
Appendix A

Example comprehension question

1. The suggestion that there is an Etruscan vase in the Louvre that depicts children blowing bubbles from a pipe was put forth by:

   a. Lord Rayleigh

   b. Van der Mensbrugghe

   c. Millais

   d. Plateau
Appendix B

Mind wandering instructions for both conditions

We have an excerpt from a book called "Soap Bubbles: Their Colors And The Forces That Mold Them" by the author C.V. Boys. The text will be displayed page by page and you can press the "right arrow key" to navigate through the text. Your primary task is to read the text in order to take a short test after reading. At some points during reading, you may realize that you have no idea what you just read. Not only were you not thinking about what you are actually reading, you were thinking about something else altogether. This is called "zoning out." If you catch yourself zoning out at any time during reading, please indicate what you are thinking about at that moment during reading.

When zoning out:
If you are thinking about the task itself (e.g., how many pages are there left to read, this text is very interesting) or how the task is making you feel (e.g., curious, annoyed) but not the actual content of the text, please press the key that is labeled "task".

OR

If you are thinking about anything else besides the task (e.g., what you ate for dinner last night, what you will be doing this weekend) please press the key that is labeled "other". Please familiarize yourself with where these two keys on the keyboard now so that you will know their location when you begin reading.

Please be as honest as possible about reporting zoning out. It is perfectly natural to zone out while reading. Responding that you were zoning out will in no way affect your scores on the test or your progress in this study, so please be completely honest with your reports. If you have any questions about what you are supposed to do, please ask the experimenter now. Please press the right arrow key to begin.
Appendix C

ANOVA results for all analogous reported ANCOVA.

<table>
<thead>
<tr>
<th>Analysis</th>
<th>ANOVA Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item Production during list making</td>
<td>$F(1, 139) = 58.1, p &lt; .01, \text{MSE} = 37.4, \eta^2 = .27$</td>
</tr>
<tr>
<td>PANAS Positive Pre Reading</td>
<td>$F(1, 139) = .35, p = .55, \text{MSE} = 4.5, \eta^2 = .001$</td>
</tr>
<tr>
<td>PANAS Negative Pre Reading</td>
<td>$F(1, 139) = .54, p = .46, \text{MSE} = 1.6, \eta^2 = .001$</td>
</tr>
<tr>
<td>PANAS Positive Post Reading</td>
<td>$F(1, 139) = .09, p = .77, \text{MSE} = 2.6, \eta^2 = .001$</td>
</tr>
<tr>
<td>PANAS Negative Post Reading</td>
<td>$F(1, 139) = .05, p = .82, \text{MSE} = 1.5, \eta^2 = .001$</td>
</tr>
<tr>
<td>Reading Times</td>
<td>$F(1, 139) = 1.2, p = .28, \text{MSE} = 74.1, \eta^2 = .008$</td>
</tr>
<tr>
<td>TUTs (N = 140)</td>
<td>$F(1, 139) = 5.4, p = .02, \text{MSE} = .02, \eta^2 = .04$</td>
</tr>
<tr>
<td>TRIs (N = 140)</td>
<td>$F(1, 139) = 1.69, p = .20, \text{MSE} = .01, \eta^2 = .01$</td>
</tr>
<tr>
<td>TUTs (N = 135)</td>
<td>$F(1, 134) = 5.46, p = .02, \text{MSE} = .02, \eta^2 = .04$</td>
</tr>
<tr>
<td>TRIs (N = 135)</td>
<td>$F(1, 134) = 1.64, p = .20, \text{MSE} = .01, \eta^2 = .01$</td>
</tr>
<tr>
<td>TUT Patterns Over Time</td>
<td>$F(3,405) = 4.88, p = .01, \text{MSE} = .01, \eta^2 = .03$</td>
</tr>
<tr>
<td>Pairwise Section 1</td>
<td>$F(1,137) = .001, p = .98, d = .001$</td>
</tr>
<tr>
<td>Pairwise Section 2</td>
<td>$F(1,137) = 9.12, p &lt; .01, d = .57$</td>
</tr>
<tr>
<td>Pairwise Section 3</td>
<td>$F(1,137) = 6.18, p &lt; .01, d = .49$</td>
</tr>
<tr>
<td>Pairwise Section 4</td>
<td>$F(1,137) = 2.95, p = .08, d = .33$</td>
</tr>
<tr>
<td>TRI Patterns Over Time</td>
<td>$F(3,411) = .364, p = .78, \text{MSE} = .01, \eta^2 = .001$</td>
</tr>
<tr>
<td>Comprehension Assessment</td>
<td>$F(1,139) = 3.95, p = .05, \text{MSE} = .03, \eta^2 = .03$</td>
</tr>
</tbody>
</table>