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Can I get me out of my head? Exploring strategies for controlling the self-referential aspects of the mind-wandering state during reading

Jet G. Sanders[a], Hao-Ting Wang[a], Jonathan Schooler[b] and Jonathan Smallwood[a]

[a]The Department of Psychology, York Neuroimaging Centre, University of York, Heslington, York, UK; [b]Department of Psychological Brain Sciences, University of California, Santa Barbara, California, USA

ABSTRACT
Trying to focus on a piece of text and keep unrelated thoughts at bay can be a surprisingly futile experience. The current study explored the effects of different instructions on participants' capacity to control their mind-wandering and maximize reading comprehension, while reading. Participants were instructed to (a) enhance focus on what was read (external) or (b) enhance meta-awareness of mind-wandering (internal). To understand *when* these strategies were important, we induced a state of self-focus in half of our participants at the beginning of the experiment. Results replicated the negative association between mind-wandering and comprehension and demonstrated that both internal and external instructions impacted on the efficiency of reading following a period of induced self-focus. Techniques that foster meta-awareness improved task focus but did so at the detriment of reading comprehension, while promoting a deeper engagement while reading improved comprehension with no changes in reported mind-wandering. These data provide insight into how we can control mind-wandering and improve comprehension, and they underline that a state of self-focus is a condition under which they should be employed. Furthermore, these data support component process models that propose that the self-referent mental contents that arise during mind-wandering are distinguishable from those processes that interfere with comprehension.

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Component processing; Comprehension; Implementation intentions; Mind-wandering; Reading; Self-generated thought

Reading for knowledge, or for pleasure, is a universal aspect of the human condition, and yet it is often hard to prevent our thoughts from straying from the words on the page. Multiple studies, from many different laboratories, have shown that our tendency to mind-wander while we read can derail our comprehension of events in the narrative (e.g., Feng, D'Mello, & Graesser, 2013; McVay & Kane, 2012; Schooler, Reichle, & Halpern, 2004; Smallwood et al., 2013; Smallwood, McSpadden, & Schooler, 2008; Unsworth & McMillan, 2013; Varao Sousa, Carriere, & Smilek, 2013) Consequently, it is important to understand the conditions that make the self-relevant mental content we generate during mind-wandering while reading common, and to understand the strategies that we can engage to reduce the negative consequences of the experience (Schooler et al., 2011; Smallwood & Schooler, 2015).

One hypothesis is that although mind-wandering may compromise our capacity to simultaneously perform complex tasks such as reading, its content reflects the expression of thoughts that have personal relevance to the individual (Smallwood, 2013a). For example, content analysis suggests that individuals engage in thoughts of themselves in the future during mind-wandering and that these can be oriented towards personal goals (e.g., Baird, Smallwood, & Schooler, 2011). Moreover, focusing an individual on emotional or self-relevant material is known to increase the tendency for the mind to

CONTACT Jet G. Sanders jgs514@york.ac.uk Department of Psychology, University of York, Heslington, York YO10 5DD, UK
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wander (Smallwood et al., 2011; Stawarczyk, Majerus, & D'Argembeau, 2013; Stawarczyk, Majerus, Maj, Van der Linden, & D'Argembeau, 2011). Finally, studies have shown an association between social problem solving and the mind-wandering state (Ruby, Smallwood, Sackur, & Singer, 2013; Stawarczyk et al., 2011). Together, these results can be adequately accounted for by the *current concerns hypothesis*—the notion that the mental content that we generate while we mind-wander reflects attempts to make progress on personal goals that are unduly active due to our personal circumstances (Klinger, 2009, 2013; Linder et al., 2013).

Although mind-wandering may reflect conscious attempts to make sense of who we are, its deleterious consequences on reading mean that it is important to understand how the occurrence of the state can be reduced. Contemporary accounts suggest that the adverse aspects of mind-wandering reflect the competition between intrinsic and extrinsic sources of information for limited conscious resources (Smallwood, 2013a). In this view, mind-wandering is a state in which our attention becomes *decoupled* from the words on the page and directed instead to information that is self-generated by the individual. This component process account (Andrews-Hanna, Smallwood, & Spreng, 2014; Smallwood, 2013a, 2013b) argues that understanding the mind-wandering state depends on distinguishing the processes that determine the mental content that occurs when we mind-wander (known as *self-generation*) and those that determine the consequences of the state for the integrity of an external task (referred to as *perceptual decoupling*, Smallwood, 2013a).

Based on this component processes view, there are two basic strategies that could influence the occurrence of mind-wandering during reading. One strategy would be to increase the priority that an individual assigns to the information by increasing the integrity of the situation model that the individual creates while reading (Zwaan & Radvansky, 1998). Situation models reflect the overall model of the narrative that readers build while they read and facilitate comprehension by provides a top-down model that helps readers to place events in the wider narrative context. Alternatively, it may be possible to reduce the priority that an individual assigns to the mind-wandering state through meta-cognitive strategies that allow a person to exert control over the content of their thoughts (Mrazek, Franklin, Phillips, Baird, & Schooler, 2013; Schooler, 2002). This could be achieved by asking participants to monitor consciousness to detect the occurrence of self-generated thoughts that are unrelated to the act of reading and to set them aside if and when they arise.

The current study

We set out to understand the effectiveness of these different strategies for controlling mind-wandering during reading and to explore the conditions under which they are most useful. To create a situation in which the self is highly salient, we manipulated an individuals' level of self-focus prior to reading. Half of the participants were asked to rate a set of personality adjectives with respect to themselves (a condition we refer to as *self-priming*), whereas the others were asked to rate whether the same adjectives were applicable to David Cameron, the (then current) UK prime minister (a condition to which we refer as *other-priming*). Based on prior studies, we expected self-priming to create a stronger incidental memory (Rogers, Kuiper, & Kirker, 1977; Symons & Johnson, 1997). Periods of self-reference increase levels of mind-wandering (Smallwood et al., 2011), and analysis of the content of the experience suggests that it is often focused on the self (Baird et al., 2011; Ruby et al., 2013). Based on these lines of evidence that indicate that self-focus is important to mind-wandering, we hypothesized that priming due to the self might create conditions when mind-wandering is more likely to require control and under which the impact of interventions may be more important.

Next, participants were assigned to one of three instruction conditions: (a) an *external* condition in which we emphasized the need to build a coherent model of what was read, (b) an *internal* condition which emphasized the need to monitor attention to identify the occurrence of mind-wandering and set it aside if it occurs and (c) a *control* condition containing no instructions. Following engagement in one of these three conditions, all participants read a series of factual texts in which we assessed their comprehension and collected data on any mind-wandering that occurred. Finally, we asked our participants to complete a surprise memory test for the words they had rated at the start of the session. This final step allowed us to assess whether there was a relationship between the strength of priming (e.g., the magnitude of the incidental memory for the words), the extent of mind-wandering experienced, and comprehension of what was read. We were particularly interested in whether these three variables were changed either by the priming or the strategies to control mind-wandering that this study explored. The protocol used in this experiment is presented in Figure 1.

Experimental study

Method

Participants

Ninety-six undergraduate students (42 males) participated in this experiment. Sixty-nine percent of the participants were paid, all others received course credits. The mean age of the sample was 20.1 ($SD = 2.0$; range = 18–29) years. Individuals were allocated to different conditions (based on instructions and prime type) using a counterbalanced design. Each condition contained the same number of participants ($n = 16$). Three participants were excluded, as they performed below chance on their memory for the incidental prime.

Procedure

Participants were informed that the experiment entailed reading two texts and subsequently answering comprehension questions on the texts, as well as number of other tasks. The reading element of the experiment was paper-and-pencil-based to ensure a naturalistic reading experience. The other aspects of the experiment were computer-based. Measures of mood were recorded at four time points across the session, and measures of mind-wandering were taken at two points, after reading each text and by self-catching during the reading (see measures for further details). Participants were guided through the experiment using a detailed instruction booklet to limit interaction with the experimenter. On average, the experiment took 37 (±15) min.

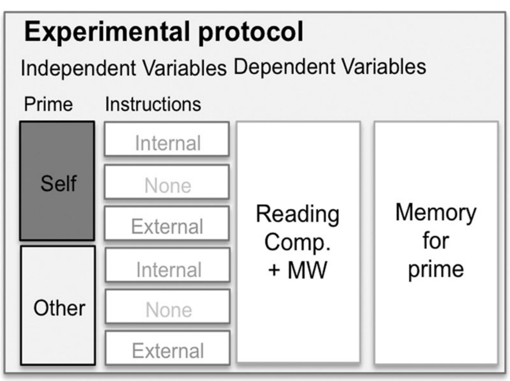

Figure 1. Schematic diagram of the experimental protocol. Participants were allocated to relate a series of personality adjectives to themselves (self) or to others (David Cameron), a manipulation that was intended to vary the participants' state of self focus. Next, participants were instructed to try to monitor their thoughts to detect the occurrence of mind-wandering and to set such thoughts aside (internal) or to link together the paragraphs that they were reading to build a coherent model of the text (external). A third group received no instructions. Participants read two factual texts during which both comprehension and mind-wandering were measured. Finally, participants were given a surprise memory test to ascertain the extent to which the strength of the priming stimuli had been memorized. MW = Mind-wandering.

Measures

Self-focus induction. To explore the conditions under which different reading instructions were effective in reducing mind-wandering and enhancing comprehension, we created a state of self-focus in half of the participants by asking them to assess whether a set of adjectives related to them or not (*self-prime*). The other half of the participants assessed the same adjectives in relation to a familiar other (in this case David Cameron) as a control (*other-prime*). Adjectives were presented sequentially on-screen, and participants were required to indicate whether each adjective applied to a particular referent by pressing "Y" with the index finger of the right hand for "yes' or "N" with the index finger of the left hand for "no". Stimuli were separated by interstimulus intervals of 2500 ms during, which participants were shown a blank screen with a fixation cross. Participants were presented with a list of 18 unique adjectives presented in a random order. All words were selected from a pool of normalized personality trait adjectives with meaningfulness and likeability ratings (Anderson, 1968). Positive, negative, and neutral adjectives with the highest meaningfulness rating were selected for this experiment.

Reading instructions. All participants were provided with reading instructions, which reminded them that they were about to read two texts about which they would be asked questions.

The instructions also allocated participants to an *internal* or an *external* instruction condition. We based our instructions on the notion of implementation intentions (Gollwitzer, 1999). Implementation intentions are a set of if–then rules that participants can employ to enhance their capacity to regulate their behaviour; they have been shown to be effective in improving health (Verplanken & Faes, 1999), regulating negative emotion (Hallam et al., 2015), and increasing exercise (Hallam et al., 2015). In the *internal* condition participants were urged to follow the rule: "If my mind is wandering, then I will stop myself and refocus my attention to the text!" In the *external* condition participants were urged to follow the rule: "As soon as I get to the end of a paragraph, I will summarize it and relate it to the next one!" There was also a control condition, where instructions contained neither of these rules. The instructions detailed that if participants caught themselves drifting off while reading, they were to circle the word in the text where they noticed this happening. Participants read two of four texts used, counterbalanced in terms of both order and across participants. A transcription of the instructions is as follows:

Reading Instructions

We would like you to read two texts. Remember—after you have finished reading both texts you will be asked questions on the content of the texts, both of a factual and comprehensive nature.

During reading, you might notice your mind-wandering to topics other than the text. The aim of this experiment is for you to pay close attention to your thoughts, to try to notice when your mind wanders, stop yourself and focus your thoughts on the text again. [Remember the rule like this: *Insert internal rule or external rule depending on the participant condition; remove for control condition.*]

Also, if you catch yourself drifting off or having drifted off from the text; please circle the word on the text where you noticed this happening.

If you have questions, now is the best time to ask, if not please turn to page 4 to continue.

Texts and comprehension questions. The four texts were selected and shortened from Bill Bryson's *A Short History of Everything* (Smallwood et al., 2013), printed on paper in font size 14, 1.5 spacing. Each participant read one on the topic of chemistry, and one on the topic of geology (mean word count = 1039, range = 885–1064). The order of texts was counterbalanced. After responding to a retrospective mind-wandering measure, participants were asked to answer 17 open-ended comprehension questions per topic, to test for acquired knowledge of each text, without being able to refer back to the texts (Smallwood et al., 2013; see measures). Comprehension questions were each rated for accuracy by two experimenters. Inter-rater reliability was high (Cronbach's $\alpha = .96$). Inter-text reliability for performance on the comprehension questions was also high (Cronbach's $\alpha = .74$).

Mind-wandering measure. The New York Cognition Questionnaire (NYC–Q) is a self-report tool used to assess mind-wandering behaviour. Specifically, it assesses thoughts and feelings experienced during the performance of a particular task. The first section contains 22 questions about the content of thoughts, rated on a scale of 1 (*Completely did not describe my thoughts*) to 9 (*Completely did describe my thoughts*). The second section contains 8 questions about the forms thoughts take, rated on a scale of 1 (*Completely did not characterize my experience*) to 9 (*Completely did characterize my experience*; Gorgolewski et al., 2014). The questionnaire was administered twice, after reading each text. For the current paper we limited our analysis to the 22 questions relating to the content of mind-wandering, creating an overall average for each participant for both texts they read. Mind-wandering was measured using NYC-Q score and a self-catching score. Rates of self catching were correlated with the NYC-Q ($r = .37$, $p < .001$) and zero order correlations of both were negative correlates of reading ($r = -.31$, $p < .005$; $r = -.32$, $p < .005$), hence these measures were averaged to create a single mind-wandering metric for each participant. However, see footnote 1 for separated analyses.

Incidental memory for the prime. Next, participants completed a surprise memory test regarding the adjectives used in the priming phase. Participants were shown words sequentially and were asked whether or not that particular item had been presented in the previous phase. This retrieval phase contained all the words presented previously, plus an equal number of new words. Items were presented in a random order, and participants had to press either "Y" if they thought the word had appeared before or "N" if they thought it was a new word. Answers were self-paced. Correct memory for each referent was calculated by subtracting the relative number of false alarms from the total number of correctly retrieved items.

Mood. To assess mood at four points throughout the experiment, participants provided answers to the following questions: 1. How aroused/excited do you currently feel? On a fine graded scale from 0 (*I don't feel at all aroused, I feel completely calm*) to 10 (*I feel *completely aroused, I don't feel calm at all*). 2. How would you describe your current feelings? On a fine graded scale from 0 (Absolutely negative) to 10 (Absolutely positive; Russell, Weiss, & Mendelsohn, 1989).

Pre-existing knowledge check. Participants were also asked to complete a questionnaire on pre-existing knowledge of chemistry and geology, by stating their previous education in years in either subject and by rating their experience of the content on a fine-graded scale 0–10.

Results

Mood and pre-existing knowledge check

We observed no significant change in arousal levels over the testing period using a repeated-measures analysis of variance (ANOVA) [$F(1.65, 155.01) = .84$, $p = .418$, Mean Time 1 = 3.18, Time 2 = 3.20, Time 3 = 3.40, Time 4 = 3.29], but there was a significant reduction in positivity over the duration of the session [$F(1.72, 154.72) = 7.09$, $p < .01$, Mean mood at Time 1 = 6.70, Time 2 = 6.58, Time 3 = 6.49, Time 4 = 6.25]. Pre-existing knowledge of the text topics did not significantly differ across conditions on any of the measures [years of education: $M = 8.49$, $SD = 1.83$, $F(5, 85) = 1.32$, $p = .262$; years of chemistry education: $M = 3.73$, $SD = 1.88$, $F(5, 85) = .96$, $p = .448$; years of geology education: $M = .27$, $SD = 1.00$, $F(5, 85) = 1.36$, $p = .250$; self-rating knowledge of chemistry $M = 4.04$, $SD = 2.67$, $F(5, 85) = .67$, $p = .644$; self-rating knowledge of geology: $M = 2.49$, $SD = 2.03$, $F(5, 85) = .47$, $p = .796$].

Comprehension

Our first analysis considers the impact of priming and instructions on the comprehension of the material that was read. We conducted a univariate ANOVA in which the dependent variable was mean comprehension (*z*-scored). Priming (self/other) and instructions (internal, external, control) were included as categorical between-participant fixed factors. To control for experiential differences across conditions, we *z*-scored the participants' memory for the primes, as well as their overall mind-wandering rates, and we included these as covariates in the model.[1]

This analysis revealed two significant effects. First, we found a negative relationship between mind-wandering levels as the covariate in the model and comprehension, $F(1, 83) = 15.386$, $p < .001$. Consistent with prior research, higher levels of mind-wandering were associated with lower levels of comprehension [$r = -.35$, $p = .001$]; as shown in Figure 2(a). We also observed a Priming × Instruction effect, $F(2, 83) = 3.098$, $p = .05$. This is presented in Figure 2(b). To follow up this interaction, we conducted a further univariate analysis focusing only on the two experimental groups and found a significant Prime × Instruction interaction, $F(1, 54) = 5.715$, $p = .02$. There was no effect of priming in the control condition, $F(1, 54) = .286$, $p = .597$. Next, we split the sample based on priming condition and found that for individuals who focused on the self, an effect of instruction type approached significance, $F(1, 24) = 4.158$, $p = .053$, where comprehension was lower following the internal conditions than the external conditions. There was no effect of instructions on comprehension following other-priming, $F(1, 28) = 2.34$, $p = .137$. Finally, there was no significant difference between the individuals allocated to the self-priming external condition and the self-priming no-instruction condition ($p = .250$) indicating that the external condition did not improve comprehension above the level associated with no instructions.

Self-referential processing

Our next analysis considered the relationship between the priming and instruction conditions on one of the aspects of the experiment incidental to the reading task: the memory for the primes (*z*-scored). We used a between-subject ANOVA to look at memory for the prime with both priming [self/other] and instruction [internal/external/control] as between-participant factors. Mean comprehension (*z*-scored) was included as a continuous between-participant factor to control for overall differences in comprehension across the conditions.

This analysis revealed a significant main effect of comprehension, $F(1, 84) = 4.25$, $p = .042$, indicating that comprehension scores are a positive predictor of memory for the prime. The analysis also shows a significant main effect of prime type, $F(1, 84) = 4.55$, $p = .036$, and a significant Prime type × Instruction interaction, $F(2, 84) = 3.59$, $p = .032$, on memory for the prime. Separate ANOVAs on each of the instruction types indicate that the observed difference is driven by the internal instruction condition, since memory for the prime was significantly higher for self-primed than for other-primed participants, $F(1, 26) = 9.319$, $p = .005$, while no significant differences between memory for prime between the self- and other- prime were observed in

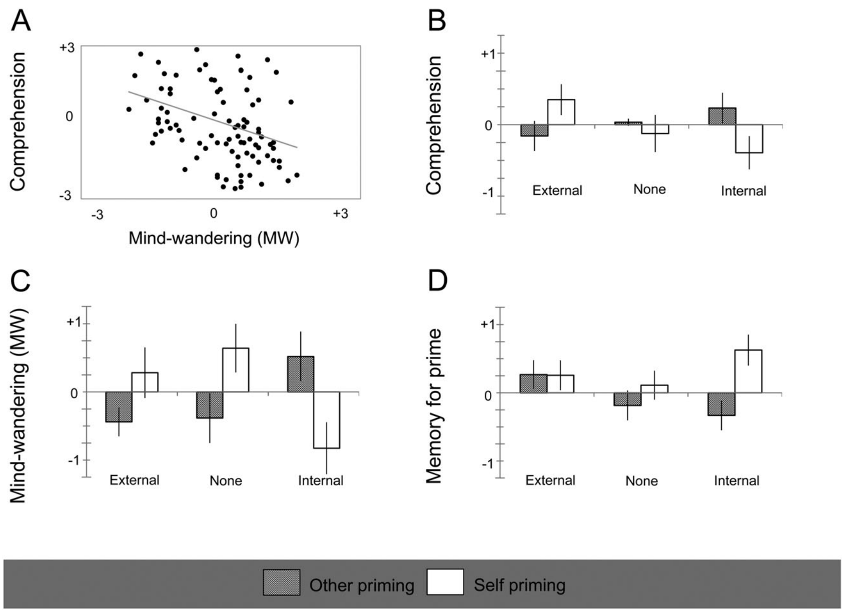

Figure 2. Reading comprehension, mind-wandering, and memory for the prime (*z*-scored) measured during a mindless reading task. (a) Correlation between MW and reading comprehension. (b) Reading comprehension separated by prime type and reading instruction (internal, none, external). Higher numbers indicate better performance. (c) MW score separated by prime type and instructions. Higher scores indicate increased mind-wandering. (d) Memory for the prime separated by prime type and reading instructions. Higher scores indicate better performance. MW = Mind-wandering.

the external, $F(1, 28) = 1.703$, $p = .203$, and the no-instruction condition, $F(1, 28) = .818$, $p = .374$. Looking at each prime type separately, there was no main effect of instruction in the self-prime condition, $F(2, 39) = 1.319$, $p = .279$. There was a main effect of instruction in the other-prime condition, $F(2, 41) = 3.54$, $p = .037$, where reported mind-wandering was higher in the external instruction than in the other two conditions (external: $M = .269$; None: $M = -.324$; internal: $M = -.476$). A comparison of the parameter estimates indicated that self-priming showed no association for memory for the primes ($\beta = -.353$, $t = -1.08$, $p = .293$).

Mind-wandering

Next we considered the relationship between the priming and instruction conditions on the amount of mind-wandering that participants reported, as another incidental aspect of the reading task. We used a between-subjects ANOVA to look at mind-wandering with both priming [self/other] and instruction [internal/external/control] as between-participant factors. Mean comprehension (*z*-scored) was included as a continuous between-participant factor to control for overall differences in comprehension across the conditions.

We observed a significant main effect of comprehension, $F(1, 84) = 15.383$, $p < .001$, indicating that comprehension was a negative predictor of levels of mind-wandering (see comprehension section). We also observed a significant Priming × Instructions interaction, $F(2, 84) = 6.226$, $p = .003$. To follow up this interaction, we conducted separate ANOVAs on the participants in the control, internal, and external conditions. This revealed no main effect of prime on mind-wandering in the control condition, $F(1, 28) = 3.96$, $p = .056$, or the external condition, $F(1, 29) = 1.865$, $p = .183$, but a significant main effect of prime in the internal condition, $F(1, 26) = 9.395$, $p = .005$, where self-primed participants reported significantly lower effects of mind-wandering than did other-primed participants. We also conducted an ANOVA in which we excluded the external instructions condition. This revealed a Priming × Condition interaction, $F(2, 54) = 4.163$, $p < .05$. Post-hoc tests indicated that following self-priming, individuals allocated to the internal condition reported less mind-wandering than did those who were primed about the self but were given no instructions ($p < .03$). This indicates that the internal monitoring condition led to less mind-wandering following self-priming than when participants were given no instructions (i.e., the control condition).

Finally, we examined whether mind-wandering and, in particular, its relationship to the process of priming varied systematically across the session. We conducted a repeated-measures ANOVA in which we compared whether reports of mind-wandering increased across the session. Analysis by text shows no significant difference between the first NYC-Q questionnaire filled out and the second, $F(1, 83) = 0.41$, $p = .840$, indicating that this measure was relatively consistent across sessions.

General discussion

This study explored the utility of different strategies in controlling mind-wandering and whether their effectiveness varied in relation to the level of self-focus that a participant had prior to reading. We considered the effectiveness of strategies that strengthened a participants' model of the text (external) and instructions that fostered a processes of introspective meta-awareness of experience (internal). In addition to replicating prior work highlighting the negative impact of mind-wandering on comprehension (Feng et al., 2013; McVay & Kane, 2012; Schooler et al., 2004; Smallwood et al., 2013; Smallwood et al., 2008; Unsworth & McMillan, 2013; Varao Sousa et al., 2013), we found that, following a period of self focus, strategies fostering meta-awareness reduced reports of mind-wandering but did not yield an improvement in comprehension. These findings have practical implications for how we can effectively limit the consequences of mind-wandering during reading, as well theoretical implications for how to understand the self-generated thoughts that occur when we mind-wander.

Our results suggest that the way that different types of strategies impact on different aspects of the reading experience is complex. We found that asking participants to be attentive to their thoughts was effective for reducing mind-wandering levels following periods of heightened self-focus. These findings suggest that being attentive to one's thoughts can be helpful in reducing the occurrence of mind-wandering, although our data suggest that this is not accompanied by improved comprehension. In fact, relative to participants who were asked to link together different sections of the text to form a stronger model, instructions to monitor thoughts led to significantly worse comprehension.

Prior work using mindfulness training over a two-week period has been shown to reduce mind-wandering, improve comprehension (Mrazek et al., 2013), and enhance certain meta-cognitive skills (Baird, Mrazek, Phillips, & Schooler, 2014). On the basis of these findings, it might have been expected that encouraging meta-awareness of mind-wandering would have similarly enhanced reading comprehension. It is possible that the discrepancy between the current findings and this prior work arises from the fact that monitoring cognition while reading acts as an additional task load, reducing available capacity for comprehension. Plausibly this is why the meditative tradition trains the process of meta-awareness in contexts where there is no explicit external task (e.g., concentrating on one's breath). Indeed, attempts at cognitive control when under load are known to frequently backfire (Wenzlaff & Wegner, 2000). Importantly, poor comprehension is not the only negative consequence of mind-wandering: an excessive focus on self-generated thoughts rather than the events in the moment can also lead to lower levels of happiness and reduced well-being (Killingsworth & Gilbert, 2010; Smallwood, Fitzgerald, Miles, & Phillips, 2009; Smallwood & O'Connor, 2011; Smallwood, O'Connor, Sudbery, & Obonsawin, 2007). Although our study cannot determine whether the longer term consequences of meta-cognitive strategies for reducing mind-wandering translate into less detrimental mind-wandering as a whole, it seems plausible that if enhancing meta-cognitive awareness decreases the amount of mind-wandering, it could help to break the cycle that links an excessive focus on self-generated thoughts with sustained levels of unhappiness (Schooler et al., 2011).

These data highlight important theoretical issues relevant to our understanding of the mind-wandering state, and particularly its self-relevant basis. The current hypothesis (Klinger, 2009, 2013; Linder et al., 2013) suggests that there is an intimate relationship between our conception of who we are and the mind-wandering state; this is consistent with studies that have shown that priming self relevant information increases mind-wandering (Smallwood et al., 2011; Stawarczyk et al., 2011). Consistent with this view, both instruction conditions led to the greatest impact on reading behaviour following self-priming. We also found a trend [$p = .08$] towards greater mind-wandering in the baseline condition under the same conditions. These data, in conjunction with prior studies (e.g., Smallwood et al., 2011; Stawarczyk et al., 2011), highlight that conditions with a heightened focus on the self are often associated with higher levels of mind-wandering. This association is consistent with work arguing for a link between self-regulation and mind-wandering, especially in terms of its content. It also suggests that states of excessive self-focus may constitute a *context* when regulating the mind-wandering may be especially important (see the context regulation hypothesis, Smallwood & Andrews-Hanna, 2013; Smallwood & Schooler, 2015).

The mind-wandering state, like other forms of higher-order thought, such as semantic cognition (e.g., Noonan, Jefferies, Corbett, & Ralph, 2010; Visser, Jefferies, & Ralph, 2010), is hypothesized to depend on a number of different component processes (Smallwood, 2013a, 2013b; Smallwood & Schooler, 2015). Our prior work had highlighted neurocognitive evidence for a distinction between the processes that underlie experiential aspects of mind-wandering and those responsible for comprehension (Smallwood et al., 2013). We found that participants who reported a more complete experiential focus on the text had greater connectivity between the medial prefrontal cortex and a large region of the left temporal lobe during the resting state. These regions of left temporal cortex have a well-documented role in semantic processing (Noonan et al., 2010; Visser et al., 2010). By contrast, effective comprehension of material from the text was associated with stronger connectivity between the posterior cingulate cortex and the right insula cortex, a region important in controlling the so-called default mode network (Bonnelle et al., 2012). Building on this work, the current experiment provides further evidence that these two aspects of the reading experience are dissociable: internal instructions impacted on the experience of mind-wandering while not improving the participants' comprehension. Evidence that the comprehension deficits that occur when the mind wanders can be dissociated from the processes involved in the self-generation of thoughts themselves through the engagement of different psychological strategies demonstrates the need for component process accounts of the mind-wandering state that can explain the distinct neurocognitive processes responsible for the subjective experience of mind-wandering and its negative consequences on task performance. It is often assumed in the literature that negative consequences of mind-wandering arise through the process of perceptual decoupling, which decreases external attention (e.g., Schooler et al., 2011). The data from this study are consistent with this hypothesis, since they show that differential effects emerge from different types of interventions.

Finally, an unexpected finding was the observation that attending to one's thoughts increased memory for the incidental prime if the items had been encoded in terms of their self-relevance. Interestingly, a recent study found that 8 weeks of Mindfulness Based Stress Reduction training led to better meta-cognitive accuracy for episodic memory for items from long-term memory (Baird et al., 2014). Our finding of enhanced self-memory in the internal condition may reflect a short-term example of the same enhanced accuracy for memory. Importantly, the process of assessing self-relevance, and of effective meta-cognition for information from memory, depends on a similar neural network that is anchored in medial aspects of the pre-frontal and cingulate cortex and regions of dorsal parietal cortex (Baird, Smallwood, Gorgolewski, & Margulies, 2013; Kelley et al., 2002; Macrae, Moran, Heatherton, Banfield, & Kelley, 2004). Together, these data provide converging neuro-cognitive support for the hypothesis that fostering meta-awareness may elicit some of its effects through enhancement of the accuracy of episodic memory. As the self-generated thoughts that arise when the mind wanders depend heavily on episodic memory for their content (Smallwood et al., 2011), fostering meta-awareness could provide control over the wandering mind because it provides insight into the memorial cues that cause the mind to wander. Gaining such insight may not increase our capacity to simultaneously perform complex tasks in the moment (such as reading). It may, however, provide a better understanding of the processes through which our thoughts are generated, which may, in the long run, allow an individual to set appropriate strategies for regulating these experiences to maximize their benefits and minimize their costs.

Note

1. Analysis of the effect of NYC-Q score on comprehension levels highlights a significant main effect of mind wandering, $F(1, 83) = 16.111$, $p < .001$, and a interaction effect approaching significance between prime and instruction type, $F(2, 83) = 2.680$, $p = .074$. Analysis of self-catching score (*z*-scored separately) highlights a significant main effect of mind-wandering on comprehension, $F(1, 84) = 6.037$, $p = .016$, and a trending interaction effect between prime and instruction, $F(2, 83) = 1.981$, $p = .144$. Moreover, both measures of mind-wandering yielded highly comparable results (NYC-Q: self-prime: external $M = .142$, none $M = .306$, internal $M = -.488$; other-prime: external $M = -.235$, none $M = -.112$, internal $M = .260$;

self-catch: self-prime: external $M = .311$, none $M = .419$, internal $M = -.510$; other-prime: external $M = -.187$, none $M = -.244$, internal $M = .099$) and were correlated, $r = .417$, $p < .001$, Hence the analysis in the body of the text uses and reports the sum of both measures.

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