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The more your mind wanders, the smaller your attentional blink: An individual differences study

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The more your mind wanders, the smaller your attentional blink: An individual differences study

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The present studies investigate the hypothesis that individuals who frequently report experiencing episodes of mind wandering do so because they *under-invest* attentional/executive resources in the external environment. Here we examined whether self-reported instances of mind wandering predict the magnitude of the "attentional blink" (AB) in a rapid serial visual presentation (RSVP) task, since a prominent view is that the AB derives from an *over-investment* of attention in the information stream. Study 1 demonstrates that subjective reports of mind wandering in a sustained attention task have a negative predictive relation with respect to the magnitude of the AB measured in a subsequent RSVP task. In addition, using the Spontaneous and Deliberate Mind Wandering Questionnaire in Study 2, we were again able to show that trait-level mind wandering in everyday life negatively predicts AB magnitude. We suggest that mind wandering may be the behavioural outcome of an adaptive cognitive style intended to maximize the efficient processing of dynamic and temporally unpredictable events.

Keywords: Attention; Mind wandering; Attentional blink.

Imagine a squirrel intently focused on locating a hidden cache of much-needed food—an endeavour that no doubt requires great effort and concentration. If, however, the squirrel is too absorbed in the task of locating the buried food, it may fail to notice the looming shadow of a hawk above; a potentially costly mistake. This example illustrates that it is often necessary to distribute the focus of our attention in the world around us in a way that allows both the successful pursuit of current goals, while also allowing us to effectively perceive and deal with upcoming events. In the present work we consider the hypothesis that individual differences in mind wandering are diagnostic of the degree of attentional/executive resources one typically invests in the external world. Specifically, we examine the possibility that a propensity towards mind wandering may be symptomatic of a tendency to prevent over-investment of attention in any one event, a cognitive style that supports "fluid" interactions with a world that is inherently complex and dynamic.

One leading theoretical account of mind wandering suggests that both on- and off-task thoughts compete for a common limited pool of executive/attentional resources (Smallwood, 2011; Smallwood & Schooler, 2006). As resources are directed internally, attention becomes "decoupled" from the external environment, resulting in an overall "dampening" of perceptual processing of both task-relevant and task-irrelevant information (Barron, Riby, Greer, & Smallwood, 2011).

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Others have suggested however that mind wandering stems from failures in attentional control processes required to inhibit intrusive off-task thoughts (McVay & Kane, 2010). In fact, these views may not be mutually exclusive as it has recently been argued that episodes of mind wandering may arise in the first place due to failures in executive control, but that once initiated, these episodes consume attentional resources needed for the primary task (Smallwood, 2013). Consequently, mind wandering has been found to be detrimental to performance in a host of real-world tasks such as reading (Smallwood, McSpadden, & Schooler, 2008), remembering (Maillet & Rajah, 2013; Thomson, Smilek, & Besner, 2014), and driving (He, Becic, Lee, & McCarley, 2011), as well as laboratory tasks such as sustained attention-to-response tasks (McVay & Kane, 2009), rhythmic responding tasks (Seli, Cheyne, & Smilek, 2013), and Flanker interference tasks (Thomson, Seli, Besner, & Smilek, 2014). Furthermore, higher instances of reported mind wandering have been negatively linked with working memory capacity (McVay & Kane, 2009) and general mood (Killingsworth & Gilbert, 2010). Although some research has linked mind wandering with creative incubation and problem solving (Baird et al., 2012; Baird, Smallwood, & Schooler, 2011), it is clear that the vast majority of research to date indicates that mind wandering has primarily negative consequences for cognition and behaviour (or no observable consequences at all; see Thomson, Besner, & Smilek, 2013).

Given that mind wandering is argued to derive from either a withdrawal of attentional resources from the primary task (Smallwood, 2010; Smallwood & Schooler, 2006), or failures in attentional control, it stands to reason that individuals with a greater tendency towards mind wandering invest fewer attentional resources and/or impart less attentional control in the external environment *in general*. Here we explore the idea that there may be situations in which a certain amount of under-investment or decrease in control can be advantageous. One such situation may be performance in a rapid serial visual presentation task (RSVP) in which participants must typically attend to a stream of distracters (digits) and watch for two serially presented targets (letters), denoted T1 and T2. It has been shown that the correct identification of T2 suffers greatly when it occurs too closely to T1 in the stream; the so-called "attentional blink" (AB; Raymond, Shapiro, & Arnell, 1992).

One prominent account of the AB states that it derives from an over-investment of attentional resources in T1 that temporarily makes those resources unavailable for T2 processing (see Shapiro, Raymond, & Arnell, 1997; see also Dux & Marois, 2009 for reviews). Alternatively, others have suggested that the AB derives from an over-investment of attentional control in T1 that prevents the identification of subsequent stimuli while T1 is being consolidated into memory (Taatgen, Juvina, Schipper, Borst, & Martens, 2009; see also Martens & Wyble, 2010, for a review). As a result, it has been argued that if attentional investment (either via "resources" or "control") in the RSVP stream can be reduced, the AB should be attenuated. Consistent with this, attenuation of the AB has been observed when participants are given a concurrent mental load (Olivers & Nieuwenhuis, 2005), a secondary task to perform (Taatgen et al., 2009), or are simply instructed to focus less on the task (Olivers & Nieuwenhuis, 2006). Similarly, presenting the RSVP stream amidst distracting, task-irrelevant perceptual information (i.e., moving dots) also results in a smaller AB (Arend, Johnston, & Shapiro, 2006). As a result, there is mounting evidence that experimental manipulations can be successful in reducing the AB, to the extent that controlled processing and/or attentional resource investment is reduced with respect to the RSVP stream.

We posit that, compared to infrequent mind wanderers, frequent mind wanderers chronically under-invest attention in the external environment (that is, they invest fewer resources, impart less control over thought content, or both), which may prevent over-investment of attention to the information stream in the context of the RSVP task. Consequently, we predict that frequent mind wanderers will exhibit a *smaller* AB relative to infrequent mind wanderers. Some recent evidence for this hypothesis comes from work showing that individual differences in mind wandering propensity has been shown to positively predict distraction by task-irrelevant stimuli (Forster & Lavie, 2014), indicating that mind wandering may be symptomatic of a broader tendency to distribute attention more broadly in the environment.

In what follows we report two studies. In Study 1 we measure mind wandering during a sustained attention task using the probe-caught method (see Smallwood, McSpadden, & Schooler, 2007; Smallwood & Schooler, 2006), while in Study 2 we measure trait-level mind wandering in everyday life using a questionnaire (Carriere, Seli, & Smilek, 2013) that can distinguish between spontaneous and deliberate forms of mind wandering. In both studies, we assess whether individual differences in mind wandering predict the magnitude of the AB in an RSVP task. Again, we predict that a propensity towards task-unrelated thought (mind wandering) may index the general level of attentional investment in the external environment at an individual difference level. As a result, higher reports of trait-level mind wandering should index a lower level of attentional investment. To the extent that the AB derives from an over-investment of attention towards the information stream, higher reports of trait-level mind wandering should predict a smaller AB.

STUDY 1

The purpose of Study 1 is to assess whether subjective reports of mind in a sustained attention task in the laboratory predict the magnitude of the AB in a subsequent rapid serial visual presentation (RSVP) task. Hu, He, and Xu (2012) found that reports of mind wandering to thought probes embedded in a Sustained Attention to Response Task (SART; Robertson, Manly, Andrade, Baddeley, & Yiend, 1997) predicted performance in the Attention Network Task (ANT; Fan, McCandliss, Sommer, Raz, & Posner 2002). Consequently, we make use of this technique here to investigate the possible relation between individual differences in the propensity to engage in mind wandering and the magnitude of the AB.

Method

Participants

The participants consisted of 121 undergraduates at the University of Waterloo (48 male, 73 female) who all provided informed consent and took part in exchange for course credit.

Stimuli and procedure

The experimental program was written in Python (http://www.python.org) and presented using PsychoPy software (Peirce, 2007). The experiment was run on a Mac Mini computer with a 2.40 GHz processor connected to a 24 inch Phillips 244E LCD monitor, placed at an approximate viewing distance of 57 cm.

Sustained Attention to Response Task (SART)

We designed this task in accord with Robertson et al. (1997). The SART consisted of 450 trials on which a single digit (1–9) was presented in the centre of the monitor for 200 ms, after which a mask consisting of a # was presented for an additional 900 ms. Each digit was presented 50 times. The digit presentation was randomly assigned to one of five font sizes (120, 100, 94, 72, and 48 point). The participants' task was to press the spacebar as quickly as possible upon presentation of each digit *except* the digit "3", in which case they were to withhold their response. Prior to the experimental session, participants completed a 20-trial practice block, after which they were given feedback on their performance.

Throughout the task, pseudo-randomly presented thought probes appeared. These thought probes required participants to indicate whether, just prior to the onset of the probes, their attention was focused on or off the task. Written definitions of on and off task were as follows:

> On task: Just prior to the probe, your attention was firmly directed towards the task. Off task: Just prior to the probe, you were aware of things other than the task; you were thinking of something completely unrelated to what you were doing.

Participants indicated an "on-task" response by pressing the "z" key and an "off-task" response by pressing the "m" key. Following this, there was a 500 ms blank interval before the SART resumed. Thought probes were presented throughout the task with the constraints that no probes were encountered within the first 15 trials and that probes were separated by a minimum of 20 intervening trials. There were 20 thought probes in total.

Rapid Serial Visual Presentation (RSVP) task

We designed this task in accord with Jefferies, Smilek, Eich, and Enns (2008). On each trial, participants were confronted with a stream of distracters (digits 0–9) in which two targets (letters excluding I, Q, O, Z) were embedded. Each trial began with the presentation of 8–14 distracters prior to the presentation of the first target (henceforth T1). Following T1, a second target (henceforth T2) was presented, either immediately afterwards (i.e., Lag 1), after an additional distracter (Lag 2), after 2 additional distracters (Lag 3), and so on, up to a maximum of 7 additional distracters (Lag 8). T2 was presented at each lag equally often (20 times at each lag for a total of 160 trials). Following T2, there was a final distracter. Each item (targets and distracters) was presented for 83 ms, followed by a 17-ms blank inter-stimulus-interval. Following each trial, participants were required to identify the two letters that appeared in the preceding stream (T1 and T2) in any order by typing the target identities into the keyboard and pressing "enter". Following this, a fixation-cross appeared until the participant pressed space bar to initiate the next trial.

Results

Sustained Attention to Response Task (SART)

Participants failed to initiate a response on an average of 1.5% (SE = .17%) of non-target trials (errors of omission), and they failed to withhold a response on an average of 43.2% (SE = 2.2%) of target trials (errors of commission). Mean correct response time (RT) for non-target trials was 379 ms (SE = 9 ms). Mean percentage of off-task reports in response to the thought probes was 40.6% (SE = 2.0%). In order to assess the relation between SART performance and self-reported mind wandering, a Pearson correlation matrix was computed that included: mind wandering rates, errors of commission, errors of omission, and correct Log RT, which we transformed to account for the non-normality of the RT distribution (see Table 1). These analyses revealed a significant association between commission errors and Log RT, $r = -.746$, $p < 001$, replicating the previously reported effects of speeding on accuracy in the SART (e.g., Peebles & Bothell, 2004; Seli, Cheyne, Barton, & Smilek, 2012). There was also a significant correlation between commission errors and mind wandering rates, $r = .231$, $p = .011$, as well as omission errors and mind wandering rates, $r = .193$, $p = .034$.

Rapid Serial Visual Presentation (RSVP) task

In the following analyses, we analyse T1 accuracy and T2 accuracy given that T1 was correctly

Table 1. *Pearson correlations assessing relations among commission errors, omission errors, transformed correct response time (Log RT) and mind wandering in the SART in Study 1 (N = 121)*

	Commission	*Omission*	*Log RT*	*Mind wandering*
Commission	–	.414**	−.746**	.231*
Omission	–	–	−.084	.193*
Log RT	–	–	–	.022
Mind wandering	–	–	–	–

Note: *correlation is significant at the .05 level (2-tailed).
**correlation is significant at the .001 level (2-tailed).

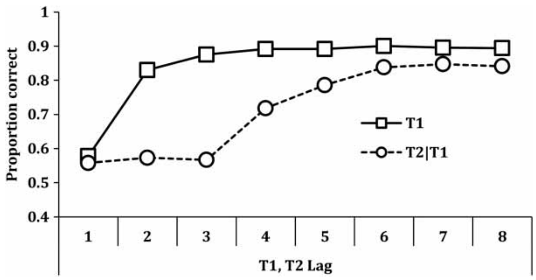

Figure 1. *Proportion of correctly identified targets for the first target in the RSVP stream (T1) and the second target in the stream, given that the first target was correctly identified (T2|T1) in Study 1. Proportion correct for the two target types is shown at each Lag. Error bars represent one standard error of the mean.*

identified (i.e., T2|T1). We analysed T2 accuracy given accurate identification of T1 because if T1 was incorrectly identified then there is no evidence that it was attended to and, consequently, no blink can be expected. In order to assess target identification accuracy for T1 as a function of Lag, mean proportion correct for each participant was entered into an analysis of variance (ANOVA) that treated Lag (1, 2, 3, 4, 5, 6, 7, 8) as a within-subject factor. This analysis revealed a significant main effect of Lag, F (7, 840) = 182.91, $p < .001$, $\eta_p^2 = .60$. As can be seen in Figure 1, this main effect on T1 accuracy is driven by the fact that T1 performance remains consistently high from Lag 2 onwards, but is quite low at Lag 1. Similarly, in order to assess target identification accuracy for T2|T1, mean proportion correct was submitted to an identical ANOVA. This analysis revealed a significant main effect of Lag, F (7, 840) = 138.29, $p < .001$, $\eta_p^2 = .54$. As can be seen in Figure 1, this main effect on T2|T1 accuracy is driven by the fact that performance starts off quite low and does not recover until around Lag 6; the well-known AB.

RSVP performance as a function of mind wandering in the SART

Our central question here concerns whether individuals' self-reported frequency of task-unrelated thought (mind wandering) during performance on the SART predicts the magnitude of those individuals' AB. The AB is measured as the deficit in correct identification of T2|T1 at short relative to long Lags (Cousineau, Charbonneau, & Jolicoeur, 2006; see also Maclean & Arnell, 2012 for a review of this method of measuring the AB). To this end, we quantify the magnitude of the AB here as the difference in proportion correct for T2|T1 at Lag 2 relative to Lag 8. The mean AB was .27 (SE = .017). To assess the relation between mind wandering during the SART and the magnitude of the AB in the RSVP task, a Pearson correlation was computed relating the proportion of "off-task" reports during the SART to the AB obtained from the RSVP task. A scatterplot of this relation is shown in Figure 2. Importantly, this correlation was significant, $r = -.20$, $p = .028$, indicating that (as per our hypothesis) higher subjective reports of mind wandering predict a smaller AB. In order to assess whether the smaller AB observed for mind-wandering-prone individuals came entirely at the expense of T1 processing, we also correlate mean T1 accuracy in the RSVP task with off-task reports in the SART. Specifically, if high mind wanderers "ignored" T1 then one would expect a small AB (if any), and thus performance could not be said to be "better" for the high mind wanderers relative to the low mind wanderers if they simply traded off T1 accuracy for T2 accuracy. This is unlikely to be the case however, since a guessing strategy with respect to T1 identity would yield a T1 accuracy of only 4.5% (well below what was observed and displayed in Figure 1). This conclusion is supported by the finding of a non-significant correlation

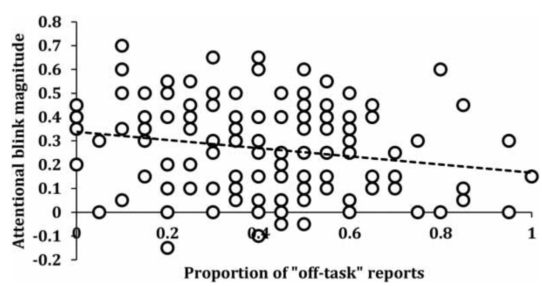

Figure 2. *A scatterplot depicting the relation between the proportion of "off-task" reports to thought probes that were embedded in the SART and the magnitude of the AB measured in the RSVP task in Study 1. The dotted line depicts the best linear fit to the data.*

between T1 accuracy and mind wandering ($r = -.14$).

Discussion

The purpose of Study 1 was to assess the relation between subjective reports of off-task thought in the laboratory and the magnitude of the AB. We found that individual differences in the propensity to report being off task in a SART negatively predicted the costs associated with the detection of the second of two targets in a subsequent RSVP task. Given that the propensity to engage in mind wandering in a given task context is argued to depend on the amount of attentional investment in the primary task (Smallwood & Schooler, 2006, 2010), we reasoned that individual differences in the propensity to engage in mind wandering might reflect individual differences in attentional investment in the external environment *in general*. Given that the AB is argued to reflect an *over*-investment of attention in the RSVP stream, we reasoned that mind-wandering-prone individuals might exhibit a *smaller* AB than mind-wandering-averse individuals. The results of Experiment 1 are consistent with this hypothesis.

Our measure of mind wandering in Experiment 1 relied upon "in the moment" responses to periodically presented thought probes. While this has been done in previous work as a means of obtaining a general trait measure of mind wandering propensity (Hu et al., 2012), we sought to replicate and extend our findings in an additional experiment in which mind wandering is measured using a trait-level measure that can distinguish between different forms of mind wandering: mind wandering that occurs despite one's intention to focus on the task at hand ("spontaneous" mind wandering), and mind wandering that one wilfully engages in ("deliberate" mind wandering).

STUDY 2

The purpose of Study 2 was twofold: (1) to replicate the novel findings of Study 1 in which individuals with a propensity to engage in mind wandering exhibit a smaller AB, and (2) to examine whether this relation is largely driven by a propensity towards spontaneous mind wandering, deliberate mind wandering, or both. Spontaneous mind wandering encompasses task-unrelated thought that occurs despite the intention to remain focused on a particular task (or train of thought), that is, mind wandering that is "uncontrolled" (Carriere et al., 2013). In comparison, deliberate mind wandering encompasses task-unrelated thoughts that are initiated deliberately, and/or are allowed to continue once initiated. To this end, rather than using probe-caught measures of mind wandering as in Study 1, in Study 2 we used the Mind Wandering Spontaneous (MW:S) and Mind Wandering Deliberate (MW:D) questionnaires (Carriere et al., 2013) as a means of measuring individual differences in trait-level mind wandering. We hypothesize that, once again, individuals with higher subjective reports of trait-level mind wandering will exhibit a smaller AB in the RSVP procedure. It is an open question as to whether this relation will manifest for both spontaneous and deliberate mind wandering propensity.

Method

Participants

The participants consisted of 102 undergraduates at the University of Waterloo (12 male, 90 female), who all provided informed consent and took part in exchange for course credit.

Stimuli and procedure

Participants completed the RSVP task in an identical manner to that in Study 1, with the following exception: only Lags of 2, 4, 6, and 8 were employed, thus reducing the length of the task by half. This was done primarily because the results of Study 1 confirmed that the AB effect can be adequately measured using performance at Lags 2 and 8, and that no difference in T1 and T2|T1 accuracy is observed at Lag 1. We therefore removed the conditions that were unnecessary for the intended analyses (retaining only two "short" and two "long" Lags), thus reducing the burden on the participants. The task therefore consisted of a total of 80 trials (20 at each Lag) and lasted approximately 15 minutes.

Trait measures of mind wandering were obtained using the Mind Wandering Spontaneous and Deliberate Questionnaires (MW:S and MW:D respectively, as per Carriere et al., 2013). These questionnaires were completed online together with other subjective report measures as part of a mass-testing research participation component that was available for all eligible undergraduates at the University of Waterloo and was completed prior to any in-lab experiment participation in the Fall term of 2013. Only participants who had completed the MW:S and MW:D portions of the mass testing battery were eligible to participate in the present study. MW:S and MW:D scores were obtained retrospectively from the mass testing database after all in-lab data collection was completed. Each mind wandering questionnaire consists of four questions and participants are required to rate how relevant each statement is to them personally on a scale from one to seven. These can be seen in the Appendix.

Results

Rapid Serial Visual Presentation (RSVP) task

As in Study 1, we analyse T1 accuracy and T2 accuracy given that T1 was correctly identified (i.e., T2|T1). In order to assess target identification accuracy for T1 as a function of Lag, mean proportion correct for each participant was entered into an ANOVA that treated Lag (2, 4, 6, 8) as a within-subject factor. This analysis revealed no main effect of Lag, ($F < 1$) on T1 accuracy. In order to assess target identification accuracy for T2|T1, mean proportion correct was submitted to an identical ANOVA. This analysis revealed a significant main effect of Lag, $F\ (3,\ 303) = 117.49$, $p < .001$, $\eta_p^2 = .54$. As can be seen in Figure 3, this main effect on T2|T1 accuracy is driven by the fact that performance starts off quite low at Lag 2 and does not recover until around Lag 6; the well-known AB.

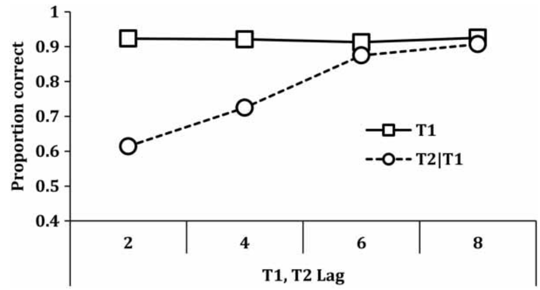

Figure 3. *Proportion of correctly identified targets for the first target in the RSVP stream (T1) and the second target in the stream, given that the first target was correctly identified (T2|T1) in Study 2. Proportion correct for the two target types is shown at each Lag. Error bars represent one standard error of the mean.*

Table 2. *Pearson correlations assessing relations among attentional blink (AB) magnitude and spontaneous and deliberate mind wandering (MW:S and MW:D) scores, as well as trait mind wandering (average of spontaneous and deliberate scores) in Study 2 (N = 102)*

	AB	*MW;S*	*MW;D*	*Trait MW*
AB	–	−.280**	−.145	−.274**
MW;S	–	–	.233*	.807***
MW;D	–	–	–	.762***
Trait MW	–	–	–	–

Note: *correlation is significant at the .05 level.
**correlation is significant at the .01 level.
***correlation is significant at the .001 level.

RSVP performance as a function of mind wandering

Our central question is whether individuals' self-reported frequency of task-unrelated thought (mind wandering) on the spontaneous and deliberate questionnaires predicts the magnitude of these individuals' AB. In order to address this question, we again quantify the AB as the difference in proportion correct for T2|T1 at Lag 2 relative to Lag 8. The mean AB was .29 (SE = .019). We next computed Pearson correlations to assess the relation between self-reported mind wandering on the questionnaire and the magnitude of the AB in the RSVP task. We included the MW:S and MW:D separately in the analyses but also combined them in a composite score by averaging the MW:S and MW:D scores for each participant

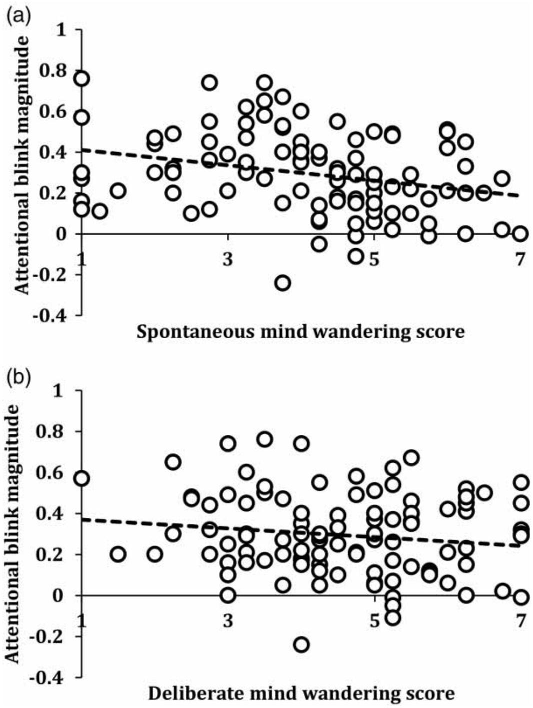

Figure 4. *Scatterplots depicting the relation between the mind wandering scores obtained from the Spontaneous (A) and Deliberate (B) Mind Wandering Questionnaires and the magnitude of the AB measured in the RSVP task in Study 2. The dotted lines depict the best linear fit to the data.*

(creating a Trait MW score). The correlations are shown in Table 2. As can be seen in the table, spontaneous (MW:S) but not deliberate (MW:S) scores negatively predicted AB magnitude, $r = -.28$, $p = .004$, and $r = -.15$, $p = .147$, respectively. Thus, the overall correlation between trait mind wandering and AB magnitude is driven primarily by the relation between spontaneous mind wandering propensity and AB magnitude. Scatterplots depicting the relation between reported trait-level spontaneous and deliberate mind wandering and AB magnitude can be seen in Figure 4. Again, in order to assess whether the smaller AB observed for the mind-wandering-prone individuals came entirely at the expense of T1 processing, we correlated mean T1 accuracy with our measure of trait mind wandering (average of MW:S and MW:D). As in Study 1, this correlation did not reach significance ($r = .02$).

Discussion

Unlike in Study 1 in which mind wandering was measured using thought probes embedded into a sustained attention task, here we used a trait-level questionnaire that is able to differentiate between spontaneous and deliberate forms of mind wandering. The results were clear: trait-level mind wandering once again predicted the magnitude of the AB. That is, individuals who reported a greater propensity towards mind wandering in everyday life displayed *better* performance on the RSVP task than individuals who rarely reported engaging in mind wandering in everyday life. Interestingly, while the correlation between spontaneous mind wandering in everyday life and AB magnitude was significant, only a weak, non-significant relation between deliberate mind wandering in everyday life and AB magnitude was observed. Nonetheless, these results corroborate those of Study 1, that the way in which individuals invest temporal attention in the RSVP stream is predicted by their propensity to engage in mind wandering.

GENERAL DISCUSSION

The purpose of the work reported here was to test the hypothesis that individual differences in the tendency to engage in mind wandering would predict the magnitude of the AB in an RSVP task. Specifically, we predicted that a propensity towards mind wandering may be symptomatic of a general tendency to under-invest attention in the external environment (either by holding back "resources" as per Smallwood & Schooler, 2006, or by relaxing attentional control as per McVay & Kane, 2010). Given that the AB is argued to derive from an "*over*-investment" of attention in the processing stream, we reasoned that individuals with a greater tendency towards mind wandering would exhibit a smaller AB. In Study 1, when individual differences in mind wandering were measured using thought probes embedded in a sustained attention task, a significant negative relation was observed in the predicted direction. That is, higher reports of mind wandering predicted a smaller AB. In Study 2, when individual differences in mind wandering were measured using the Spontaneous and Deliberate Mind Wandering Questionnaire, higher reports of trait-level mind wandering once again predicted a smaller AB. In addition, we were able to further specify the nature of this relation where it was found that spontaneous, but not deliberate, mind wandering propensity drives the observed effect. These findings indicate that mind wandering propensity is predictive of the extent to which individuals invest attention over time, at least in the context of the RSVP task.

The association between mind wandering propensity and AB magnitude seen here fits nicely with at least one recent study in which experienced meditators were shown to exhibit a smaller AB when performing the RSVP task under "open" as opposed to "focused" attention meditation (van Vugt & Slagter, 2014). That is, meditators who allowed their attention to remain open to incoming events showed smaller T2 processing costs than when they focused intently on the items in the RSVP stream. It may therefore be the case that mind-wandering-prone individuals possess a trait-level tendency to engage with the world in an "open" attentional state, much in the way that practised meditators can train themselves to do wilfully. On the other hand, it has also been shown that adults with diagnosed Attention Deficit Hyperactivity Disorder (ADHD, characterized as a deficit in the exertion of controlled attention) show a larger AB than controls (Armstrong & Munoz, 2003). While this might seem at odds with the findings of the present study, the deficits in controlled attention experienced by mind-wandering-prone individuals and those with diagnosed ADHD likely differ markedly in severity. One can imagine that there is an optimal degree to which attention is flexibly deployed in the RSVP task (exhibited by mind-wandering-prone individuals and practised meditators) such that too much focus (exhibited by mind-wandering-averse individuals) or too little (as in the case of ADHD) is detrimental to performance. Examining these issues should be a focus of future research.

It has recently been argued that the sheer ubiquity of mind wandering implicates it as a form of adaptive cognition (Mooneyham & Schooler, 2013). Here we suggest that mind wandering may be the behavioural outcome of a cognitive style that serves to prevent individuals from "over-investing" in *particular* events in the environment, since over-investment can be severely detrimental to the processing of other (potentially critical) stimuli. Indeed, the ability to attend to relevant stimuli in the world, and yet also remain able to process other temporally contiguous information, seems equally important for successful interactions with a dynamic and changing environment. Importantly, while there are certainly individual differences in the extent to which attention is flexibly deployed, the present work indicates that the act of mind wandering may be related to such differences. Indeed, future work should examine other relations between trait-level mind wandering and performance in situations in which dynamic and fluid interactions with the perceptual environment are required. In fact, self-reports of mind wandering may not simply represent transient "lapses" of attention away from the task at hand, but may be indicative of differences in individuals' propensity to invest attentional resources in the external world in general.

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APPENDIX

Spontaneous and Deliberate Mind Wandering Questionnaires

Instructions: For the following statements please select the answer that most accurately reflects your everyday mind wandering:

Deliberate Mind Wandering Questionnaire

1. I allow my thoughts to wander on purpose.

Rarely	1	2	3	4	5	6	7	A lot

2. I enjoy mind wandering.

Rarely	1	2	3	4	5	6	7	A lot

3. I find mind wandering is a good way to cope with boredom.

Not at all True	1	2	3	4	5	6	7	Very True

4. I allow myself to get absorbed in pleasant fantasy.

Rarely	1	2	3	4	5	6	7	A lot

Spontaneous Mind Wandering Questionnaire

1. I find my thoughts wandering spontaneously.

Rarely	1	2	3	4	5	6	7	A lot

2. When I mind wander, my thoughts tend to be pulled from topic to topic.

Rarely	1	2	3	4	5	6	7	A lot

3. It feels like I don't have control over when my mind wanders.

Almost Never	1	2	3	4	5	6	7	Almost Always

4. I mind wander even when I'm supposed to be doing something else.

Rarely	1	2	3	4	5	6	7	A lot