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Cognitive aging and the distinction between intentional and unintentional mind wandering

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Abstract

A growing number of studies have reported age-related reductions in the frequency of mind wandering. Here, at both the trait (Study 1) and state (Study 2) levels, we re-examined this association while distinguishing between intentional (deliberate) and unintentional (spontaneous) mind wandering. Based on research demonstrating age-accompanied deficits in executive functioning, we expected to observe increases in unintentional mind wandering with increasing age. Moreover, because aging is associated with increased task motivation, we reasoned that older adults might be more engaged in their tasks, and hence, show a more pronounced decline in intentional mind wandering relative to young adults. In both studies, we found that older adults did indeed report lower rates of intentional mind wandering compared with young adults. However, contrary to our expectations, we also found that older adults reported lower rates of unintentional mind wandering (Studies 1 and 2). We discuss the implications of these findings for theories of age-related declines in mind wandering.

Keywords

Mind wandering; Aging; Deliberate; Spontaneous; Intentional; Unintentional

In recent years, there has been a considerable increase in the number of studies examining mind wandering, which is often defined as the drifting of one's attention from the external environment, inwardly, toward unrelated thoughts (see Smallwood & Schooler, 2015, for a review). One area of research in the literature on mind wandering that has garnered much attention concerns rates of mind wandering in aging populations. Research on this topic has now clearly established that older adults self-report *less* mind wandering than younger adults (e.g., Giambra, 1989; 1993; Grodsky & Giambra, 1990–91; Jackson & Balota, 2012; Krawietz, Tamplin, & Radvansky, 2012; for review, see Maillet & Schacter, 2016). However, this finding is rather striking given that results from numerous studies have suggested that (a) mind wandering is associated with poor executive control (e.g., McVay & Kane, 2009; McVay & Kane, 2010; McVay & Kane, 2012), and (b) aging is accompanied by various cognitive deficits, including deficits in working memory and executive functioning (see Foster, Cornwell, Kisley, & Davis, 2007, for a review). In light of these findings, rather than

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expect older adults to experience *less frequent* mind wandering than younger adults, one might expect older adults to experience *more frequent* mind wandering.

When considering the seemingly paradoxical finding that older adults report less mind wandering than younger adults, it is important to note that some researchers have distinguished between two types of mind wandering, and this distinction may provide important insights into the age-related declines in mind wandering. In particular, researchers have distinguished between intentional (deliberate) and unintentional (spontaneous) mind wandering (Forster & Lavie, 2013; Giambra, 1989; Grodsky & Giambra, 1990–91; Golchert et al., 2017; Seli, Carriere, & Smilek, 2015; Seli, Cheyne, Xu, Purdon, & Smilek, 2015; Seli, Smallwood, Cheyne, & Smilek, 2015; for a review, see Seli, Risko, Smilek, & Schacter, 2016). True to their names, whereas intentional mind wandering reflects the willful engagement of internally focused thoughts, unintentional mind wandering reflects the engagement in internally focused thoughts despite one's intentions to refrain from experiencing such thoughts. These two types of mind wandering are particularly relevant to examinations of the relation between mind wandering and aging because, based on the extant literatures concerning aging populations and mind wandering, it is specifically unintentional mind wandering that ought to be positively associated with aging because this type of mind wandering appears to be reflective of difficulties with inhibiting unwanted thoughts, or failures of executive control (e.g., Seli, Risko, Purdon, & Smilek, 2016; Seli, Smallwood, et al., 2015). On the other hand, given that research has demonstrated that (a) relative to younger adults, older adults are more conscientious and motivated to remain engaged during laboratory tasks (Jackson & Balota, 2012; Frank et al., 2015), and (b) individuals reporting higher levels of task-based motivation tend to less frequently engage in intentional mind wandering (Seli, Cheyne, et al., 2015; Seli, Wammes, Risko, & Smilek, 2015), it is reasonable to suspect that age might be negatively associated with reported rates of intentional mind wandering. Thus, there is the possibility that the seemingly paradoxical finding of a negative relation between mind wandering and age (e.g., Giambra, 1989; Grodsky & Giambra, 1990; Jackson & Balota, 2012; Krawietz, et al., 2012) has been observed because studies have conflated two very different types of mind wandering. Indeed, it could be the case that (a) unintentional mind wandering is positively associated with age, (b) intentional mind wandering is negatively associated with age, and (c) the negative relation between intentional mind wandering and age is stronger than the positive relation between unintentional mind wandering and age, which would result in a negative correlation between "overall mind wandering" (the sum of intentional and unintentional mind wandering) and age, as has been frequently reported in the literature.

Although the distinction between intentional and unintentional mind wandering has been largely overlooked in the extant literature, there is some early work on the topic that provides some initial insights into the relation between aging and the intentionality of mind wandering. Grodsky and Giambra (1990–91) conducted a small-scale laboratory study (N = 35) in which participants completed a reading task and a vigilance task, and throughout each task, rates of intentional and unintentional mind wandering were assessed. For the reading task, participants were instructed to monitor their mental states and to "self-catch" any periods of mind wandering that they experienced. Upon self-catching their mind wandering, they were to use a pen/pencil to indicate, on the text, the point at which their minds had

wandered, and additionally, they were to report whether their mind wandering was engaged with or without intention. Similarly, for the vigilance task, participants were instructed to self-catch and report (via button press) any experiences of intentional and unintentional mind wandering. Interestingly, in examining data from the reading task, Grodsky and Giambra found significant negative correlations between (a) age and intentional mind wandering and (b) age and unintentional mind wandering, indicating that older adults may experience lower rates of both types of mind wandering compared with younger adults. At the same time, however, Grodsky and Giambra failed to observe any significant relations between age and intentional/unintentional mind wandering for the vigilance task, which signalled a lack of consistency in their results.

Although Grodsky and Giambra's (1990–91) work sheds some light onto the relation between the intentionality of mind wandering and aging, there are some important limitations to their study that suggest that their results should be interpreted with caution. First, as noted above, although Grosky and Giambra found significant relations among aging and intentional and unintentional mind wandering during the reading task, no such relations were observed during the vigilance task. Why this inconsistency was present in their results, however, is not altogether clear. Second, the sample size in their study was relatively small: their correlational analyses included data from only 35 participants (which could explain the inconsistency across tasks). Third, and most important, to assess rates of intentional and unintentional mind wandering, the researchers employed the "self-caught" method, which requires participants to actively monitor their mental states while concurrently completing a separate task. Although the self-catching procedure has since been used in the literature (see Schooler, 2002), it has largely fallen out of favor in studies examining *rates* of mind wandering, likely because concerns have been raised about its use as such a measure. Indeed, as noted by Smallwood and Schooler (2006, p. 948), the self-caught method is "not a good gauge of overall mind-wandering frequency" because this measure conflates mind-wandering frequency and awareness of mind wandering (for instance, an individual who spends the entirety of an experimental session engaged in mind wandering might, if he or she has poor self-monitoring abilities, never report the experience of mind wandering). Given the limitations of Grodsky and Giambra's (1990–91) study, more research on the topic is clearly needed before any firm conclusions can be drawn.

In a related line of research, Jackson and Balota (2012) examined how the awareness of mind wandering (Schooler, 2002) might vary as a function of age. More specifically, they examined whether young and older adults differ in the extent to which they experience mind wandering that occurs with and without awareness of its occurrence. The authors replicated previous findings of a decrease in overall mind wandering with increasing age, and more critically, they found that, compared with young adults, older adults reported lower rates of mind wandering with awareness as well as lower rates of mind wandering without awareness.

Jackson and Balota's (2012) results could be interpreted as providing evidence that older adults experience lower rates of both intentional and unintentional mind wandering. Indeed, it is reasonable to assume that intentionally occurring mind wandering must be accompanied by awareness of its occurrence, and conversely, that unintentional mind wandering must be

accompanied by a lack of awareness of its occurrence. Although this assumption appears plausible, recent research has called into question the overlap between the awareness and the intentionality of mind wandering. For example, Seli, Risko, and Smilek (2016a) found that performance outcomes for periods of mind wandering occurring with and without intention were different from performance outcomes for periods of mind wandering occurring with and without awareness, respectively. In addition, it has been shown that participants report a significant (non-zero) number of reports of mind wandering that occur (a) with intention but without awareness, and (b) without intention but with awareness (Seli, Ralph, et al., in press).[1] Collectively, this research provides evidence that awareness and intentionality are not redundant measures, which in turn suggests that Jackson and Balota's findings, although clearly important, do not directly speak to the issue of the intentionality of mind wandering in aging populations.

The Present Studies

Building on the foregoing work, in the present studies we separately examined rates of intentional and unintentional mind wandering as a function of age at both the trait and state levels. In Study 1, participants completed an online survey study in which they reported trait-level rates of intentional and unintentional mind wandering, along with their age. This study allowed us to examine the relations among age and everyday rates of intentional and unintentional mind wandering. In Study 2, we examined the associations among age and state-level reports of intentional and unintentional mind wandering by assessing these two types of mind wandering in young and older adults as they completed a sustained-attention task in the laboratory. This study allowed us to conceptually replicate our findings from Study 1, while also allowing us to investigate the intentionality of mind wandering across age groups in situ.

Study 1

Method

We report how we determined our sample sizes, all data exclusions (if any), all manipulations, and all measures for our two studies (Simmons, Nelson, & Simonsohn, 2012).

Participants—Participants were 795 individuals (mean age = 37.03; 437 females) who completed a Human Intelligence Task (HIT) posted on the Amazon Mechanical Turk (www.mturk.com). All participants provided informed consent and were treated in accordance with guidelines approved by the ethics committee at the University of Waterloo. We decided, in advance, that we were willing to spend approximately $500 Canadian dollars on this study, which allowed us to collect data from 795 participants. Participants were paid $0.50 (U.S. dollars) for completing the HIT, which lasted approximately 10 minutes and consisted of brief demographic and mind-wandering questionnaires. Also included among

[1]Although such results may seem paradoxical, they can be explained within the context of a model of mind wandering that takes into consideration both the "ignition points" and the "continuation" of mind-wandering episodes (Smallwood, 2013; for such an explanation, see Seli, Risko, & Smilek, 2016a).

our scales of interest were various other questionnaires that were of interest to other researchers, but that were not analyzed for the present study. Each participant completed every item of each questionnaire included in the study, and no data were excluded from our analyses.

Intentional and Unintentional Mind Wandering—We measured trait levels of intentional and unintentional mind wandering with the 4-item Mind Wandering: Deliberate (MW-D) scale and the 4-item Mind Wandering: Spontaneous (MW-S), respectively (Carriere et al., 2013). The MW-D items include: (1) "I allow my thoughts to wander on purpose," (2) "I enjoy mind-wandering," (3) "I find mind-wandering is a good way to cope with boredom," and (4) "I allow myself to get absorbed in pleasant fantasy." The MW-D is scored using a seven-point Likert scale ranging from *rarely* (1) to *a lot* (7) for items 1, 2 and 4, and ranging from *not at all true* (1) to *very true* (7) for item 3. The MW-S items include: (1) "I find my thoughts wandering spontaneously," (2) "When I mind-wander my thoughts tend to be pulled from topic to topic," (3) "It feels like I don't have control over when my mind wanders," and (4) "I mind-wander even when I'm supposed to be doing something else." The MW-S is also scored using a seven-point Likert scale ranging from *rarely* (1) to *a lot* (7) for items 1, 2 and 4, and ranging from *almost never* (1) to *almost always* (7) for item 3.

Demographic information—In addition to indexing mind wandering with the MW-D and MW-S, we collected data pertaining to participants' age and sex.

Results

We first examined the descriptive statistics for the MW-D, MW-S, and found rates of intentional ($M = 4.28$, $SD = 1.59$) and unintentional ($M = 4.02$, $SD = 1.61$) mind wandering that were comparable to those reported in previous work that likewise administered the MW-D and MW-S via Amazon Mechanical Turk (Carriere et al., 2013). In addition, in Figure 1, we present a histogram displaying the distribution of participants' ages, along with descriptive statistics and skewness and kurtosis values. As can be seen in Figure 1, there was a relatively large age range in our sample (16–82), with a good distribution of participants across this range.

Next, we examined the Pearson product-moment correlation coefficients for all measures. As has been shown in previous studies (Carriere et al., 2013; Seli, Carriere, & Smilek, 2015; Seli, Risko, & Smilek, 2016b; Seli, Smallwood, et al., 2015), the MW-D and MW-S were moderately positively correlated, $r = .46$, $p < .001$. Additionally, we observed a negative correlation between the MW-D and age, $r = -.23$ $p < .001$), and the MW-S and age, $r = -.23$, $p < .001$.

Given that the MW-D and MW-S were moderately correlated with one another, we next sought to determine their unique relations with age. To this end, we conducted a multiple regression analysis predicting age with MW-D and MW-S (see Table 1 and Figure 2). Recall that, because older adults tend to report higher levels of task-based motivation (e.g., Frank et al., 2015), and because higher levels of task-based motivation are associated with lower levels of intentional mind wandering (e.g., Seli, Cheyne, et al., 2015), we hypothesized that

we would observe a negative relation between age and intentional mind wandering. Consistent with this hypothesis, we found that the MW-D was uniquely negatively associated with age. On the other hand, because older adults are known to experience deficits in executive functioning, and because unintentional mind wandering is reflective of failures of executive control, we hypothesized that we would observe a positive relation between age and unintentional mind wandering. However, contrary to our hypothesis, we found that the MW-S was also uniquely negatively associated with age. Thus, the results of Study 1 indicate that increases in age are associated with decreases in both intentional and unintentional types of mind wandering, as initially reported in Grodsky and Giambra's (1990–91) small-scale state-level study.

Discussion: Study 1

In Study 1, we explored the relations among age and everyday rates of intentional and unintentional mind wandering. In considering previous research demonstrating age-accompanied deficits in executive functioning (see Foster et al., 2007, for a review), we hypothesized that we would observe increases in unintentional mind wandering with increasing age. Moreover, because aging is known to be associated with increased task engagement, conscientiousness, and motivation (Jackson & Balota, 2012; Frank et al., 2015), we reasoned that older adults might be more engaged in their daily tasks, and hence, show a more pronounced decline in intentional mind wandering relative to young adults. However, results indicated that *both* intentional and unintentional mind wandering were uniquely negatively associated with age. Thus, our results suggest – in line with Grodsky and Giambra's (1990–91) initial findings – that older adults tend to engage in less intentional and unintentional mind wandering than do younger adults.

Although the results from Study 1 provide support for the view that aging is associated with decreases in both intentional and unintentional mind wandering, one limitation of this study is that participants' reports of mind wandering were assessed using questionnaires that required them to retrospectively evaluate and report on their rates of everyday mind wandering. One reasonable concern about this procedure is that the trait-level questionnaires used in Study 1 might have been susceptible to retrospective biases and/or problems produced by participant forgetting, particularly for older adults. Thus, in Study 2, we again examined the relations among age and rates of intentional and unintentional mind wandering, but this time we used thought probes to assess rates of mind wandering at the state level while participants completed a sustained-attention task. Unlike the self-caught method used in Grodsky and Giambra (1990–91), the probe-caught method does not require participants to continuously monitor the content of their thoughts. Rather, this method involves intermittently interrupting participants as they complete a task and requiring them to report whether, immediately prior to the interruptions, they were "on task" or "mind wandering." Given our interest in examining the intentionality of mind wandering, we further had participants report whether any mind wandering that they experienced was engaged with or without intention (as in previous work; e.g., Seli, Risko, & Smilek, 2016a). Critically, this design allowed us to minimize concerns surrounding (a) the potential for retrospective biases and/or forgetting that were present in Study 1, and (b) the conflation of

people's awareness of mind wandering and their rates of mind wandering, which likely resulted from the use of the self-catching procedure in Grodsky and Giambra (1990–91).

Of secondary interest in Study 2 were the relations among intentional mind wandering, unintentional mind wandering, and task motivation. Recall that we initially hypothesized that older adults would experience lower rates of intentional mind wandering because of their tendency to experience higher levels of task-based motivation (e.g., Frank et al., 2015). Although the sample size in Study 2 was too small to formally test this hypothesis via mediation analyses, we included a measure of task motivation (Unsworth & McMillan, 2013) to determine whether this measures (a) was significantly higher in older compared with young adults, and (b) correlated with rates of intentional and unintentional mind wandering, as in previous work (e.g., Seli, Cheyne, Xu, et al., 2015).

Study 2

Method

Participants—29 young adults (age range: 18–28, $M = 21.93$, $SD = 3.05$) and 27 older adults (age range: 65–88, $M = 73.48$, $SD = 6.48$) participated in the study at Harvard University's William James Hall. All participants provided informed consent and were treated in accordance with guidelines approved by the ethics committee at Harvard University. Although we had planned to recruit 30 young and 30 older adults, we terminated testing slightly early because the William James Hall parking lot closed for construction (which made it difficult to accommodate older adults, given that many them tend to drive to William James Hall for testing). No data were excluded from our analyses. Older adults completed an extensive neuropsychological battery that included the mini-mental status examination (Folstein, Folstein, & McHugh, 1975), verbal fluency, the Third Edition of the Wechsler Adult Intelligence Scale (WAIS-III; Wechsler, 1997), the Wechsler Memory Scale (Wechsler, 1987), the California verbal learning test (Delis, Kramer, Kaplan, & Ober, 1987), and the Wisconsin card sorting test (Grant & Berg, 1948). Only older adults performing above accepted thresholds were asked to participate in the study. There was no between-group difference in gender ratio ($p = 0.57$). Older adults had significantly more years of education compared with young adults, $t(1,54) = 2.21$, $p = 0.03$.

The Sustained Attention to Response Task (SART)—On each SART (Robertson et al., 1997) trial, a single digit was presented for 350 ms in the centre of the monitor, after which time an encircled "x" mask was presented for 1650 ms (total trial duration = 2000 ms). For each block of 9 trials, a single digit (1–9) was randomly chosen without replacement, and presented in white on a black background. The digits were presented in Courier New font, and digit sizes were randomly varied across all trials, with equal sampling of five possible font sizes (120, 100, 94, 72, and 48 points). Participants were instructed to respond (by pressing the spacebar) to each GO digit (i.e., digits 1–2, and 4–9) and to withhold responses to each NOGO digit (i.e., 3). After 18 practice trials, participants completed 522 experimental trials.

Thought probes—Throughout the SART, mind wandering was sampled using a total of 18 intermittently presented thought probes. When a probe was presented, the SART

temporarily stopped and the participant was presented with the following instruction: "Which of the following responses best characterizes your mental state just prior to the presentation of this screen." The possible response options were: (1) On task, (2) Intentionally mind wandering (3) Unintentionally mind wandering (Seli, Cheyne, Xu, et al., 2015). Participants were instructed to respond to one of these options via key press (1–3), after which time the SART resumed.

Procedure—After providing informed consent, participants were given instructions to familiarize them with the requirements of the SART. Prior to beginning the experiment, participants were also given detailed instructions regarding thought-probe responses. They were told that being on task meant that they were thinking about things related to the task (e.g. thoughts about their performance, thoughts about the digits, or thoughts about their response), whereas mind wandering meant they were thinking about something completely unrelated to the task (e.g. thoughts about what to eat for dinner, thoughts about plans with friends or about an upcoming test). They were given further instructions that, in the case that they experienced any mind wandering, they should indicate whether the mind wandering was engaged intentionally or unintentionally (for detailed instructions, see Seli, Risko, & Smilek, 2016a). After the practice trials and before beginning the main task, participants were asked to rate, on a scale of 1–9, "How motivated are you to do well on the task?" and "How interested are you in the task?" (possible responses ranged from "1, not at all motivated/interested" to "9, very motivated/interested"). Interest and motivation ratings were collected a second time, following completion of the main task. In total, the SART took roughly 20 minutes to complete.

Measures—Performance measures include NOGO errors, GO-trial response times (RTs), mind-wandering rates for each of the two types of mind wandering (intentional and unintentional), as well as the pre-SART and post-SART ratings of interest and motivation. NOGO errors occurred when participants failed to withhold their response to the digit 3. GO-trial RTs were the mean response latencies for all GO trials on which a response was made. Mind-wandering rates for intentional and unintentional mind wandering were calculated as the proportion of each type of mind-wandering response provided across all 18 thought probes. Also computed was a measure of "overall mind wandering," which was the sum of the proportion of intentional and unintentional mind wandering.

Results

Performance on the SART, as well as measures of task motivation and interest, were compared across groups of younger and older adults (see Table 2). Levene's test for equality of variances was statistically significant for several of the variables, so tests with adjusted degrees of freedom are reported where appropriate. Older adults reported being more interested and motivated on average, and the group differences in motivation and interest were evident both prior to and following the SART. In addition, younger adults responded more rapidly on the SART than did older adults, but they also produced higher rates of NOGO errors. Given previous work showing speed-accuracy trade-offs in the SART (e.g., Jonker, Seli, Cheyne, & Smilek, 2013; Seli, 2016; Seli, Jonker, Cheyne, & Smilek, 2013), we also examined rates of NOGO errors while statistically controlling for RTs. Results of

this analysis indicated that older adults made fewer errors than younger adults when RT was held constant.[2]

Mean rates of intentional, unintentional, and overall (the sum of intentional and unintentional) mind wandering appear in Table 3. Older adults reported less overall mind wandering than did young adults. Most critically, and in line with the results from Study 1, when this variable was decomposed into its component parts, we found that older adults reported lower rates of both intentional and unintentional mind wandering compared with young adults. When conducting a mixed ANOVA with report type (intentional mind wandering, unintentional mind wandering) as the within-subjects factor, and age group (young, older adults) as the between-subjects factor, we found that (a) older adults reported lower rates of both types of mind wandering compared with younger adults ($F = 10.32$, $df = 1,54$, $p < .01$), (b) both younger and older adults reported lower rates of intentional mind wandering than unintentional mind wandering ($F = 40.20$, $df = 1,54$, $p < .001$), and (c) the difference in rates of mind wandering across younger and older adults did not vary across type of mind wandering ($F = 2.56$, $df = 1,54$, $p = .12$).

As noted earlier, to formally test that hypothesis that older adults experience lower rates of intentional and unintentional mind wandering than do young adults as a result of their increased motivation, mediation and path analyses are necessary. However, the sample sizes in Study 2 were too small to allow us to conduct meaningful mediation and path analyses. Nonetheless, in an attempt to shed some light on this issue, we examined the Pearson product-moment correlation coefficients, separately for young and older adults, for motivation (the average of the pre- and post-task motivation reports), intentional mind wandering, and unintentional mind wandering. Results of the correlation analysis indicated that motivation in young adults was significantly negatively associated with unintentional mind wandering, $r = -.60$, $p = .001$, but not intentional mind wandering, $r = -.30$, $p = .117$. With respect to the nonsignificant relation between motivation and intentional mind wandering, it is worth noting that previous research has, on a few occasions, reported a significant negative correlation between motivation and intentional mind wandering in young adults (e.g., Seli, Cheyne, et al., 2015; Seli, Wammes, et al., 2015), and moreover, it is heartening to note that the present result, although statistically nonsignificant, is in the same direction as this previously reported finding. Turning to older adults, we found that motivation was likewise significantly negatively associated with unintentional mind wandering, $r = -.53$, $p = .004$; however, we did not observe a signification relation between motivation and intentional mind wandering, $r = .037$, $p = .854$. Notably, however, only six of the 27 older adults reported at least one instance of intentional mind wandering, and as such, it is reasonable to assume that the failure to find a significant relation between intentional mind wandering and motivation in older adults might have been due to the relative lack of variability in reports of intentional mind wandering in this group.

[2]Notably, in the present study, we did not distinguish between on-task performance and task-related interferences (TRIs; thoughts about one's performance on a focal task). It is, however, worth noting that previous research (McVay, Meier, Touron, & Kane, 2013) has found that both mind wandering and TRIs are associated with performance costs on cognitively-demanding tasks. In addition, research has found that, whereas older adults report fewer bouts of mind wandering than do young adults, they also report higher levels of TRIs (Frank et al., 2015).

Together with the finding that older adults reported higher levels of motivation than did young adult, these findings suggest the possibility that the observed age-related decreases in unintentional mind wandering might, at least in part, be attributable to older adults' tendency to be more motivated than young adults. That said, given (a) the relatively small sample sizes of Study 2, (b) the small number reports of intentional mind wandering produced by older adults, and (c) the fact that we could not formally test this hypothesis via mediation and path analyses, we encourage the reader to cautiously interpret these findings, and we suggest that future research further examine this important issue.

Discussion: Study 2

In Study 2, we sought to (a) conceptually replicate our Study 1 results and (b) address the limitations of Study 1 by examining rates of intentional and unintentional mind wandering in young and older adults at the state level, using thought probes, while they completed a sustained-attention task in the laboratory. Consistent with our Study 1 findings, in Study 2 we found that older adults reported significantly lower levels of intentional and unintentional types of mind wandering. Thus, it appears that the results from Study 1 are not attributable to retrospective biases/memorial problems surrounding the trait-level measures of intentional and unintentional mind wandering.

In addition to examining rates of intentional and unintentional mind wandering as a function of age, we also explored the possible role that motivation plays in mind wandering across young and older adults. We initially proposed that motivation might determine the amount of intentional (but not unintentional) mind wandering during task performance. However, given that older adults reported higher levels of task-based motivation (Study 2; see also Frank et al., 2015), and given the finding that increasing age was associated with reductions in both intentional and unintentional mind wandering (Study 1 and Study 2), we reasoned that perhaps motivation may be associated with reductions in both types of mind wandering. Although our sample was too small to allow for a formal mediation-based test of this possibility, we did find that (a) older adults reported higher motivation and interest compared with young adults, and (b) motivation was significantly negatively associated with rates of unintentional mind wandering in both young and older adults. Although these results provide some evidence to suggest that the reason older adults experience lower rates of unintentional mind wandering than do young adults because they report higher levels of task-based motivation, we recommend that future research more directly assess this possibility via mediation and path analyses with larger sample sizes.

Interestingly, in comparing levels of intentional and unintentional mind wandering across our two studies, we found that, whereas levels of unintentional mind wandering were lower than levels of intentional mind wandering in Study 1 (at the trait level), the opposite pattern emerged in Study 2 (at the state level). Although, at first blush, this divergence in the relative rates of intentional/unintentional mind wandering might seem surprising, it appears to make good sense when one considers the inherent differences between trait and state measures of psychological constructs. Whereas trait measures index an individual's characteristic abstracted across many contexts, state measures index the characteristic in a single context. It is therefore conceivable, and in fact very likely, that the relative levels of intentional/

unintentional mind wandering differ across various contexts (see Seli, Risko, & Smilek, 2016a for one such example). Thus, the relative levels of state-level measures of intentional and unintentional mind wandering (Study 2) might be very context specific, and hence, depending on the context, they might differ from the relative levels of trait measures of intentional and unintentional mind wandering. Importantly, this further highlights the need to conduct studies at both the trait and state levels (Seli, Risko, & Smilek, 2016b), and, when measuring constructs at the state level, to attempt to do so across numerous different contexts.

General Discussion

Although numerous studies have demonstrated that older adults experience deficits in working memory and executive function (see Foster et al., 2007, for a review), researchers have also found that older adults report significantly less mind wandering than younger adults. We reasoned that this seemingly paradoxical finding might owe to the fact that past research on the topic has conflated intentional and unintentional types of mind wandering, and that separate analyses of these two types of mind wandering might reveal very different results. In particular, we predicted that, whereas older adults should report lower rates of intentional mind wandering compared with younger adults, they should report higher rates of unintentional mind wandering. Although we found evidence for the former hypothesis, contrary to the latter hypothesis, results indicated that older adults reported lower rates of unintentional mind wandering than do younger adults, and this pattern was observed at both at the trait and the state levels.

In addition to examining rates of intentional and unintentional mind wandering as a function of age, in Study 2 we also examined age-related differences in motivation levels. We found that older adults were more motivated than were young adults, and additionally, that motivation levels were significant negatively associated with rates of unintentional mind wandering. In line with previous work (Frank et al., 2015; Krawietz et al., 2012), these findings suggest the possibility that age-related differences in unintenitonal mind wandering might be explained, at least in part, by age-related differences in motivation. Although conducting a mediation analysis would be the most appropriate way to test this hypothesis, in Study 2, our sample sizes (young, older adults) were too small to allow for any meaningful mediation analyses. We therefore recommend that future research with larger samples more directly tests this interesting hypothesis.

Other possible explanations for age-related declines in mind wandering

Although motivation may play an important role in explaining age-related differences in mind wandering, there are other factors (beyond motivation) that may contribute to our understanding of these differences. Indeed, researchers have provided numerous alternative explanations for age-related differences in mind wandering. To place the present results in the context of such views, it is important to consider some of the more popular explanations and assess their explanatory power.

Older adults' reports of mind wandering may not be veridical

The first explanation is that older adults' reports of mind wandering are less valid than younger adults' reports because these individuals often lack awareness or memory of their episodes of mind wandering and therefore cannot report on them, and/or older adults are reluctant to report periods of task-unrelated thought (e.g., Einstein & McDaniel, 1997; Jackson & Balota, 2012; Zavagnin, Borella, & DeBeni, 2014). Thus, on this view, the commonly observed age-related reduction in mind wandering is not veridical, but instead owes to older adults' invalid reports of mind wandering. While this seems to be a reasonable view to take, certain experimental findings call into question its accuracy. For example, in early work demonstrating a negative relation between mind wandering and age, Giambra (1973) found that older adults reported a more positive view of mind wandering than their younger counterparts, which suggests that it is not a lack of willingness to report mind wandering that is contributing to the negative relation; indeed, it is not clear why older adults would be reluctant to report on experiences that they view in a positive light. Moreover, recent work by Frank et al. (2015) directly examined the validity of older adults' thought reports by attempting to link these reports to behavioural data (i.e., eye-tracking patterns). Here, the authors found that older adults' eye-movement patterns significantly predicted their reports of mind wandering, thereby providing support for the validity of the thought reports provided by older adults. Taken together, these results suggest that the report-validity explanation of age-related declines in mind wandering is perhaps unwarranted.

Older adults have fewer current concerns

A second explanation for age-related declines in mind wandering relates to Klinger's (1971) Current Concerns hypothesis, which suggests that mind wandering occurs when: (a) currently relevant goals (that have yet to be achieved) are active in a person's mind, and (b) the person appraises these goals as being more important than the demands of the immediate external environment, and consequently shifts his/her focus toward these goals (see also Klinger, 1975). The Current Concerns hypothesis is potentially useful in understanding age-related differences in mind wandering because research has indicated that older adults report fewer current concerns than younger adults (Parks, Klinger, & Perlmutter, 1988), which in turn suggests that the frequency at which they mind-wander ought to be relatively lower. In the context of the present results, it seems reasonable to posit that thoughts about one's current concerns could be engaged either with or without intention, in which case one would expect older adults (who have fewer current concerns) to less frequently engage in both intentional and unintentional mind wandering than younger adults.

In more recent work extending Klinger's Current Concerns Hypothesis (Klinger, 1971), McVay and Kane (2010) proposed the Control Failures × Concerns theory (see also McVay, Meier, et al., 2013). According to this theory, mind wandering can be explained in terms of an interaction between executive-control abilities and current concerns. In particular, the theory holds that, whereas the executive-control factor "…reflects the ability of executive-control processes to maintain ready access to task goals and suppress TUTs [episodes of mind wandering] … before they enter awareness and disrupt goal maintenance," the concerns factor reflects "…the extent to which the environment cues a current concern and thereby interferes with ongoing-task goals" (McVay, Meier, et al., 2013, pp. 145–146).

When considering this theoretical account in the context of research showing decreases in mind wandering with increasing age, it appears that this account is not adequate in explaining such findings. Indeed, as noted earlier, it has been well-established that older adults experience more cognitive deficits than do young adults (see Foster et al., 2007, for a review). Hence, one might expect the Control Failures × Concerns theory to predict that older adults should in fact experience *more* mind wandering than young adults. However, as noted by McVay, Meier, et al. (2013), the "concerns factor" of this theory plays a key role in interpreting the extant findings of decreased mind wandering in older adults. That is, it could be the case that, although older adults experience more executive-control failures than do younger adults (which should be associated with increases in mind wandering), they also generate fewer bouts of mind wandering (presumably both in terms of intentional and unintentional types of mind wandering) in response to environmental cues than do younger adults, and hence, they experience decreased levels of mind wandering. Although this theory is promising, more research is needed to determine its veracity.

Older adults have fewer cognitive resources

One final potential explanation for the present findings is that the observed reductions in mind wandering are a consequence of reductions in cognitive resources in older adults. It has been argued that older adults spend a greater proportion of their cognitive resources on an ongoing task or external activity compared with younger adults (Craik, 1983, 1986; Craik & Byrd, 1982). Thus, if mind wandering is a resource-demanding process (e.g., Smallwood & Schooler, 2006), then it follows that older adults may have fewer resources left over to exhibit mind wandering (be it intentional or unintentional) compared with young adults (e.g., Giambra, 1989; Krawietz et al., 2012; Maillet & Rajah, 2013).

Although many researchers have endorsed the cognitive-resources explanation of age-related decreases in mind wandering (for a review, see Maillet & Schacter, 2016), McVay, Meier, et al. (2013) have claimed that this explanation is at least incomplete because it does not comport well with the finding that, during periods of mind wandering, young and older adults experience the same degree of task disruption (i.e., equivalent performance decrements; McVay, Meier et al., 2013). According to McVay, Meier, et al., if cognitive resources are divided between task performance and mind wandering, and if older adults have fewer cognitive resources, then during periods of mind wandering, older adults should show pronounced performance decrements because they have fewer resources to devote toward task performance than do young adults (McVay, Meier, et al., 2013). Of course, this critique of the cognitive-resources account necessarily assumes that young and older adults allocate the exact same amount of resources to their bouts of mind wandering. If, for example, older adults did allocate fewer resources to their mind wandering than young adults, then it would not follow that older adults ought to exhibit more pronounced performance decrements during periods of mind wandering. However, as noted by McVay, Meier, et al., resource views are sufficiently flexible to accommodate nearly any result or prediction, an as such, it is not clear that pursuing such a view will shed light on age-related differences in mind wandering.

Concluding Remarks

Consistent with previous work, our results suggest that increased age is associated with a reduction in mind wandering. Adding to this well-documented finding, and extending early work by Giambra and colleagues (e.g., Giambra, 1989; Grodsky & Giambra, 1990–91), our results also suggest that the age-related decline in mind wandering is not due to a conflation of unintentional and intentional mind wandering: Older adults exhibited similar reductions in both types of mind wandering. Furthermore, and in line with previous work (Frank et al., 2015; Krawietz et al., 2012), our findings that (a) older adults were more motivated than younger adults and (b) higher levels of motivation were negatively associated with rates of intentional and unintentional mind wandering suggest the possibility that motivation differences may play an important role in explaining, at least to some extent, age-related differences in mind wandering. That said, it should be noted that, even if one were to find support for a motivation-based account of age-related declines in mind wandering, there are other theoretical explanations that could be at play, including a current-concerns explanation (e.g., Klinger, 1971), a control Failures × concerns explanation (e.g., McVay & Kane, 2010), and a cognitive resource account (e.g., Smallwood & Schooler, 2006). Of course, the foregoing accounts might not be mutually exclusive. It could be the case, for example, that increases in task-based motivation and conscientiousness, decreases in the number of current concerns, and a reduction in cognitive resources might all contribute to the negative relation between age and mind wandering (both unintentional and intentional types). Given the current lack of clarity surrounding the mechanisms responsible for these age-related decreases in mind wandering, we suggest that future research explores these (and perhaps other) possibilities to provide further insights into this important topic.

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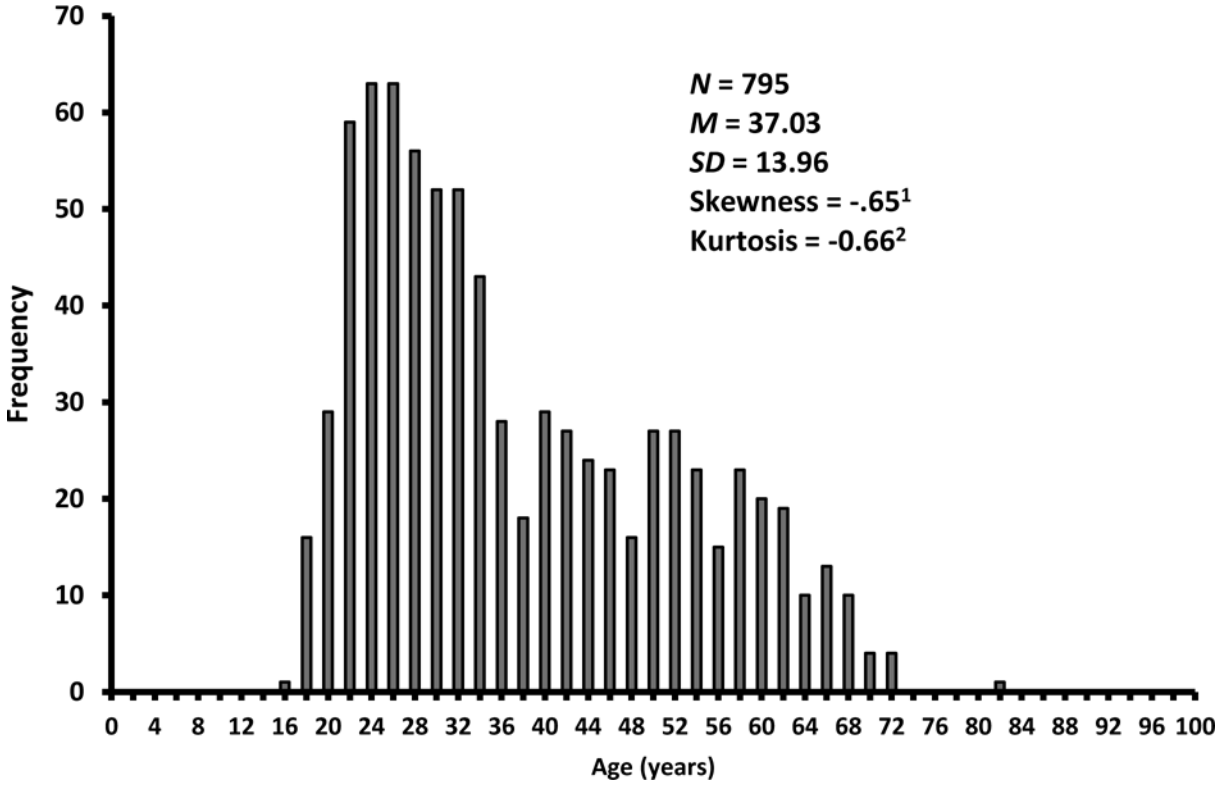

Figure 1.

Histogram displaying the distribution of participants' age. *Note.* [1]Std. Error = .087, [2]Std. Error = .173

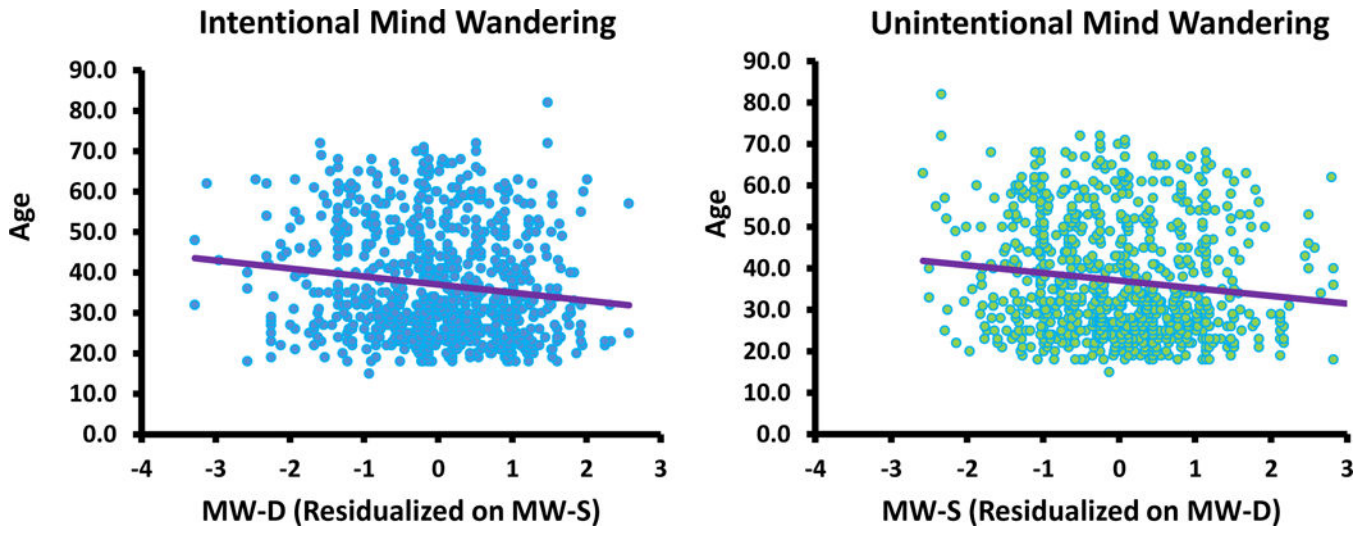

Figure 2.

Scatterplots showing the unique relations of intentional mind wandering (assessed via the MW-D; left column) and unintentional mind wandering (assessed via the MW-S; right column) with Age.

Table 1

Multiple regression testing for unique contributions to age by intentional mind wandering (MW-D) and unintentional mind wandering (MW-S) (N = 795)

Dependent variable: Age

	Standardized Coefficients	***t***	***p***
MW-D	−.16	4.161	<.001
MW-S	−.15	3.857	<.001
	Final Model: $R = .27$, $F(2, 792) = 29.87$, $p < .001$		

Table 2

Comparison of Performance on the SART and Task Motivation Across Groups of Younger and Older Adults

		n	*M*	*SD*	*t*	*df*	*p*
Task Motivation							
Before SART	Younger	29	7.0345	1.4996	4.971	41.731	<0.001
	Older	27	8.5926	0.7473			
After SART	Younger	29	5.7778	2.2246	4.788	47.898	<0.001
	Older	27	8.3462	1.6478			
Average	Younger	29	6.4138	1.6533	5.439	49.773	<0.001
	Older	27	8.4630	1.1345			
Task Interest							
Before SART	Younger	29	4.2759	2.5898	5.787	51.366	<0.001
	Older	27	7.7778	1.9082			
After SART	Younger	29	5.6897	2.1564	3.689	54	0.001
	Older	27	7.7407	1.9922			
Average	Younger	29	4.9828	2.1359	5.349	54	<0.001
	Older	27	7.7593	1.7062			
SART Performance							
RT	Younger	29	362.9853	73.1004	5.356	54	<0.001
	Older	27	470.7049	77.3974			
NOGO errors	Younger	29	0.42093	0.1958	5.591	42.613	<0.001
	Older	27	0.19029	0.1013			
NOGO errors controlling RT	Younger	29	0.0475	0.1838	2.469	45.637	0.017
	Older	27	-0.051	0.1072			

Table 3

Comparison of Mean Rates of Self-Reported Mind Wandering Across Groups of Younger and Older Adults.

		n	*M*	*SD*	*t*(54)	*p*
Intentional Mind Wandering	Younger	29	0.1073	0.0995	2.627	0.011
	Older	27	0.0412	0.0880		
Unintentional Mind Wandering	Younger	29	0.3314	0.2081	2.700	0.009
	Older	27	0.1749	0.2258		
Overall Mind Wandering	Younger	29	0.4387	0.2662	3.212	0.002
	Older	27	0.2160	0.2515		