The Journal of Experimental Education

ISSN: 0022-0973 (Print) 1940-0683 (Online) Journal homepage: https://www.tandfonline.com/loi/vjxe20

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To cite this article: Noah D. Forrin, Caitlin Mills, Sidney K. D'Mello, Evan F. Risko, Daniel Smilek & Paul Seli (2021) TL;DR: Longer Sections of Text Increase Rates of Unintentional Mind-Wandering, The Journal of Experimental Education, 89:2, 278-290, DOI: 10.1080/00220973.2020.1751578

To link to this article: https://doi.org/10.1080/00220973.2020.1751578

THE JOURNAL OF EXPERIMENTAL EDUCATION
2021, VOL. 89, NO. 2, 278–290
https://doi.org/10.1080/00220973.2020.1751578

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TL;DR: Longer Sections of Text Increase Rates of Unintentional Mind-Wandering

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ABSTRACT

The prevalence of the acronym tl;dr ("too long; didn't read") suggests that people intentionally disengage their attention from long sections of text. We studied this real-world phenomenon in an educational context by measuring rates of intentional and unintentional mind-wandering while undergraduate student participants ($n = 80$) read academic passages that were presented in either short sections of text (one sentence per screen) or relatively long sections (2–6 sentences per screen). We found that participants were significantly more likely to *unintentionally* disengage their attention while reading the longer sections of text, whereas intentional mind-wandering rates were equivalent across short and long sections of text. The difference in unintentional mind-wandering rates suggests that section length may serve as a cue that people use to assess the cost-benefit tradeoffs involved in attending to (or disengaging from) text. We conclude that instructors should avoid presenting electronic reading material in long sections of text.

KEYWORDS

Intentional; mind-wandering; reading; text presentation; unintentional

IN RECENT YEARS, enrollment in online courses has steadily been on the rise (Ginder, Kelly-Reid, & Mann, 2017). Even in traditional brick-and-mortar classrooms, many texts are now available in e-text format, as are other study materials (e.g., lecture notes). It is therefore important for educational and cognitive psychologists to study and better understand features of electronic text presentation that might affect students' attentiveness and learning. One such textual feature is the length of sections in which a given text is presented. The growing use of the short form "tl;dr"—which stands for "too long; didn't read"—suggests that people may be more likely to attend to bite-sized segments of information (e.g., Twitter posts, news-bites) compared to longer chunks of information (e.g., long paragraphs in a news article).

Recent empirical work (Forrin et al., 2018, 2019) tested for the existence of this "tl;dr" phenomenon in an educational context. Undergraduates read several academic passages on the computer, half of which were presented in shorts sections of text (one sentence per screen), and the other half of which were presented in longer sections (2–6 sentences per screen). Participants' attentiveness was measured using thought probes, interspersed during reading, which asked participants to report on whether they were 'on task' or 'mind-wandering' (see Smallwood & Schooler, 2006, for a review of this method) just prior to the onset of the probe. Participants more frequently reported mind-wandering when the passages were presented in long sections relative to short sections. Moreover, there were consequences in terms of learning: Participants

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had poorer comprehension (assessed by a multiple-choice test that followed each passage) of passages that were presented in long sections vs. short sections.

One possible explanation for this "section-length effect" (Forrin et al., 2018, 2019) is that people use section length as a cue to gauge the demands associated with reading a given text This view is consistent with recent work on effort evaluation (Dunn et al., 2016; Dunn et al., 2019; Dunn & Risko, 2019). Along these lines, section length may inform a basic cost-benefit analysis of engaging attention (see Kurzban et al., 2013). Indeed, it has been shown that more effort is needed to sustain attention for longer periods of time (see e.g., Head & Helton, 2014; Helton & Russell, 2011, 2015), possibly because the opportunity costs associated with refrained engagement in other tasks (or thoughts) increases over time as attention is focused on a particular task (Kurzban et al., 2013). On this view, section length might function as an indicator of possible attentional costs, with longer sections of text being perceived as more costly in terms of anticipated effort.

Here, we examined the role of *intentionality* in peoples' tendency to mind-wander more often while reading longer vs. shorter sections of text. Our goal was to help elucidate whether this effect—which is related to the real world "tl;dr" phenomenon—reflects the intentional or unintentional disengagement of attention from passages with relatively long sections of text.

Although the bulk of prior mind-wandering research has assumed that participants' reports of mind-wandering reflect unintentional (i.e., spontaneous) mind-wandering (for a review, see Seli et al., 2016), recent research has shown that people report *intentional* (i.e., deliberate) mind-wandering during a variety of tasks, such as those examining sustained-attention (Seli et al., 2016), lecture comprehension (Seli et al., 2016; Wammes et al., 2016), and re-reading (Phillips et al., 2016). For example, Wammes et al. (2016) found that during live undergraduate lectures students report mind-wandering unintentionally roughly 14% percent of the time they were probed, but report mind-wandering intentionally roughly 19% percent of the time.

Recent findings demonstrate that it is important to distinguish between intentional and unintentional types of mind wandering. Indeed, across numerous studies it has been shown that intentional and unintentional mind wandering are differentially related to a variety of other variables, such as the tendency to present with attention deficits (Seli et al., 2015) and obsessive-compulsive symptoms (Seli et al., 2017), as well as the tendency to experience mindfulness (Seli et al., 2015). Importantly, it has been suggested that it is imperative to consider the intentionality of mind wandering episodes when designing interventions to curtail mind wandering, given that intentional processes are presumably more likely to be changed by instructions and conscious strategies than are unintentional processes (Wammes et al., 2016).

At first blush, the aforementioned account—that section length can be used heuristically to infer task demands—appears to align with the possibility that participants intentionally disengage from relatively long sections of text (as would seem to occur when people report "tl;dr"). An alternative possibility, however, is that section-length cues might be rapidly processed independently of intentions, with longer sections of text unintentionally triggering lower attentional investment. This latter possibility is intriguing because it would imply that surface features of text, such as section length, might influence attentional engagement outside the scope of a person's conscious control.

In the present experiment, we expanded on Forrin et al. (2018, 2019) methodology to test these two possibilities. Participants read passages that were presented as short sections of text and passages that were presented as long sections of text, and mind-wandering was periodically assessed via thought probes. However, building on Forrin et al.'s prior research—in which participants were provided intentionality-insensitive response options to thought probes (i.e., "on task" or "mind-wandering")—participants in this experiment were required to report whether any mind-wandering they experienced was engaged with or without intention. Specifically, each probe asked participants to indicate whether, just prior to the onset of the probe, they were "on task", "intentionally mind-wandering", or "unintentionally mind-wandering" (for detailed probe instructions, see Appendix A). We expected to replicate Forrin et al.'s result that section length influences overall rates of mind-wandering. Of main interest, however, the present experiment tested whether this effect was driven by intentional and/or unintentional mind-wandering.

Method

In accordance with the recommendations of Seli et al. (2018), we conceptualized mind-wandering as *task-unrelated thought*, and we operationally defined it for our participants in terms of thoughts pertaining to something other than their task (see below for more details).

Participants

To account for the possibility that the effect of section length on intentional and/or unintentional mind-wandering might be fairly small (there are no extant data to inform predictions of an effect size), for our within-subjects design, we tested a large sample of 80 University of Waterloo participants who were reimbursed with course credit. A power analysis using G*Power (Erdfelder et al., 1996) indicated that running 80 participants in our within-subjects study would yield adequate statistical power (0.80) to reliably detect a relatively small-sized effect ($d = 0.32$). One participant was excluded prior to data analysis because they missed a thought probe due to extremely rapid reading speed that the Eprime program was not designed to accommodate. This participant was replaced, resulting in a final sample of 80 participants who did not miss any thought probes.

Reading Materials and Comprehension Questions

We used the same pool of 12 passages, and corresponding comprehension questions used in Forrin et al. (2018, 2019), which were derived from Wikipedia (http://en.wikipedia.org) articles on a wide array of topics (e.g., the galaxy, Pompeii, Sartre; see https://osf.io/62xtp for the passages and comprehension questions). The passages were 496–528 words long ($M = 515.58$, $SD = 8.16$). In terms of readability, they were at a Flesch-Kincaid (Klare, 1974) grade level 9 ($M = 9.00$, $SD = 0.21$).

Passage section-length was manipulated such that each passage had a short and a long section-length version. Short-section versions were presented one sentence at a time ($M = 12.51$ words/screen, $SD = 1.40$ words/screen) and long-section versions were presented with as many as 6 sentences at a time ($M = 30.38$ words/screen, $SD = 1.97$ words/screen).[1] The content of the passages and overall passage length were not affected by this section-length manipulation.

Procedure

The experiment was programed in Eprime 2.0. Participants were seated in front of 15′' or 17′' computer monitors, in groups of up to five. Participants were instructed that the experiment involved reading passages and that comprehension questions would follow each passage. They were also informed that the task would occasionally pause and that they would be asked to indicate whether they were on task, intentionally mind-wandering, or unintentionally mind-wandering just before the task paused. Each of these response options was defined for participants prior to beginning the reading task (see Appendix A for detailed instructions, which were adapted from Seli et al., 2016).

Participants read eight passages that were randomly selected from the pool of 12: four short-section versions and four long-section versions, in block-counterbalanced order. All text was presented in black, 18-pt. Arial font on a white background. Participants pressed the spacebar to advance to the next section of text, and could not go back to previous sections. For both the short-section and long-section versions of passages, there were two thought probes per passage. The first thought probe appeared 10–30 s after the onset of the first section of text (i.e., probe timing was random within that interval). Likewise, the second probe appeared 10–30 s after the onset of the section of text that was closest to the mid-point of the passage. If a participant reached the mid-point (or the end) of the passage before the first (or second) probe was scheduled to appear, it appeared at the mid-point (or the end) of the passage. After providing a response to a given probe, participants were returned to the section of text that they had been reading and resumed the reading task. Due to the probe interruptions, a valid comparison of reading times across conditions could not be made. For this reason, we present reading time data in Appendix B.

Immediately following each passage, participants rated passage difficulty ("How *difficult* was the passage you just read?) and interestingness ("How *interesting* was the passage you just read?") using 11-point Likert scales (0 = *not at all difficult/interesting*; 10 = *extremely difficult/interesting*). Question order was randomized. These subjective measures were included as a test of our account that people mind-wander more frequently while reading relatively long (vs. short) sections of text because they associate long sections with high task demands. In line with this account, we expected that participants would rate the long-section passages as more difficult and less interesting than short-section passages.

Participants then answered four multiple-choice reading comprehension questions by typing the letter (a, b, c, or d) corresponding to the "most correct" answer. Given that prior research has demonstrated that higher rates of mind-wandering are associated with poorer reading comprehension (see, e.g., Smallwood et al., 2007), we anticipated that participants would have worse comprehension of long-section passages than short-section passages.

After answering the comprehension questions, the next passage appeared, and participants underwent the same procedure outlined above. This sequence of events continued until participants read all eight passages or time expired (participants signed up for a 1-hour experimental session). The vast majority of participants (78/80) finished all eight passages within the time limit (one finished seven passages whereas another finished six passages). Data from all 80 participants of the final sample were included in the analyses below.

Results

Given the repeated-measures nature of our design, analyses were completed using mixed-effects logistic (or linear, when appropriate) regressions using the lme4 package in R (Bates et al., 2016). Logistic regressions were estimated using Laplace Approximation and linear models used restricted maximum likelihood estimation. All models included two random intercepts (participant and passage topic) to account for baseline variability across participants and passages. *Section length* (long vs. short) was included as a categorical fixed effect with long section length as the reference group. The direction of B estimates reported below can thus be interpreted as a comparison of the short relative to long section lengths (e.g., negative B estimates indicate the average value of the dependent variable is smaller for the shorter section lengths). Table 1 summarizes the results of these mixed-effect logistic/linear regression models, which are reported below.

Mind-Wandering

All of the probe responses made by the final sample of 80 participants—1274 probe responses in total—were recorded. Three mixed-effects logistic regressions, that included all probe responses,

Table 1. Full model statistics for the mixed-effect regression models reported in the Results section.

	Fixed Effects								Random Effects	
	Condition		Passage Number		Probe position		Intercept			
Probe Level	*B* (SE)	*p*	*B* (SE)	*p*	*B* (SE)	*p*	*B* (SE)	*p*	Participant *Var (SD)*	Passage name *Var (SD)*
1274 observations, 80 subjects										
Overall mind-wandering	−.391 (.136)	.004	.247 (.031)	<.001	.322 (.135)	.017	−.199 (.261)	<.001	1.23 (1.11)	.177 (.420)
Intentional mind-wandering	−.155 (.184)	.398	.197 (.042)	<.001	<.001 (.018)	.999	−3.23 (.307)	<.001	1.04 (1.02)	<.001 (<.001)
Unintentional mind-wandering	-.355 (.149)	.017	.170 (.033)	<.001	.391 (.148)	.008	−2.40 (.271)	<.001	1.03 (1.02)	.163 (.404)
Passage Level										
627 observations, 80 subjects										
Comprehension	−.028 (.019)	.140	−.014 (.004)	.001			.601 (.040)	<.001	.015 (.123)	.011 (.106)
Reading Time	−4.74 (2.55)	.063	−8.26 (.558)	<.001			215 (7.10)	<.001	2568 (50.6)	106 (10.3)
Difficulty	.460 (.147)	.002	−.048 (.032)	.141			4.50 (.417)	<.001	2.30 (1.52)	1.37 (1.17)
Interest	−.114 (.184)	.537	−.134 (.040)	.001			4.65 (.460)	<.001	1.23 (1.11)	1.76 (1.33)

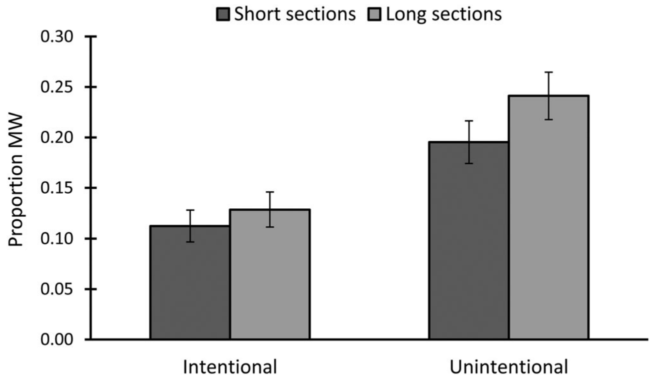

Figure 1. Mean observed intentional and unintentional mind-wandering rates (with SEs) for passages that were presented as short sections and long sections.

were constructed to assess the effect of condition on mind-wandering (1 yes vs. 0) for: (1) overall mind-wandering (the combination of intentional and unintentional MW responses), (2) intentional MW, and (3) unintentional MW. Figure 1 displays the mean observed intentional and unintentional mind-wandering rates for passages that were presented as short sections and long sections.

The model for overall MW revealed that participants were more likely to MW for passages with long sections ($M = 0.370$, $SE = 0.029$) compared to passages with short sections ($M = 0.308$, $SE = 0.026$), $B = -.380$ ($SE = .131$), $\chi^2 = 8.35$, $p = .004$, $d = 0.25$. There was no effect of section length on intentional MW, as participants reported similar rates of MW while reading long sections ($M = 0.129$, $SE = 0.017$) and short sections ($M = 0.113$, $SE = 0.016$), $B = -.167$ ($SE = .181$), $\chi^2 = .845$, $p = .358$, $d = 0.11$. Critically, however, participants were more likely to report unintentional MW while reading passages with long sections ($M = 0.241$, $SE = 0.023$) compared to those with short sections ($M = 0.195$, $SE = 0.021$), $B = -.355$ ($SE = .146$), $\chi^2 = 5.90$, $p = .015$, $d = 0.23$.

We repeated the above analyses with *passage number* (1–8) and *probe position* (first probe or second probe) as additional covariates to account for potential effects of time on task. (Tables 2 and 3 show mean mind-wandering rates across the two probes and across the eight passages, respectively.) The effect of passage length was unchanged, overall MW: $B = -.391$ ($SE = .136$), $\chi^2 = 8.24$, $p = .004$; intentional MW: $B = -.155$ ($SE = .184$), $\chi^2 = .714$, $p = .398$; unintentional MW: $B = -.355$ ($SE = .149$), $\chi^2 = 5.69$, $p = .017$. Although the main effects of length were consistent after controlling for probe position, these models revealed that participants were more likely to report overall MW at the second probe compared to the first, $B = .322$ ($SE = .135$), $\chi^2 = 5.69$, $p = .017$, $d = .187$. The same pattern was found for unintentional MW, $B = .391$ ($SE = .148$), $\chi^2 = 7.02$, $p = .008$, $d = .226$, whereas intentional MW was similar across the first and second probe $B < -.000$ ($SE = .018$), $\chi^2 = 0.00$, $p = .999$, $d = .003$. Similarly, passage number was significantly positively related to all three types of MW, suggesting that overall time on task was related to increases in MW in general, overall MW: $B = .247$ ($SE = .031$), $\chi^2 = 63.0$, $p < .001$; intentional MW: $B = .197$ ($SE = .042$), $\chi^2 = 22.4$, $p < .001$; unintentional MW: $B = .170$ ($SE = .033$), $\chi^2 = 26.5$, $p < .001$.

Reading Comprehension

The proportion of correctly answered comprehension questions was nominally lower for long-section passages ($M = 0.508$, $SE = 0.022$) than for short-section passages ($M = 0.533$, $SE = 0.019$), but a mixed-effects linear regression (*fixed effects*: section length and passage number; *random*

Table 2. Mean observed intentional, unintentional, and overall mind-wandering (MW) rates for the first probe and second probe of passages that were presented as short sections, passages that were presented as long sections, and overall (i.e., collapsed across those conditions). Standard errors of the mean are in parentheses.

	Short sections		Long sections		Overall	
	First probe	Second probe	First probe	Second probe	First probe	Second probe
Intentional MW	.11 (.02)	.12 (.02)	.13 (.02)	.13 (.02)	.12 (.02)	.12 (.02)
Unintentional MW	.16 (.03)	.23 (.02)	.22 (.03)	.26 (.03)	.19 (.02)	.25 (.02)
Overall MW	.27 (.03)	.34 (.03)	.35 (.03)	.39 (.03)	.31 (.03)	.37 (.03)

Table 3. Mean observed intentional, unintentional, and overall mind-wandering rates; proportion of comprehension questions answer correctly; self-reported difficulty ratings; and self-reported interest ratings of each of the eight passages that were presented to participants (each passage was randomly selected from a pool of twelve passages). Standard errors of the mean are in parentheses.

Passage Number	1	2	3	4	5	6	7	8
Intentional MW	.03 (.01)	.07 (.02)	.13 (.03)	.11 (.03)	.17 (.03)	.15 (.03)	.17 (.03)	.15 (.03)
Unintentional MW	.12 (.03)	.17 (.03)	.18 (.03)	.26 (.04)	.21 (.04)	.22 (.03)	.30 (.04)	.30 (.04)
Overall MW	.14 (.03)	.24 (.03)	.30 (.04)	.36 (.04)	.38 (.04)	.37 (.04)	.47 (.05)	.46 (.04)
Comprehension	.52 (.03)	.57 (.03)	.25 (.03)	.54 (.03)	.54 (.03)	.53 (.03)	.47 (.03)	.43 (.03)
Difficulty	4.81 (.31)	5.09 (.30)	4.66 (.29)	4.46 (.29)	4.15 (.30)	4.41 (.28)	4.19 (30)	4.78 (.31)
Interest	4.20 (.33)	4.20 (.30)	4.38 (.30)	3.84 (.31)	4.05 (.34)	3.85 (.32)	3.56 (.33)	3.47 (.33)

effects: participant and passage topic) revealed the difference was statistically nonsignificant, $B = .028$ ($SE = .019$), $\chi^2 = 2.17$, $p = .141$, $d = 0.14$. Table 3 displays participants' comprehension performance over passages. Passage number was negatively and significantly related to comprehension, $B = -.014$ ($SE = .004$), $\chi^2 = 11.4$, $p = .001$, suggesting that participants performed worse on comprehension tests over time.

As a supplemental analysis, we also examined the association between the proportion of correctly answer comprehension questions and mind-wandering rates. We regressed comprehension scores on mind-wandering rates (overall, intentional, unintentional) with Passage Number as a fixed effect and subject as a random effect. Reading comprehension was significantly negatively associated with overall mind-wandering rates, $B = -.153$ ($SE = .030$), $\chi^2 = 26.1$, $p < .001$, intentional mind-wandering rates, $B = -.153$ ($SE = .042$), $\chi^2 = 13.0$, $p = .001$, and unintentional mind-wandering rates, $B = -.010$ (SE $= .035$), $\chi^2 = 8.11$, $p = .004$.

Subjective Ratings

We also constructed two mixed-effects linear regressions to assess the main effect of section length on subjective ratings of difficulty and interest. Similar to above, passage number was included to control for potential order effects. Difficulty ratings were significantly higher for long-section passages ($M = 4.76$, $SE = 0.20$) than for short-section passages ($M = 4.34$, $SE = 0.21$), $B = -.460$ ($SE = .147$), $\chi^2 = 9.85$, $p = .002$, $d = 0.23$. Interest ratings, however, were not significantly different across long-section passages ($M = 3.90$, $SE = 0.19$) and short-section passages ($M = 3.99$, $SE = 0.17$), $B = .114$ ($SE = .184$), $\chi^2 = .381$, $p = .537$, $d = 0.06$. Table 3 displays the mean difficulty and interest ratings over passages. Passage number was nonsignificant related to difficulty ratings, $B = -.048$ ($SE = .032$), $\chi^2 = 2.17$, $p = .141$, but was significantly negatively related to interest ratings, $B = -.134$ ($SE = .040$), $\chi^2 = 11.0$, $p < .001$, suggesting that passages became less interesting (but not more difficult) over time.

Discussion

In everyday life, people seem to disengage their attentional resources from long sections of text, as suggested by the reaction "too long; didn't read" (tl;dr). In line with this suggestion, we found that participants reported more frequent mind-wandering while reading passages with long sections of text compared to passages with short sections (importantly, our section length manipulation controlled for overall passage length). Of main interest, we found that section length significantly influenced *unintentional*, but not intentional, mind-wandering rates. This finding dovetails with recent research that highlights dissociations between intentional vs. unintentional mind-wandering (see Seli et al., 2016, for a review; see also Golchert et al., 2017). For example, Phillips et al. (2016) found that re-reading texts increases rates of intentional mind-wandering, but not unintentional mind-wandering. Adding to this literature, here we report another dissociation wherein longer (vs. shorter) sections of text yielded higher rates of unintentional mind-wandering but not intentional mind-wandering.

Although participants did not have significantly higher comprehension scores for short-section passages vs. long-section passages ($p = .141$), prior research (Forrin et al., 2018; 2019) typically yielded a small, statistically significant effect. The nonsignificant effect here may therefore reflect a Type II error. Notably, collapsing across section length conditions, reading comprehension was significantly negatively associated with overall mind-wandering rates, with intentional mind-wandering rates, and with unintentional mind-wandering rates. This replicates prior research that found a negative relation between mind-wandering and reading comprehension (e.g., Schooler, Reichle, & Halpern, 2004).

Theoretical Implications

How might passage section length influence unintentional mind-wandering? As outlined in the Introduction, we suggest that (a) section length serves as a salient *effort cue* (Dunn et al., 2016) that individuals use to assess the demands associated with reading a text (irrespective of overall passage length), and (b) that this assessment informs a basic cost-benefit analysis of engaging attention (see Kurzban et al., 2013). This idea could be likened to Kahneman's (1973) notion of an "allocation policy" that governs the distribution of available capacity and which is set by an evaluation of demands (amongst other factors; e.g., enduring dispositions).

The present work therefore highlights the utility of better understanding how perceived task demands influence the allocation of attentional resources, and suggests a possible relation between perceived task demands and unintentional mind-wandering. Relatedly, an intriguing possibility is that impressions of task demands form after only a brief exposure to the task. Salient effort cues (e.g., the amount of text on a page) may rapidly and implicitly guide these impressions of task demands—akin to how "thin slices" of behavior strongly influence impression formation (for a review; see Ambady et al., 2000). For example, when students glimpse a long section of text, they may spontaneously form the impression that the reading task is demanding, which could have downstream consequences on task engagement.

Another notable result of the present experiment was that students' mind-wandering rates tended to increase while reading each individual passage. Regardless of the length of sections of text in the passage, participants unintentionally mind-wandered more often during the second half of passages than during the first half, whereas rates of intentional mind-wandering were stable (see Table 2). The tendency for unintentional mind-wandering to increase while reading a given passage may have occurred due to increasing demands on working memory to form a mental model of the text as the number of pertinent details increased (especially since participants could not re-read previous sections of text in our paradigm).

Across the eight successive passages, both unintentional and intentional mind-wandering rates increased (see Table 3). This result aligns with prior research demonstrating that students' tendency to mind-wander increases over the duration of video lectures (Risko et al., 2012; Wammes & Smilek, 2017); indeed, time-on-task increases in mind-wandering are common across a variety of cognitive tasks (see Thomson et al., 2014). In sum, the present results not only suggest that students' rates of mind-wandering increase during educational reading tasks, but, moreover, that rates of *both* unintentional and intentional mind-wandering increase. In addition to this increase in mind-wandering over passages, we also found a marked decrease in students' interest ratings over passages. Taken together, this pattern of results suggests that, at least in the context of reading educational texts, interest may be strongly related to both types of mind-wandering.

Practical Implications

The present work also has practical implications. Our main result—that undergraduate student participants mind-wandered more often while reading passages with longer sections of text (i.e., more words/screen)—demonstrates that text presentation affects students' ability to sustain attention while reading material on the computer. More specifically, this result suggests instructors may be able to reduce rates of unintentional mind-wandering in their classrooms by formatting electronic reading materials (when possible) to be presented in relatively short sections of text. Given that enrollment in postsecondary online courses has been increasing over the years (Ginder et al., 2017), this is a timely recommendation. Future research could examine whether students' tendency to mind-wander more often while reading long (vs. short) sections of text applies to other types of reading material (e.g., text on lecture slides). This could be achieved by varying the amount of text on PowerPoint slides and measuring students' attentiveness and lecture comprehension.

Second, our results regarding mind-wandering over probes and over passages also have notable implications. The finding that rates of unintentional mind-wandering increased from the first half to the second half of short passages (see Table 2), which took, on average, approximately three minutes to read (see Appendix B for reading times) suggests that students' attention tends to diminish even while reading brief educational texts. This increase in mind-wandering—both unintentional and intentional—was even more pronounced over the course of reading the eight successive passages, and comprehension scores and interest ratings showed a similarly steep decline. In sum, the present results suggest that students' increase in mind-wandering while reading educational texts may (i) emerge rapidly (ii) persist over time, (iii) harm comprehension, and (iv) be related to a decrease in interest.

The present results thus highlight the importance of future research developing interventions that curb the increase over time of students' mind-wandering while reading. Notably, prior research has found that instructions that increase participants' motivation decreased *both* unintentional and intentional mind-wandering during a sustained attention task (Seli et al., 2019). Future studies should therefore test whether interventions that target students' motivation are effective at lowering the particularly high rates of *unintentional* mind-wandering during a reading task with long-section passages that we observed here (which were 11.2 percentage points higher, on average, than intentional mind-wandering rates for those same passages).

Limitations

One limitation of the present work is that we cannot confirm that participants were truthful in their probe response (an issue with any self-report measure). Reassuringly, however, prior studies have demonstrated the validity of experience sampling approaches to measuring mind-wandering. For example, there is coherence between self-reported mind-wandering and neural activity in the default network (Christoff, Gordon, Smallwood, Smith, & Schooler, 2009; Mason et al., 2007), a brain region that is implicated in internally-focused thought. Additionally, numerous behavioral studies have demonstrated that, relative to periods of self-reported on-task focus, periods of self-reported mind-wandering are associated with poorer performance on a variety of cognitive tasks (for a review, see Mooneyham & Schooler, 2013); indeed, we found a robust negative association between mind-wandering and reading comprehension in the present study. Behavioral dissociations have also been observed between reported bouts of intentional and unintentional mind wandering (for a review, see Seli et al., 2016), and more recent work has likewise shown that they are associated with distinct neural markers (Martel, Arvaneh, Robertson, Smallwood, & Dockree, 2019). Thus, the extant literature suggests that thought probes—which are commonly used in mind-wandering research (for a review, see Smallwood & Schooler, 2015)—yield accurate estimates of mind-wandering frequency.

Second, a related issue is that the thought probes themselves may have influenced participants' attention to the reading task (perhaps by interfering with the construction of a mental model or by signaling to participants that mind-wandering was a viable option). Importantly, however, thought probe number and timing were equated across the two section-length versions, and thus any influence of thought probes on participants' attentiveness would have been equivalent across conditions. Moreover, prior research by Schooler et al. (2004) found that the inclusion (vs. exclusion) of thought probes during a reading task did *not* affect reading comprehension, which suggests that mind-wandering is similarly unaffected by thought probes.

Third, students are presumably less motivated when reading educational texts in the lab (vs. for a class). We therefore cannot rule out the possibility the observed section-length effect on mind-wandering occurs in the context of our laboratory study, but not in the classroom, due to differences in motivation between these two contexts, or other differences (e.g., our passages were likely shorter than passage that undergraduates would typically encounter). Future research should examine whether students in the classroom tend to mind-wander more while reading long (vs. short) sections of text.

Conclusion

To conclude, the present research highlights a novel dissociation between unintentional and intentional mind-wandering in a reading task (in which undergraduate students read a series of educational passages presented on the computer). Participants had significantly higher rates of unintentional mind-wandering while reading passages that were presented as short (vs. long) sections of text, while differences in intentional mind-wandering were nonsignificantly different.

At least in the laboratory, then, it would appear that attentional disengagement to long sections of text is involuntary. The lack of a significant effect of section length on intentional mind-wandering is surprising given that individuals' protestations of "too long, didn't read" seem to imply an intentional disengagement of attention from long sections of text. Instead, we found that people's aversion to long sections of text appears to be partly reflexive in the sense that participants succumbed to more frequent bouts of unintentional mind-wandering while reading longer (vs. shorter) sections of text. These findings suggest that, when possible, instructors should present electronic reading materials in relatively short sections of text. A "wall of text" may impede students' attentiveness by increasing unintentional mind-wandering.

Author note

Any opinions, findings and conclusions, or recommendations expressed in this paper are those of the authors and do not necessarily reflect the views of the funding agencies. The materials and program used in this research, as well as the raw data files, are publicly available on the Open Science Framework (https://osf.io/62xtp).

Note

1. We used the same two section-lengths here as were used in Forrin et al. (2019; Experiments 4a and 4b). Forrin et al. (2018, 2019) also found that undergraduates mind-wander more often while reading passages

that are presented across full pages of text compared to passages that are presented across single sentences or short paragraphs. Thus, the effect of passage section length on mind-wandering is reliable and has been demonstrated across a variety of different section lengths.

Funding

This research was supported by Natural Sciences and Engineering Research Council of Canada (NSERC) Discovery Grant (RGPIN-2014-06459) and by the National Science Foundation (DRL 1108845, DRL 1920510, and IIS 1523091).

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Appendix A: Detailed probe instructions

Before continuing, there is one more thing you should know about this task. Every once in a while, the task will temporarily stop and you will be presented with a screen asking you to indicate whether you were ON TASK or MIND WANDERING just before the screen appeared.

Being ON TASK means that, just before the screen appeared, you were focused on reading and were not thinking about anything unrelated to the task.

On the other hand, MIND WANDERING means that, just before the screen appeared, you were thinking about something completely unrelated to the task. Some examples of mind wandering include thoughts about what to eat for dinner, thoughts about plans you have with friends, or thoughts about an upcoming test.

Importantly, mind wandering can occur either because you INTENTIONALLY decided to think about things that are unrelated to the task, OR because your thoughts UNINTENTIONALLY drifted away to task-unrelated thoughts, despite your best intentions to focus on the task.

When the thought-sampling screen is presented, we would like you to indicate whether any mind wandering you might experience is intentional or unintentional. After responding, please resume reading from where you left off.

Press the SPACEBAR when you are ready to begin the experiment.

Appendix B: Passage reading times

On average, participants spent 5.27 fewer seconds (2.94% less time) reading passages that were presented as long sections ($M = 173.77$ s, $SE = 5.88$ s) compared with those presented as short sections ($M = 179.04$ s, $SE = 6.02$ s). A linear mixed-effects model revealed a marginal effect of section length on reading time after controlling for passage number, $B = 4.74$ ($SE = 2.55$), $\chi^2 = 3.45$, $p = .063$, $d = 0.100$. The mean total reading time across all eight passages was 1399.21 s ($SE = 43.86$ s)—approximately 23 minutes and 19 seconds.

We caution that there are at least two factors that may bias comparisons of reading times across section-length conditions. First, short-section passages were presented across more sections of text than were long-section passages, resulting in more brief delays when participants pressed the spacebar to advance to the next section of the text (and re-oriented themselves to the start of the next section). Second, immediately following thought probes, participants may be slower to resume reading long-section passages vs. short-section passages (e.g., it may take participants more time to locate the point of the section at which they had been interrupted). For these reasons, the reading time data should be interpreted cautiously.