Text-Based and Memory-Based Metrics of Cognitive Coupling

Shikang Peng

and

Peter Dixon

Department of Psychology

University of Alberta

Author Note

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Correspondence should be addressed to Peter Dixon, Dept. of Psychology, Univ. of Alberta, Edmonton, Alberta, Canada T6G 2E9, peter.dixon@ualberta.ca.
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Abstract

The present study was an investigation of the relation between cognitive coupling, a correlation between text difficulty and reading time, and other measures of mind wandering during reading. To measure cognitive coupling, we manipulated the text difficulty of individual sentences. Because mind wandering may shift attention away from the text, we predicted cognitive coupling, that is, that the effect of difficulty on processing time, should be less when readers are off task. We also manipulated the consistency of a target sentence's content with a prior information. Analogous to the text-based cognitive coupling, we predicted an interaction of consistency with task focus: the impact of this consistency should be less noticeable when readers are off task. The results demonstrated the predicted text-based cognitive-coupling effect: There was less of an effect of text difficulty when readers reported being off task. However, there was no such interaction between consistency and task focus. We conclude that the consistency effect may depend on the relatively automatic activation of prior information, rather than requiring consciously retrieving related information in the mindset.

Keywords: Mind wandering, reading, cognitive coupling, memory resonance, standards of coherence

Public Significance Statement: Cognitive coupling refers to the modulation of reading as a function of sentence difficulty. In the present research, we demonstrated that mind wandering affects text-based cognitive coupling but not situation-model-based coupling. The results suggest that some situation-model inferences may occur even when readers are not fully focused on reading.

Text-Based and Memory-Based Metrics of Cognitive Coupling

To comprehend a narrative, readers must form mental connections among characters and events. It is well known that this process is impaired when readers are mind wandering or off task (Schooler et al., 2004; Reichle et al., 2010). Mills et al. (2017) proposed that mind wandering during reading could be indexed by a measure that they referred to as “cognitive coupling.” The essential idea behind cognitive coupling is to measure the relationship between the time spent on reading a text and its level of difficulty. When the text is difficult, readers should slow down; when the text is easier, readers should speed up. Mills et al. proposed that this cognitive coupling breaks down when readers are off task and, thus, that the degree of task focus could be indexed using a performance-based measure by the degree of cognitive coupling. In the present paper, we investigated the relationship between mind wandering and cognitive coupling using a direct manipulation of the difficulty of the text.

A number of researchers have looked for performance-based indices of mind wandering during reading. For example, Schad et al. (2012) found that different types of proof-reading errors were missed depending on the degree of task focus. In particular, high-level semantic errors were overlooked with some frequency regardless of task focus; low-level text-based errors were more likely to be detected unless task engagement was very low. They identified mindless reading as segments of text in which errors were missed. Schad et al. found relationships between the degree of mindless reading (as identified by such missed text errors) and patterns of eye movements. For example, word frequency and end-of-sentence wrap effects were reduced during mindless reading, consistent with the cognitive-coupling account.

Eye movement data has provided further evidence on the relationship between comprehension and mind wandering. Employing a predictive modeling approach, Southwell et al. (2020) trained a regression model to use such data to predict subsequent comprehension. They discovered that more fixations on the text accurately predicted comprehension-test performance across extensive connected-text datasets, even with a significant delay. This suggests a relationship to cognitive coupling: More time with segments of text presumably reflects more processing and better memory. One might conjecture that such variations in patterns of eye movements might be related to mind wandering. Indeed, Reichle et al. (2010) found, among other results, that the effect of word frequency on eye fixations was less pronounced when readers reported being off task, suggesting a lack of cognitive coupling. Machine learning has been used to further our understanding of patterns of eye movements and mind wandering. For example, D'Mello et al. (2017) succeeded in predicting mind wandering from patterns of eye movements with an A' accuracy of .66. Their model included variables such as the number of saccades, proportion of horizontal saccades, and fixation duration (Faber et al., 2018). Although these results do not bear directly on the effects of text difficulty that are involved in cognitive coupling, they do indicate that computational techniques can capture variations in patterns of eye movements that are related to both mind wandering and comprehension.

In support of the notion that mind wandering may negatively correlate with cognitive coupling, mind wandering has been found to vary with text difficulty. Feng et al. (2013) reported that mind wandering was more frequent while reading difficult text, and that this lead to weaker comprehension. As well, Kahmann et al. (2022) found that mind wandering varied continuously with text difficulty, but only when the text was regarded as relatively interesting. A related result was found by Schurer et al. (2022): More mind wandering during reading was found with a concurrent memory task but only with more difficult material. The effect of text difficulty may also relate to presentation format. For example, Forrin et al. (2021) found that people mind wander more when they read material presented in longer sections. These results are consistent with a relationship between cognitive coupling and mind wandering if it is assumed that readers often do not take the requisite time to process difficult text adequately when they are mind wandering.

Related results were reported by Franklin et al. (2011). They were able to predict, with some accuracy, mind wandering in a word-by-word reading task.

They classified readers as being on or off task by examining their reading time per word locally relative to their average, global reading time. When the reading times were relatively fast, they were classified as being off task. This classification rule agreed with self-report mind wandering probes 72% of the time. This result is not of itself consistent with the idea that cognitive coupling predicts mind wandering. However, it seems likely that when reading times are fast, they are *uniformly* fast, so that effects of local text difficulty would be minimal. If this interpretation is correct, the Franklin et al. results would fit with a relationship between cognitive-coupling and mind wandering.

If cognitive coupling is a useful index of mind wandering, it should predict comprehension, just as other indices of mind wandering do (e.g., Dixon & Li, 2013). To assess this prediction, Mills et al. (2017) computed cognitive coupling in several ways, including a comparison of reading time to Flesh-Kincaid grade level, a common index of readability (Klare, 1974). Across four datasets, the measure of cognitive coupling predicted both text-based and inferential comprehension. The authors' interpretation was that mind wandering reduced cognitive coupling and that both were related to comprehension performance. In the present investigation, we examined the same question, but used a manipulation of text complexity rather than depending on endogenous variation in the reading material. This index of coupling is analogous to that used by Mills et al. (2017) except for two changes: First, our index was computed at a sentence rather than paragraph level, and second, we directly manipulated word and sentence length rather than relying on the Flesh-Kincaid index for preexisting material. Our conjecture was that this would provide a stronger test of the relationship between cognitive coupling and mind wandering.

In addition to text complexity, we attempted to examine cognitive coupling related to memory retrieval during reading. In a memory-resonance view of narrative comprehension, information encountered in the text can “resonate” with the memory of previously encountered, matching textual information (O’Brien et al., 1998; Gerrig, 2005). One of the consequences of this form of memory retrieval is that when the prior information is inconsistent with the current information, readers will slow down to resolve the inconsistency (e.g., Albrecht & O’Brien, 1993). We conjectured that mind wandering would interfere with this retrieval of the inconsistent information. For example, previous research has demonstrated negative effects of mind wandering on episodic memory (Blondé et al., 2022). However, such effects have not been investigated in the context of narrative comprehension. Our hypothesis here is that if mind wandering is related to the memory retrieval that is involved in the consistency effect, we would expect a form of cognitive coupling: The consistency effect should be larger when readers report being on task. When readers are off task, they may fail to notice the inconsistency. This effect would be analogous to the text-based cognitive coupling described above: In both cases, processing difficulty should have less of an effect on reading time when readers are off task. On the other hand, other interpretations of the consistency effect assume that it might not be related to the reactivation of prior text information. For example, Zwaan and Madden (2004) proposed a here-and-now view of comprehension and suggested that information currently related to the protagonist would be more accessible than other information in the situation model. (See also the results of Murray & Engle, 2005). Possibly, that associated information might be available even if readers are not focused completely on the reading task. If this is the case, there might be little relationship between mind wandering and the variation in reading time with consistency, that is memory-based cognitive coupling.

We also explored another, somewhat less direct, approach to measuring cognitive coupling. Rather than looking at reading time directly, we assessed whether readers report more cognitive effort in comprehending difficult texts. If readers do not work harder on more difficult material, that is tantamount to less cognitive coupling. This effect is related to the concept of "standards of coherence" proposed by van den Broek et al. (1995). According to Van den Broek et al. (2005), standards of coherence reflect reader's reading goals and reader's knowledge about how to obtain a good comprehension. In particular, a low standard of coherence would be associated with less concern with text difficulties that hinder comprehension. As a result, we would expect to see weaker comprehension performance when the standard of coherence is low. We conjecture that mind wandering should produce a low standard of coherence because in this case, readers would be devoting less attention to the development of a coherent situation model. In the present research, we measured the standard of coherence in a straight-forward, but subjective, manner by simply asking readers how much effort they devoted to resolving comprehension problems encountered in the text.

Mind wandering during reading has commonly been assessed with probe techniques in which readers are periodically interrupted and asked to report whether (or the extent to which) they are on task (cf. Smallwood, 2013), and this is the operationalization of mind wandering that we use here. In our version of the on-task probe, we asked participants to use a continuous scale to report their degree of task focus at the end of each of the narratives they read (cf. Dixon & Bortolussi, 2013; Dixon et al., 2015). Our supposition is that one can be on or off task to various degrees. For example, the resources devoted to the reading task might vary in a graded fashion. Other researchers have also assumed that task focus varies continuously or at least has more than two possible states. For example, Zanesco et al. (2020) found evidence for multiple task-focus states, and Allen et al. (2013) demonstrated apparently continuous relationships between the extent of mind wandering and brain activity in the medial prefrontal cortex measured with fMRI. On the other hand, Kane et al. (2021) argued that a binary measurement technique was more reliably related to the presence of task-unrelated thoughts. While this may be true, our view is that a more flexible, continuous response scale is likely to be more sensitive to different aspects of the reader's experience.

In sum, the main goal of the present study was to investigate the relations among different indices of cognitive coupling and mind wandering and to assess how these are related to comprehension. To accomplish this, we constructed short narratives with a structure comparable to that of Albrecht and O'Brien (1993). Each passage contained a target sentence that could be consistent or inconsistent with the prior text; the effect of consistency presumably provided an index of cognitive coupling based on memory retrieval. In addition, each passage contained sentences that were textually simple or complex, and the difference in reading time between complex and simple sentences provided a text-based index of cognitive coupling. Finally, after each passage, readers were asked to rate the extent to which they were on or off task, providing a probe-based measure of mind wandering. At the end of the session, readers were asked to report their reading effort as an index of their standard of coherence.

In this design, we had two classes of hypotheses. The first concerned the relations between indices of cognitive coupling and mind wandering. In this case, we expected both that the reading time effect of text difficulty to be larger when readers report being on task and that the effect of target sentence consistency would similarly be larger when readers are on task. The second class of hypotheses concerned the relation between measures related to mind wandering and comprehension. In this case, we hypothesized that on-task probe response, readers' standard of coherence, and the cognitive coupling measures should be related to comprehension.

Method

Participants

Data from 140 participants were collected in this study. The sample size was selected based on experience with similar reading-time paradigms and was deemed to be adequate for finding good evidence in favour of moderate-sized effects. The participants were undergraduates at the University of Alberta and received course credit. Data from one participant were not used because of a technical error during data collection which allowed the participant to run through the study twice. Eighteen participants were excluded because their median time per word was shorter than 50 ms, suggesting that they were not paying attention to the text. (Fifty ms, corresponding to a reading speed of 1200 words/m, was selected as a conservative cutoff for how long readers would spend on a word if they were trying to comprehend the passages in good faith.) An additional four participants were excluded because their accuracy on the comprehension questions was less than 50%. In total, data from 123 participants were used in the subsequent data analysis. For these participants, the mean reading time was 174 ms/word (with a standard deviation of 57 ms/word) and the proportion comprehension accuracy was .767 (with a standard deviation of .103). All participants had normal or corrected-to-normal vision.

Materials

Twenty-four narratives were constructed for the study. Some of these were based on the materials of Albrecht and O'Brien (1993) and O'Brien et al. (1998), but others were new. Each narrative consisted of a title indicating the name of the narrator (e.g., "Celia's Story"), followed by two to four introduction sentences to set up the narrative context. Following the introductory sentences, there was an elaboration sentence that was, in different versions of the passage, either consistent or inconsistent with a subsequent target sentence. There were then four continuation sentences. One of these was written to be textually difficult, and one was written to be simple. The difficult sentences had a Flesch-Kincaid grade level of 14.6, and the simple sentences a grade level of 4.1. All possible positions of the simple and difficult continuation sentences among the four continuation sentences occurred equally often across the 24 passages. The continuation sentences were followed by the target sentence; the target sentence was written to be sensible but relatively implausible in the context of the story introduction. Finally, there were two or three concluding sentences. On average, the narratives were 181.7 words and 11.8 sentences long. After the narrative, there were four multiple-choice comprehension sentences. An example passage is shown in Table 1, and the entire stimulus set is available at https://osf.io/dhp2w.

Table 1

Sample Passage Used in the Study

Sentence Type_Sentence	
Title	Celia's Story
Introduction 1	Tina and I were helping to throw a birthday party for our friend Becky.
Introduction 2	It's Becky's birthday, so we wanted to get together and celebrate.
Introduction 3	Tina and I both bought presents to give Becky at the party.
Consistent Elaboration	Tina said she wasn't happy with the gift she had gotten for Becky.
Inconsistent Elaboration	Tina said she was happy with the gift she had gotten for Becky.
Simple Continuation	There were only eight people at the party, besides me and her.
Neutral Continuation 1	We reserved an Italian restaurant.
Neutral Continuation 2	Becky was happy when she arrived here because she saw all her friends seating in one table in her birthday.
Difficult Continuation	Following our sumptuous banquet at this exquisite restaurant, we withdrew the gift from the shopping bag and made a formal presentation of it to her.
Target	Tina seemed sad to give Becky her gift.
Conclusion 1	Becky opened the presents and thanked both of us.
Conclusion 2	A few of her other friends brought gifts for her as well.
Conclusion 3	As Becky was opening the last few presents, the waitress came by with a complementary dessert for her.
Conclusion 4	Becky said it was one of the best birthdays she'd ever had.
Question 1	Whose birthday was it? Stacy's; Maddie's; Tina's; Becky's

Question 2	What kind of food did the restaurant serve? Mexican; Italian; Japanese; Moroccan
Question 3	How many people other than Tina and the narrator were at the party? Four; Six; Eight; Twelve
Question 4	What was the present given to Becky by the restaurant? A teddy bear; A complementary dessert; A birthday cake; A gift card

Procedure

Eight different counterbalancing orders for the passages were constructed in the following manner. To generate the first order, a random selection of half of the passages was assigned to the consistent condition and the remainder assigned to the inconsistent condition. A second, matching order was then created in which the consistent and inconsistent assignments were reversed. The sequence of the passages in the two orders was then randomized. This process was then repeated four times to create eight orders. Participants were randomly assigned to the eight orders in approximately equal numbers.

Each passage presentation began with the title; participants pressed the space bar to see each subsequent sentence. After each narrative, an on-task probe was presented, so that there were 24 probes in total. (Probes were included only at the end of each passage because we were concerned that probes during the reading of a passage might affect the memorial processes involved in resolving inconsistencies.) The probe consisted of the question, “Were you focused on the story or were thinking of something else?” Below the question was a grey-scale bar with the labels “Fully thinking of something else,” “Thinking of something else to some extent,” “Focused on the story to some extent,” and “Fully focused on the story” arrayed underneath. Participants responded by using the mouse to click somewhere along the bar to indicate the degree of task focus. The mean probe response was 345 (with a standard deviation of 81) on a scale from 0 to 566 pixels. After the on-task probe, participants responded to four multiple-choice comprehension questions; the answers were selected by clicking on a radio button next to the answer. Finally, at the end of the session, participants were asked, “How hard did you work to try to clearly understand what was going on the in the stories?” Participants again responded by clicking along a gray-scale bar with the labels “Hardly worked at all,” “Worked a little bit,” “Worked to some extent,” and “Worked very hard” arrayed underneath. The mean response to this question was 324 (with a standard deviation of 100) on a scale from 0 to 566 pixels. Data were collected using the online platform Testable (Rezlescu et al., 2020).

All procedures were approved by the Research Ethics Board at University of Alberta.

Analysis

We first analyzed the reading time effects in order to assess cognitive coupling and our first class of hypotheses. For each participant, reading time per word was calculated for the target sentence and the following sentence for consistent and inconsistent passages and for the simple and difficult continuation sentences. In order to minimize the effect of outliers, medians of these measures were calculated across passages. To examine effects of task focus, participants were divided into on-task and off-task groups based on a median split of participants' mean probe response across passages. We anticipated that cognitive coupling would be more evident among on-task participants, leading to greater effects of consistency and difficulty relative to off-task participants. In other words, if readers are on task, there should be an effect of consistency in which the inconsistent sentence was read more slowly than the consistent sentence; this memory-based cognitive coupling should be reduced if readers are off task. Similarly, if readers are on task, there should be a difference in reading time between the difficult and simple continuation sentences; this text-based cognitive coupling should be reduced if readers are off task. Models of these variables were fit using the program lmer (Bates et al., 2015) running in the R statistical environment (R Core Team, 2022). Model intercepts were assumed to vary across participants.

In addition to the reading time analyses, we also assessed the relationships among variables calculated for each participant to assess our second class of hypotheses. These variables were the standard of coherence score, the mean on-task probe score, the mean accuracy, the difference in median reading time for easy and difficult sentences, and the difference in median reading time for the consistent and inconsistent target sentences. These variables were first standardized, and then models were fit using the R program lm. Mediation analyses were performed using the program sem in the R package lavaan (Rosseel, 2012).

We did not use null hypothesis significance testing to assess the results because of the many well-documented problems with this approach (e.g., Cohen, 1994; Dixon, 2003; Wagenmakers, 2007). Instead, models were compared by calculating an adjusted likelihood ratio, λ_{adj} (cf. Glover & Dixon, 2004). This is functionally equivalent to comparing models on the basis of AIC values (Akaike, 1973), a well-known model-selection index. In some prototypical hypothesis testing scenarios, a *p* value less than .05 would correspond to an adjusted likelihood ratio of about 3. For our sample size, a moderate-sized effect of $d = 0.5$ would correspond to an adjusted likelihood ratio of 15.45 (as calculated by the methods described by Dixon and Glover (2020)).

Results

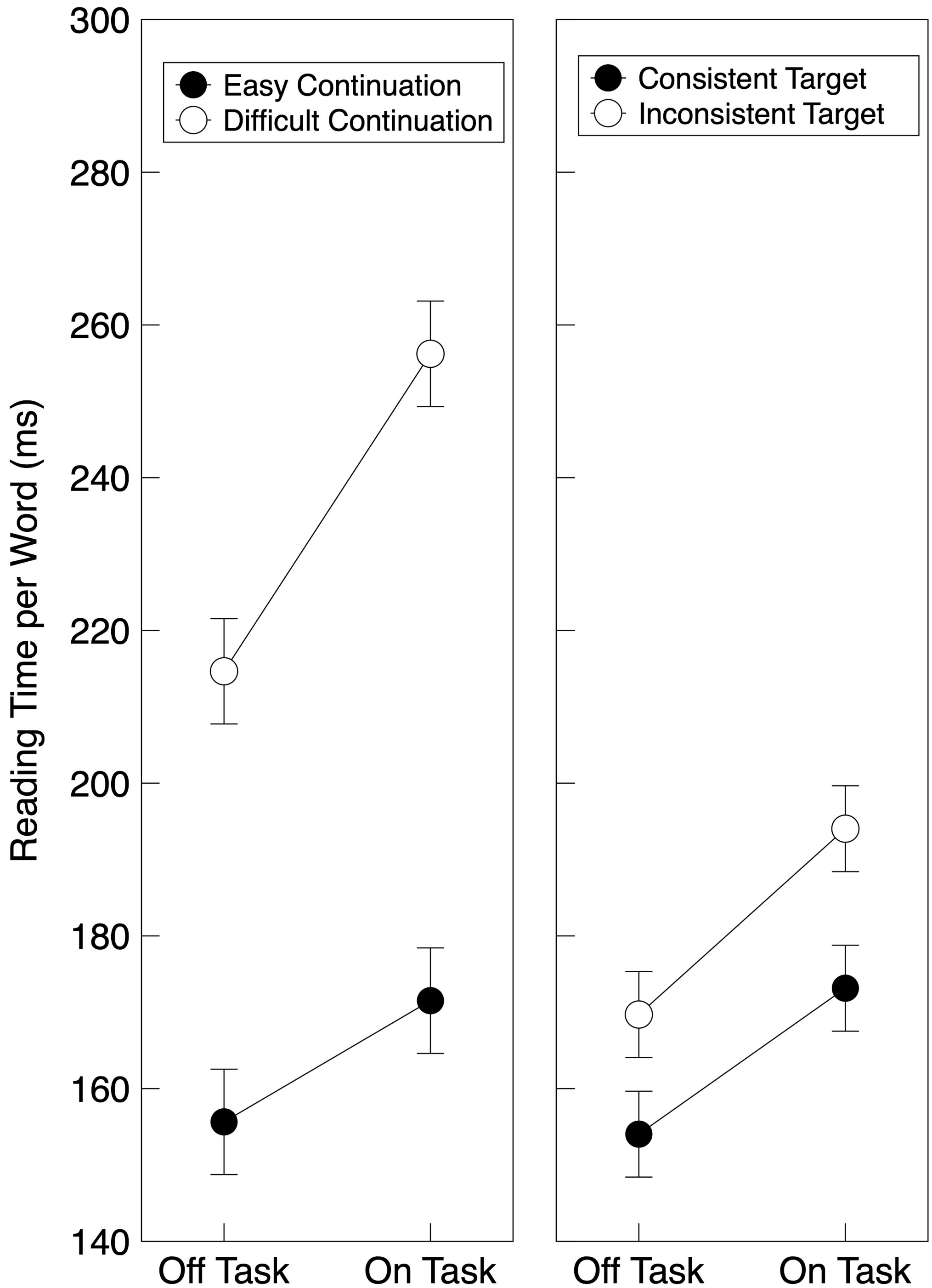
For the simple and difficult continuation sentences, there was a substantial effect of both text difficulty and on-task probe response on reading time, as shown in the left panel of Figure 1. Critically, the effect of text difficulty was smaller for off-task participants; this is the task-focus cognitive-coupling effect. This pattern of results was supported by the comparison of nested linear models. A model that included the effect of difficulty was better than the null model, $\lambda_{adj} > 1000$. Adding the effect of being on task improved the model further, $\lambda_{adj} = 5.43$. Critically, adding the interaction of on-task response and difficulty also improved the model, $\lambda_{adj} = 18.49$. Analyses treating probe response as a continuous measure was consistent with these results. In this case, there was evidence for an interaction between probe response and difficulty, $\lambda_{adj} = 6.51$, with a greater effect of on-task probe for the difficult continuation (0.26 ms/pixel with a standard deviation of 0.08) than for the easy continuation (0.13 ms/pixel with a a standard deviation of 0.08). These analyses confirm our first hypothesis that textual cognitive coupling would be related to mind wandering.

The consistency effect for the target sentence reading time is shown on the right of Figure 1. In this case, though, the effect appeared to be additive with the effect of being on task. Including the consistency effect made the model substantially better than the null model, $\lambda_{adj} > 1000$. Adding the effect of being on task led to further improvement, $\lambda_{adj} = 3.21$. However, there was no evidence for an interaction between the two, $\lambda_{adj} = 0.52$. Consistent results were also obtained using probe response as a continuous predictor. In this case, there was no evidence for an interaction between consistency and probe, $\lambda_{adj} = 0.41$, and the slope of the probe response predictor was similar for consistent (0.17 ms/pixel) and inconsistent (0.19 ms/pixel; standard deviation in both cases was 0.07 ms/pixel) sentences. Unlike some other studies using similar materials (e.g., O’Brien et al., 1998), there was no evidence for an effect of consistency on the reading time for the sentence following the target, λ_{adj} =

0.73 . These analyses indicate little support for our second hypothesis that memory-based cognitive coupling would be related to mind wandering.

Figure 1

Reading Time as a Function of Task Focus, Text Difficulty, and Target Consistency



Relevant to our second class of hypotheses, the correlations among the participant variables in shown in Table 2. There was a general positive relationship among all of the variables with the exception of the consistency effect, which was only modestly related to the effect of text difficulty.

Table 2

Correlation among Participant Measures

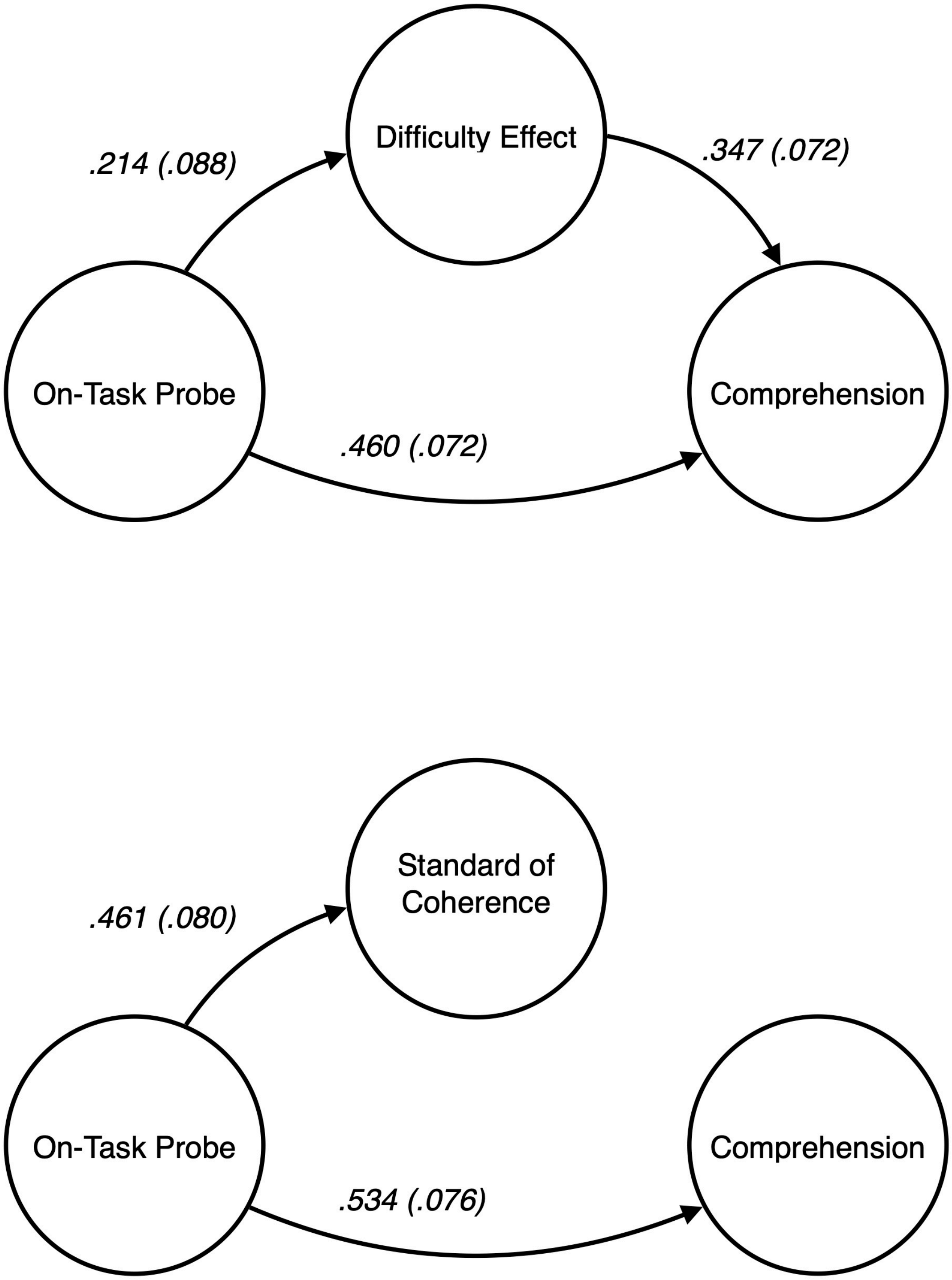
	Accuracy	Standard of Coherence	On-Task Probe	Text Difficulty Effect	Consistency Effect
Accuracy	1.00	0.38	0.55	0.48	0.09
Standard of Coherence	0.38	1.00	0.51	0.25	-0.07
On-Task Probe	0.55	0.51	1.00	0.26	0.05
Text Difficulty Effect	0.48	0.25	0.26	1.00	0.21
Consistency Effect	0.09	-0.07	0.05	0.21	1.00

In order to understand the relationships in Table 2, we compared nested linear models. Our analyses focused on comprehension accuracy as the outcome variable. A model that included the on-task probe score was a better predictor of accuracy than the null model, $\lambda_{adj} > 1000$. Similarly, a model that included the standard of coherence was also better than the null model, $\lambda_{adj} > 1000$. However, adding the standard of coherence measure to the on-task-probe model was no better than using probe score by itself, $\lambda_{adj} = 1.91$, while the model with both variables was substantially better than standard of coherence alone, $\lambda_{adj} > 1000$. Thus, with respect to comprehension, standard of coherence is part of the same variance indexed by on-task probe. On the other hand, adding the difficulty effect to that same model led to a substantial improvement, $\lambda_{adj} > 1000$, and difficulty and probe was better than difficulty alone, $\lambda_{adj} > 1000$. This result indicates that the difficulty effect also predicts comprehension, over and above what on-task probe score predicts. A model based on the consistency effect was no better than the null model, $\lambda_{adj} = 1.03$.

This pattern is consistent with a mediation analysis. The upper panel of Figure 2 is a depiction of the path model for the difficulty effect and probe. As can be seen, there is both direct and indirect effects of mind wandering on comprehension. This model is better than a model that excludes the direct effect of mind wandering, $\lambda_{adj} > 1000$. In contrast, the effect of the standard of coherence, although related to mind wandering, has no relationship to comprehension. This is shown in the lower panel of Figure 2. Adding an effect of standard of coherence on comprehension does not improve the model, λ_{adj} = 1.00. (Note that the model fit would be the same if probe response was assumed to be a function of standard of coherence rather than the reverse.) Thus, with respect to our second class of hypotheses, only the text-based difficulty effect and the on-task probe predicted comprehension performance.

Figure 2

Path Models for Predicting Comprehension



Discussion

The results of the present study demonstrate that text-based cognitive coupling is related to comprehension and mind wandering. This pattern of results is consistent with that of (Mills et al., 2017). Indeed, our path analysis in Figure 2 is comparable to the path analysis shown in their Figure 2. However, our results indicate that this effect can be found in relatively short, manipulated text segments consisting of a single sentence. On the other hand, there is a direct effect of mind wandering on comprehension, independent of cognitive coupling. This result, as well as those of Mills et al., supports the conclusion that cognitive coupling is not the same thing as mind wandering as measured by self-report probes. One possibility is that when readers report being off task, they are responding to aspects of their cognitive processing that is only partly related to text difficulty. For example, they may base their on-task responses based on the quality of their situation model representation (cf. Dixon & Bortolussi, 2013). Cognitive coupling may also index other aspects of text processing that may be related to subsequent comprehension test performance.

We also found a relationship between mind wandering and the amount of effort readers reported devoting to comprehension. Based on the assumption that this measure is related to readers' standards of coherence (van den Broek et al., 1995), we predicted that this measure would be related to comprehension as well. In particular, we surmised that readers with a higher standard of coherence would construct detailed, more elaborated mental models of the situation described in the text. However, this result failed to occur. A similar null effect on mind wandering was found by (Clinton-Lisell, 2023); they found no effect of a reading-purpose instruction that they presumed would be related to standards of coherence. Our conjecture is that the comprehension questions that we used may have been too superficial and circumscribed to be sensitive to such variation, and a similar analysis may apply to the Clinton-Lisell results. It is possible that recall-based comprehension test would show such effects more clearly (cf. Dixon & Bortolussi, 2013).

In contrast to our manipulation of text difficulty, we were unable to demonstrate a relationship between the consistency effect and other measures in our study. In particular, there was no interaction between the effect and either comprehension accuracy or on-task probe, even though we were able to find clear evidence for the consistency effect overall. According to the logic described in the introduction, this would be expected with the “here-and-now” view of the consistency effect described by Zwaan and Madden (2004). Our reasoning is that, according to this view, the inconsistent prior information would be maintained with the representation of the main character in the reader’s situation model. For example, in the inconsistent version of the passage shown in Table 1, Tina is happy with the nature of her gift; this disposition would be maintained as part of the representation of Tina in the situation model. This means that when the target sentence, "Tina seemed sad to give Becky her gift," is encountered, no further memory retrieval would be needed in order to notice and resolve the inconsistency. If the effect of mind wandering is localized primarily in the retrieval of prior text information, one would not expect an interaction with the effect of consistency. More generally, the complexity of these patterns of results make it difficult to conceptualize mind wandering as simply a failure of executive control (cf. Kane & McVay, 2012).

However, other interpretations are possible. For example, one may argue that memory resonance processes and the subsequent resolution processes transpire automatically so that there is no effect of whether the reader is on task or not. Another, related, possibility is that the *detection* of an inconsistency is unrelated to task focus, but when such an inconsistency is found, readers become more focused on the task in order to resolve the comprehension problem. In other words, a detected inconsistency leads readers to process the text more fully regardless of their prior state. Thus, there would be no interaction between the consistency effect and whether readers report being on task. (Note that this account predicts that there might be an effect of consistency condition on probe response: Readers would be more likely to be on task following an inconsistent passage. Although no such effect was found, the time between the presentation of the target sentence and the on-task probe could weaken such an effect.)

The present results also bear on the question of how task focus varies with task difficulty. As discussed earlier, text difficulty is known to affect the rate of mind wandering (e.g., Feng et al., 2013; Schurer et al., 2022; Kahmann et al., 2022). These types of results make the interpretation of cognitive-coupling relationships difficult because textual difficulty could be a cause of mind wandering in addition to providing an index for when it occurs. However, that causal relationship may be complex: For example, Kahmann et al. (2022) found an effect of difficulty only when readers found the material interesting; relatedly, Soemer and Schiefele (2019) found that the effects of difficulty on mind wandering were mediated by interest. Schurer et al. (2022) found more mind wandering during reading with a concurrent memory task but only with more difficult material. More generally, though, these issues may not apply to the current results because difficulty was manipulated on a sentence-by-sentence basis. Variables such as interest and text difficulty are unlikely to have an impact on mind wandering over the course of the few seconds it takes to read a sentence. Instead, we believe the most plausible interpretation of cognitive coupling in the present context is that a smaller effect of difficulty on reading time occurs because readers are already off task when the sentences are encountered.

There are also some important limitations of this study. For example, our measure of mind wandering is limited to only a retrospective probe at the end of each narrative rather than unpredictable probes during reading. Because they were only placed at the end of each passage, our approach could have missed episodes of mind wandering, particularly if they occurred early in the passage. Moreover, because the occurrence of the probe was predictable to some extent, readers might have curtailed mind wandering in anticipation of its presentation. Other, performance-based indices of mind wandering might also be used to eliminate possible biases in the subjective report. In addition, it might be argued that our manipulation of consistency was too weak. For example more dramatic differences between a character's previous and current behaviour could have yielded a larger consistency effect that interacted with task focus. Finally, our standard of coherence measure may have depended too heavily on readers' subjective, retrospective assessment of cognitive effort. Perhaps more immediate, online probes of effort would be sensitive.

In sum, the present results demonstrate that cognitive coupling is related to mind wandering when the measure of difficulty is text based and that this effect can be demonstrated on a sentence-by-sentence level. In contrast, cognitive coupling related to resolving textual inconsistencies does not seem to be related to mind wandering, perhaps because no memory retrieval is needed to identify and resolve the inconsistency.

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