



## Shifting the Coherence Threshold

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### **Author Note**

The authors declare that there are no conflicts of interest with respect to this preprint.

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**Abstract**

Within the RI-Val model of reading comprehension the coherence threshold marks the point at which the reader has deemed comprehension sufficient to move on in a text. Previous research has demonstrated that the readers' coherence threshold can be manipulated by increasing task-demands (Williams et al., 2018) or including text-based disruption in coherence (Sonia & O'Brien, in prep). The goal of the current research was to investigate factors that influence the resetting of the coherence threshold to baseline.

*Keywords:* reading comprehension, memory-based text processing, misinformation

### **Shifting the Coherence Threshold**

When readers are told to pay close attention to sentences such as: “It is well known that Moses took two of each kind of animal on the Ark,” they often do not notice the semantic anomaly (Erickson & Mattson, 1981). Processes described in the RI-Val model (O’Brien & Cook, 2016a; 2016b) can be used to understand the cognitive processes underlying comprehension, including if and when readers will detect incorrect information. As outlined by the model, readers encode incoming information from the text and integrate it with the contents of active memory. That information is then “checked” via a passive pattern matching process to assess whether the encoded information matches the information in memory. How long this pattern matching process runs before the reader moves on in a text depends upon the reader’s coherence threshold. If the coherence threshold is high, the reader will allow for an extensive check; in this case, they would likely detect misinformation. In contrast, if the coherence threshold is low, the reader will spend little time checking; in this case, readers are unlikely to detect misinformation.

Williams, Cook, and O’Brien (2018) embedded anomalies in short texts and measured reading times on target sentences, that contained a semantic anomaly (e.g. “Moses brought two animals of each kind on the ark.”) Across several experiments, readers failed to detect the semantic anomaly on the target sentence, but under some conditions, they did detect it on the spillover sentence—the sentence after the target. However, when readers’ coherence threshold was raised by using a task-based manipulation (i.e., asking multiple comprehension questions after each passage), the semantic anomalies were detected on the target sentence.

Williams et al. (2018) demonstrated that task-based manipulations can be used to raise a reader’s coherence threshold and thereby comprehension. Sonia & O’Brien (in prep) investigated

whether the coherence threshold could be raised using a text-based manipulation, resulting in readers detecting the semantic anomaly on the target sentence. For each passage from the Williams et al. (2018) study, Sonia and O'Brien added an extended opening (see sample passage in Appendix). The openings contained a target sentence that was either consistent or inconsistent with the information presented in an early portion of the opening. Following the target sentence, the passages transitioned into the semantic anomaly passages from Williams et al. (2018). If the inconsistency in the extended opening serves to alert the reader to pay closer attention (i.e., raise their coherence threshold), the readers should notice the anomaly on the target sentence. Reading times on the semantic anomaly confirmed that the early inconsistency raised the reader's coherence threshold; reading times on the semantic anomaly sentence were now disrupted indicating that readers were detecting the anomaly. In a second experiment, additional filler was added after the early inconsistency to determine if the increase in the reader's coherence threshold was transient or was held at a higher level over an extended period. Readers continued to detect the anomaly on the target sentence, indicating that once the coherence threshold is raised, it remained high at least over several sentences.

Sonia and O'Brien (in prep) demonstrated that once a text-based manipulation increases the reader's coherence threshold, it remains high for an extended period, at least within the passage being read. The goal of the current experiments was to assess whether the coherence threshold would reset if a break was placed after the early inconsistency but before the semantic anomaly (see sample passage in Appendix). If placing a break between the initial inconsistency and the semantic anomaly results in a resetting of the coherence threshold, the readers should no longer detect the semantic anomaly on the target sentence. Each of the passages was split in half. The first half contained the complete opening that included the early inconsistency. The second

half contained the portion of the passage that contained the semantic anomaly. In Experiment 1, the reader was required to pause between the two passage halves. In Experiment 2, a more complete break, including a comprehension question was placed in between the passage halves.

## **Method**

### **Participants**

Ninety-six undergraduates were recruited from the University of New Hampshire for Experiment 1.

### **Materials**

The materials of these studies consisted of 24 experimental passages adapted from Sonia & O'Brien (in prep). The first half of each passage was either consistent or inconsistent with a mid-passage target sentence. The second half of each passage began with an elaboration section, followed by the semantic anomaly target sentence that was either correct or incorrect. This resulted in four conditions: consistent-correct, consistent-incorrect, inconsistent-correct, and inconsistent-incorrect.

### **Procedure**

Participants read the passages line-by-line on a computer. Reading times were measured on all the target and spillover sentences. After each passage, the stimulus "QUESTIONS" appeared on the screen followed by a comprehension question to ensure that participants were reading carefully. Participants would respond to the question by pressing either "yes" or "no" and then the word "READY" would appear to indicate that they could move onto the next passage. This study was run using a between-subjects design. Half of the participants (n=48) were assigned to the no-pause group which followed the exact procedure described above. Half of the participants (n=48) were assigned to the pause group in which directly after the mid-

passage conclusion they were presented with the words “PAUSE” on the screen for 2000ms.

During this time, they were not allowed to press the line-advance key to continue. After the time was up, they were prompted to continue reading with the cue “PAUSE-CONTINUE”.

### Results

The reading times for both sets of target and spillover sentences were recorded. Reading times greater than 2.5 standard deviations from a participant’s mean were discarded; this resulted in the loss of less than 3% of the data across all experiments. In all analyses reported,  $F_1$  refers to tests against error terms based on participant variability and  $F_2$  refers to tests against error terms based on item variability.

There were no reliable differences between the with pause and without pause groups. The mean reading times for the target and spillover sentences for the with pause condition are presented in Table 1. The results of Experiment 1 replicated those of Sonia & O’Brien (in prep), in the first half the passage the inconsistency disrupted comprehension: reading times on the target sentence were slower when they appeared in the inconsistent condition than the consistent condition,  $F_1(1, 91) = 233.50$ ,  $MSE = 75,035$ ,  $p < .001$ ;  $F_2(1, 43) = 109.86$ ,  $MSE = 88,326$ ,  $p < .001$ . When the first half of the passage was consistent, there was no effect from the semantic anomaly on the target sentence  $F_1(1, 91) = .480$ ,  $MSE = 73,602$ ,  $p = .490$ ;  $F_2(1, 43) = .511$ ,  $MSE = 170,003$ ,  $p = .479$ ; however the effect appeared on the spillover sentence,  $F_1(1, 91) = 33.06$ ,  $MSE = 106,193$ ,  $p < .001$ ;  $F_2(1, 43) = 11.22$ ,  $MSE = 128,826$ ,  $p = .002$ . When the first half of the passage was inconsistent, the effect from the semantic anomaly appeared on the target sentence itself,  $F_1(1, 91) = 100.48$ ,  $MSE = 111,687$ ,  $p < .001$ ;  $F_2(1, 43) = 31.06$ ,  $MSE = 149,704$ ,  $p < .001$ . This suggests that processing an inconsistency earlier in the text served to raise the readers’ coherence threshold and that the coherence threshold was not reset following a pause in reading.

**Table 1**

*Exp 1: Mean Reading Times for the With Pause Condition.*

	<b>Consistent (C)</b>	<b>Inconsistent (I)</b>	<b>I-C</b>
<b>Opening Target Sentence</b>	2257	2749	492
<b>Opening Spillover Sentence</b>	2100	2412	312
<b>Semantic Anomaly Target Sentence</b>			
	<b>Correct (C)</b>	<b>Incorrect (I)</b>	<b>I-C</b>
<b>Consistent</b>	2329	2332	3
<b>Inconsistent</b>	2270	2556	286
<b>Semantic Anomaly Spillover Sentence</b>			
	<b>Correct (C)</b>	<b>Incorrect (I)</b>	<b>I-C</b>
<b>Consistent</b>	2086	2265	179
<b>Inconsistent</b>	2066	2330	264

## Experiment 2

In Experiment 2 a full passage break including a comprehension question was placed in between the two passage halves. If placing a full passage break in between the two sections is still not enough to reset the coherence threshold then we should see the same results as Experiment 1. However, if a passage break does reset the coherence threshold then we should see the semantic anomaly effect delayed to the spillover sentence regardless of whether the opening is consistent or inconsistent.

## Method

### Participants



Forty-eight undergraduates were recruited from the University of New Hampshire for Experiment 2.

### **Materials**

The passages from Experiment 1 were used with one major change. A comprehension question was added in between the two passage halves. The content of the passages was not changed.

### **Procedure**

The procedure remained the same except that for each passage in between the passage opening and the semantic anomaly, participants received a full passage break. Following the last line of the opening section, the cue “QUESTIONS” appeared in the center of the screen for 2,000ms. This was followed by the comprehension question, to which participants responded by either pressing the “yes” or “no” key. On the trials where participants made an error, the word “ERROR” appeared in the middle of the screen for 750ms. Following this the cue “READY” appeared on the screen and participants were instructed to press the line advance key to continue reading. These passage breaks also occurred at the end of each semantic anomaly section as they had in the previous experiments.

### **Results**

The mean reading times for the target and spillover sentences are presented in Table 2. The results replicated the results from Experiment 1 with one major exception: reading times on the incorrect semantic anomaly target sentences were not disrupted regardless of whether the opening was consistent or inconsistent,  $F_1(1, 44) = .72$ ,  $MSE = 21,909$ ,  $p = .402$ ;  $F_2(1, 20) = .05$ ,  $MSE = 60,821$ ,  $p < .825$ . The effect was instead delayed to the semantic anomaly spillover sentence in all conditions,  $F_1(1, 44) = 123.67$ ,  $MSE = 19,893$ ,  $p < .001$ ;  $F_2(1, 20) = 26.06$ ,  $MSE = 44,053$ ,

$p < .001$ . This finding demonstrates that inserting a significant break in reading (i.e., inserting a comprehension question) was sufficient to reset the reader's coherence threshold.

**Table 2**

*Mean Reading Times in Experiment 2.*

	<b>Consistent (C)</b>	<b>Inconsistent (I)</b>	<b>I-C</b>
<b>Opening Target Sentence</b>	2053	2583	530
<b>Opening Spillover Sentence</b>	2001	2269	268
<b>Semantic Anomaly Target Sentence</b>			
	<b>Correct (C)</b>	<b>Incorrect (I)</b>	<b>I-C</b>
<b>Consistent</b>	2352	2391	39
<b>Inconsistent</b>	2371	2374	3
<b>Semantic Anomaly Spillover Sentence</b>			
	<b>Correct (C)</b>	<b>Incorrect (I)</b>	<b>I-C</b>
<b>Consistent</b>	2002	2212	210
<b>Inconsistent</b>	2064	2306	242

### **Discussion**

These studies replicated the effect that the coherence threshold is raised following an in-text processing disruption, and they also expanded upon what we know about the coherence threshold. The current results confirm the hypothesis that the coherence threshold is reset following a passage break. However, simply asking participants to pause in their reading was not enough to cause the coherence threshold to be reset. It only returned to baseline when the two passage halves were separated by a comprehension question as if they were entirely separate passages.

## Appendix

### Sample Passage

#### *Consistent Introduction:*

Tom was an avid reader who enjoyed many different kinds of magazines and books. There were piles of books all over his house and a bookshelf in every room. Each morning, Tom started his day by eating a bowl of cereal and reading the morning paper. He wanted to stay up to date with current news and found this morning ritual to be both relaxing and informative.

#### *Inconsistent Introduction:*

Tom was an avid reader who enjoyed many different kinds of magazines and books. There were piles of books all over his house and a bookshelf in every room, but no newspapers. Tom found reading about current events to be depressing and preferred to read things that allowed him to escape reality. Each morning, Tom started his day by eating a bowl of cereal and reading.

#### *Background:*

One morning when Tom got up to start his day he found that he had run out of his regular cereal. He didn't have time to go to the store before work. He decided to make a tall cup of coffee instead. It was important that he be on time to work that day because he had an early meeting. Tom worked very hard, but when he had any free time, he would sneak away to the break room and read as much as he could.

*Target Sentence:* He enjoyed staying up to date with current events.

*Spillover Sentence:* Tom sat down with his cup of coffee to read.

*Closing 1:* His desire to learn about new topics helped to make his reading material more interesting. Tom liked to pick readings that were from very different genres.

*PAUSE (Experiment 1)*

*Question (Experiment 2):*

Does Tom read in the break room?

#### *High Context:*

Tom also had a desire to understand other people's cultures, so he decided to read some of the **bible**. He began with the **Old Testament** and the many stories found within its chapters. Tom read about the **beginning of mankind** and a **great flood that God had used to punish his people**. Although Tom was not devotedly **religious**, he thought that by reading about prominent **religious** figures he would better understand other people's views.

One new piece of information Tom learned was that

*Target Sentence:* Noah/Moses brought two animals of each kind on the ark.

*Spillover Sentence:* Tom enjoyed learning about the ark in the bible.

#### *Closing 2:*

Eventually, Tom remembered there was still work to do and put away his book. He refilled his coffee and thought about all the interesting things he had read about.

*Question (Experiment 1):*

Does Tom read in the break room?

*Question (Experiment 2):*

Was Tom devotedly religious?

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