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Comprehension processes and outcomes with refutation and expository texts and their contribution to learning

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ABSTRACT

The study compared the comprehension processes and outcomes obtained with refutation and expository text and their association with learning outcomes. After a knowledge pretest, undergraduate students read an extended expository text or a corresponding refutation text that addressed three potential misconceptions about the scientific concept of energy. Think-aloud, cued recall, and posttest data indicated that the positive impact of refutation text was more associated with comprehension outcomes than processes. Refutation text did not influence comprehension processes but facilitated valid inference generation in recall and minimized the negative effects of distortions on learning. The findings suggest the timing of the refutation text effect to be later, after reading, and its nature to be that of neutralizing the influence of any misconceptions on learning from text instead of changing them.

1. Introduction

Research exploring conceptual change in science learning has shown refutation texts that explicitly acknowledge and refute potential misconceptions to be generally more beneficial than standard expository science texts when learning requires the restructuring of prior incorrect knowledge (e.g., Braasch, Goldman, & Wiley, 2013; Diakidoy, Kendeou, & Ioannides, 2003; Mikkilä-Erdmann, 2001). However, a positive refutation text effect on learning and conceptual change has not been a consistent finding (e.g., Hynd & Guzzetti, 1998; Mason, Gava, & Boldrin, 2008; Palmer, 2003). As a result, one strand of research has examined more closely reader and refutation text characteristics that may facilitate learning (e.g., Braasch et al., 2013; Kendeou, Muis, & Fulton, 2011). A parallel, yet related, line of research has focused on text comprehension, recognizing it as the basis for learning from text (Sinatra & Broughton, 2011). In this context, it has been acknowledged that the underlying mechanisms that may result in any learning gains with refutation text remain unclear. Consequently, several relatively recent studies have focused on the comprehension processes and outcomes with refutation texts (e.g., Ariasi & Mason, 2011; Diakidoy, Mouskounti, & Ioannides, 2011; Kendeou et al., 2011; Kendeou & van den Broek, 2007; Kendeou, Walsh, Smith, & O'Brien, 2014). This research, however, provides an incomplete picture as there has been no simultaneous focus on all three constructs of interest: comprehension processes, comprehension outcomes, and learning outcomes. Consequently, although the findings are intriguing, they also raise a set of questions regarding the association between comprehension processes and outcomes and their relative contribution to learning as a function of text structure. Therefore, the purpose of this study was to contribute to our understanding of the refutation text effect by comparing directly the comprehension processes and outcomes obtained with refutation and expository texts and their contribution to subsequent learning from text.

1.1. Refutation text effects

Comprehension and learning from text depend on readers' ability to construct a coherent and well-elaborated mental representation of the information presented in text. Critical text parts need to be mentally represented in relation to each other as well as in relation to existing knowledge structures that may be relevant or related (Kintsch, 1988). The coherence of the representation is a key factor for deep comprehension as it is intimately tied with integration of new information with existing knowledge in long-term memory (Coté, Goldman, & Saul, 1998; McNamara & Magliano,

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2009). This integration, in turn, opens the way for the enrichment and/or modification of existing knowledge structures – that is, meaningful learning. Since no text explicitly specifies all the possible connections that can exist between text ideas, a lot of coherence building rests on the ability to activate and use available knowledge structures to infer within-text and knowledge connections that give rise to an understanding of the text as a whole and its integration with relevant knowledge structures facilitating, thereby, their enrichment and/or modification. Inferencing, however, is complicated in the case of expository text as readers are likely to lack an adequate knowledge base to support their coherence building and integration efforts (e.g., Coté et al., 1998). The problem is compounded by the possibility of incompatible or inaccurate prior knowledge, as is often the case with scientific expository text. In this case, readers' misconceptions may hinder any attempts at integration or they may give rise to incorrect inferences.

The findings of Kendeou and van den Broek (2005) support this latter possibility by showing readers with misconceptions to engage in the same processes, such as paraphrasing and inferencing, as readers without misconceptions. Incompatible prior knowledge, however, had a negative influence on the content of these processes resulting in more invalid inferences during reading and lower recall of text information after reading (Kendeou & van den Broek, 2005). These findings were replicated in a subsequent study that included text structure as a variable (Kendeou & van den Broek, 2007). They had young adult readers with and without misconceptions read a refutation or a non-refutation text on Newton' laws of motion. Their think-aloud results indicated that readers with misconceptions generated fewer valid and more invalid inferences during reading regardless of text structure. These invalid inferences that were incorrect on the basis of text information were interpreted to reflect the influence of incorrect knowledge (Kendeou & van den Broek, 2007). The refutation text, however, led readers to engage in conceptual change strategies like noticing and attempting to revise discrepancies between prior knowledge and text information. This type of online processes was not observed with readers who had no misconceptions or those who read the non-refutation text. Kendeou and van den Broek (2007; van den Broek & Kendeou, 2008) interpreted their findings to indicate that the refutation text effect on learning is due to the co-activation of misconceptions and scientific explanations that supports their comparison and contrast. Having the two contrasting conceptions active in working memory at the same time increases the likelihood that the reader will notice and possibly attempt to resolve any discrepancies (see also McCrudden, 2012).

Noticing and attempting to revise discrepancies between what one knows and what one reads should be reflected in longer processing times for readers with misconceptions when they read a refutation text. However, studies that have employed a reading time methodology provide mixed results showing longer, shorter, or comparable reading times for different parts of the text or the refutation text as a whole (e.g., Braasch, et al. 2013; Broughton, Sinatra, & Reynolds, 2010; Kendeou & van den Broek, 2007; experiment 2). In an eye-tracking study, Ariasi and Mason (2011) had young adult readers with misconceptions about the phenomenon of tides read either a refutation or a standard expository text on the topic. Online measures (first- and second-pass fixations) indicated that refutation text readers spent less time on refutation segments and more time (overall and during rereading, but not on first-pass) on segments that presented scientific concepts, that is, text information that conflicted with their prior knowledge. More interestingly, fixation times on refutational and scientific conception segments were positive and significant predictors of subsequent learning, while overall reading time of the text was a negative predictor of learning from refutation text.

Ariasi and Mason (2011) interpreted their pattern of results as indicating the strategic allocation of attention to the processing of critical text information as opposed to non-critical information. Moreover, in line with the co-activation hypothesis, they assumed this strategic processing to entail discrepancy resolution attempts on the part of their readers. Nevertheless, the longer fixation times could also reflect strategic processing to ensure the encoding and retention of this critical information in memory instead, and to minimize the influence of existing misconceptions. Considering that refutations tag misconceptions as faulty knowledge (Braasch et al., 2013), they may also function as signals to warn readers against relying on this knowledge as they process the text. In fact, in light of explicit refutations, an overreliance on prior knowledge for generating inferences could be taken as a sign of non-strategic processing and a failure to comprehend the meaning and the implications of the refutational segments. Instead, a more profitable first-step strategy would be to ensure that the memory imprint of the new incompatible information is distinct and as strong, if not stronger, as that of any misconceptions in order to counteract their influence and to ensure the availability of new information for further processing and use later on and as needed (see also Penttinen, Anto, & Mikkilä-Erdmann, 2013).

If attention and processing resources are allocated to ensure the encoding of critical scientific information in memory because the refutations have warned readers against the use of prior knowledge, then readers may adopt a more text- and sentence-based approach (e.g., Coté et al., 1998) resulting in fewer online (valid and invalid) inferences during the reading of a refutation text when compared to an expository text. This possibility, however, is not supported by results showing no effect of text on online inferences, that is, inferencing during reading (Kendeou & van den Broek, 2007). Moreover, assuming that comprehension processes are associated with comprehension outcomes (e.g., Coté et al., 1998; Kintsch, 1988), this possibility appears to also run counter to findings showing a positive refutation text effect on offline inferences, that is, those manifested after reading in response to post–reading tasks like text recall. Specifically, Diakidoy et al. (2011) had young adults with varying amounts of prior knowledge and misconceptions read either an expository text about energy or a corresponding refutation text that addressed and refuted three potential misconceptions about this concept. Comprehension was assessed after reading with a cued recall task that was scored to provide measures of both overall retention of text information as well as number and kinds of inferences generated in recall. Their results indicated a significant text effect on inferences only. Refutation text recalls contained more valid inferences than expository text recalls and regardless of prior knowledge (Diakidoy et al., 2011).

1.2. Refutation text after-effects

The contrast between findings regarding online and offline inferences leaves open the possibility that the increased inference generation observed in the recall of refutation text is the product of reconstructive and more goal-directed processes operating in response to a certain task: to produce a coherent recall protocol. According to the elaborative retrieval hypothesis, recall involves top-down, monitoring, and reconstructive processes associated with the re-activation and further (re)processing of retained information (Carpenter, 2009). In the case of learning from text, the re-activated representation of its content provides the grounds for reworking, reconnecting, and restructuring the originally encoded information. It is reasonable to suppose, then, that the quality of this subsequent processing and its outcomes depend on the