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Abstract

Texts vary. Thus, accordingly, do different texts encourage certain types of online comprehension processing? This presentation illuminates how science texts with varying levels of cohesion may contribute to the online comprehension processing of seventh grade readers during a think-aloud task. Our analyses illustrate how students' inference generation differed in science texts with varying degrees of deep and referential cohesion. Implications are drawn about the effects of text cohesion for online inference generation in adolescents.

Keywords: Deep cohesion, referential cohesion, text comprehension, adolescent, text processing

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Introduction

Length, topic, and overall difficulty of a text have been shown to influence how well a reader comprehends text (e.g., Deane et al., 2006). Middle school readers are tasked with comprehending texts from diverse genres, novel vocabulary, and varying syntactic norms (e.g., science) which presents distinctly different challenges. One such challenge includes the extent to which a text creates explicit connections between referents, events, ideas, and relationships, also known as *cohesion*. The amount of cohesion within a text has specific implications for the types of processing readers engage in while reading (i.e., inferencing), in addition to general implications for how well a text is understood (e.g., Best et al., 2005). Furthermore, science texts often lack cohesion, which contributes to how well science texts are understood, especially in young learners (Best et al., 2005). Thus, it is imperative to account for text cohesion in the pursuit of understanding how middle school readers successfully comprehend science texts.

Text Cohesion

Cohesion is a text feature that can contribute to text quality and difficulty levels for a reader. Inferencing is a central component in how readers process text (e.g., Kintsch, 1988) and several studies have demonstrated that low cohesion texts may be disadvantageous for readers who struggle to infer (e.g., O'Reilly & McNamara, 2007). This is because texts with cohesion gaps, or low cohesion texts require readers to generate inferences.

Referential and Deep Cohesion's Effects on Inferencing

Referential cohesion is the extent to which words or ideas are explicitly connected from sentence to sentence in a text. Deep cohesion refers to the extent to which relationships and events connect across a passage. Texts with deep cohesion gaps prevent readers from generating inferences related to causal events, processes, and actions within a text and as a consequence, reader comprehension suffers (McNamara et al., 2014). Texts with referential cohesion gaps also present potential hurdles for readers when words or ideas are not connected across sentences, and therefore, can affect one's text-base comprehension and time spent reading (McNamara & Kintsch, 1996). Thus, the link between text cohesion and inferencing has significant implications for readers who struggle with inferencing and lack prior knowledge (McNamara et al., 1996), which is unfortunately a frequently observed characteristic of middle school readers (Best et al., 2005).

Text Cohesion and Online Comprehension Processing in Middle School Readers

In order understand higher-level (e.g., inferencing) comprehension processes, researchers use a method called a think-aloud task. In a think aloud task, readers are asked to read a text, talk out loud after each line or sentence, and say whatever comes to mind (e.g., Ericsson & Simon, 1993). Responses during a think aloud task reflect how a reader processes text in the moment and therefore, think aloud tasks afford researchers insight into how a reader engages with text in real-time, rather than traditional measures of reading comprehension which gather data on comprehension products derived after the act of reading has concluded (i.e., multiple-choice questions, recall).

There is limited existing research which distinguishes how cohesion, but especially deep cohesion, affects reading comprehension processes broadly, and more specifically with middle school readers and science texts. However, the aforementioned body of research indicates that cohesion, specifically referential comprehension, contributes to how well children understand text (e.g., Best et al., 2005; Hall et al., 2016). Furthermore, deep and referential cohesion are not typically examined together, and to our knowledge, have not been examined in tandem with middle school readers' comprehension processing.

The Current Study

Thus, the current study extends the literature in order to understand how science texts with text cohesion variability contribute to the online comprehension processes of middle school readers. Our efforts in this study are primarily exploratory and although we did not attempt a rigorous experimental manipulation, we did seek to better understand how the reading comprehension processes of middle school readers unfold in real-time while reading authentic science texts.

Method

Participants

The participants were seventh grade ($N = 30$) children from a rural city in the southeastern U.S. Sex was distributed as 53% female and 46% male in the population with the following racial demographics: 87% caucasian, 7% African-American, 3% Asian, 3% Hispanic. Participants were recruited via parent consent.

Materials

Science texts

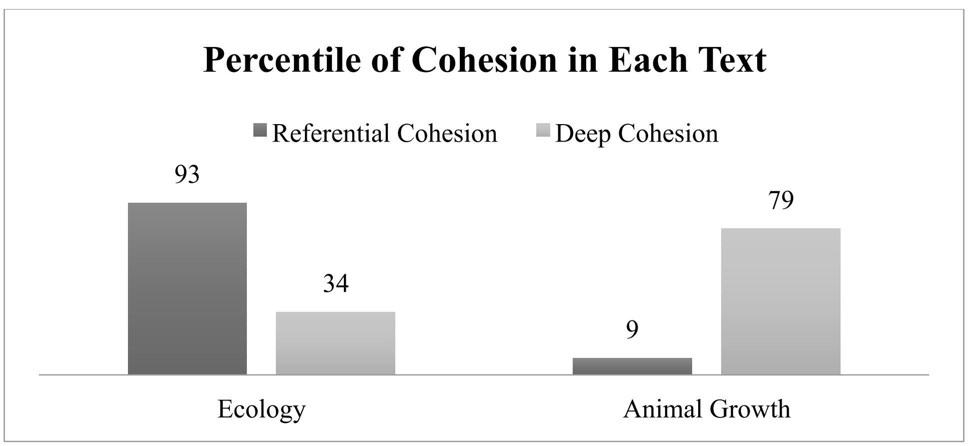
Two age and content-appropriate Grade 7 science texts were selected after consultation with our students' teachers and middle and secondary education specialists. We used Coh-Metrix to quantify the deep and referential cohesion present within each text (Graesser et al., 2014). For our analyses we also included typical descriptive measures (length as indicated by word count and sentence length) and readability (Flesh-Kincaid Grade Level).

Ecology Text. "The Kelp Forest" (i.e., ecology text), defined kelp as an ecosystem (Wood, 2008) and is 45 sentences, 846 words, and a 9.6 Flesch-Kincaid grade-level. The *Ecology* text presented with a low deep cohesion score (*z* score = -.42; percentile = 34%) and a high referential cohesion score (*z* score = 1.49; percentile = 93%) (see Figure 1 below).

***Animal Growth* Text.** "Explaining the Factors that Influence Animal Growth Text" (i.e., animal growth text) explained generational change in animals due to genetics and the environment (DiSpezio et al., 2018) and is 29 sentences, 422 words, and a 9.8 Flesch-Kincaid grade-level. The *Animal Growth* text earned a high deep cohesion rating (*z* score = .80; percentile = 78%) and a low referential cohesion rating (*z* score = -1.33; percentile = 9%) (also see Figure 1).

Figure 1.

Percentile of Cohesion in the Ecology and Animal Growth Texts



Measures

Think-aloud Task

Think-aloud tasks are used to measure the comprehension processes readers engage in while reading. Students read the *Ecology* and *Animal Growth* texts sentence-by-sentence from a binder while being audio recorded. After each sentence, participants thought out loud about whatever came to mind, even if it were obvious, because there were no right or wrong answers. After reading each text in its entirety, participants answered open-ended comprehension questions in order to ensure basic understanding of each passage.

Procedures

Participants completed individually administered think-aloud tasks during designated school hours. Texts were counterbalanced and presented in quiet setting at the students' school by trained graduate researchers. Verbal responses were recorded and transcribed for later coding based on comprehension processes identified in previous research (Carlson et al., 2014).

Think-aloud responses were coded as: connecting inferences, elaborative inferences, evaluative comments, paraphrases, metacognitive comments, and associations (see Table 1). Each response in a think-aloud protocol was coded as one comprehension process. Twenty percent of the transcripts were coded by four investigators and the remaining were coded by two graduate student researchers. When present, discrepancies were resolved via group discussion. Coding reliability was achieved at $k = .90$ (Light, 1971).

Table 1.

Think-Aloud Coding Scheme

Code	Definition
Connecting Inference (CI)	Explains the current sentence using words in the text
Elaborative Inference (EI)	Explains the current sentence using relevant background knowledge
Evaluation (EV)	Evaluation about the text function, content, or structure

Paraphrase (PAR)	Uses words of the current sentences to restate what was read
Metacognitive Comments (MC)	Reflecting on understanding or lack of understanding; agreement or disagreement; or lack of prior knowledge with the text.
Association (AS)	Concepts brought to mind using background knowledge, but not directly related

Results

Analytic Strategy

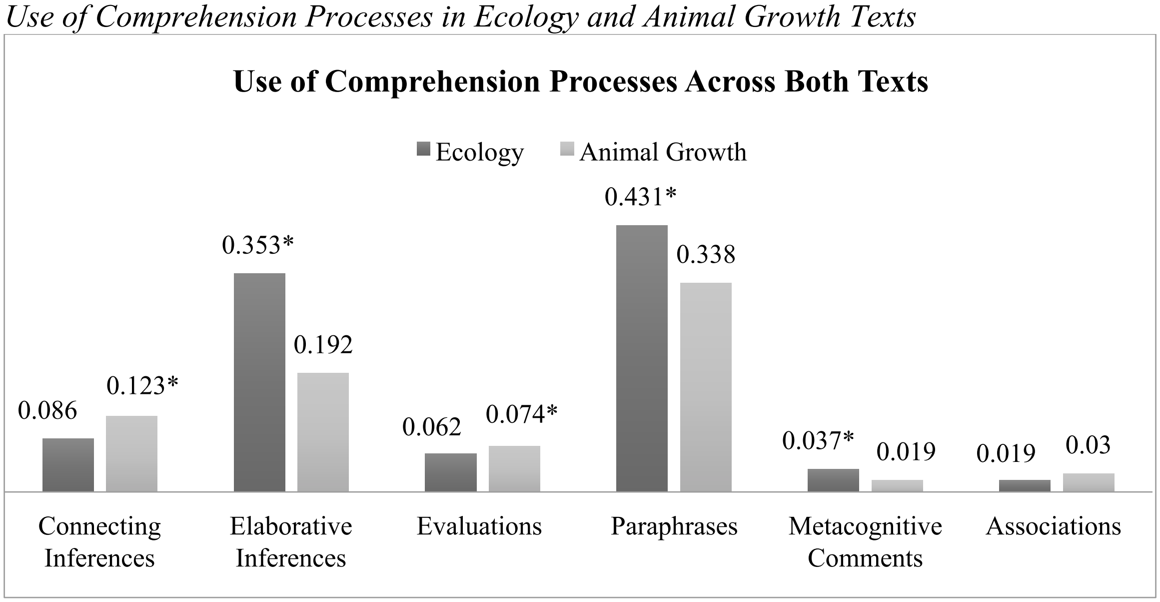
We employed a combination of descriptive and inferential statistical analyses to evaluate students' comprehension processes. Descriptive analyses included a comparison of the quantity and type of comprehension processes generated by students while reading the *Ecology* and *Animal Growth* texts. Inferential statistical analysis included a within-subjects design where the independent variables were the two informational science texts and dependent variables were the comprehension processes participants generated during the think-aloud task.

Prior to conducting our inferential statistical analyses, we also accounted for differences in text length. To mitigate text length differences, we used proportional means as a method for comparing the comprehension processes in each text. For example, the mean number of evaluations generated in the *Ecology* text was divided by 45 (the amount of lines in the text) and accordingly, the mean number of evaluations generated in the *Animal Growth* text was divided by 29 (the amount of lines in the text). Next, we performed a one-way within-subjects repeated measure multivariate analysis of variance (RM-MANOVA) to compare the number of comprehension processes participants employed as a function of text. Follow-up paired samples t-tests were conducted to determine whether the type of comprehension processes participants used during reading the two texts differed significantly.

Descriptive Analyses

Overall, elaborative inferences and paraphrases were the most commonly used comprehension processes (*M* = 0.353 and *M* = 0.431 respectively). Connecting inferences, evaluative comments, metacognitive comments, and associations were generated less often than elaborative inferences and paraphrases. Figure 2 depicts the spread of comprehension processes produced across both texts. The higher incidence of elaborative inferences and paraphrases is consisent with previous research investigating the types of comprehension processes produced by children during think-aloud tasks (e.g., Carlson et al., 2014). This visual inspection also indicates how cohesion may have impacted readers across the two texts that we now explore quantitatively.

Figure 2.
Use of Comprehension Processes in Ecology and Animal Growth Texts



Note. * depicts a significant difference of process use as determined by paired samples t-test ($p < .05$).

Inferential Statistics Analyses

The RM-MANOVA results indicated that there was not a significant difference between participants' number of comprehension processes used across the texts ($p > .05$); however, there was an overall statistically significant difference in the proportion of comprehension process types generated across participants $F(5, 25) = 114.26$, $p < .001$; Wilk's $\Lambda = .04$, $\eta 2 = .42$. In addition, a statistically significant interaction between comprehension processes generated and text was found $F(5, 25) = 3.54$, $p = .015$; Wilk's $\Lambda = .59$, $\eta 2 = .42$. These findings depict that the type of comprehension processes middle school readers employed as they read were different when reading the high referential cohesion text (i.e., *Ecology*) than when reading the text with high deep cohesion (i.e., *Animal Growth*).

Follow-up analyses included six paired-samples *t*-tests in order to discern which specific comprehension processes were generated at higher rates in each text. Results indicated that significantly more inferencing (i.e., connecting/elaborative inferences) occurred while reading a the *Animal Growth* text, with high deep cohesion: (CI: $M = -.03$, $SD = .09$; $t(29) = -2.24$; $p = .033$; EI: $M = -.09$, $SD = .17$; $t(29) = -2.87$; $p = .008$). By comparison, students generated more evaluative comments, paraphrases, and metacognitive comments while reading the *Ecology* text, with high referential cohesion (EV: $M = .03$, $SD - .07$; $t(29) = 2.41$; $p = .022$; PAR: $M = .09$, $SD = .19$; $t(29) = 2.68$; $p = .012$; MC: $M = .04$, $SD = .04$; $t(29) = 2.30$; $p = .029$). See Figure 2.

Discussion

Our work offers an enriched understanding of how deep and referential cohesion may be related to middle school readers' processing of science texts. Specifically, this exploratory study supports previous research which shows that readers generate fewer inferences in highly cohesive text (McNamara et al., 2001). However, our findings differ in suggesting that cohesion type (deep, referential) may be a contributing factor in the amount and type of inferences readers generate while reading. That is, readers may generate more inferences in a text with high deep cohesion than a text with high referential cohesion. Future research should replicate these findings, however, with a larger sample size and a more rigorous selection of well-matched texts to further explore cohesion's effects on comprehension processing. Additionally, other features of text complexity at the word, sentence, and passage level of the text (eg., word concreteness, syntax) should be considered for a more thorough understanding of how text features are related to the ways that middle school readers process science texts in order to inform how texts are selected and applied for appropriate instruction in classroom settings. (Dahl et al., in press).

References

Best, R., Rowe, M., Ozuru, Y., & McNamara, D. (2005). Deep-level comprehension of science texts: The role of the reader and the text. Topics in Language Disorders, *25*(1)65–83.

Carlson, S. E., Seipel, B., & McMaster, K. (2014). Development of a new reading comprehension assessment: Identifying comprehension differences among readers. *Learning and Individual Differences*, *32*, 40-53.

Deane, P., Sheehan, K.M., Sabatini, J., Futagi, Y. & Kostin, I. (2006). Differences in text structure and its implications for assessment of struggling readers, *Scientific Studies of Reading*, *10*:3, 257-275.

DiSpezio, M. A., Frank, M., Heithaus, M. R., & Sneider, C. I. (2018). HMH Science Dimensions, Module B: Cells and Heredity, Teacher Edition. Houghton Mifflin School. (Pages 186-188).

Ericsson, K. A., & Simon, H. A. (1993). *Protocol analysis: Verbal reports as data* (Revised ed.). Cambridge, MA: MIT Press.

Graesser, A.C., McNamara, D.S., Cai, Z., Conley, M., Li, H., and Pennebaker, J. (2014). Coh-Metrix measures text characteristics at multiple levels of language and discourse. *The Elementary School Journal*, *115*(2), 210-229.

Hall, S.S., Maltby, J., Filik, R., & Paterson, K.B. (2016). Key skills for science learning. The importance of text cohesion and reading ability, Educational Psychology, *36*:2, 191-215.

Kintsch, W. (1988). The role of knowledge in discourse comprehension: a construction integration model. *Psychological review*, *95*(2), 163–182.

McNamara, D. S., & Kintsch, W. (1996). Learning from texts: Effects of prior knowledge and text coherence. *Discourse processes*, *22*(3), 247–288.

McNamara, D. S., Kintsch, E., Songer, N. B., & Kintsch, W. (1996). Are good texts always better? Interactions of text coherence, background knowledge, and levels of understanding in learning from text. *Cognition and Instruction*, *14*, 1–43.

McNamara, D. S., Graesser, A.C., McCarthy, P. M., & Cai, Z. 2014. Automated Evaluation of Text and Discourse with Coh-Metrix. Cambridge University Press, USA.

O'Reilly, T., & McNamara, D.S. (2007). Reversing the reverse cohesion effect: Good texts can be better for strategic, high-knowledge readers. *Discourse Processes*, *43*, 121-152.

Wood, L. (2008). *Ecosystems--the kelp forest* Marine Science: Exciting Activities for Kids—Book 2 Prufrock Press. Retrieved from: http://discoverer.prod.sirs.com