

The effects of interest on inference generation while reading

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Dedication

I dedicate my dissertation to my grandfather, Archie Jennings Thomte, who is probably looking down from heaven with relief that I am finally done with school. He made good use of his eight years of formal education by being successful in his field, a prominent member of his community, and a patron of educational causes. Hopefully my twenty-three years of formal education will not get in the way of me doing the same.

Abstract

A positive association between interest and learning from texts has been well noted in the literature. However, the cause of the positive association between interest and learning from text is uncertain. The primary purpose of this dissertation was to examine a potential cause, inference generation, of the positive association between interest and learning from texts. Sixty undergraduate students participated in Experiment 1 by reading two scientific texts and writing recalls and answers to comprehension questions. Topic interest and text-based interest were measured using self-reports. The results indicated that topic interest and text-based interest were indeed positively associated with learning from texts. In Experiment 2, sixty-nine undergraduate students participated by completing the same measures as the participants in Experiment 1, with the inclusion of the think-aloud task while reading. The results from Experiment 2 indicated that topic and text-based interest were both found to be positively associated with inference generation. Subsequent analyses indicated that inference generation explained (as a mediator) the positive association between both topic and text-based interest and accurate answers to comprehension questions. In contrast, inference generation was statistically independent from the positive association between topic interest and recall. Inference generation affected the strength of (as a moderator) the positive association between text-based interest and recall. The findings from both experiments are discussed in the context of interest and text comprehension theories, specifically in regards to standards of coherence.

The secondary purpose of this dissertation was to determine the usefulness of Wii Fit™ boards as a cost-effective means of incorporating gross body movements as

an indirect measure of interest. Gross body movement data from forty-two of the participants in Experiment 1 was measured while the participants read the experimental texts. The findings indicated that interest and learning from text were negatively associated with both leaning back and shifting in one's seat. These findings are discussed in the context of embodied theories of cognition.

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Chapter One

Overview

It has been well noted in the literature that interest is positively associated with learning from texts. This has been found when the interest is in the material discussed (topic interest) or in the writing style of the text (text-based interest). However, it is uncertain what the cause of this positive association is. The primary purpose of this dissertation was to examine a potential cause of the positive association between interest and learning from texts. Specifically, the role of inference generation in the positive association between interest and learning from texts was determined. Inference generation was considered a potential cause because of its necessity in successful reading comprehension. Moreover, a positive association between interest and inference generation was expected because of previous findings in standards of coherence and deep processing of texts.

To address the primary purpose of this dissertation, two research questions were asked. The first research question asked if topic interest and text-based interest were positively associated with learning from texts as measured through recall and answers to comprehension questions. Experiment 1 addressed the first research question of this dissertation. In Experiment 1, sixty undergraduate participants read two experimental science texts. Background knowledge and topic interest were assessed prior to reading. Text-based interest and learning from texts was assessed after reading each text. It was determined that topic interest and text-based interest were indeed positively associated with learning from texts, independent of the effects of background knowledge.

The second research question asked what was the role of inference generation in the positive association between topic interest and text-based interest and learning from texts. Experiment 2 addressed the second question through the inclusion of a think-aloud task to measure inference generation while reading. Experiment 2 also included the Nelson-Denny subtest of Reading Comprehension to control for the effects of reading comprehension skill. It was hypothesized that interest would lead to stricter standards of coherence, which would be indicated by increased inference generation while reading. Sixty-nine undergraduate students participated in Experiment 2 by thinking aloud as they read the same science texts as were used in Experiment 1. The results from Experiment 2 supported the hypothesis: interest was found to be positively associated with inference generation.

Once inference generation was found to be positively associated with both topic interest and text-based interest, the next step was to determine the role of inference generation in the positive association between interest and learning from texts. The role of inference generation in the positive association between interest and learning from text was found to be different depending on the measure for learning from text. Analyses of the data indicated that inference generation explained (as a mediator) the positive association between both topic and text-based interest and accurate answers to comprehension questions. In other words, interest was no longer positively associated with learning from texts once the effects of inference generation were included. These results were independent of the effects of background knowledge and reading comprehension skill.

In contrast, inference generation was statistically independent from the positive association between topic interest and recall and affected the strength of (as a moderator) the positive association between text-based interest and recall. The positive association between text-based interest and recall was examined at three levels of inference generation (low, middle, and high). For the low and middle inference generation groups, text-based interest was found to be positively associated with recall. However, for the high inference generation group, text-based interest was found not be associated with recall. Therefore, the cause of the positive association between interest and recall is yet to be determined. These findings were independent of the effects of background knowledge. However, the low inference generation group did not have a significant association between text-based interest and recall after accounting for the effects of reading comprehension skill. The other findings from Experiment 2 were independent of the effects of reading comprehension skill. The findings from both experiments are discussed in the context of interest and text comprehension theories, specifically in regards to standards of coherence.

Interest, as a subjective experience, is a difficult construct to measure. Because of this, it is beneficial to incorporate both direct and indirect measures of interest in research studies. One means of indirectly measuring interest is through gross body movements, however, the equipment typically used to measure gross body movements is sophisticated and expensive (about \$10,000). The secondary purpose of this dissertation was to determine the usefulness of Wii Fit™ boards as a cost-effective (about \$200) means of incorporating gross body movements as an indirect measure of interest. It was hypothesized that the interest and learning from text variables would be

negatively associated with changes in body movement (i.e., fidgeting or shifting in one's seat). It was also hypothesized that interest and learning from text variables would be negatively correlated with leaning back. The findings from Experiment 1 supported both of the hypotheses. These findings are discussed in the context of embodied theories of cognition and connected to previous findings regarding interest and gross body movements.

Dissertation Chapters

This dissertation is formatted in the following manner: Chapter Two introduces the issues of interest, including how it is related to learning from text and how it is measured, as well as outlines the purposes and research questions. The literature related to the purposes and questions of this dissertation is reviewed in Chapter Three. In Chapter Four, the purpose, methods, and results for Experiment 1 are explained. A discussion of the results from Experiment 1 is also provided. Chapter Five provides the purpose, methods, and results from Experiment 2 as well as a discussion of Experiment 2's results. The results across both experiments are discussed and connected to previous findings in Chapter Six. Chapter Six also included the theoretical and practical implication of the dissertation. Finally, the dissertation concludes in Chapter Seven. Chapter Seven examined the limitations of the research in addition to ideas for future research based on this dissertation.

Chapter Two

Introduction

Interest and learning from text are positively associated with each other (Ainley, 2006; Dewey, 1913; Hidi, 1990, 2001, 2006; Krapp, 1999; Renninger, 2000). This positive association occurs for both interest in the topic (i.e., topic interest) and for interest in the text (i.e., text-based interest; Boscolo & Mason, 2003; Schiefele, 1990, Wade & Adams, 1990). The explanation for this positive association between interest and learning from texts is not well known. Moreover, measuring interest, as with many psychological constructs, is difficult. Therefore, it is beneficial to use both direct and indirect measures of interest to provide a holistic measure of the construct. Unfortunately, the means of measuring interest through indirect means are not available to many researchers.

Background: Interest and Learning from Texts

Topic interest is one's value of and feelings towards reading particular topics (Flowerday, Schraw, & Stevens, 2004; Frick, 1992; Kintsch, 1980). Topic interest is a stable disposition that is specific to the reader (Schiefele, 1999). Topic interest is frequently positively associated with a reader's background knowledge; readers who are interested in a topic typically read and therefore learn more about that topic thus leading to an increase in background knowledge (Silvia, 2008). Topic interest is frequently measured using self-report ratings before a text is read (Wade, Buxton, & Kelly, 1999). The topic interest can be presented by the title, a summary of the topic, or themes for self-report ratings (Naceur & Schiefele, 2005). Previous research findings have shown that topic interest is positively associated with performance on cloze assessments of

texts (Asher & Markell, 1974), accuracy in answers to open-ended reading comprehension questions (Boscolo & Mason, 2003; Schiefele, 1990), text recall (Naceur & Schiefele, 2003; Schiefele & Krapp, 1996).

Text-based interest is a state in which one is engaged in a text because of its features (Schiefele & Krapp, 1996). Text-based interest is a temporary state that is specific to the text (Hidi, 1990; Schiefele & Krapp, 1996). For example, readers typically report higher levels of text-based interest in texts that are consistent and concrete than texts that are inconsistent and abstract (Beck et al., 1995; Wade et al., 1999). Text-based interest is frequently measured through self-reports after reading (Naceur & Schiefele, 2005). These self-reports for text-based interest typically involve the readers indicating on a Likert scale the level of the interest for the text (Schraw, Bruning, & Svoboda, 1995). Previous research findings have shown that text-based interest is positively associated with learning from text as measured through recall (Sadoski, Goetz, & Rodriguez, 2000; Wade & Adams, 1990) and test scores on reading comprehension assessments (Bray & Britton, 2004).

Background: Measuring Interest

Interest, like many psychological constructs, is difficult to measure (Ainley et al., 2002; Silvia, 2006). Therefore it is beneficial to use multiple measures of interest. Measures of interest are either direct, such as self-reports, or indirect, such as gross body movements. Using multiple methods, such as using both self-reports and body movement, allow for both direct and indirect measures of interest to be incorporated into a study. The use of both direct and indirect measures allows for the weaknesses of one method to be compensated by the strengths of another method.

Self-reports, in which readers state what they consider interesting or indicate their level of interest on a Likert scale, are frequently employed as a direct measure of interest (Ainley et al., 2002; Wade et al., 1999). Typically speaking, self-reports requested prior to reading assess topic interest and after reading assess text-based interest (Naceur & Schiefele, 2005). Although readers are typically aware of their level of interest and able to provide accurate responses, self-reports are dependent on the willingness of readers to honestly disclose their level of interest (Schiefele, 1992; Valsiner, 1992).

Gross body movements have been incorporated as an indirect measure in interest research (e.g., D'Mello, Chipman, & Graesser, 2007). The rationale behind the use of body movements in measuring interest is based on embodied theories of cognition that state that there is a connection between body movements and psychological states, such as interest (deVega, Glenberg, & Graesser, 2008). Certain body postures or gross body movements have been found to be associated with interest during learning: learners who are interested have been found to lean forward and learners who are bored have been found to lean back (Kapoor, Mota, & Picard, 2001). In addition, interest has been negatively associated with the amount of gross body movements; in other words, learners who are interested move less than those who are not interested (D'Mello et al., 2007b; Mota & Picard, 2003). Gross body movements are helpful in gauging interest without interrupting the reading process, but the use of gross body movements is an indirect measure that does not account for individual variation in body posture independent of interest level.

Statement of the Problem: Interest and Learning from Texts

The positive association between interest and learning from texts has been frequently noted in the literature. However, the cause of this positive association is yet to be determined. Several researchers have tested a variety of explanations. These explanations include an increase in attention with an increase in interest (Anderson, 1982; Shirey & Reynolds, 1988; McDaniel, Waddill, Finstad, & Bourg, 2000), greater use of reading strategies when reading interesting texts (Schiefele & Krapp, 1996), differences in background knowledge between readers with high and low levels of topic interest (Boscolo & Mason, 2003; Schiefele, 1990), topic interest prompting positive affect that increases persistence (Ainley, Hidi, & Berndorff, 2002), and increased imagery elicited from interesting texts than boring texts (Sadoski, Goetz, & Rodriguez).

Review of the empirical tests of these proposed explanations has not indicated that a clear cause is known for the positive association between interest and learning from texts. The findings regarding the effects of interest on attention have been mixed. Some researchers have found that interest increases attention (Anderson, 1982), although other researchers have found that interest decreases attention (Hidi, 1990; Shirey & Reynolds, 1988; Shirey, 1992; McDaniel et al., 2000). Moreover, statistical analyses have indicated that attention is statistically independent from the positive association between interest and recall (Anderson, 1982). In regards to reading strategies, Schiefele and Krapp (1996) did not find any association between topic interest and reading strategies such as note-taking and underlining. Researchers have controlled for the effects of background knowledge by using answers to pre-tests, results have indicated that the effect of topic interest on recall and answering open-

ended comprehension questions was independent of the effects of background knowledge (Boscolo & Mason, 2003; Schiefele & Krapp, 1996). The findings from a study in which topic interest was found to increase levels of positive affect, which increased persistence, which subsequently increased learning from texts were not independent of reader characteristics, such as background knowledge (Ainley et al., 2002b). Moreover, the measure of learning differed between readers, which make comparisons of interest on learning difficult. Sadoski et al. argued that increased recall for texts that had higher levels of interest due to concreteness was due to dual coding theory. However, this explanation only applies to one type of text-based interest.

Statement of the Problem: Measuring Interest

The use of gross body movements has been demonstrated to be an informative indirect measure of interest in previous research studies (D'Mello et al., 2007a; Kapoor et al., 2001; Mota & Picard, 2003). However, the apparatus used in these research studies is too expensive (about \$10,000) for use in most research studies. Therefore, it would be helpful to develop a cost-effective method of monitoring gross body movements.

Significance: Interest and Learning from Texts

The reader needs to create a coherent mental representation of a text in order to learn from a text. Coherent mental representations of text are constructed through inferences (Thurlow & van den Broek, 1997). Inferences provide connections between the currently read text and the previously read text or reader's background knowledge (Graesser, Bertus, & Magliano, 1995). There is reason to expect a positive association between interest and inference generation. Readers vary in their inference generation

depending on their *standards of coherence* or criteria readers use to achieve their deserved level of text comprehension (van den Broek, Risen, & Husebye-Hartmann, 1995). Although standards of coherence has not been previously connected with interest, previous offline (i.e., after reading) findings have indicated that readers generated more inferences when interested than when not interested (Lehman & Schraw, 2002; Schiefele & Krapp, 1996). Moreover, interest has been previously indicated to prompt deep processing of texts (Krapp, 1999). Inference generation is an example of deep processing because it requires the reader to go beyond what is currently read by connecting it with previously read text or background knowledge (Best, Rowe, Ozuru, & McNamara, 2005; Graesser, Singer, & Trabasso, 1994). However, a specific relation between interest and inference generation while reading has not previously been examined.

Significance: Measuring Interest

The use of Wii Fit™ boards in monitoring gross body movements is a promising, cost effective means of indirectly measuring interest (Olney & D’Mello, 2010). Wii Fit™ boards are relatively affordable (about \$200) and easy to obtain. Therefore, if Wii Fit™ boards would be found to provide reliable indicators of interest, they may be useful for other researchers who wish to incorporate indirect measures of interest into their studies.

Purposes

The primary purpose of this dissertation is to examine a potential cause of interest and learning from texts. This purpose was addressed with two research questions:

1. Are topic interest and text-based interest positively associated with learning from texts?
2. What is the role of inference generation in the positive association between interest and learning from texts?

The secondary purpose of this dissertation is to develop a cost effective means to monitor gross body movements while reading as an indirect measure of interest. This purpose was addressed with the third research question:

- 3: Are Wii Fit™ boards useful for measuring interest as indicated through gross body movements?

Chapter Three

Literature Review

It has been well noted in the literature that interest is positively associated with learning from texts (Boscolo & Mason, 2003; Hidi, 2006; Schiefele, 1992; Schraw & Lehman, 2001). However, it is not known why the positive association between interest and learning from texts occurs. The primary purpose of this dissertation is to propose and examine a potential explanation as to why interest and learning from texts are positively associated.

Interest is a subjective construct and, as such, is difficult to measure (Hidi, 2006). Direct measures of interest, such as questionnaires and self-reports, depend on readers' willingness to disclose their levels of interest. Therefore, it is beneficial to develop multiple measures of interest, both direct and indirect, for use in research studies. Gross body movements have been used as an indirect measure of interest, but most of the previous studies used sophisticated and expensive measurement systems. The secondary purpose of this dissertation is to determine the usefulness of Wii Fit™ boards as a novel and cost-effective means to incorporate gross body movements as an indirect measure of interest.

The purpose of this literature review is to examine the previous findings related to the purposes of this dissertation. The first section of this literature review discusses the construct of interest and how it relates to text. This is followed by the previous findings regarding the relation between interest and learning from text. Previously tested explanations of the positive association between interest and learning from text are presented. Then, the potential for inference generation as an explanation for the

positive association between interest and learning is articulated. Finally, there is an explanation of the process by which the role of inference generation in the positive association between interest and learning from texts is tested.

The second section of this literature review discusses the rationale for using gross body movements as an indirect measure of interest. The benefits and weakness in direct and indirect measures of interest are discussed. The theoretical foundation for an expected link between the mental state of interest and physical movement is provided in the context of embodied theories of cognition. Previous findings on gross body movement and interest are discussed.

Interest

Interest is a complex construct of which most have an intuitive understanding, but is difficult to categorize or define. Researchers disagree regarding the categorization of interest. According to some researchers, interest is best categorized as an emotion although it is not included in many theories of emotion (Schiefele, 1992; Silvia, 2008). Components of emotion are “physiological changes, facial and vocal expressions, patterns of cognitive appraisal, a subjective feeling, and an adaptive role across the lifespan,” each of which is a component of interest (Silvia, 2008, p. 57). Other researchers disagree, arguing that interest should be categorized as a psychological state to accurately reflect its affective and cognitive components as categorization as an emotion emphasizes the affective components of interest (Hidi, 2006; Hidi & Renninger, 2006; Renninger, Ewen, & Lasher, 2002). The categorization of interest as a psychological state, rather than an emotion, is preferable in research

regarding the effects of interest on learning as it promotes the examination of both the affective and cognitive components of interest.

In addition to debate regarding the categorization of interest, researchers disagree regarding the characterization of the affective aspects of interest. Some researchers consider enjoyment and positive feelings aspects of the definition of interest, that is, one must like something in order to be interested (Ainley, 2006; Schiefele, 1992; Schraw & Lehman, 2001). Other researchers disagree, stating that enjoyment and positive feelings are frequently involved in interest, but that exceptions exist (Iran-Nejad, 1987; Silvia, 2008). For example, one can be interested in a disturbing work of art, but not enjoy or have positive feelings regarding it. Therefore, the inclusion of enjoyment and positive feelings in the definition may oversimplify the construct of interest.

Despite the disagreements regarding the categorization and characterization of interest, researchers do agree on certain aspects of interest. Researchers agree that interest occurs in the interaction between a person and an external stimulus (Ainley, 2006; Hidi & Baird, 1986; Krapp, Hidi, & Renninger, 1992; Renninger, 2000, 2002; Silvia, 2008). Moreover, interest is characterized by focus on and willful engagement in a particular task or source of content (Hidi, 1990; Hidi, Renninger, & Krapp, 2004; Schiefele, 1992; Schraw & Lehman, 2001). Because interest is characterized as willful, one is conscious of his or her level of interest (Hidi, 2006).

There is a consensus among researchers that interest is multi-faceted and complex (Hidi, 2006; Krapp, Hidi, & Renninger, 1992; Schraw, Flowerday, & Lehman, 2001). Therefore, a discussion of the various components of interest is warranted

before discussing its relation to learning from text. Interest is frequently categorized as personal and situational in the literature (Ainley, Hillman, & Hidi, 2002; Hidi, 1990, Schiefele, 1996; Schraw & Lehman, 2001). Personal interest, also called individual interest, is an individual's enduring opinion on a particular domain (e.g., a stable, positive orientation towards learning about dinosaurs; Hidi, 1990; Mason, Gava, & Boldrin, 2008; Schiefele, 1999). Personal interest stems from within an individual and develops over a significant length of time (Krapp, Hidi, & Renninger, 1992). With personal interest, one is engaged with a particular object, event, or idea for its own sake; there are no extrinsic motivators (Schiefele, 1991). In contrast, situational interest is a temporary state, induced by certain features of the environment, such as unexpectedness (Hidi & Renninger, 2006; Kim, 1999; Mason et al., 2008; Schiefele, 1999). One manner of conceptualizing the differences between personal and situational interest is to consider personal interest as the "interestedness" of the individual and situational interest as the "interestingness" of the situation (Bray & Barron, 2004; Frick, 1992; Hidi & Baird, 1986; Kim, 1999; Tsai, Kunter, Ludtke, & Ryan, 2008).

There are aspects of personal and situational interest that are specific to text comprehension. Topic interest, specific to the reader, is a subgroup of personal interest (Hidi, 1990). Topic interest is a stable disposition in which one prefers to read about certain topics (e.g., sports, science, the Civil War; Schiefele & Krapp, 1996). Text-based interest, specific to the text, is a subgroup of situational interest (Schiefele & Krapp, 1996). Text-based interest is a temporary state in which one is engaged in a text because of its features (Schiefele, 1992).

Topic interest and text-based interest are not identical, but they may overlap or influence each other due to the interactive nature of interest (Ainley et al., 2002b; Hidi & Harackiewicz, 2000). A reader's interest in a topic may lead to an increased interest in a particular text (Ainley et al.). Moreover, a reader may not have had an interest in a topic prior to reading, but a particular interest in a text may spark an interest in that topic during or after reading (Hidi & Renninger, 2006).

Topic Interest

Topic interest is one's value of and feelings towards reading particular topics and is frequently positively associated with a reader's background knowledge and engagement (Flowerday, Schraw, & Stevens, 2004; Frick, 1992; Kintsch, 1980). Readers who are interested in a topic typically read and therefore learn more about that topic thus leading to an increase in background knowledge (Silvia, 2008). Topic interest is frequently measured using self-report ratings before a text is read (Wade, Buxton, & Kelly, 1999). The topic interest can be presented by the title, a summary of the topic, or themes for self-report ratings (Naceur & Schiefele, 2005). These self-report ratings for interest can simply be for a scale of how interested a reader is in a particular topic or delve into the components of interest, such as how much a reader is familiar with or engaged in a topic (Ainley, Hidi, & Berndorff, 2002).

Topic interest has been found to predict learning from text through a variety of tasks. These tasks include performance on cloze assessments of texts (Asher & Markell, 1974), accuracy in answers to open-ended reading comprehension questions (Boscolo & Mason, 2003; Schiefele, 1990), short- and long-term text recall (Boscolo & Mason, 2003; Naceur & Schiefele, 2005; Schiefele & Krapp, 1996). In the next section,

the studies that have examined the relation between topic interest and learning from texts are discussed.

Elementary-school aged readers have been found to perform better on cloze assessments of texts in which they have topic interest (Asher & Markell, 1974). Asher and Markell (1974) assessed topic interest by having the readers rate their interest on a Likert scale ranging from “not interesting” to “very interesting” for 25 pictures based on themes used in the experimental texts from the *Encyclopedia Britannica*. The advantage of this method of measuring topic interest is that the readers were unaware that the pictures were related to a future reading task; therefore, attitudes about reading did not influence interest ratings. Each of the readers was assigned to complete three cloze passages (with every ninth word deleted) from paragraphs in which they had high levels of topic interest and three cloze passages from paragraphs in which they had low levels of topic interest. In addition to finding that readers performed better on the cloze assessment when on passages in which they had high levels of topic interest, Asher and Markell found that boys had more of a benefit from topic interest than did girls. There was no difference in the effect of interest between readers with high scores on a general reading comprehension assessment and readers with low scores.

The relation between topic interest and accuracy of responses on open-ended reading comprehension questions has been investigated (Schiefele, 1990). Topic knowledge and topic interest are highly correlated; therefore it can be difficult to ascertain whether better performance on various assessments of text learning by participants with high levels of topic interest can be contributing to topic interest or topic knowledge (Wade et al., 1999). To address the issue of background knowledge,

background knowledge on the topic was assessed through open-ended questions answered prior to reading (Schiefele, 1990). Readers were selected so that the high and low topic interest groups would have equivalent levels of background knowledge. The readers who had high levels of topic interest in a text produced more accurate comprehension questions than did readers with low levels of topic interest. Therefore, topic interest, independent of background knowledge, may prompt the reader to better comprehend a text.

Naceur and Schiefele (2005) tested the effect of topic interest in a text on short-term and long-term recall. After their participants rated their interest in four text topics, Naceur and Schiefele randomly assigned the readers to read either the text they rated as highest in interest or the text they rated lowest in interest and then provide a recall of what they just read. One week later, the readers recalled the text they read and read a second text (either the most or least interesting, depending on which text they received the first session), and recalled the text they just read. The following week, the readers recalled the second text they read. Topic interest was positively correlated with both short-term and long-term recall of the text; although these results for long-term recall were only consistent in the within-participants analyses. The results from this study indicate that topic interest predicts immediate recall, as is consistent with other studies (Schiefele, 1990; Schiefele & Krapp, 1996), and long-term recall as well.

Boscolo and Mason (2003) examined the effects of topic knowledge and topic interest on learning from texts. Topic knowledge was assessed through correctly completing a diagram with a schematic representation of the earth and sun (the text topic was the greenhouse effect) and through true-false questions. Topic interest was

assessed through a nine-item questionnaire in which readers rated on a five-point Likert scale the degree to which they agreed with statements about their feelings and values towards the greenhouse effect and other ecological issues. This information was used to create four groups of readers: high topic-knowledge/high topic-interest, low topic-knowledge/high topic-interest, high topic-knowledge/low topic-interest, and low topic-knowledge/low topic-interest. Learning from the text was measured through recall and accuracy in answering open-ended questions. The open-ended questions either required a bridging inference in which the readers needed to connect separate sections of the text or the application of the knowledge in the text through problem solving. The readers in the high topic-knowledge/high topic-interest group produced best recalls and most accurate responses to both the bridging inference and knowledge transfer questions, followed by the readers in the high topic-knowledge/low topic-interest group. The low topic-knowledge/high topic-interest group produced better recalls than did the low topic-knowledge/low topic-interest groups. However, the low topic-knowledge/high topic-interest group did not produce more accurate responses to the open-ended questions than did the low topic-knowledge/low topic-interest group. The results with the high topic-knowledge groups indicate that when background knowledge is strong, topic interest promotes a better-developed understanding of a text. The results with the low topic-knowledge group indicate that topic interest alone is insufficient to promote a better-developed situation model of a text. One needs to have a requisite level of background knowledge to develop a situation model (Kintsch, 1998).

The findings from these studies indicate that topic interest is positively associated with learning from texts both for comparisons within- (e.g., Naceur &

Schiefe, 2005) and between subjects (e.g., Schiefele & Krapp, 1996). The positive relation between topic interest and learning from text was independent of the effects of background knowledge, which is correlated both with topic interest and with learning from texts. In the next section, text-based interest and its relation to learning from texts is discussed.

Text-based interest

Text-based interest is a temporary state in which one is engaged in a text due to its features. Text-based interest can be increased by certain elements in a text (Beck, McKeown, & Worthy, 1995; Schank, 1979). For example, readers typically report higher levels of text-based interest in texts that are consistent and concrete than texts that are inconsistent and abstract (Sadoski, Goetz, & Fritz, 1993a; Wade et al., 1999). Text-based interest is frequently measured through self-reports after reading (Naceur & Schiefele, 2005). These self-reports for text-based interest typically involve the readers indicating on a Likert scale the level of the interest for the text (Schraw, Bruning, & Svoboda, 1995).

Like topic interest, text-based interest has been demonstrated to be positively associated with learning from texts. Previous research findings have shown that text-based interest is positively associated with learning from text as measured through recall (Sadoski, Goetz, & Rodriguez, 2000; Wade & Adams, 1990) and test scores on reading comprehension assessments (Bray & Barron, 2004). However, some efforts to make texts more interesting have been known to hamper learning from texts. The next section reviews the previous research findings regarding text-based interest and learning from texts.

The potential relation between text-based interest and recall was investigated by Wade and Adams (1990). To determine text-based interest, Wade and Adams had one group of readers rate sentences of a biographical text for interest. To determine the relation between text-based interest and recall, a second group of readers, matched to the first group in reading comprehension scores, read the text and recalled it immediately after reading or one week later. Information considered to be interesting by the first group was more likely to be recalled by the second group in comparison to information not considered to be interesting by the first group. Therefore, text-based interest, like topic interest (Boscolo & Mason, 2003; Schiefele & Krapp, 1996), can predict the recall of texts.

Increasing the concreteness of the text has been found to increase the text-based interest and recall of the text. Sadoski, Goetz, and Rodriguez (2000) manipulated the level of text-based interest by adjusting the level of concreteness in various texts to determine the effects of text-based interest on recall. Readers were randomly assigned to read the experimental texts with either concrete or abstract titles and rate the texts for concreteness, interestingness, and comprehensibility. The texts with concrete titles were better recalled and received higher ratings in concreteness, interestingness, and comprehensibility than the texts with abstract titles.

The relation between text-based interest and test scores on reading comprehension assessments has been examined (Bray & Barron, 2004). As part of item development for the Iowa Test of Basic Skills, thousands of students in the fourth through eighth grades read and responded to one to three of ninety-eight different texts. These texts were from multiple genres and topics. Students provided their interest level

on a Likert scale for each text after reading. Each text had 6 to 19 different multiple-choice questions that were answered by the students. The findings indicated that interest in the text predicted choosing the correct answers for the multiple-choice questions about the text. Therefore, text-based interest is positively associated with accurately answering questions about a text.

Attempts to make texts more interesting may have unintended negative consequences. In textbook and other expository writing, authors have frequently inserted amusing anecdotes, and other divergent and highly engaging, but unimportant, information into the text, either embedded in paragraphs or in a separate section (Garner, Alexander, Gillingham, Kulikowich, & Brown, 1991; Hidi & Baird, 1988; Wade et al., 1999). When this type of information is included in the text, often referred to as *seductive details*, readers recall the divergent information, but not the main ideas of the text (Garner et al., 1991). This is because readers may allocate their limited attention to the parts of the text in which they are interested, a phenomenon termed *interest-based parsing*, as indicated by slower reading times (Schank, 1979; Wade, Schraw, Buxton, & Hayes, 1993). Often these seductive details are detrimental to a readers' comprehension of a text (Hidi, Baird, & Hildyard, 1982). The divergent nature of these details can break the coherence of the text, making it more difficult to comprehend (Garner et al., 1991; Hidi et al., 1982; Wade et al., 1999).

The research presented in this literature thus far has outlined the association between interest and learning from texts. Both topic and text-based interest have been found to be positively associated with performance on a variety of tasks intended to assess learning from texts. The exception to this is when highly interesting, but

irrelevant information is added to text; doing so has a negative influence on learning from texts. In the following section, literature from studies in which potential causes of the positive association between interest and learning from text is reviewed.

Previously Tested Explanations

The studies regarding the relation of interest to learning from text raise the question of why the relation of interest and learning from texts exists. In this section, previously tested explanations for the positive association between interest and learning are discussed. These explanations included attention, a combination of persistence and positive affect, use of reading strategies, background knowledge, and dual coding theory. The theoretical bases for the previously tested explanations along with the empirical findings when these explanations were tested are reviewed.

Dewey (1913) proposed the *increased effort hypothesis* in which he argued interest increases effort that increases learning. Asher (1974) proffered the suggestion that increased attention, as part of increased effort, that explains the relation between interest and learning, which is logical considering engagement is associated with interest (Ainley et al., 2002b). This was further developed into the selective attention model in which readers choose to allocate their limited cognitive resources to text they find interesting (Anderson, 1982). The selective attention model predicts that reading times and secondary task reaction times would increase with interest. However, findings regarding the effect of interest on attention as measured by reading times have been mixed (Anderson, 1982; Hidi, 1990; Shirey & Reynolds, 1988; Schiefele & Krapp, 1996). In some studies, interest was been found to be negatively associated with reading time, although it was positively associated with the recall (Shirey & Reynolds,

1988; Shirey, 1992). Other studies have found that interest was positively associated with reading time and recall, although subsequent analyses indicated that attention did not explain the positive association between interest and recall (Anderson, 1982). Moreover, some studies have found no association between interest and reading time (McDaniel et al., 2000; Schiefele & Krapp, 1996). In regards to secondary-task reaction times, the findings have also been mixed. Secondary-task reactions times have been found to be shorter while reading low-interest texts than high-interest texts in some studies (Shirey & Reynolds, 1988; McDaniel et al.), but longer in another study (Anderson, 1982).

The reasons for the conflicting results regarding reading times, secondary-task reaction times, and interest, may be due to the differences in difficulty of the texts used in the experiments. The experimental texts used in studies with findings that interest was negatively associated with reading times and secondary-task reaction time were either isolated sentences or relatively simple narratives (McDaniel et al., 2000; Shirey & Reynolds, 1988). Interesting texts that are relatively easy may make the reading process less effortful (Hidi, 2001). In contrast, boring texts may require the reader to engage in self-regulation to attend to the text, thereby resulting in slower reading times in comparison to interesting texts (McDaniel et al.).

The role of persistence and positive affect in the positive association between interest and learning from texts has been examined. Ainley, Hidi, & Berndorff (2002), had students indicate their level of topic interest in expository texts which were divided into three sections. As a measure of affect, students were asked to indicate their affective state by choosing one of eleven faces, each representing a different emotion,

which represented their feelings after they read a section of a text. As a measure of persistence, students could opt to continue reading the next section of the text or discontinue reading after each section. Learning from the texts was measured through three multiple-choice test questions per text. Test questions were designed to only cover the amount of text the students read—each student answered the same number of questions for each text. The results from structural equation modeling differed for each text, but generally topic interest was found to positively influence affect, which positively influenced persistence, which then positively influenced the learning from text measures. These findings, however, were not independent of the effects of background knowledge; background knowledge had effects on topic interest, affect, persistence, and test score. Although this study had an authentic measure of persistence, the difference in test questions for each student makes interpreting the results difficult. Moreover, the generalizability of the analyses of this study is constrained to instances in which interest produces positive affect. As previously discussed, interest in a topic is not necessarily associated with positive affect when reading that topic.

The hypothesis that arousal or reading strategies (e.g., note-taking and elaborative strategies) could explain the relation between topic interest and recall of main ideas from text has been tested (Schiefele & Krapp, 1996). Topic interest was assessed through a questionnaire prior to reading. Arousal and elaboration (a reading strategy) were assessed through questionnaires after reading. The reading strategies of note-taking and underlining were assessed by coding whether the readers made such marks on the texts during the experiment. Topic interest was found to be positively

associated with recalling the main ideas of an expository text (Schiefele & Krapp, 1996). Although arousal, attention, and note-taking were each positively correlated with both topic interest and main idea recall, they did not have significant mediating effects on the relation between topic interest and main idea recall. Therefore, the relation between topic interest and recall cannot be explained by increased arousal, attention, or reading strategies.

Topic knowledge and topic interest are highly correlated; therefore it can be difficult to ascertain whether better performance on various assessments of text learning by participants with high levels of topic interest can be contributing to topic interest or topic knowledge (Wade et al., 1999). Schiefele (1990) addressed this issue by assessing the background knowledge and topic interest of potential experiment participants. Using information from the background knowledge and topic interest assessments, he created groups of participants with high and low topic interest, but approximately equal background knowledge. The findings indicated that topic interest was positively associated with learning from text after this control for background knowledge. In addition, Boscolo and Mason (2003) examined the effects of topic knowledge and topic interest on learning from texts. Topic knowledge was assessed through correctly completing a diagram with a schematic representation of the earth and sun (the text topic was the greenhouse effect) and through true-false questions. Topic interest was assessed through a nine-item questionnaire in which readers rated on a five-point Likert scale the degree to which they agreed with statements about their feelings and values towards the greenhouse effect and other ecological issues. This information was used to create four groups of readers: high topic-knowledge/high topic-interest,

low topic-knowledge/high topic-interest, high topic-knowledge/low topic-interest, and low topic-knowledge/low topic-interest. Learning from the text was measured through recall and accuracy in answering open-ended questions. The readers in the high topic-knowledge/high topic-interest group produced the best recalls and most accurate responses to both the bridging inference and knowledge transfer questions, followed by the readers in the high topic-knowledge/low topic-interest group. The low topic-knowledge/high topic-interest group produced better recalls than did the low topic-knowledge/low topic-interest groups. Therefore, the positive association between topic interest and learning from texts may be beyond the effects of background knowledge.

There is an argument that interest may not necessarily be the direct cause of segments with high text-based interest being recalled better than segments with low text-based interest. Sadoski et al. (2000) manipulated the level of text-based interest by adjusting the level of concreteness in various texts to determine the effects of text-based interest on recall. Readers were randomly assigned to read the experimental texts with either concrete or abstract titles and rate the texts for concreteness, interestingness, and comprehensibility. The texts with concrete titles were better recalled and received higher ratings in concreteness, interestingness, and comprehensibility than the texts with abstract titles. Through causal path analysis, Sadoski et al. (2000) determined that concreteness was the best predictor of text-based interest and recall. Sadoski et al. stated that these findings support a *dual coding theory* in which concrete language promotes imagery that thereby results in dual encoding of the text in verbal and visual forms. In short, the dual encoding of the concrete language is responsible for the increase in recall and the increase in text-based interest is statistically independent in

the process. However, this explanation is limited in that it only explains the positive association between text-based interest and recall for one particular type of test.

In summary, both topic and text-based interest have been found to be positively associated with learning from texts as measured through a variety of tasks (recall, comprehension questions, inference verification, etc.). Several explanations for this positive association have been tested, including attention, affect, use of reading strategies, background knowledge, and dual coding theory. Empirical findings from testing these explanations have indicated conflicting results, results that are difficult to generalize, or null results. In the next section, a proposed explanation, inference generation, is introduced. The previous literature regarding inference generation and the role of inference generation in learning from texts is discussed. This is followed by a rationale for an investigation of inference generation as an explanation of the positive association between interest and learning from texts.

Inference generation while Reading

Successful reading comprehension requires that the reader produce a coherent mental representation of the text. The more coherent the mental representation of the text is, the better the comprehension of the text (Thurlow & van den Broek, 1997). Readers construct coherence by generating inferences that make connections between different ideas in the text or between the text and their background knowledge (Graesser, Bertus, & Magliano, 1995). Inference generation is necessary for coherence because texts are not written to explicitly state every relation between the ideas presented; a text that would do so would be cumbersome to read (Hansen, 1981; Kintsch, 1998). Readers use inferences to fill in missing information from the text

(Sanford & Garrod, 1982). In addition, the ability to accurately generate inferences is a predictor of performance on reading comprehension assessments (Bowyer-Crane & Snowling, 2005; Cain, Oakhill, & Bryant, 2004; Cromley & Azevedo, 2007; Long, Oppy, & Seely, 1997).

Broadly speaking, the inferences that can be made during reading generally fall into two broad categories: text-connecting and knowledge-based (van den Broek, 1990). Text-connecting inferences connect two individual ideas presented in the text (Magliano, 1999). Text-connecting inferences are necessary to join different ideas of the text together into a *textbase* to obtain the main ideas or theme of the text (Kintsch, 1998). In contrast to text-connecting inferences, knowledge-based inferences are *extratextual* in that they involve information from outside the text (Graesser et al., 1994). These knowledge-based inferences are generated by the reader to predict or explain a text (Graesser, Millis, & Zwaan, 1997). Knowledge-based inferences are necessary for textbase understanding when the basic message of a text cannot be understood without using background knowledge (Graesser et al., 1995; Kintsch, 2004). Knowledge-based inference generation is necessary for a reader to construct an in-depth mental representation of a text known as a *situation model* (van Dijk & Kintsch, 1983; Kintsch, 1998; Graesser et al., 1994; Graesser et al., 1995). Readers construct situation models by integrating the message of the text with their general world knowledge and personal experiences (Kintsch, 1986, 1998). This integration of the text with the reader's background knowledge allows for the application of the ideas in the text for future use (Kintsch, 2004).

Inference generation is relevant to learning from texts because of its necessity

for successful reading comprehension (Cain & Oakhill, 2007). Text-connecting inferences enable the reader to monitor situations and actors in the text (Graesser et al., 1994). Knowledge-based inferences enable the reader to apply information in the text to other situations or conditions, such as through problem solving (Kintsch, 1998).

Standards of Coherence

Readers vary in their inference generation depending on whether the reader is satisfied with the current level of comprehension or believes more connections need to be developed to construct a coherent mental representation of the text. The concept of *standards of coherence* provides a theoretical framework for understanding the varying levels of inference generation among different readers, texts, or contexts (van den Broek, Lorch, Linderholm, & Gustafson, 2001). Standards of coherence are the criteria that readers incorporate while reading to achieve their intended depth of comprehension. A reader with low standards of coherence would generate the minimal amount of inferences necessary to maintain basic comprehension or a ‘good-enough’ representation of the text (Christianson, Williams, Zacks, & Ferreira, 2006; van den Broek, Bohn-Gettler, Kendeou, Carlson, & White, in press). In contrast, a reader with high standards of coherence would generate additional inferences beyond those necessary to maintain comprehension in order to ensure thorough, in-depth comprehension of the text (van den Broek, Risdén, & Husebye-Hartmann, 1995). Readers may or may not be aware of their standards of coherence; however, their standards of coherence will determine their cognitive processes (e.g., inference generation) while reading (van den Broek et al., in press).

Standards of coherence are determined through a variety of factors that may involve characteristics of the context for reading, the reader or the text. A reader who has a goal of studying has stricter standards of coherence and therefore engages in greater inference generation than a reader who has a goal of entertainment (van den Broek et al., 2001). A reader who is fatigued or distracted will likely have more shallow standards of coherences than one who is well rested and attentive (van den Broek et al., in press). The consistency of a text influences a reader's standards of coherence, but the manner of the influence may be dependent upon certain characteristics of the reader. A reader who is knowledgeable about the text's topic has more shallow standards of coherence for a consistent text whereas a reader who is not knowledgeable about the text's topic has stricter standards of coherence for a consistent text (McNamara, Kintsch, Songer, & Kintsch, 1996).

Interest and Inference Generation

There is evidence that interest, in either the topic or the text, may be a factor in a reader's standards of coherence as is indicated through an increase in inference generation. Some researchers have argued that interest prompts deep processing in which the reader thinks critically about the material presented in the text (Krapp, 1999; Schiefele & Krapp, 1996; Silvia, 2006). Inference generation is an example of deep processing because it requires that the reader go beyond the currently read sentence to connect it with information in previously-read text or background knowledge (Graesser et al., 1994; Lehman & Schraw, 2002). Moreover, analyses of information from post-reading self-reports have indicated that readers are more likely to connect the text to background knowledge (a type of inference) when they have high levels of topic

interest in the text (Schiefele & Krapp, 1996). Offline measures of inference generation through inference verification tests and answers to open-ended comprehension questions, which have required inference generation to be answered correctly, have been found to be positively associated with interest (Boscolo & Mason, 2003; Schiefele & Krapp, 1996).

However, there are reasons to believe that interest does not increase inference generation while reading. The previously discussed findings regarding a positive association between interest and inference generation were obtained using post-reading measures and may not accurately reflect inference generation during reading. Moreover, interest has not been previously examined as a factor in standards of coherence.

Think-aloud Tasks

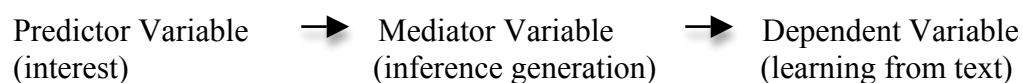
To determine the role of inference generation in the positive association between interest and learning from texts, it first must be determined if interest is positively associated with inference generation. A think-aloud task is a useful tool for investigating whether interest is positively associated with inference generation. A think-aloud task, which involves readers reading a unit of text (e.g., a sentence), then stating what they are thinking about when reading the text, allows researchers to examine the process of reading as it unfolds (van den Broek et al., 2001; Côté & Goldman, 2004). Exploration into offline (i.e. after reading) processes, such as asking the reader to produce a recall of the text or answer questions after reading allow for understanding the products of reading, but do not elucidate the process (Rapp, van den Broek, McMaster, Kendeou, & Espin, 2007). A think-aloud task is particularly useful in examining inference generation as it is intended to capture the inferential process as it

happens and examine how readers build their mental representations of the text they are reading (Pressley & Afflerbach, 1995). Therefore, the information gleaned from a think-aloud task may answer the question of whether interest and inference generation are positively associated.

Mediation and Moderation

If interest is positively associated with inference generation while reading and inference generation is positively associated with learning from text, then further analyses are necessary to determine the role of inference generation. Specifically, these analyses would determine whether inference generation is a mediator, a moderator, or statistically independent from the positive association between interest and learning from text. If inference generation accounts for the positive association between interest and learning from text (i.e., interest and learning from text no longer have a positive association), then it is a mediator (see Figure 1 for a diagram of a mediator effect).

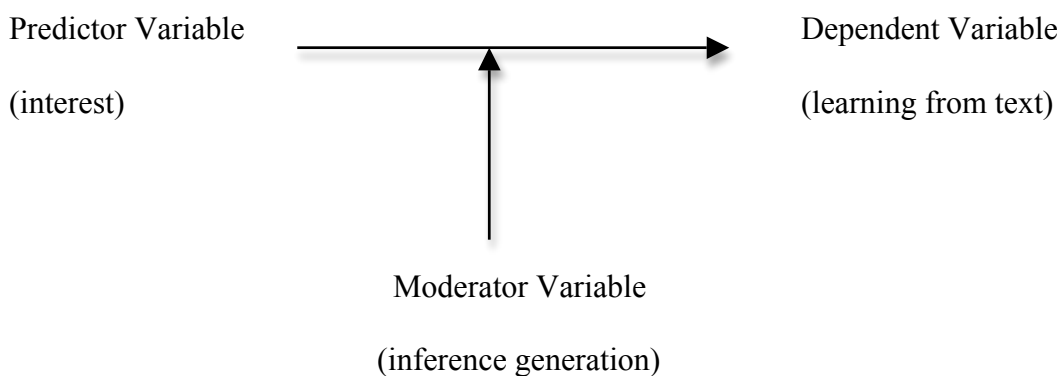
Figure 1. Diagram of a Mediator Effect



If inference generation does not account for, but instead affects the direction or strength of the positive association between interest and learning from text, then it is a moderator (see Figure 2 for a diagram of moderator effects). If inference generation does not have any effect on the positive association between interest and learning from

text, then it is statistically independent from the positive association between interest and learning from text.

Figure 2. Diagram of a Moderator Effect



In summary, there is evidence that inference generation may explain the positive association between interest and learning from text. Inference generation is necessary for successful reading comprehension and learning from texts (Graesser et al., 1995). Inference generation may vary among different readers or texts based on one's standards of coherence or criteria for comprehension (van den Broek et al., in press). Given previous findings, interest may affect inference generation while reading (Lehman & Schraw, 2002; Silvia, 2006). However, interest has not been previously investigated regarding its effects on inference generation. A think-aloud task is a useful method in examining inference generation. Further analyses could determine if inference generation explains the positive association between interest and learning from texts as a mediator, affects the strength or the direction of the positive association as a moderator, or is statistically independent from the positive association. The next

section introduces issues with measuring interest in studies examining interest and learning.

Measuring Interest

Interest is a subjective experience and, as such, is difficult to measure (Ainley et al., 2002a; Silvia, 2006). Measures of interest are either direct, such as questionnaires, or indirect, such as body movements. Both direct and indirect measures have their own strengths and weaknesses.

Self reports, in which readers state what they consider interesting or indicate their level of interest on a Likert scale, are frequently employed as a direct measure of interest (Ainley et al., 2002; Wade et al., 1999). One strength of self reports for measuring interest pertains to the characteristics of interest itself. Interest is considered a psychological state of which one is conscious (Hidi, 2006). Therefore, readers are aware of their level of interest and are able to respond to self reports accurately. However, self report responses are dependent on the willingness of readers to honestly disclose their level of interest (Schiefele, 1992; Valsiner, 1992).

Body movements have been incorporated as an indirect measure in interest research. The rationale behind the use body movements in measuring interest is based on embodied theories of cognition that state that there is a connection between body movements and psychological states, such as interest (deVega, Glenberg, & Graesser, 2008). Certain body postures or gross body movements have been found to be associated with interest during reading: readers who are interested have been found to lean forward and learners who are bored have been found to lean back (Bianchi-Berthouze, Caims, & Cox, 2008; D'Mello, Picard, & Graesser, 2007; Kapoor & Picard,

2005). From the viewpoint of embodied cognition, the physical movement of leaning forward occurs so that the reader can be closer to the source of content determined to be interesting. In addition, interest has been negatively associated with gross bodily movements; in other words, readers who are interested move less than those who are not interested (D'Mello, Chipman, & Graesser, 2007; Kapoor, Mota, & Picard, 2001). From the viewpoint of embodied cognition, readers move their bodies when they are not interested to create external stimulation. In other words, because the text they are reading is not interesting or stimulating to them, readers may move their bodies in an effort to obtain physical stimulation.

Indirect measures of interest, such as gross bodily movements, are helpful in gauging interest during the reading process without interrupting the reader. However, indirect measures of interest assess factors associated with interest (such as leaning forward), but not interest itself. In addition, indirect measures of interest may indicate interest, but they do not discriminate subgroups of interest (e.g., topic interest and text-based interest). In summary, there are strengths and weaknesses to both direct and indirect measures of interest. Moreover, every measure, no matter how reliable or valid, has a certain degree of error. Combining bodily measures of interest with self reports allows for direct and indirect measure of interest to be incorporated into a study. The use of both direct and indirect measures allows for the weaknesses of one method to be compensated by the strengths of another. Therefore, it is beneficial to develop indirect measures of interest to complement and converge with traditional, direct measures of interests, such as self reports.

Much of the previous work on gross body movements and interest has focused on learning sessions with Intelligent Tutoring Systems and uses sophisticated and expensive (\$10,000) measurement systems to monitor bodily movements (e.g., D’Mello et al., 2007). Therefore, it would be beneficial for researchers with limited financial resources to have a cost effective method to monitor gross body movements. Specifically, Wii Fit™ boards (\$200) may be promising devices (Olney & D’Mello, 2010). If the Wii Fit™ boards are found to provide reliable indicators of interest, they may be of use to other researchers who wish to incorporate indirect measures of interest that are cost effective into their studies.

The Current Study

This dissertation seeks to answer three research questions. The first research question asks if topic interest and text-based interest were positively associated with learning from texts. This question is addressed in Experiment 1 in which learning from texts is measured through recall and answers to comprehension questions. Two hypotheses have been developed based on previous research findings. It is hypothesized that interest will be positively associated with learning from texts. It is also hypothesized that the positive association between interest and learning from texts will be independent of the effects of background knowledge.

The second research question asks what is the role of inference generation in the positive association between interest and learning from texts. This question is addressed in Experiment 2 through the inclusion of a think-aloud task to measure inference generation while reading. If interest leads to stricter standards of coherence, this would be indicated by increased inference generation while reading. The increase

in inference generation would create a more in-depth mental representation of the text thereby explaining (as a mediator) why interest is positively associated with learning from the texts. However, inference generation may not explain the positive association between interest and learning from text as a mediator. Instead, it may affect the direction or strength of the positive association between interest and learning from text as a moderator. Alternatively, inference generation could be statistically independent of the positive association between interest and learning from texts.

Inference generation and learning from texts are related to one's reading comprehension skill (Cain et al., 2004; Cromley & Azevedo, 2007). Therefore, reading comprehension skill is assessed through the Nelson-Denny subtest of reading comprehension in Experiment 2. The findings in Experiment 2 will be re-analyzed with the inclusion of reading comprehension skill. This is to ascertain whether findings regarding a positive association between interest and inference generation or the role of inference generation in the positive association between interest and learning from text are independent of the effects of reading comprehension skill. The findings from Experiment 2 can be interpreted with greater confidence if they are found to be independent of the effects of reading comprehension skill.

The third research question asks if Wii Fit™ boards are useful in measuring interest as indicated through gross body movements. This question is addressed in Experiment 1. There are two hypotheses regarding gross body movements and the interest and learning from text measures based on previous research findings. The first hypothesis is that the interest and learning from text variables would be negatively associated with changes in body movement (i.e., fidgeting or shifting in one's seat). The

second hypothesis regarding gross body movement is that the interest and learning from text variables would be negatively associated with leaning back while reading.

Chapter Four

Experiment 1

The primary purpose of Experiment 1 is to replicate findings in previous studies regarding the positive relation between interest and learning from texts. My first hypothesis is that both measures of interest (topic and text-based) will be positively associated with both measures of learning from texts (recall and answers to comprehension questions) based on previous findings reported in the literature (e.g., Bray & Barron, 2004; Boscolo & Mason, 2003; Naceur & Schiefele, 2003; Sadoski et al., 2000; Schiefele, 1990; Wade & Adams, 1990). My second hypothesis is that the positive associations between interest and learning from text will be independent of the effects of background knowledge as measured through scores on a pre-test. It is important to address the potential effects of background knowledge given the previous findings regarding the influence of background knowledge on both topic interest and learning from texts (Boscolo & Mason, 2003; Flowerday et al., 2004; Frick, 1992; Kintsch, 1980; Kintsch, 1998). However, my hypothesis that the positive associations between interest and learning from texts will be independent of the effects of background knowledge has been supported by previous findings (Boscolo & Mason, 2003; Schiefele & Krapp, 1996).

Although a positive association between interest and learning from texts independent of the effects of background knowledge has been previously found, it is still important to conduct Experiment 1 to test my hypotheses. The materials used in this study have not been previously examined for associations between interest and learning. In addition, a positive association between text-based interest and answers to

open-ended comprehension questions has not been previously investigated in the literature. Therefore, it is necessary to establish a positive association between interest and learning with this study's experimental texts and participant population before investigating a potential cause of the positive association.

Once such a positive association between interest and learning has been found, it will be further investigated with a think-aloud task in Experiment 2. The think-aloud task provides a rich source of data that is useful in analyzing cognitive processing, but it does have certain limitations. Because think-aloud tasks prompt readers to articulate their thoughts, think-aloud tasks may also prompt readers to process the text differently than they would if they were reading silently. Moreover, the need to articulate thoughts during the think-aloud task may affect a reader's spontaneous processing of the text (Fletcher, 1986). Therefore, it is advantageous to have data from two experiments when using the think-aloud methodology: one experiment with the think-aloud task and one experiment without the think-aloud task. The experiment without the think-aloud task provides a control to compare the offline (i.e., after reading) findings from both experiments. If the offline findings between the two experiments are similar, then this provides empirical support that the offline findings from the experiment with the think-aloud task were not caused by the think-aloud task.

The secondary purpose of Experiment 1 is to test the utility of Wii Fit™ boards in measuring interest. I have two hypotheses regarding body movement and the interest and learning from text variables. The first hypothesis is that the interest and learning from text variables would be negatively associated with changes in body movement (i.e., fidgeting or shifting in one's seat). This is based on previous research findings

that fidgeting or shifting in one's seat is indicative of boredom (D'Mello et al., 2007a; D'Mello et al., 2007b; Mota & Picard, 2003), which is negatively associated with learning (Kort, Reily, & Picard, 2001). The second hypothesis is that the interest and learning from text variables would be negatively correlated with leaning back (as indicated through increased pressure on the back board). This is based on previous research findings that leaning back is indicative of boredom (Kapoor et al., 2001).

Gross body movements are measured with Wii Fit™ boards in Experiment 1. More expensive and sophisticated systems of measuring gross body movements have had 76.5% to 83% accuracy in detecting interest from posture patterns in gross body movements (D'Mello & Graesser, 2007; Moto & Picard, 2003). Because the reliability of body movements as a measure of detecting interest is less than desirable, body movement data were not the primary interest measure. Instead, body movement data were used to provide converging evidence with the questionnaire responses that measure interest.

Methods

Participants

Sixty-two students from a large, Upper Midwestern university participated for course credit. One participant was a non-Native English speaker and another participant refused to complete the experiment; therefore their data were removed. Of the remaining 60 participants, 42 were female and 18 were male, with a mean age of 20.88 years ($SD = 6.84$ years), 90% were Caucasian, 3.3% were African American, 1.7% were Asian American, 1.7% were multi-racial, and 3.3% declined to provide racial background information. Due to equipment malfunction, body posture data were

recorded for only 42 of the participants, of whom 28 were female and 14 were male, with a mean age of 20.88 years ($SD = 7.08$ years), 92.9% were Caucasian, 2.4% were African American, 2.4% were multi-racial, and 2.4% declined to provide racial background information.

Materials

One practice and two experimental science texts were used. These texts were chosen because they provide a theoretical explanation for an observed phenomenon; therefore, learning could be assessed both in comprehension of the material presented and through application of the theory. Moreover, topic interest has been found to be positively associated with offline measures of inference generation with science texts (Alexander, Kulikowich, & Schulze, 1994; Ozunger & Guthrie, 2004; Schiefele, 1990, 1991). The experimental texts, “Origins of the moon” and “Why American songbirds are vanishing” were adapted from *Scientific American* articles (see Appendix A for experimental texts). The materials were adapted from their original form for two reasons. The first reason was to ensure that both texts were approximately the same length in sentences and difficulty. The same sentence length is important because participants were asked to think-aloud after each sentence in Experiment 2. As can be seen in Table 1, the original texts were different lengths in sentences. Following the adaptations, the experimental texts were the same number of sentences in length. To assess difficulty, Flesch-Kincaid Grade Level, which measures text difficulty based on average word and sentence lengths, was used. The original texts had different Flesch-Kincaid Grade Levels. Following the adaptations, the experimental texts had the same Flesch-Kincaid Grade Levels.

Table 1

Flesch-Kincaid and length of original and experimental texts

	Sentences	Words per sentence	Syllables per word	Flesch-Kincaid
Original texts				
Moon	40	19.53	1.51	10
Songbirds	32	21.58	1.71	12
Experimental texts				
Moon	32	27.58	1.56	12
Songbirds	32	22.70	1.73	12

Apparatus

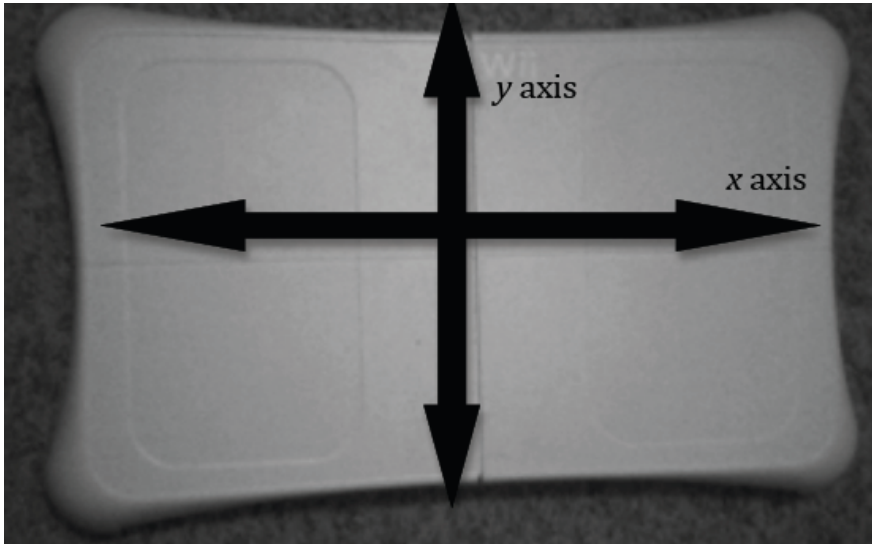
Two Wii Fit™ boards were used to collect body movement data. Wii Fit boards are constructed of durable plastic and are made to withstand up to 330 pounds (Nintendo of America, Inc., 2011). Nintendo developed Wii Fit™ boards for use in fitness activities and games involving body movement (Nintendo of America, Inc.). Wii Fit™ boards rest on four feet located in the four corners of the board. Each of the four feet has pressure sensors (see Figure 3; Wang, 2010). The four pressure sensors measure the center of gravity of a person standing on the board (Valkov, Steinicke, Bruder, & Hinrichs, 2010).

Figure 3. Bottom of a Wii Fit™ board



The center of gravity is measured by synthesizing the information from the four pressure sensors to determine the pressure exerted along the x and y axes of the Wii Fit™ board (see Figure 4; Valkov et al., 2010). The intersection of the pressure exerted along the x and y axes (i.e., the center of the board) is used to deduce the center of gravity of a person standing on the board (Valkov et al., 2010). The Wii Fit™ boards were designed to use Bluetooth to communicate these data to the Nintendo Wii console; however, the data can also be communicated to a computer using Bluetooth (Clark, Bryan, Pua, McCrory, Bennell, & Hunt, 2010). The Wii Fit™ boards were designed to be battery powered. This can be problematic for data collection if the batteries would lose charge causing the Wii Fit™ boards to become ineffective in the middle of an experimental session. To address this potential problem, the Wii Fit™ boards used in this study were adapted to run on A/C power.

Figure 4. Top of a Wii Fit™ board on which x and y Axes were Drawn and Labeled.



For use in this experiment, two Wii Fit™ boards were placed on an office chair (see Figure 5). A thin mat designed for yoga practice was placed over the Wii Fit™ boards for participant comfort (see Figure 6).

Figure 5. Gross Body Movement Measurement Device with Wii Fit Boards



Figure 6. Gross Body Movement Measurement Device for Participant Use



Measures

The measures used to assess background knowledge, text comprehension, topic interest, and text-based interest in Experiment 1 were developed by the experimenter.

The same measure was used to assess background knowledge and text comprehension (pre/post-tests; see Appendix B). Self-reports were developed to assess topic and text-based interest (see Appendix C and Appendix D, respectively).

Pre/post-tests. The pre-tests consisted of six free-response questions covering material that was provided in the experimental text (see Appendix B). These pre-tests were not meant to be an exhaustive inventory, but provide an estimate of the reader's

previous knowledge and familiarity with the topic. The post-test was identical to the pre-test to ensure that participants learned the information from the text and did not have the background knowledge prior to reading the text to correctly answer the question. The first two questions were designed to require the participant to recall facts that were presented in the article in order to answer the question accurately. The third and fourth questions were designed to require the participant to connect information explicitly stated in the article in order to answer the question accurately. The fifth and sixth questions were designed to require the participant to apply the information presented in the article in a novel way to answer the question accurately; the information needed to answer the questions was not explicitly stated in the article.

Each of the questions for the pre/post-tests had its quality objectively assessed using the software tool QUAID (question understanding aid; Graesser, Karnavat, Daniel, Cooper, Whitten, & Louwerse, 2000). QUAID was developed to assist researchers in identifying questions in their measures that are difficult to understand (Graesser et al., 2000). It is important to have questions that are understandable because questions that are not understood are more likely to be answered inaccurately than questions that are understood (Graesser, Cai, Louwerse, & Daniel, 2006). The increase in inaccurate answers for questions that are difficult to understand compared to questions that are easy to understand may lead to lower reliability for test measures (Graesser, Wiemer-Hastings, Kreuz, Wiemer-Hastings, & Marquis, 2000). QUAID identifies nine categories of problems that may lead to questions that are difficult to understand: unfamiliar technical term, vague or imprecise predicate or relative term, vague or ambiguous noun phrase, complex syntax, working memory overload,

misleading or incorrect presupposition, unclear question category, amalgamation of more than one question category, unclear question purpose, mismatch between question category and answer option, difficult to access specific or generic knowledge, and respondent unlikely to know answer (Graesser, Bornmareddy, Swamer, & Golding, 1996). Some of the questions were identified as problematic by QUAID for containing an unfamiliar technical term (questions 4 and 5 from “Origins of the moon” and questions 1-5 from “Why American songbirds are vanishing”). The unfamiliar technical terms identified by QUAID were “isotopes” and “neotropical.” These terms are used through the experimental articles and could not be removed or adapted without changing the nature of the questions. The other questions used in the pre/post-tests were not identified as belonging to any of the categories of problems (i.e., QUAID did not identify any problems with the questions).

Self-reports. To assess topic interest, the participants were asked to report their level of agreement with statements regarding their interest, boredom, familiarity, and engagement in both the specific and general text topics. Interest in both the specific and general text topics was included, to ensure a holistic assessment of topic interest. Interest was included to provide a simple and explicit measure of the participant’s interest. Boredom, considered the opposite of interest, was included so that the participant would be prompted to think differently about their level of interest in the topic. Familiarity is considered an aspect of topic interest; one is typically familiar with topics in which one is interested (Kintsch, 1980; Tobias, 1994). Engagement is considered a defining aspect of topic interest; if one is interested in a topic, then one is

engaged in that topic (Frick, 1992). Internal consistency for the topic interest self report in Experiment 1 was high (Cronbach's $\alpha = .88$)

To assess text-based interest, participants were asked to indicate their level of agreement with statements regarding their interest in the text they had just read. Direct statements regarding the participant's interest and boredom in the article were included for the same rationale these statements were asked in the topic interest self-report (i.e., to provide a basic measure of participant interest and to encourage the participant to think differently about the text, respectively). Statements about whether the participant would like to read articles by the same author, in the same magazine, and similar to the article just read were asked to implicitly determine if the participant found the writing of the article interesting. One can infer that if a participant would be interested in reading an article written similarly to the experimental text recently read, that participant found the writing of the article interesting. Internal consistency for the text-based interest self report in Experiment 1 was high (Cronbach's $\alpha = .92$).

The Likert scale for the topic and text-based self reports was designed based on empirical findings and recommendations in the literature. Comparisons of the reliability of Likert scales with various numbers of response categories found that scales with 6-9 response categories were more reliable, as measured by coefficient α , than both scales with 5 or fewer response categories and scales with 10 or more response categories (Preston & Colman, 2000; Weng, 2009). Moreover, scales that undergraduate students were asked to complete (e.g., for research studies or student satisfaction surveys) typically contained 7 response categories (Wang & Weng, 2002). Therefore, undergraduate students are most familiar with Likert scales with 7 response

categories. For these reasons, it is recommended to use Likert scales with 7 response categories when undergraduate students are the population of interest (Weng, 2004). In regards to the presentation of the categories, Weng noted that response categories that were labeled were more reliable than response categories that were only numbers. Because of this finding, each of the categories in the Likert scales in the questionnaires was labeled.

Procedure

Upon being greeted by their experimenter, participants provided informed consent and demographic information. Participants then completed pre-tests for each experimental text using pencils and paper. They were instructed to answer the questions for the pre-tests only if they knew the answer (i.e., they were not to guess at the answers).

Prior to completing the experimental tasks, participants completed a practice session that used the same sequence and style of measures as the experimental session. Participants completed all measures for a particular text either prior to or immediately after reading the text, then continued to the next text and its relevant measures.

Participants completed a pre-reading questionnaire of their topic interest for each text (i.e., the interest in the topic prior to reading the text). This questionnaire was completed prior to reading each experimental text. After completing the pre-reading questionnaire, participants read the text at their own pace, one sentence at a time, with the sentences presented on a computer screen. While the participants read, their body movements were recorded using Wii Fit™ boards and software developed by Sidney D'Mello at the University of Memphis.

After reading each text, the participants completed a post-reading questionnaire asking the participants to provide a retrospective account of their text-based interest (i.e., interest in the text as a whole). After rating the text's interest, the participants were asked to produce a written recall of the text with the instructions "Type out everything you can remember about the article you just read. Don't worry about spelling or grammar." Next, they completed a post-test to assess their learning (see Appendix A).

Data Analysis

Self-report responses. Self-report responses were used to measure interest. To do so, responses to items from the topic interest self reports (items 2 and 6 were reversed-scored) were summed to provide the measure of topic interest for each text. Responses to items from the text-based interest self reports (item 3 was reverse-scored) were summed to provide the measure of text-based interest for each text.

Body movement. Body movement data were analyzed to provide a secondary measure of interest. Time series of pressure exerted on the back and the seat over the course of reading the text were recorded for each participant at a 10Hz-sampling rate. The time series was then standardized in order to control for differences between participants in weight. Two types of posture measures were obtained from the boards on the back and the seat, thereby yielding four measures (two measures per board for two boards). The first measure was the mean pressure throughout the time series. The mean pressure for the centers of gravity along both the x and y axes of the Wii Fit™ boards were computed. Heightened mean pressure on the back board indicates a backward

lean, which is indicative of boredom (Bianchi-Berthouze, Cairns, & Cox, 2008; D'Mello, Picard, & Graesser, 2007; Kapoor & Picard, 2005).

The second measure pertained to the standard deviation in pressure exerted on the boards. The standard deviation in pressure for the centers of gravity along both the x and y axes of the Wii Fit boards were computed. Increased standard deviation is diagnostic of restlessness and fidgeting; this is because the more movement a participant creates, the greater the standard deviation from the mean pressure. Typically interest has been negatively associated with changes in seat pressure; in other words, participants who are interested shift in their seat less than those who are not interested (D'Mello et al., 2007a; Kapoor et al., 2001).

It is important to note that a single static posture is not considered informative of the participant's state of interest. Therefore, body movement data analysis provides an overall indicator of interest across a given time period as opposed to a moment-by-moment indicator of interest (Kapoor & Picard, 2003; Mota & Picard, 2003).

Dependent variables. The written recalls and post-test comprehension question answers were used to calculate two measures of learning from texts: the number of idea units recalled and the post-test gain scores. The written recalls were parsed by idea unit and coded for matching the original text's idea unit independently by trained undergraduate research assistants (cf. Linderholm & van den Broek, 2002). Twenty-five percent of the recalls were coded in common. Agreement on codes for idea units was reliably high ($\kappa = .89, p < .001$). Disagreements were resolved through discussion. The number of idea units recalled was one of two dependent variables in analyses.

The answers to the pretests and post-tests were scored for accuracy. The comprehension questions were scored on a scale and worth two points each (2 for completely accurate answers, 1 for partially accurate answers, and 0 for incorrect answers). Twenty-five percent of the answers to comprehension questions were scored in common. Agreement on scores for each question was reliably high ($\kappa = .98, p < .001$ for pre-tests; $\kappa = .93, p < .001$ for post-tests). Disagreements were resolved through discussion. The sum of the points for pre-tests was a predictor variable and the sum of points for post-tests was a dependent variable in analyses.

Results

Interest and learning from texts. The primary purpose of Experiment 1 is to determine whether topic interest and text-based interest had positive effects on the two measures of learning from texts: number of idea units accurately recalled and post-test scores on the comprehension questions. This question was first addressed by testing for correlations among topic interest, text-based interest, number of idea units accurately recalled, pre-test scores, and post-test scores (descriptive statistics and results are in Table 1). As indicated in the correlation matrix in Table 2, there are positive associations among topic interest, text-based interest, number of idea units accurately recalled, pre-test scores, and post-test scores. The positive association between topic interest and pre-test scores replicate previous findings that topic interest and background knowledge were positively associated (Garner & Gillingham, 1991; Tobias, 1994). Pre-test scores in Experiment 1 were quite low indicating the participants had little prior knowledge to answer the questions prior to reading the texts. Pre-test scores were positively associated with idea units recalled, but not for post-test gain scores.

This is likely due to the greater variability of idea units recalled compared to post-test gain scores; thereby increasing the possible predictive power of pre-test scores.

Moreover, the low pre-test scores created a floor effect for the variable; therefore, the lack of variability in the pre-test score lowers the possibility of a significant association with any of the other variables. The positive associations between the two interest variables (topic and text-based) and the two learning from text variables (idea units recalled and post-test scores) converge with previous findings regarding interest and learning from texts (Boscolo & Mason, 2003; Naceur & Schiefele, 2005; Sadoski et al., 1993; Sadoski et al., 2000; Schiefele & Krapp, 1996; Wade & Adams, 1990).

Table 2

Descriptive statistics and correlation matrix of interest and learning from text variables from Experiment 1

	Observed Min	Observed Max	M(SD)	
Topic	7	48	24.96(8.26)	
Text	4	28	19.10(6.94)	
Recall	1	32	10.63(6.49)	
Pre-test	0	7	.45(1.14)	
Post-test	0	12	6.35(3.34)	

	2	3	4	5
1. Topic	.68**	.46**	.28*	.39**
2. Text		.50**	.15	.46**
3. Recall			.23*	.63**
4. Pre-test				.13
5. Post-test				

Note. N = 60, 1. Topic = topic interest, 2. Text = text-based interest, 3. Recall = number of idea units recalled, 4. Pre-test = pre-test scores, 5. Post-test = post-test scores

* $p < .05$

** $p < .01$

The primary purpose of Experiment 1 is to replicate previous findings regarding a positive association between interest and learning from texts. To investigate the positive association between interest and learning from texts, hierarchical multiple regression analyses were performed. Hierarchical multiple regression analyses were chosen because they allow for the effects of pre-test scores to be partialled out of the effect of interest on learning. Four separate hierarchical multiple regression analyses were conducted for the two interest variables (topic and text-based) and two measures of learning (idea units recalled and post-test gain scores). The dependent variables were the number of idea units recalled and post-test gain scores. For each analysis, pre-test scores were entered into the first step of the regression model. The interest variable was entered into the second step. Because the pre-test scores were regressed onto the dependent variable of post-test scores, adjusted post-test scores are referred to as post-test gain scores to signify that they are residual gain scores (not simple gain scores) and to clarify that they measure a gain in learning. As can be seen in Tables 3 and 4, both topic and text-based interest were significant, positive predictors for both idea units recalled and post-test scores. Therefore, the primary purpose of Experiment 1 has been achieved.

Table 3

Hierarchical multiple regression analyses predicting learning from text variables from topic interest variable from Experiment 1

	Recall		Post-test	
	ΔR^2	B	ΔR^2	B
Step 1	.05**		.02	
Pre-test		.23*		.13
Step 2	.22**		.21**	
Pre-test		.11		.01
Topic interest		.43**		.40**

* $p < .05$

** $p < .01$

Table 4

Hierarchical multiple regression analyses predicting learning from text variables from topic interest variable from Experiment 1

	Recall		Post-test	
	ΔR^2	B	ΔR^2	β
Step 1	.05**		.02	
Pre-test		.23*		.13
Step 2	.22**		.21**	
Pre-test		.17*		.06
Text-based interest		.44**		.47**

* $p < .05$

** $p < .01$

Topic and text-based interest. Topic interest and text-based interest have strong positive associations with each other, as can be noted in the correlation matrix presented in Table 2. Previous researchers have discussed how topic interest can affect text-based interest (Hidi & Harackiewicz, 2000). This is because readers who have a strong interest in the topic of a text before reading will likely rate the text as highly-interesting after reading. Therefore, it is possible the findings regarding text-based interest in Table 4 could be influenced by the readers' topic interest. To examine this

possibility, hierarchical multiple regression analyses predicting learning from texts were conducted with topic interest and pre-test scores in the first step and text-based interest in the second step. This was done to determine if text-based interest had a positive association with learning from texts independent of topic interest. As can be seen in Table 5, text-based interest continued to have a positive association with both measures of learning from texts after the inclusion of topic interest in the regression model.

Table 5

Hierarchical multiple regression analyses predicting learning from text variables from text-based interest independent of topic interest from Experiment 1

	Recall		Post-test	
	ΔR^2	B	ΔR^2	β
Step 1	.22**		.17**	
Pre-test		.11		.01
Topic interest		.43**		.40**
Step 2	.05**		.07**	
Pre-test		.12		.03
Topic interest		.23*		.16
Text-based interest		.29**		.35**

* $p < .05$

** $p < .01$

Interest and gross body movement. The secondary purpose of Experiment 1 was to test the utility of Wii Fit™ boards in measuring interest. There were two hypotheses regarding body movement and the interest and learning from text variables. The first hypothesis was that the interest and learning from text variables would be negatively correlated with changes in body movement (i.e., fidgeting or shifting in one's seat; as indicated through increased standard deviations of pressure on the boards). The second hypothesis was that the interest and learning from text variables

would be negatively correlated with leaning back (as indicated through increased pressure on the back board)

The variables used to examine gross body movement were the means and standard deviations of pressure exerted on the center of gravity for the x and y axes of the two Wii Fit™ boards (i.e., the seat board and the back board). Correlations were tested among the gross body movement variables, the two interest variables, and the two learning from text variables. There were neither significant correlations between the interest variables and the seat board and the gross body movement variables from the seat board (see Table 6). There was a significant, negative correlation between the number of idea units recalled and the standard deviation of the pressure on the y axis of the seat board. In addition, as is shown in Table 7, there was a significant, negative correlation between the post-test scores and the standard deviation of the pressure on the y axis of the back board. Moreover, the standard deviations for the pressure on x and y axes of the back board were negatively correlated with both the interest variables. Increased standard deviation of pressure indicates increased body movement (e.g., fidgeting or shifting in one's seat). Therefore, these findings support the hypothesis that interest and learning from texts would be negatively associated with frequency of body movement.

The mean pressure on the y axis of the back board was negatively correlated with both text-based interest and the number of idea units recalled. An increase of mean pressure on the back board is indicative of the participant leaning back while reading. Therefore, these findings support the hypothesis that leaning back would be negatively

associated with interest and learning (although these findings were only significant for text-based interest and the number of idea units recalled).

Table 6

Correlation matrix for interest, learning from text, and body movement variables (seat board only) Experiment 1

	2	3	4	5	6	7	8
1. Topic	.72**	.47**	.45**	.07	.13	.11	-.06
2. Text		.56**	.48**	-.16	.07	-.06	-.09
3. Recall			.59**	-.09	-.07	-.11	-.23*
4. Post-test				.00	-.14	.03	-.03
5. SB COG X M					-.06	.11	-.05
6. SB COG Y M						.11	.13
7. SB COG Y SD							.67**
8. SB COG Y SD							

Note. N = 42, 1. Topic = topic interest, 2. Text-based = text-based interest, 3. SB COG X M = Mean pressure for seat board center of gravity on the x axis, 4. SB COG Y M = Mean pressure for seat board center of gravity on the y axis, 5. SB COG X SD = Standard deviation of pressure for the seat board center of gravity on the x axis, 6. SB COG Y SD = Standard deviation of pressure for the seat board center of gravity on the y axis.

* $p < .05$

** $p < .01$

Table 7

Correlation matrix for interest, learning from text, and body movement variables (back board only) Experiment 1

	2	3	4	5	6	7	8
1. Topic	.72**	.47**	.45**	-.06	-.24	-.14	-.30**
2. Text		.56**	.48**	-.04	-.30**	-.24*	-.34**
3. Recall			.59**	-.07	-.25*	-.07	-.14
4. Post-test				-.06	-.22	-.07	-.23*
5. BB COG X M					.08	.11	-.01
6. BB COG Y M						-.12	-.06
7. BB COG Y SD							.89**
8. BB COG Y SD							

Note. N = 42, 1. Topic = topic interest, 2. Text-based = text-based interest, 3. BB COG X M = Mean pressure for back board center of gravity on the x axis, 4. BB COG Y M = Mean pressure for back board center of gravity on the y axis, 5. BB COG X SD = Standard deviation of pressure for the back board center of gravity on the x axis, 6. BB COG Y SD = Standard deviation of pressure for the back board center of gravity on the y axis.

* $p < .05$

** $p < .01$

Discussion

Interest and learning from texts. The primary purpose of this experiment was to replicate previous findings regarding a positive association between interest and learning from texts. It was hypothesized that both forms of interest (i.e., topic and text-based) would be positively associated with both forms of learning from texts (the number of idea units recalled and post-test gain scores). The results of the experiment showed that both topic and text-based interest were positively associated with both the

number of idea units recalled and post-test gain scores. The positive associations between both measures of interest with both measures of learning from texts were independent of background knowledge, as measured with pre-test scores. Moreover, the positive association between text-based interest and both measures of learning was independent of topic interest. Therefore, the results of this study have supported the hypothesis.

It was hypothesized that the positive associations between interest and learning from texts would be independent of the effects of background knowledge. This hypothesis was confirmed. However, the measure of background knowledge, pre-test scores, was quite low indicating that the readers in this study did not know the answers to the questions prior to reading the texts. It was important to include the effects of background knowledge because, although the pre-test scores were quite low, there were positive associations between pre-test scores and both topic interest and the number of idea units recalled.

The results from Experiment 1 converge with previous empirical findings on interest and learning from texts. As was found in Experiment 1, topic interest has previously been found to be positively associated with recall (Naceur & Schiefele, 2003; Schiefele & Krapp, 1996) and accuracy in answers to open-ending reading comprehension questions (Schiefele, 1990). In addition, text-based interest has been found to be positively associated with recall (Sadoski, Goetz, & Rodriguez, 2000; Wade & Adams, 1990). A positive association between text-based interest and answers to open-ended comprehension questions has not been specifically investigated, but the findings from Experiment 1 converged with previous findings that text-based interest is

positively associated with test scores on multiple-choice reading comprehension assessments (Bray & Barron, 2004).

Interest and gross body movement. The secondary purpose of this experiment was to test the utility of Wii Fit™ boards as an indirect measure of interest. The findings indicated that there was a negative association between interest and fidgeting or shifting in one's seat, which has been previously found to be associated with boredom or lack of interest (D'Mello et al., 2007b). In regards to learning from texts, both the number of idea units recalled and post-test scores were negatively associated with fidgeting or shifting in one's seat while reading. In addition, the findings indicated that there was a negative association between both topic interest and text-based interest and leaning back on the seat, which has been previously found to be associated with boredom or lack of interest (Kapoor et al., 2001). In regards to learning from texts, recall was negatively associated with leaning back while reading. Although the strengths of these findings were relatively weak, they were significant and converge with previous findings on body movement and interest (e.g., D'Mello et al., 2007a, Mota & Picard, 2003). Therefore, the use of Wii Fit™ boards is promising for use in future research studies as an economical means to assess gross body movements as an indirect measure of interest.

It is difficult to provide an accurate comparison of the strength of the findings from Experiment 1 with the strengths of the findings from previous studies. The results from previous studies on gross body movement and interest used categorical interest variables (e.g., “interested” and “not interested”) acquired while reading and tested the accuracy of the body movements in predicting the reader's state of interest (D'Mello et

al., 2007a; Kapoor et al., 2001; Kapoor, Picard, & Ivanov, 2004). Moreover, unlike in Experiment 1, body movements in these studies were not tested for an association with performance on a learning task. The strength of the association between interest and body movement was tested in these studies by comparing the effect size (e.g., Cohen's *d*) between the categories. In contrast, Experiment 1 used continuous variables acquired before and after reading. The strength of the association between interest and body movement in Experiment 1 was tested using correlations. However, the strength of the findings from previous studies appears to be approximately comparable to those from Experiment 1 (D'Mello et al., 2007a; Kapoor et al., 2001; Kapoor, Picard, & Ivanov, 2004).

There are anomalies regarding the correlations for the mean pressure on the centers of gravity for the *x* and *y* axes. For the back board, significant correlations for mean pressure on the center of gravity of the *y* axis and both text-based interest and recall were found. However, there were no significant correlations for any of the interest or learning from text measures and mean pressure on the center of gravity on the *x* axis on the back board. In addition, there were no correlations between the mean pressure for the centers of gravity of the *x* and *y* axes for either the seat or the back boards. These findings may appear odd because the centers of gravity for axes *x* and *y* are on the same board; it would be logical to assume that pressure on a board would influence the *x* and *y* axes in a similar manner. However, there are four likely reasons for the different findings between mean pressure for *x* and *y* axes on the back board and the lack of correlations between the two centers of gravity. The first reason may be due to the layout of the axes. The *x* and *y* axes are different lengths (see Figure 4) which

creates differences in mean pressure on the centers of gravity of the two axes. The longer axis has more area for pressure on which to be exerted than the shorter axis; therefore a greater mean pressure variable would be calculated. This difference in how mean pressure is calculated for the x and y axes could explain the odd findings regarding the correlations.

The second reason the mean pressure for the x and y axes of each Wii Fit™ board were not correlated may be due to the analysis of the data. This reason would explain the lack of correlation between mean pressure on the centers of gravity on the x and y axes and does not address the lack of correlation between the mean pressure for the x axis and the interest and learning from text variables. The standardization of the raw data (to account for differences in body weight) may have affected the means in such a way that the x and y axes of the same board were no longer correlated with each other. In other words, if the mean pressure on the center of gravity from the x axis was greater than the y axis, the subsequent standardization of the variables may have transformed them differently. This may have removed a prior association between the two variables.

The third reason for the anomalies in correlations with the x and y axes could be due to the purpose for the development of the Wii Fit™ board, which was to determine the center of balance of a person standing on the board. The data from the Wii Fit™ board are used to calculate the center of balance by determining the intersection of the user's centers of gravity on the x and y axes (Valkov et al., 2010). In other words, the information from the x and y axes was intended to be used jointly to provide a single measure (i.e., center of balance) and not as separate measures as they were in this study.

Information from the x and y axes in this study was examined separately because measuring gross body movements while sitting is different from measuring center of balance while standing. The use of information from the two axes separately provides a better understanding of gross body movement because a person's weight is not centered in one place when sitting. Unlike the means, the standard deviations of the pressure on the center of gravity on the x and y axes were positively correlated with each other. This is likely because changes in body pressure, through body movement, would affect changes in pressure away from the mean in both the x and y axes. The issues that may have affected the correlations between the means would likely not have affected the standard deviations.

The fourth reason for the lack of a correlation between the mean pressure on the x axis and the interest and learning variables is likely due to the set-up of the gross body movement measurement device. This reason only addresses the lack of correlations with the mean pressure on the x axis and the interest and learning variables. The Wii Fit™ boards were placed on a padded office chair as has been done in previous research studies on gross body movement and interest (see Figure 5; D'Mello et al., 2007b; Mota & Picard, 2003). However, the shape of the back of the office chair is such that two of the feet on the back Wii Fit™ board have little contact with the chair. This is due to a gap between the seat and the backs of the chair. Given the placement of the x and y axes on the Wii Fit™ board (see Figure 4), leaning back exerts more pressure along the y axis than along the x axis. This would lead to the software determining that the mean pressure for the center of gravity on the x axis would be lower than the mean pressure for the center of gravity of the y axis. Because the software then determines the

pressure exerted along two axes differently there may be insufficient data from the x axis, but sufficient data from the y axis, to determine a significant correlation with text-based interest and recall. Although the set-up of the office chair may affect the calculation of the means of the pressure for the center of gravity on the two axes, the changes from those means (i.e., the standard deviations) would not be affected.

Summary

The purposes of Experiment 1, to replicate previous findings on interest and learning and to test the use of Wii Fit™ boards as an indirect measure of interest, were achieved. Both measures of interest were found to be positively associated with both measures of learning from texts. The findings from Wii Fit™ boards converged with previous findings on gross body movement and interest. The next step is to address a potential cause of the positive association between interest and learning from texts.

Chapter Five

Experiment 2

Experiment 1 replicated previous findings that interest is positively associated with learning from texts. The next step is to test if inference generation either accounts for (mediates) or affects the direction or strength of (moderates) the positive association between interest and learning from text. Specifically, I hypothesize that interest, either the interest in the topic the individual had prior to reading (topic interest) or the interest the reader had in that particular text (text-based interest), prompts a greater number of inferences generated. This hypothesis is based on the concept of standards of coherence that would predict that readers who are interested in either the topic or the text would generate more inferences than reader who are not interested. If interest increases the number of inferences generated, this could lead to greater learning from texts. This is because inference generation is positively associated with learning from texts (Kintsch, 1986, 1998; McNamara & Kintsch, 1986).

If inference generation is positively associated with interest both interest and learning from text, the next step is to determine the role of inference generation. The role of inference generation in the positive association between interest and learning from text can be determined through tests of mediation and moderation (cf. Baron & Kenny, 1986). If inference generation satisfies the tests of mediation it can be said to account for the positive association between interest and learning from texts. In other words, interest and learning from text would no longer have a positive association with each other with the inclusion of inference generation. The positive association between interest and learning from texts would be explained by inference generation.

If inference generation does not account for the positive association between interest and learning from text, but satisfies the tests of moderation, it can be said to modify or affect the direction or strength of the positive association between interest and learning from texts. Interest and learning would continue to have a positive association with the inclusion of inference generation, but inference generation interacts with interest in such a way that the strength of the positive association changes with differences in levels of inference generation. For example, readers with high numbers of inferences generated could have a stronger positive association between interest and learning from text than readers with low numbers of inferences generated. This would indicate that generating inferences somehow strengthens the positive association between interest and learning from texts. Conversely, readers with low numbers of inferences generated could have a stronger positive association between interest and learning from text than readers with high numbers of inferences generated. This would indicate that generating inferences somehow weakens the positive association between interest and learning from texts. For either scenario, the moderating influence of inference generation would be informative as to the nature of the positive association between interest and learning from texts.

It is possible that interest will not be positively associated with inference generation. There is no direct evidence from the literature that interest may be positively associated with inference generation while reading. Moreover, interest and inference generation may be positively associated, but inference generation may not satisfy the tests of mediation or moderation and may be statistically independent from the positive association between interest and learning from texts.

With mediation analyses, a temporal order is necessary. The independent variable (interest) must precede the proposed mediator variable (inference generation) that must precede the dependent variable (learning from texts). Topic interest is the interest a reader has prior to reading the text. Therefore, topic interest clearly exists prior to inferences generated while reading the text. In contrast, text-based interest is measured after reading as a retrospective account of interest in the text. With the methodology used in Experiments 1 and 2, it is not possible to definitively determine the time course of when text-based interest occurs. Therefore, text-based interest could be developed after or concurrently with inference generation. Because of this, mediation analyses with text-based interest as a potential mediator between inference generation and learning from texts will be conducted.

A think-aloud task was used in Experiment 2 whereas the participants in Experiment 1 read silently. One criticism of think-aloud tasks is that the changes in cognitive processing may occur as a result of the participant thinking aloud while reading. These changes in cognitive processing may influence offline tasks (recall and answering comprehension questions). Therefore, it is helpful to compare the offline results from a study with a think-aloud task to a similar study without a think-aloud task to determine if the think-aloud task affected the offline results.

Methods

Participants

Seventy students from a large, Upper Midwestern university participated for course credit. One participant did not produce think-aloud responses to more than 25% of the sentences in the experimental texts; therefore the data from this participant were

removed. Of the remaining 69 participants, 39 were female and 30 were male, with a mean age of 20.97 years ($SD = 4.91$ years), 78.6% were Caucasian, 5.7% were African American, 5.7% were Asian American, 2.9% were Native American, 2.9% were multi-racial, and 4.3% declined to provide racial background information.

Materials

The materials used were the same as those in Experiment 1. As with Experiment 1, the internal consistencies of the topic interest and text-based interest self reports were high for Experiment 2 (Cronbach's $\alpha = .87$; Cronbach's $\alpha = .94$, respectively).

Measures

The Nelson-Denny Comprehension Subtest Form G consists of seven reading passages and eight multiple-choice questions each with five answer choices and a 20 minute time limit for university students (Brown, Fishco, & Hanna, 1993). The first minute of the subtest is used to obtain reading rate. Reading rate is not a variable of interest for this study; therefore, it is not used in analyses. Scale scores were used in all analyses as a measure of reading comprehension skill. Alternate form reliability for university students between Form G and Form H is .81 (Brown et al., 1993).

Procedure

The procedure for Experiment 2 is the same as the procedure for Experiment 1 with the removal of body movement recording and the addition of the Nelson-Denny Comprehension Subtest and think-aloud procedure. Body movement data were not recorded in Experiment 2 out of concern the Wii Fit™ boards would distract the readers during the think-aloud procedure. As in Experiment 1, participants read texts one

sentence at a time on a computer screen. Unlike Experiment 1, participants were instructed to read each sentence aloud at their own pace and verbally reflect or comment on what they had read (e.g. Linderholm & van den Broek, 2002; Pressley & Afflerbach, 1995; Trabasso & Suh, 1993; van den Broek et al., 2001). If a participant did comment on the sentence, the experimenter encouraged the participant to provide a response by stating, "Please comment after every sentence." The experimenter modeled the think-aloud procedure with the beginning of the practice text; the participant read the remainder of the practice text using the think-aloud procedure before beginning the experimental texts (see Appendix E for think-aloud instructions and model responses). Think-aloud responses were recorded with a digital recorder.

Data Analysis

Verbal data from the think-aloud procedure were transcribed. Each of the idea units (noun-verb combinations that express a single idea) from participant responses was coded into one of the following categories: paraphrases, text repetitions (verbatim reiterations of the text), affective responses (emotional reactions), associations (elaborations irrelevant to the text), text-based inferences (explanations or predictions of the text based on previously read information in the text), knowledge-based inferences (explanations or predictions about the text based on background knowledge), and metacognitive comments (reflections of the readers own understanding or lack of understanding), and evaluative comments (opinions about the text; cf. Linderholm & van den Broek, 2002; van den Broek et al., 2001). Inferences were further coded as valid, if they are accurate or consistent with the text, or invalid, if they are inaccurate or inconsistent with the text. Only valid inferences are included in analyses. Two raters

independently coded the think-aloud protocols. Twenty-five percent of the think-aloud protocols were coded in common. Agreement on codes for think-aloud responses was reliably high ($\kappa = .94, p < .001$). Disagreements were resolved through discussion.

Text-connecting and knowledge-based inferences were combined into one variable for analyses. Potential mediators should only be examined separately if they are not highly correlated with each other and conceptually distinct (Kenny, 2010). In other words, text-connecting knowledge-based inferences should only be examined separately as potential mediators if they would provide different statistical and conceptual explanations for the positive association between interest and learning from text. The correlation between text-connecting and knowledge-based inferences was strong, $\rho(69) = .55, p < .001$, indicating a considerable amount of overlap in the two constructs. Moreover, both text-connecting and knowledge-based inferences contribute to a coherent mental representation of the text (Graesser et al., 1994; Kintsch, 1998). Text-connecting and knowledge-based inferences contribute to coherence by providing connections between the currently read text and either previously read text (for text-connecting inferences) or background knowledge (for knowledge-based inferences; Singer, 1994; van den Broek, 1990). Moreover, both text-connecting and knowledge-based inferences are affected by standards of coherence (van den Broek et al., in press). Therefore, both types of inferences would explain the positive association between interest and learning from text for the same reason, that is, both types of inferences allow the reader to construct a coherent mental representation of the text.

The written recalls were parsed and coded in the same manner by the same trained research assistants as in Experiment 1. Agreement on recall codes was reliably

high ($\kappa = .89, p < .001$). The pre-test and post-test comprehension question answers were scored in the same manner as in Experiment One. Agreement on scores was reliably high (for pre-tests $\kappa = .98, p < .001$; for post-tests $\kappa = .89, p < .001$). Disagreements were resolved through discussion.

Results

Comparison with Experiment 1

The purpose of Experiment 2 was to determine if the positive association between interest and learning noted in Experiment 1 could be explained by an increase in inference generation. To do this, we must first determine whether results similar to Experiment 1 regarding interest and learning were found in Experiment 2. The offline results from Experiments 1 and 2 were compared to determine if the inclusion of the think-aloud task in Experiment 2 affected the cognitive processing of the participants. Separate one-way ANCOVAs were conducted with the number of idea units and post-test scores as the dependent variables, pre-test scores as the covariate, and participation in Experiment 1 or Experiment 2 as the between subjects variable. The results indicated that there were indeed differences in the offline results from Experiment 1 and Experiment 2. In regards to recall, participants in Experiment 1 ($M = 31.32; SD = 7.37$) wrote more idea units from the text than did participants in Experiment 2 ($M = 24.56; SD = 10.50$), $F(1, 127) = 16.04, p < .001$, Cohen's $d = .69$. In regards to post-test scores, participants in Experiment 1 ($M = 12.69; SD = 5.97$) answered fewer questions accurately than did participants in Experiment 2 ($M = 14.84; SD = 4.65$), $F(1, 127) = 4.60, p = .03$, Cohen's $d = .40$. Pre-test scores were not significant as a covariate for

either recall or post-test scores. Therefore, the offline measures between Experiment 1 and Experiment 2 were quite different.

The difference between the offline measures in Experiment 1 and Experiment 2 does not eliminate the possibility of similar findings in regards to the positive association between interest and learning from texts. Although the number of idea units recalled and post-test gain scores differed in the two experiments, the associations between interest and the offline variables may still be the same. To examine the associations between interest and learning from text in Experiment 2, I conducted the same statistical analyses as for Experiment 1. In addition to the variables included in the correlation matrix from Experiment 1, I included the number of inferences, Nelson-Denny scale scores, and time on task. Correlations among topic interest, text-based interest, idea units recalled, pre-test scores, post-test gain scores, number of inferences, and scale scores on the Nelson-Denny were conducted (descriptive statistics and results in Table 8).

As can be seen in Table 8, the positive correlations among interest and learning from texts that were found in Experiment 1 were also found in Experiment 2. Also as found in Experiment 1, topic interest and pre-test scores are positively correlated. Similar to Experiment 1, pre-test scores were quite low, suggesting a floor effect. Unlike Experiment 1, pre-test scores are not significantly correlated with the number of idea units recalled. This may be due to the fact that because there was greater variability, as indicated by the standard deviations, in pre-test scores in Experiment 1. The greater variability in pre-test scores in Experiment 1 provided more variance thereby increasing the likelihood of a significant correlation. Overall, the correlations

from Experiment 2 regarding interest and learning from text are similar, although not as strong, as the correlations from the same variables in Experiment 1.

Regarding the variables which were only included in Experiment 2, the Nelson-Denny scale scores were positively associated with the number of idea units recalled and post-test accuracy scores. There did not appear to be any associations between the Nelson-Denny scale scores and the interest variables. The number of inferences was positively associated with the two interest variables, the Nelson-Denny scale scores, and the two learning from text variables.

Table 8

Descriptive statistics and correlation matrix of interest variables, learning from text variables, reading comprehension skill, and inference generation from Experiment 2

	Observed Min	Observed Max	M(SD)
Topic	8	56	28.75(9.06)
Text	5	35	19.92(7.36)
Recall	1	31	12.28(5.98)
Pre-test	0	3	.31(.61)
Post-test	2	12	7.42(2.74)
N-D	191	251	226.71(13.93)
Inference	0	42	16.58(9.67)

	2	3	4	5	6	7
1. Topic	.61**	.32**	.24**	.24**	.07	.28**
2. Text		.32**	.14	.28**	.02	.30**
3. Recall			.16	.31**	.23**	.24**
4. Pre-test				.08	.13	.18*
5. Post-test					.44**	.48**
6. N-D						.36**
7. Inference						

Note: N = 69, 1. Topic = topic interest, 2. Text = text-based interest, 3. Recall = idea units recalled, 4. Pre-test = pre-test scores, 5. Post-test = post-test gain scores, 6. N-D = Nelson-Denny Reading Comprehension Subtest scale scores, 7. Inference = number of inferences

* $p < .05$

** $p < .01$

Tests of Mediation

The primary purpose of Experiment 2 is to determine the role of inference generation on the positive association between interest and learning from texts. If inference generation accounts for the positive association between interest and learning from text, it would be a mediator. According to Baron and Kenny (1986), mediation should be tested through three regression equations. The first regression equation tests the effects of the independent variable (topic or text-based interest) on the mediator (inference). The second regression equation tests the effects of the independent variable (interest) on the dependent variable (idea units recalled or post-test accuracy gains scores). The third regression equation tests the effects of both the independent variable (topic or text-based interest) and the mediator (inference) on the dependent variable (idea units recalled or gain scores). In order to establish mediation, the independent variable must have a significant effect on both the mediator and the dependent variable in the first and second equations and the mediator must affect the dependent variable in the third equation. Furthermore, the effect of the independent variable on the dependent variable must be greater in the second equation than in the third equation (in which the mediator was included).

To test for mediation, the regression equations recommended by Baron and Kenny (1986) were conducted with topic or text-based interest as the independent variables, number of inferences as the mediator, and number of idea units recalled or post-test gain scores as the dependent variables. In order to control for the effects of background knowledge on the dependent variables, the second and third regression

equations were conducted as hierarchical multiple regression analyses with pre-test scores in the first step and the recommended predictor variables in the second step.

Topic interest and text-based interest were positive predictors of number of inferences, $\beta = .28, p = .001$; $\beta = .30, p < .001$, respectively. This is not surprising given the positive correlations between both topic and text-based interest and the number of inferences reported in Table 8. Therefore, the first test of mediation recommended by Baron and Kenny has been satisfied. Topic interest and text-based interest were positive predictors of the number of idea units recalled and post-test gain scores as can be noted in Table 9 and Table 10, respectively. Therefore, the second test of mediation recommended by Baron and Kenny has been satisfied.

Table 9

Hierarchical multiple regression analyses predicting learning from text from topic interest from Experiment 2

	Recall		Post-test	
	ΔR^2	β	ΔR^2	B
Step 1	.03		.01	
Pre-test		.16		.08
Step 2	.11**		.03**	
Pre-test		.09		.02
Topic interest		.30**		.23*

* $p < .05$

** $p < .01$

Table 10

Hierarchical multiple regression analyses predicting learning from text from text-based interest from Experiment 2

	Recall		Post-test	
	ΔR^2	β	ΔR^2	β
Step 1	.03		.01	
Pre-test		.16		.08
Step 2	.09**		.07**	
Pre-test		.02		.04
Text-based interest		.31**		.27**

* $p < .05$

** $p < .01$

Recall. When the number of inferences was entered with the interest variables, topic interest and text-based interest remained significant predictors of the number of idea units recalled (see Table 10 and Table 11, respectively). The number of inferences generated was not a significant predictor of the number of idea units recalled. Therefore, inferences did not mediate the positive association between the interest variables and the number of idea units recalled.

Post-test gain scores. When the number of inferences was entered with the interest variables, topic interest and text-based interest were no longer significant predictors of post-test gain scores (see Table 11 and Table 12, respectively). The number of inferences generated was a significant predictor of post-test gain scores. Therefore, in regards to the post-test gains scores, the third test of mediation recommended by Baron and Kenny (1986) was satisfied. This indicates that the number of inferences accounted for the positive association between the interest variables and post-test gain scores, but not idea units recalled.

Table 11

Hierarchical multiple regression analyses predicting learning from text from topic interest and inference generation from Experiment 2

	Recall		Post-test	
	ΔR^2	β	ΔR^2	β
Step 1	.03		.01	
Pre-test		.16		.08
Step 2	.11**		.24**	
Pre-test		.07		-.04
Topic interest		.26**		.12
Inference		.16		.45**

* $p < .05$

** $p < .01$

Table 12

Hierarchical multiple regression analyses predicting learning from text from text-based interest and inference generation from Experiment 2

	Recall		Post-test	
	ΔR^2	β	ΔR^2	β
Step 1	.03		.01	
Pre-test		.16		.08
Step 2	.11**		.24**	
Pre-test		.10		-.02
Text-based interest		.26**		.15
Inference		.15		.44**

* $p < .05$

** $p < .01$

Tests of Moderation

Although inference generation does not mediate the positive association between the interest variables and the number of idea units recalled, there is a possibility that inference generation modifies the direction or strength of the positive association as a moderator. Moderator effects are indicated if the interaction of the moderator (number of inferences) and the independent variable (topic interest or text-

based interest) has a significant effect on the dependent variable (number of idea units recalled) after the effects of the independent variable and moderator are controlled.

Topic interest. As can be seen in Table 13, the interaction between the number of inferences and topic interest was not a significant predictor of the number of idea units recalled. Therefore, there is no indication that number of inferences was a moderator between topic interest and the number of idea units recalled. In other words, inference generation was statistically independent from the positive association between topic interest and recall. The number of inferences generated while reading did not affect strength of the positive association between topic interest and recall.

Table 13

Hierarchical multiple regression analyses predicting recall from the interaction between topic interest and inferences

	Recall	
	ΔR^2	β
Step 1	.03	
Pre-test		.16
Step 2	.11**	
Pre-test		.07
Topic interest		.26**
Inference		.16
Step 3	.01*	
Pre-test		.07
Topic interest		.25**
Inference		.16
Topic interest x inference		-.10

* $p < .05$
** $p < .01$

Text-based interest. Unlike topic interest, the interaction between the number of inferences and text-based interest was a significant predictor of the number of idea units recalled (see Table 14). This indicates the number of inferences was a moderator of the positive association between text-based interest and the number of idea units recalled. In other words, the number of inferences generated while reading appears to affect the strength of the positive association between text-based interest and the number of idea units recalled.

Table 14

Hierarchical multiple regression analyses predicting recall from interaction between text-based interest and inferences

	Recall	
	ΔR^2	B
Step 1	.03	
Pre-test		.16
Step 2	.11**	
Pre-test		.10
Text-based interest		.26**
Inference		.15
Step 3	.03*	
Pre-test		.11
Text-based interest		.25**
Inference		.16
Text-based interest x inference		.17*

* $p < .05$

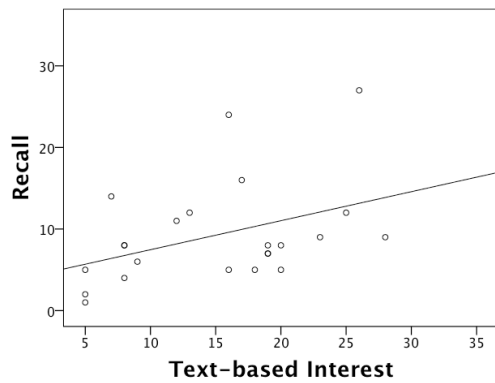
** $p < .01$

To further understand the nature of the interaction between text-based interest and number of inferences, follow-up regression analyses were conducted to determine the simple effects. The purpose of this was to examine the positive association between text-based interest and the number of idea units recalled for readers of varying levels of inference generation (i.e., the moderator; cf. Judd & Kenny, 2010). Readers were divided into three groups based on their inference generation (low, middle, and high levels of inference generation). The low group ($N = 12$) generated a number of inferences less than one standard deviation below the mean. The middle group ($N = 45$) generated a number of inferences between one standard deviation below the mean and one standard deviation above the mean. The high group ($N = 12$) generated a number of inferences greater than one standard deviation above the mean. Separate regression

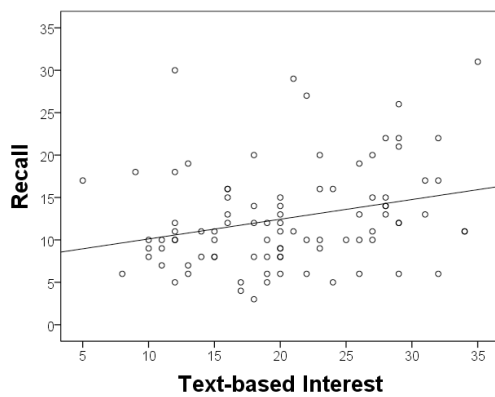
analyses were conducted for each group with pre-test scores entered into the first step, text-based interest entered into the second step, and the number of idea units recalled as the dependent variable. For readers in the low inference generation group, pre-test scores were not a significant predictor, but text-based interest was a significant predictor of the number of idea units recalled ($\beta = .42, p = .049$). For readers in the middle inference generation group, pre-test scores were not a significant predictor, but text-based interest was a significant predictor of the number of idea units recalled ($\beta = .25, p = .02$). For readers in the high inference generation interest group, pre-test scores and text-based interest were not significant predictors of the number of idea units recalled. Scatterplots from each inference group with the number of idea units recalled on the y axis and text-based interest on the x axis can be seen in Figure 7.

Figure 7. Scatterplots of text-based interest and recall for inference generation groups

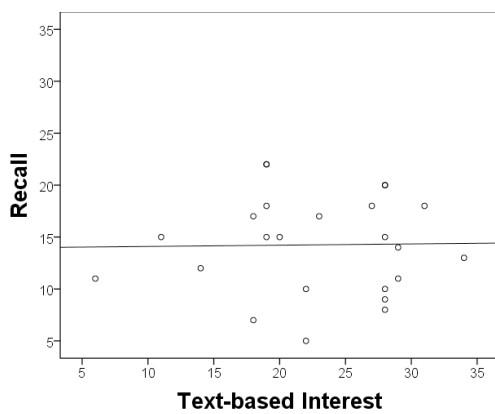
Low inference generation group



Middle inference generation group



High inference generation group



These results indicate that the positive association between text-based interest and the number of idea units recalled varies with inference generation. For readers in the low and average inference generation groups, text-based interest has a positive association with the number of idea units recalled. For readers in the high inference generation group, text-based interest does not seem to have any association with the number of idea units recalled.

Topic interest and text-based interest. As with Experiment 1, topic interest and text-based interest had strong positive associations with each other (see Table 8). Because topic interest exists prior to text-based interest, it is possible that the previously found results regarding text-based interest could be due to topic interest. Therefore, the tests of mediation recommended by Baron and Kenny (1986) were conducted with the inclusion of topic interest and pre-test scores in the first step. This is done so that the findings regarding text-based interest as an independent variable can be determined to be beyond the potential influence of topic interest. The first test of mediation tests the effect of the independent variable on the proposed mediator. Text-based interest was a positive predictor of the number of inferences, ($\beta = .22, p = .04$), independent of topic interest. The second test of mediation test the effect of the independent variable on the dependent variable. As can be seen in Table 15, text-based interest is a positive predictor of both recall and post-test gain scores independent of pre-test scores and topic interest. Therefore the second test of mediation has been satisfied.

Table 15

Hierarchical multiple regression analyses predicting learning from text from text-based interest independent of topic interest from Experiment 2

	Recall		Post-test	
	ΔR^2	β	ΔR^2	β
Step 1	.10		.24*	
Pre-test		.09		.02
Topic interest		.30**		.23**
Step 2	.12*		.29*	
Pre-test		.09		.02
Topic interest		.18		.11
Text-based interest		.20*		.21*

* $p < .05$

** $p < .01$

The third test of mediation tests the effect of both the independent variable and the mediator variable on the dependent variable. The results reported in Table 16 indicate that the inclusion of topic interest does not significantly change the role of inference generation in the positive association between text-based interest and learning from texts. As can be seen in Table 16, neither text-based interest nor inference generation were significant predictors of recall with inclusion of topic interest in the first step. Therefore, inference generation does not mediate the positive association between text-based interest and the number of idea units recalled. In contrast, inference generation was a significant predictor of post-test gain scores. Text-based interest was no longer a significant predictor of post-test gain scores after the inclusion of inference generation. Therefore, the results of the third test of mediation indicate that inference generation mediates the positive association between text-based interest and post-test gain scores, independent of topic interest.

Table 16

Hierarchical multiple regression analyses predicting learning from text from text-based interest and inferences independent of topic interest from Experiment 2

	Recall		Post-test	
	ΔR^2	β	ΔR^2	β
Step 1	.10		.24*	
Pre-test		.09		.02
Topic interest		.30**		.23**
Step 2	.15*		.20	
Pre-test		.08		-.03
Topic interest		.16		.06
Text-based interest		.18		.12
Inference		.13		.44**

* $p < .05$

** $p < .01$

Although inference generation was not a mediator of the positive association between text-based interest and the number of idea units recalled, it could still be a moderator. As can be seen in Table 17, the interaction between text-based interest and inference generation was significant independent of topic interest. These results are consistent with the results without the inclusion of topic interest. To further understand the nature of the moderator, the positive association between text-based interest and recall independent of topic interest for each of the three inference generation groups (low, medium, high). These were the same groups used in the analyses without topic interest. Text-based interest was not a significant predictor of recall independent of topic interest for any of the three groups. This may be because the inclusion of topic interest weakened the predictive power of text-based interest. Therefore, there was not sufficient power to detect an effect of text-based interest within these groups. The

previously discussed findings regarding text-based interest independent of topic interest have been consistent with findings of text-based interest without the inclusion of topic interest. Therefore, it is unlikely that the findings regarding text-based interest have been due to the influence of topic interest. In other words, text-based interest appears to have an effect on learning from texts independent of topic interest.

Table 17

Hierarchical multiple regression analyses predicting recall from interaction between text-based interest and inferences independent of topic interest

	Recall	
	ΔR^2	B
Step 1	.33**	
Pre-test		.16
Topic interest		
Step 2	.04*	
Pre-test		.08
Topic interest		.16
Text-based interest		.18
Inference		.13
Step 3	.03*	
Pre-test		.09
Topic interest		.18
Text-based interest		.15
Inference		.14
Text-based interest x inference		-.18*

* $p < .05$

** $p < .01$

Role of text-based interest. The methodology used in this study does not provide information regarding when text-based interest was developed. Therefore, it is possible that inferences were generated before text-based interest was developed. Because the time course is uncertain, the possibility that text-based interest mediates the

positive association between inference generation and learning from texts should be examined. The same tests of mediation used with inference generation as a potential mediator are used to test text-based interest as a potential mediator. In the first test of mediation, inference generation was a positive predictor of text-based interest, ($\beta = .28$, $p = .001$). In the second test of mediation, inference generation was a positive predictor for both the number of idea units recalled and post-test gain scores (see Table 18).

Therefore, the second test of mediation has been satisfied.

Table 18

Hierarchical multiple regression analyses predicting learning from text from inference generation from Experiment 2

	Recall		Post-test	
	ΔR^2	β	ΔR^2	β
Step 1	.03		.01	
Pre-test		.16		.08
Step 2	.08*		.23**	
Pre-test		.12		-.01
Inference		.23**		.49**

* $p < .05$

** $p < .01$

The third test of mediation tests the effect of both the independent variable and mediator variable on the dependent variables. For the third test, the regression model testing if text-based interest mediates the positive association between inference generation and learning from texts is identical to the regression model testing if inference generation mediates the positive association between text-based interest and learning from texts (refer to Table 12). Inference generation is no longer a significant predictor of the number of idea units recalled after the inclusion of text-based interest. Therefore, text-based interest may mediate the positive association between text-based

interest and the number of idea units recalled. However, inference generation remained a significant predictor of post-test gain scores after the inclusion of text-based interest. Therefore, text-based interest does not appear to mediate the positive association between inference generation and post-test gains scores. The interaction between text-based interest and inference generation was tested to determine if text-based interest moderates the positive association between interest and learning from texts. As can be seen in Table 19, the interaction was not significant. Therefore, it appears that text-based interest is statistically independent from the positive association between inference generation and post-test gain scores.

Table 19

Hierarchical multiple regression analyses predicting post-test gain scores from the interaction between text-based interest and inferences

	Post-test	
	ΔR^2	B
Step 1	.08	
Pre-test		.08
Step 2	.25**	
Pre-test		-.02
Text-based interest		.14
Inference		.45**
Step 3	.02	
Pre-test		-.01
Text-based interest		.13
Inference		.46**
Text-based interest x inference		-.14

* $p < .05$

** $p < .01$

Covariate analysis

As can be seen in Table 8, inference generation is positively associated with Nelson-Denny scale scores. In addition, Nelson-Denny scale scores are positively associated with the number of idea units recalled and post-test gain scores. Therefore, it is possible that reading comprehension skill, as assessed through Nelson-Denny scale scores may have influenced the tests of number of inferences as a mediator or moderator. In other words, it is possible the results previously found in the mediation and moderation analyses could be due to individual differences in reading comprehension skill rather than individual differences in topic or text-based interest. Because there was no random assignment of interest in this study and therefore no control for potential covariates, such as reading comprehension skill, additional tests of mediation and moderation that statistically control for the effects of reading comprehension skills were conducted. Nelson-Denny scale scores were entered into the first step of each of the regression equations to control for the potential effects of reading comprehension skill.

Tests of mediation. First, we conducted the three regression equations to test for mediation recommended by Baron and Kenny (1986) with the effects of Nelson-Denny scale scores controlled. Topic interest and text-based interest were significant predictors of the number of inferences generated, $\beta = .25, p = .001$, $\beta = .29, p < .001$, respectively. Nelson-Denny scale scores were also significant predictors of the number of inferences generated, $\beta = .36, p = .001$, and remained significant predictors of the number of inferences in the second step with the inclusion of topic and text-based

interest, $\beta = .34, p = .001$, $\beta = .35, p < .001$, respectively. Therefore, the first test of mediation recommended by Baron and Kenny (1986) has been satisfied.

The second test of mediation was conducted to determine the effects of the independent variables (topic interest and text-based interest) on the dependent variables (number of idea units recalled and post-test gain scores) with the effects of Nelson-Denny scale scores and pre-test scores controlled. As can be seen in Table 20 and Table 21, topic interest and text-based interest continued to be positive predictors of the number of idea units recalled and post-test gain scores after the effects of Nelson-Denny scale scores and pre-test scores were controlled. It appears that the positive association previously found between interest and learning from texts was not due to individual differences in reading comprehension skill. Therefore, the second test of mediation recommended by Baron and Kenny (1986) has been satisfied.

Table 20

Hierarchical multiple regression analyses predicting learning from texts from topic interest and reading comprehension skill from Experiment 2

	Recall		Post-test	
	ΔR^2	β	ΔR^2	B
Step 1	.07**		.19**	
Pre-test		.14		.02
Nelson-Denny		.21*		.43**
Step 2	.08**		.04**	
Pre-test		.07		-.03
Nelson-Denny		.20*		.42**
Topic interest		.29**		.22**

* $p < .05$

** $p < .01$

Table 21

Hierarchical multiple regression analyses predicting learning from texts from text-based interest and reading comprehension skill from Experiment 2

	Recall		Post-test	
	ΔR^2	β	ΔR^2	B
Step 1	.07**		.19**	
Pre-test		.14		.02
Nelson-Denny		.21*		.43**
Step 2	.09**		.07*	
Pre-test		.09*		-.01
Nelson-Denny		.21**		.43**
Text-based interest		.31**		.27**

* $p < .05$

** $p < .01$

The third test of mediation was conducted to determine the role of inference generation in the positive association between interest and learning from texts after the effects of Nelson-Denny scale scores and pre-test scores were controlled. When the number of inferences was entered into the regression equation, the results with the effects of Nelson-Denny scale scores controlled were consistent with the previous findings without the effects of Nelson-Denny scale scores controlled. Consistent with previous findings, the number of inferences had different roles with the number of idea units recalled and post-test gain scores (see Table 22 and Table 23 for regression analyses).

Table 22

Hierarchical multiple regression analyses predicting learning from texts from topic interest, inferences, and reading comprehension skill from Experiment 2

	Recall		Post-test	
	ΔR^2	β	ΔR^2	B
Step 1	.07**		.19**	
Pre-test		.14		.02
Nelson-Denny		.21*		.43**
Step 2	.09**		.14**	
Pre-test		.06		-.06
Nelson-Denny		.17*		.31**
Topic interest		.27**		.14
Inference		.10		.34**

* $p < .05$

** $p < .01$

Table 23

Hierarchical multiple regression analyses predicting learning from texts from text-based interest, inferences, and reading comprehension skill from Experiment 2

	Recall		Post-test	
	ΔR^2	β	ΔR^2	B
Step 1	.07**		.19**	
Pre-test		.14		.02
Nelson-Denny		.21*		.43**
Step 2	.10**		.15**	
Pre-test		.08		-.05
Nelson-Denny		.19*		.32**
Text-based interest		.28**		.19*
Inference		.08		.32**

* $p < .05$

** $p < .01$

Recall. With inclusion of Nelson-Denny scale scores and pre-test scores, the number of inferences was not a significant predictor of the number of idea units recalled in the regression analyses for either interest variable. Therefore, inferences did not mediate the positive association between the interest variables and the number of idea units recalled with the effects of Nelson-Denny scale scores controlled. This finding is

consistent with previous findings without the effects of Nelson-Denny scale scores controlled.

Post-test gain scores. With the inclusion of Nelson-Denny scale scores and pre-test scores, the number of inferences was a significant predictor for post-test gains scores in the regression analyses for both interest variables. In addition, the effect of topic interest was no longer significant when inference generation was included in the regression model. In contrast, the effect of text-based interest was significant when inference generation was included in the regression model. However, the effect of text-based interest was considerably less in the third regression model than the second. Therefore, the third test of mediation has been satisfied for post-test gain scores indicating that inferences mediate the positive association between the interest variables and post-test gain scores with the effects of Nelson-Denny scale scores controlled. In other words, the number of inferences appeared to account for the positive association between both topic interest and text-based interest and post-test gain scores after the potential influence of individual differences in reading comprehension skill had been controlled.

Tests of moderation. The number of inferences did not mediate the positive association between the interest variables and the number of idea units recalled with the effects of Nelson-Denny scale scores controlled. This is consistent with the previous findings without the effects of Nelson-Denny scale scores controlled. However, there is a possibility that the number of inferences may be a moderator of the positive association between interest and the number of idea units recalled with the effects of Nelson-Denny scale scores controlled. The number of inferences was tested as a

moderator by entering the interactions for both the interest variables and number of inferences were entered into regression models after the effects of the covariates (Nelson-Denny scale scores and pre-test scores), independent variables (topic interest or text-based interest), and the number of inferences (potential moderator) have been controlled. As can be seen in Table 24 and 25, the results were consistent with those without the effects of Nelson-Denny scale scores controlled.

Table 24

Hierarchical multiple regression analyses predicting recall from the interaction between topic interest and inferences with reading comprehension skill as a covariate

	Recall	
	ΔR^2	B
Step 1	.07*	
Pre-test		.14
Nelson-Denny		.21*
Step 2	.09**	
Pre-test		.06
Nelson-Denny		.17*
Topic interest		.27**
Inference		.10
Step 3	.01	
Pre-test		.06
Nelson-Denny		.18*
Topic interest		.26**
Inference		.10
Topic interest x inference		-.11

* $p < .05$

** $p < .01$

Table 25

Hierarchical multiple regression analyses predicting recall from the interaction between text-based interest and inferences with reading comprehension skill as a covariate

	Recall	
	ΔR^2	B
Step 1	.07*	
Pre-test		.14
Nelson-Denny		.21*
Step 2	.10**	
Pre-test		.09
Nelson-Denny		.19*
Text-based interest		.28**
Inference		.08
Step 3	.03*	
Pre-test		.10
Nelson-Denny		.21*
Text-based interest		.27**
Inference		.08
Text-based interest x inference		-.19*

* $p < .05$

** $p < .01$

Topic interest. The interaction between topic interest and the number of inferences generated was not significant. Therefore, there is no indication the number of inferences is a moderator of the positive association between topic interest and the number of idea units recalled. Consistent with the previous findings without the influence of Nelson-Denny scale scores, the number of inferences did not appear to have any influence on the positive association between topic interest and the number of idea units recalled.

Text-based interest. The interaction between text-based interest and the number of inferences generated was significant. This indicates that the number of inferences moderated the positive association between text-based interest and the number of idea units recalled. In other words, the strength or the direction of the positive association between text-based interest and the number of idea units recalled varies depending on the number of inferences. These findings were consistent with the findings without the effects of the Nelson-Denny scale scores controlled.

To further understand the nature of the interaction between text-based interest and the number of inferences, three separate regression analyses were conducted for three groups at different levels of inferences (low, middle, and high). The groups were the same as those determined previously; that is, the low group generated a number of inferences less than one standard deviation below the mean, the middle group generated a number of inferences between one standard deviation below and one standard deviation above the mean, and the high group generated a number of inferences greater than one standard deviation above the mean. Regression analyses to determine the effect of text-based interest on the number of idea units recalled were conducted for each group with Nelson-Denny scale scores controlled. For readers in the low inference generation group, pre-test scores, Nelson-Denny scales, and text-based interest were not significant predictors of the number of idea units recalled. For readers in the middle inference generation group, pre-test scores were not a significant predictor, but Nelson-Denny scale scores and text-based interest were significant predictors of the number of idea units recalled, $\beta = .23, p = .03$; $\beta = .28, p = .01$, respectively. For readers in the high inference generation group, pre-test scores and text-based interest were not

significant predictors, but Nelson-Denny scale scores were a significant predictor of the number of idea units recalled, $\beta = .49, p = .03$. These results indicate that the number of inferences influences the strength of the positive association between text-based interest and the number of idea units recalled. Specifically, there is a positive association between text-based interest and the number of idea units recalled, but is a more powerful predictor of the number of idea units recalled for readers with average numbers of inferences than for readers with low and high numbers of inferences with the effects of Nelson-Denny scale scores controlled.

These results for the inference generation group differ slightly from those without the effects of Nelson-Denny scale scores in regards to the low inference generation group. This could be due to the loss of power with the inclusion of Nelson-Denny scale scores in the regression analyses. Without the effects of the Nelson-Denny scale scores controlled, text-based interest barely reached the threshold for significance as a predictor of the number of idea units recalled in the low inference generation group. Therefore, there was insufficient power to obtain a reliable result with the inclusion of Nelson-Denny scale scores.

Role of text-based interest. As previously discussed, the methodology used in this experiment cannot be used to definitively determine whether text-based interest developed prior to or after inferences were generated. Therefore, it is possible that inference generation occurred prior to the development of text-based interest. As previously reported, analyses indicated that text-based interest may mediate the positive association between inference generation and the number of idea units recalled. Text-based interest appears to be statistically independent from the positive association

between inference generation and post-test gain scores. Further analyses were conducted to determine if these findings were independent of Nelson-Denny scale scores. Hierarchical regression analyses were conducted with the inclusion of Nelson-Denny scale scores in the first step.

In the first test of mediation, inference generation was a significant predictor of text-based interest, $\beta = .29, p < .001$. Nelson-Denny scale scores were also significant, $\beta = .35, p < .001$ in the first step, and $\beta = .35, p < .001$ in the second step. Therefore, the first test of mediation has been satisfied. In the second step of mediation, inference generation was not a significant predictor of the number of idea units recalled when Nelson-Denny scale scores were included, as can be seen in Table 26. Therefore, it can be concluded that inference generation does not have a positive association with the number of idea units recalled independent of Nelson-Denny scale scores. In contrast, inference generation was a significant predictor post-test gain scores. Therefore, the second test of mediation is satisfied in regards to post-test gain scores.

Table 26

Hierarchical multiple regression analyses predicting learning from texts from inference generation and reading comprehension skill from Experiment 2

	Recall		Post-test	
	ΔR^2	B	ΔR^2	β
Step 1	.07**		.18**	
Pre-test		.14		.02
Nelson-Denny		.21*		.43**
Step 2	.10		.13**	
Pre-test		.11		-.04
Nelson-Denny		.15		.30**
Inference		.17		.38**

* $p < .05$

** $p < .01$

In the third test of mediation, both inference generation and text-based interest were significant predictors of post-test gain scores independent of Nelson-Denny scale scores, as can be seen in Table 27. The effect of inference generation on post-test gain scores with the inclusion of text-based interest is less than that without text-based interest. Therefore, the third test of mediation has been satisfied. It appears that the positive association between inference generation and post-test gain scores may be mediated by text-based interest. Inference generation remains a significant predictor of post-test gain scores; therefore, the mediation by text-based interest is not complete.

Table 27

Hierarchical multiple regression analyses predicting learning from texts from inference generation and reading comprehension skill from Experiment 2

	Post-test	
	ΔR^2	B
Step 1	.19**	
Pre-test		.02
Nelson-Denny		.43**
Step 2	.15**	
Pre-test		-.04
Nelson-Denny		.32**
Inference		.32**
Text-based interest		.18*

* $p < .05$

** $p < .01$

Discussion

The purpose of this experiment was to determine the role of inference generation in the positive association between interest and learning from texts. A think-aloud task was used to examine inference generation while reading. To determine if the think-

aloud task affected the offline (i.e., after reading) measures, comparisons between Experiment 1 and Experiment 2 were conducted. The offline measures were different between Experiment 1 and Experiment 2. In Experiment 1, in which readers read silently, readers recalled more idea units, but answered fewer questions accurately than in Experiment 2, in which readers thought aloud as they read. However, the results of Experiment 2 were consistent with the results of Experiment 1 regarding interest and learning from texts. Both experiments found reliable and positive associations between both of the interest variables with both of the learning from text variables, although the strength of these associations varied somewhat between Experiment 1 and Experiment 2.

Tests were conducted to examine the associations between inference generation and interest and learning from text. The results indicated that there was a positive association between both topic and text-based interest and inference generation. Inference generation was also positively associated with both measures of learning from texts (the number of idea units recalled and post-test gain scores.)

Mediation and Moderation

Tests were conducted to determine if inference generation accounted for (mediated), modified or affected the strength of (moderated), or was statistically independent from the positive association between interest and learning from texts. Tests of mediation indicated that inference generation did not account for the effects of interest on the number of idea units recalled; however, inference generation did account for the effects of interest on post-test gain scores. With the inclusion of inference generation, there was no longer a positive association between either interest variable

and post-test gain scores. Therefore, inference generation seems to be a mediator of the positive association between interest and post-test gain scores.

After inference generation was determined not to be a mediator of interest and the number of idea units recalled, tests of moderation were conducted by examining the interaction between the inference generation and both interest variables. The purpose of the tests of moderation was to determine if the strength of the positive association between interest and the number of idea units recalled varied at different levels of level inference generation. Tests of moderation indicated that the interaction between topic interest and inference generation was not significant; therefore, inference generation appears to be statistically independent from the positive association between topic interest and the number of idea units recalled. In contrast, tests of moderation indicated that the interaction between text-based interest and inference generation was significant. Subsequent regression analyses to determine the nature of interaction revealed the positive association between text-based interest and the number of idea units recalled was stronger for readers who generated a low or average number of inferences than for readers who generated high number of inferences.

The moderating effects of inference generation on recall were found for text-based interest, but not topic interest. This may be because topic interest is relatively stable whereas text-based interest is flexible (Tsai et al., 2008). Topic interest, being an aspect of personal interest, is developed over a length of time and is enduring; whereas, text-based interest, being an aspect of situational interest, is piqued because of features of the text and is temporary (Schiefele, 1992). Because topic interest is stable, the positive association of topic interest on recall may be unlikely to vary depending on the

levels of other variables, such as inference generation. In contrast, text-based interest is flexible: it varies from text to text (Schraw et al., 1995). Therefore, it stands to reason that the positive association of text-based interest on recall may be more likely to vary depending on level of a variable critical to text comprehension such as inference generation.

Reading comprehension skill

Reading comprehension skills were assessed in Experiment 2 using the Nelson-Denny comprehension test. Consistent with previous findings, scores on the reading comprehension assessment were positively associated with inference generation (Cain et al., 2004; Cromley & Azevedo, 2007). The positive association is likely because readers who generate more inferences develop a more coherent mental representation of the text than readers who generate fewer inferences (Graesser et al., 1995). The coherent mental representation of the text is necessary for successful reading comprehension to occur. Therefore, readers who have achieved successful reading comprehension are more likely to answer questions in the multiple-choice reading comprehension assessment accurately than readers who have less successful reading comprehension (Thurlow & van den Broek, 1997).

There were also positive associations between scores on the reading comprehension assessment and the number of idea units recalled and post-test gain scores. This is likely because the ability to learn from texts, either to produce a recall of the text or to answer comprehension questions accurately, is dependent upon being able to comprehend the text. Therefore, readers with strong reading comprehension skills, as measured through the Nelson-Denny reading comprehension assessment, would likely

be able to better learn from the experimental texts than readers with weak reading comprehension skills.

There was no evidence of an association between topic or text-based interest and reading comprehension skill. However, there were positive associations between reading comprehension skill and both inference generation and the learning from text measures. Therefore, it is possible that the findings regarding the role of inference generation in explaining or affecting the strength of the positive association between interest and learning from texts could be due to individual differences in reading comprehension skill. To address this possibility, the tests of mediation and moderation were conducted with the inclusion of scores on the Nelson-Denny reading comprehension assessment. The findings regarding the mediating or moderating effects of inference generation generally were not affected when the effects of reading comprehension skill was controlled. Inference generation continued to explain the positive association between both topic and text-based interest and post-test gain scores after the effects of reading comprehension skill were controlled. There was no evidence of a moderating effect of inference generation on topic interest and the number of idea units recalled after the effect of reading comprehension skill was controlled. Inference generation continued to moderate the positive association between text-based interest and the number of idea units recalled after the effect of reading comprehension skill was controlled. Therefore, it is unlikely that differences in reading comprehension skill were the underlying cause of the findings on the roles of inference generation in the positive association between interest and learning from texts.

The inclusion of reading comprehension skill as a covariate slightly altered the previous findings regarding the association between text-based interest and recall at different levels of inference generation. As was found previously, readers in the high inference generation group continued to have no association between text-based interest and recall and readers in the average inference generation group had a positive association between text-based interest and recall after reading comprehension skill was controlled. In contrast, readers in the low inference generation group had no association between text-based interest and recall after reading comprehension skill was controlled. This is in contrast to the previous finding that readers in the low inference generation group had a positive association between text-based interest and recall without a control for reading comprehension skill.

There are two possible reasons the readers in the low inference generation group no longer had a positive association between text-based interest and recall after reading comprehension was controlled. One reason could be that the positive association between text-based interest and recall was dependent upon reading comprehension skill. It is possible that the variation in the number of idea units recalled was due primarily to reading comprehension skill and not text-based interest. After the effects of reading comprehension skill were controlled, there was insufficient variation in recall for a positive association between text-based interest and recall to be found. A second reason could be due to the loss of statistical power with the inclusion of reading comprehension skill as a covariate. Prior to the inclusion of reading comprehension skill, the association between text-based interest and recall was not robust. Therefore, there may

have been insufficient power to obtain a reliable positive association between text-based interest and recall with the inclusion of Nelson-Denny scale scores.

Role of Text-based Interest

The methodology used in this study cannot determine whether text-based interest developed before or after inferences were generated while reading. Therefore, it is possible that text-based interest mediated or moderated the positive association between inference generation and learning from texts. Tests of mediation indicated that text-based interest mediated the positive association between inference generation and the number of idea units recalled, but this was not independent of Nelson-Denny scale scores. Without the inclusion of Nelson-Denny scale scores, text-based interest appeared to be separate from the positive association between inference generation and post-test gain scores. However, text-based interest appeared to partially mediate the positive association between inference generation and post-test gain scores with the inclusion of Nelson-Denny scale scores. Therefore, when the influence of reading comprehension skill is controlled, text-based interest explains some of the positive association between inference generation and post-test gain scores.

Comparison with Experiment 1

One limitation of think-aloud methodology is that it may affect how readers process a text (Fletcher, 1986). Indeed, comparisons of the offline measures between Experiment 1 and Experiment 2 indicated that readers processed the texts differently in the two experiments. In Experiment 1, in which readers read silently, readers recalled more idea units, but answered fewer questions accurately than in Experiment 2, in which readers thought aloud as they read. However, the results of Experiment 2 were

consistent with the results of Experiment 1 regarding interest and learning from texts. Both experiments found reliable and positive associations between both of the interest variables with both of the learning from text variables, although the strength of these associations varied somewhat between Experiment 1 and Experiment 2. Therefore, the inclusion of the think-aloud in Experiment 2 did not appear to substantially alter the pattern of results between interest and learning from texts in found in Experiment 1.

The differences found in the offline measures should not be interpreted as an indication the think-aloud task is inappropriate for use in reading comprehension research. It is important to note that readers were not randomly assigned to think aloud or read silently; Experiment 1 and Experiment 2 were conducted during different time periods. Moreover, previous comparisons in which thinking aloud or reading silently was compared have not indicated significant differences in the offline measures (Gustafson, 1999; Kendeou, 2005; Magliano & Millis, 2003). Therefore, the differences in recall and post-test gain scores between Experiment 1 and Experiment 2 could be due to the time period in which the experiments were conducted.

Summary

The purpose of Experiment 2 was to determine the role of inference generation in the positive association between interest and learning from texts. This purpose was achieved: inference generation was determined to likely explain the positive association between interest and answers to comprehension questions as well as affect the strength of the positive association between text-based interest and recall. The role of inference generation in the positive association between interest and learning from

texts was relatively unaffected when the possible influence on reading comprehension skill was controlled.

Chapter Six

General Discussion

There were three research questions that were addressed in this dissertation. The general discussion is structured to discuss the answers to these questions in the following manner. The questions are presented in the introduction of the general discussion. The findings relevant to answering each question are discussed and connected to previous findings in the literature in the order the questions were presented. Then, the theoretical and pedagogical implications for the dissertation findings across the three questions are discussed.

The first two questions sought to examine a potential explanation of the positive association between interest and learning from texts. The first research question was if topic interest and text-based interest were positively associated with learning from texts, as measured through recall and post-test gain scores (answers to comprehension questions). The second research question asked what the role of inference generation in the positive association between interest and learning from texts was.

For its third research question, this dissertation asked if Wii Fit™ boards were useful in measuring interest as indicated through gross body movements. There were two hypotheses regarding gross body movements and the interest and learning from text measures. The first hypothesis was that the interest and learning from text variables would be negatively associated with changes in body movement (i.e., fidgeting or shifting in one's seat). The second hypothesis regarding gross body movement was that the interest and learning from text variables would be negatively associated with leaning back while reading.

Interest and Learning from Texts

I hypothesized that both topic and text-based interest would be positively associated with both recall and post-test gain scores. I also hypothesized that this positive association between interest and learning from texts would be independent of the effects of background knowledge, as measured with pre-test scores. This question and these hypotheses were addressed in Experiment 1. In Experiment 1, the results indicated that interest was positively associated with both the number of idea units recalled and post-test gain scores. The positive associations found in interest and learning from text in Experiment 1 were independent of the effects of background knowledge, thus supporting my hypotheses.

The positive association found between interest and learning from texts is consistent with previous findings in the literature. Topic interest, the enduring interest a reader has in reading about certain topics or themes, has previously been found to be positively associated with recall and answers to open-ended comprehension questions (Boscolo & Mason, 2003; Schiefele & Krapp, 1996). Text-based interest, the temporary interest a reader has due to the features of a particular text, has been previously found to be positively associated with recall (Sadoski et al., 2000; Schraw et al., 1995; Wade & Adams, 1990). Text-based interest has not been previously associated with accurate answers to open-ended comprehension questions, but the findings from Experiment 1 converge with previous findings that text-based interest was positively associated with accurate answers to multiple-choice comprehension questions (Bray & Barron, 2004).

The role of background knowledge in topic interest found in Experiment 1 is consistent with previous findings in the literature (Boscolo & Mason, 2003; Kintsch, 1980; Tobias, 1994; Schiefele, 1990). Although the pre-test scores assessing background knowledge were quite low, suggesting a floor effect, there was a positive association between topic interest and background knowledge. This finding is consistent with theoretical viewpoints regarding topic interest: readers who are interested in a topic typically read about it frequently thereby building their background knowledge of that topic (Silvia, 2008). For this reason, researchers have previously proposed that the positive association between topic interest and background knowledge may cause the positive association between topic interest and learning from texts (Krapp, 1999; Renninger et al., 2002). However, the positive associations between both topic interest and text-based interest were independent of the effects of background knowledge in Experiment 1.

The Role of Inference Generation

The second research question regarded the role of inference generation in the positive association between interest and learning from texts. In Experiment 2, a think-aloud task was used to examine the possible effects of inference generation while reading on the positive association between interest and learning from texts. The results indicated that inference generation was positively associated with both topic and text-based interest and both the number of idea units recalled and post-test gain scores. In regards to the number of idea units recalled, the results indicate that inference generation moderates the effects of text-based interest, although inference generation did not have such a role with topic interest. In regards to post-test gain scores, the

results indicate that inference generation mediates the positive association with both topic interest and text-based interest.

The moderating effects of inference generation on text-based interest and recall were investigated by splitting the sample into three groups based on their level of inference generation. The results indicated that readers in the low and middle inference generation groups had positive associations between text-based interest and the number of idea units recalled, but the high inference generation group had no association between text-based interest and the number of idea units recalled. Therefore, it appears that the strength of the association between text-based interest and recall is influenced by the reader's level of inference generation.

The positive association between text-based interest and recall varied according to the readers' levels of inference generation. One reason for the findings among the different groups could be that the high inference generation group constructed highly-connected mental representations through inference generation. Connections within a mental representation of a text facilitate the recall of that text (van den Broek et al., 1999). The connections generated by the high inference generation group may have enabled recall of the text beyond the potential effects of text-based interest. When inference generation is medium or low, there is more of an effect of text-based interest on recall. This may be because fewer connections exist therefore the reader is more influenced by his or her level of text-based interest on recall. The greatest effect of text-based interest on recall was found in the group with the medium number of inferences. This could be because the medium group had a balance between having

enough inferences to create connections to prompt recall of the text, but not so many that there is no effect of text-based interest.

Reading comprehension skill. In Experiment 2, reading comprehension skill was assessed through the Nelson-Denny. Reading comprehension skill was found to be positively associated with inference generation and both measures of learning from texts. There were no associations between reading comprehension skill and either topic interest or text-based interest. However, the positive association between reading comprehension skill and inference generation and learning from texts created the possibility that the previous findings regarding the role of inference generation could be dependent upon individual differences in reading comprehension skill. Therefore, the tests of mediation and moderation were conducted with the inclusion of reading comprehension skill as a covariate. The role of inference generation as a mediator between interest and post-test scores was determined to be independent of the effect of reading comprehension skill. However, the role of inference generation as a moderator between text-based interest and recall changed slightly with the inclusion of the effect of reading comprehension skill.

After controlling for the effects of reading comprehension skill, the results for the high and medium inference generation group were unchanged; however, the results for the low inference generation group were not longer significant. Therefore, inference generation accounted for the positive association between interest and post-test gain scores independent of the effect of reading comprehension skill. However, the positive association between text-based interest and recall at different levels of inference generation was affected by the inclusion of reading comprehension skill.

Different roles of inference generation. The role of inference generation on the positive association between interest and learning from texts differs between the two measures of learning from texts. Inference generation appears to mediate the positive association between interest and post-test gain scores, but not the positive association between interest and recall. This may be because inference generation has a stronger positive association with post-test gain scores than with recall. Recall is a more superficial measure of learning from texts than answering comprehension questions (Gilbert, Martinex, & Vidal-Abarca, 2005; Kintsch, 1994; McNamara et al., 1996). Because it is a relatively superficial measure, recall is less dependent upon inference generation than deep measures, such as post-test gain scores. Moreover, the positive association between text-based interest and recall is weakest when inference generation is high compared to low and medium inference generation. Therefore, the positive association between interest and recall is almost certainly not due to increased inference generation.

Topic and text-based interest. Topic interest and text-based interest were highly-correlated with each other in both Experiment 1 and Experiment 2. In addition, topic interest and text-based interest had fairly similar findings with each other in regards to associations with other constructs. In both Experiment 1 and Experiment 2, topic interest and text-based interest had similar positive associations with the learning from text measures. In Experiment 2, topic interest and text-based interest had similar positive associations with inference generation. This is important to note because topic interest has generally been regarded as having a stronger effect on learning from texts than has text-based interest (Hidi, 2001, 2006). However, many studies have examined

either topic interest or text-based interest, not both, when relating interest to learning from text. Therefore, the comparison of the strength of topic interest and text-interest on learning from texts may have been caused by the differences in the studies that examined interest, not by differences in the interest constructs themselves. Topic and text-based interest are considered to be overlapping (Ainley et al., 2002b); therefore, the similarity in findings regarding topic interest and text-based interest is not surprising.

There was an important difference between topic interest and text-based interest regarding the role of inference generation in their positive associations with recall. Inference generation was determined to be a moderator for recall and text-based interest, but not topic interest. This may be because topic interest is relatively stable whereas text-based interest is flexible. Topic interest, being an aspect of personal interest, is developed over a length of time and is enduring; whereas, text-based interest, being an aspect of situational interest, is piqued because of features of the text and is temporary (Schiefele, 1992). Because topic interest is stable, the positive association of topic interest on recall may be unlikely to vary depending on the levels of other variables, such as inference generation. In contrast, text-based interest is flexible: it varies from text to text (Schraw et al., 1995). Therefore, it stands to reason that the positive association of text-based interest on recall may be more likely to vary depending on level of a variable critical to text comprehension such as inference generation.

Gross Body Movements and Interest

The third research question of this dissertation asked if Wii Fit™ boards were useful for measuring interest as indicated through gross body movements. There were

two hypotheses regarding gross body movements and the interest and learning from text measures. The first hypothesis was that the interest and learning from text variables would be negatively associated with changes in body movement (i.e., fidgeting or shifting in one's seat). The results indicated that changes in body movement were negatively associated with both topic and text-based interest. In addition, changes in body movement were negatively associated with recall and post-test gain scores. In other words, there appears to be a pattern in which the less interested readers were, the more they moved and the less they learned from the texts. These findings are consistent with previous findings between interest and changes in gross body movement (D'Mello et al., 2007a; Kapoor et al., 2001).

The second hypothesis regarding gross body movement was that the interest and learning from text variables would be negatively associated with leaning back while reading. The results indicated that both topic and text-based interest were negatively associated with leaning back. In addition, recall was negatively associated with leaning back. In other words, the less interested readers were, the more they leaned back on their chair while reading, and the less they recalled from the texts. These findings are consistent with previous findings regarding interest and leaning back (D'Mello et al., 2007b; Kapoor et al., 2004; Mota & Picard, 2003).

The gross body movement results in this study demonstrate that posture can be incorporated with other methods to provide multiple measures of interest. One advantage of using gross body movements as an indirect measure is that gross body movements are typically unconscious and unintentional; therefore, readers are less likely to willfully modify them (D'Mello et al., 2007a; 2007b). In contrast, providing answers

to self-reports is a conscious and willful process; responses may be affected by one's desire to please or annoy the experimenter (Garland, 1991; Worchester & Burns, 1975). Combining bodily measures of interest with self-reports allows for direct and indirect measure of interest to be incorporated into a study. The use of both direct and indirect measures allows for the weaknesses of one method to be compensated by the strengths of another.

The specific association between gross body movements and learning from texts has not been previously empirically investigated. However, the findings from Experiment 1 that fidgeting and leaning back were negatively associated with learning from texts are not surprising. Fidgeting and leaning back were negatively associated with interest, which was positively associated with learning from text. Therefore, the negative association between certain patterns of gross body movements and learning from texts was likely caused by the level of interest of the reader. It is unlikely the gross body movements themselves contributed to the amount of learning from text.

Theoretical Implications

These findings have theoretical implications for understanding the nature of the relation between interest and learning from text. As a mediator, inference generation appears to explain the positive association between both topic and text-based interest and post-test gain scores. This is likely because interest increases inference generation while reading which in turn increases post-test gain scores. Therefore, inference generation appears to be the reason why interest is positively associated with learning from texts as measured with post-test gain scores.

Interest may be a factor in determining a reader's standards of coherence. The findings from this study indicated that readers generated more inferences when they were interested than when they were not interested. Standards of coherence may determine the number of inferences a reader generates to construct a mental representation of the text (van den Broek et al., in press). However, there were no direct measures of standards of coherence incorporated into this study; therefore, it cannot be definitely determined that interest influenced readers' standards of coherence.

The results from this study support the notion that interest prompts a deeper understanding of the text while reading. The idea that interest prompts deeper processing has been previously based on the products of reading such as answers to difficult questions that require an in-depth analysis of the text or solving problems presented in the text (Boscolo & Mason, 2003; Schiefele, 1990; Silvia, 2006). The findings from Experiment 2 indicated that deeper processing while reading may explain why interest and performance on difficult tasks after reading are positive associated. This is because interest and inference generation while reading were found to be positively associated. Inference generation is considered indicative of deep processing because it requires the reader to think critically by connecting what is being read with background knowledge or previously read information in the text (Best et al., 2005). In other words, processing the text more deeply while reading, through inference generation, explains why readers who are interested provide better answers to questions that require in-depth analysis than readers who are not interested.

According to embodied theories of cognition, body movements and complex mental states, such as interest, are linked together (deVega et al., 2008; Glenberg et al.,

2005). In other words, there is a connection between the body and the mind that can be observed through actions of the body during mental states. The findings regarding gross body movement and interest in this dissertation are supported by embodied theories of cognition and emotion. Readers in this study appeared to be more likely to move in their seat when they were not interested. This could be interpreted as the body's attempt to create external stimulation because the mind was bored with the text being read (cf. Martin, Sadlo, & Stew, 2006). The increase in movement could be an attempt for the readers to alleviate or distract them from the source of information they did not consider interesting (D'Mello et al., 2007b). Moreover, readers appeared to be more likely to lean back in their chairs when they were not interested. This could be interpreted as the body's response to move away from the source of the information that does not interest them. By moving from the source of information, the readers could increase their space physically from content they may wish to be cognitively removed (cf. Markman & Brendl, 2005).

Pedagogical Implications

The findings on the research on interest and learning from texts have implications for education. Given the findings on the positive association between topic interest and learning from text, it could be beneficial for students to be able to read texts in which they have topic interest. However, it is challenging for reading instructors to differentiate instruction to allow for readers to read texts in which they are interested. It is not possible for a teacher to choose a text topic in which all students are interested. A computer tutoring program in which an agent provides instruction on texts in which the student has interest may be helpful in this regard. A computer-tutoring program could

allow students to their topic to read about, then provide instruction and measures of learning from the text. The teacher could evaluate the students' performance on the measures of learning to determine the students' progress. However, it would be unwise for students to be permitted to read only texts in which they are interested. Students need to be exposed to a variety of topics in order to have a well-rounded education.

There were positive associations between text-based interest and learning from texts. Reading instructors can use the information regarding styles of writing that increase text-based interest to assist them in choosing texts for their classes. For example, previous research findings have indicated that styles of writing that are concrete, consistent, and vivid are more likely to be considered interesting than writing styles that are abstract, inconsistent, and bland (Beck et al., 1995; Sadoski et al., 1993a; Wade et al., 1999). More research in developing and identifying high-interest texts that are coherent would be helpful for reading instructors.

Reading instructors are not always able to choose interesting texts for their students to read or allow students to read topics in which they are interested. However, the findings in this study may have implications for instruction when the material is not interesting for the students. The findings presented in this dissertation indicate that inference generation is positively associated with interest. Although teachers may not always be able to enhance interest, enhancing inference generation may be particularly useful when the material of instruction is not interesting for the students. Therefore, interventions that encourage inference generation, such as SERT and iSTART (McNamara, 2004; McNamara, O'Reilly, Rowe, Boonthum, & Levinstein, 2007), may be particularly useful when students are not interested in the text.

Summary

This dissertation addressed three research questions regarding interest. The first research question addressed whether there was a positive association between interest and learning from text. The findings indicated that there was a positive association between interest and learning from texts. The second question addressed the role of inference generation in the positive association between interest and learning from texts. The findings indicated that inference generation explained the positive association between interest and accurate answers to comprehension questions. Also, the findings indicated that the positive association between text-based interest and recall varied at different levels of inference generation. Specifically, readers who generated a low or medium number of inferences had a positive association between text-based interest and recall. Readers who generated a high number of inferences did not have an association between text-based interest and recall. The third question addressed the usefulness of Wii Fit boards in determining gross body movements while reading as an indirect measure of interest. The findings indicated that the Wii Fit boards were effective in replicating previous findings with more expensive equipment regarding gross body movements and interest.

Chapter Seven

Conclusion

This dissertation sought to answer three research questions. The first research question asked if topic interest and text-based interest were positively associated with learning from texts as measured through text recall and accurate answers to comprehension questions (post-test gain scores). The findings from Experiment 1 indicated that both topic and text-based interest were positively associated with learning from texts. The findings from Experiment 1 were replicated in Experiment 2. The second research question asked what was the role of inference generation in the positive association between interest and learning from texts. The findings from a think-aloud task in Experiment 2 indicated that inference generation explained (i.e., mediated) the positive association between interest and post-test gains scores. The findings also indicated that inference generation affected the strength of (i.e., moderated) the positive association between text-based interest and recall. Readers with low and average levels of inference generation had a positive association between text-based interest and recall. Readers with high levels of inference generation had no association between text-based interest and recall. Inference generation did not appear to have a role in the positive association between topic interest and recall.

The third research question addressed in this dissertation asked if Wii Fit™ boards were useful in measuring interest as indicated through gross body movements. There were two hypotheses regarding gross body movements and the interest and learning from text measures. The first hypothesis was that the interest and learning from text variables would be negatively associated with changes in body movement

(i.e., fidgeting or shifting in one's seat). The second hypothesis regarding gross body movement was that the interest and learning from text variables would be negatively associated with leaning back while reading. The findings from the gross body movement data in Experiment 1 supported both hypotheses.

The discussion section of this dissertation connected the results from the two experiments to previous research findings and theoretical viewpoints. This dissertation concludes with by outlining the future directions of this research. Specifically, the limitations of the experiments and their findings and suggestions for future research projects based on the findings are discussed in this chapter.

Limitations

The methodology used in this study cannot be used to make causal claims from the findings. This is because there was a lack of experimental treatment and control conditions. Without the ability to randomly assign readers to conditions, it is not possible to adequately control for all potential confounding variables. However, experimental conditions for either topic or text-based interest were not feasible for this study. Topic interest varies among individuals and cannot be assigned. Readers could have been randomly assigned to read texts in which they are interested or not interested, but the differences in texts among participants would have made results regarding inference generation difficult to interpret. This is because qualities of the texts are known to influence a reader's standards of coherence thereby leading to different levels of inference generation (van den Broek et al., in press).

There are issues with randomly assigning text-based interest. Materials could be designed to vary in levels of text-based interest and participants could be randomly

assigned to receive materials with low- or high-levels of text-based interest.

Unfortunately, the qualities that have been found to increase text-based interest, such as consistency and concreteness, are also qualities that have been found to increase learning from text (independent of interest level). Therefore, it would be difficult to confidently determine that differences in learning from texts were due to different levels of text-based interest themselves.

There were limitations with the measures used to assess learning from texts in this study. Recall is a rather basic measure that is limited in its applicability in educational settings. Although recall is a commonly used measure in text comprehension research, teachers are generally not interested in whether a student can reproduce a text shortly after reading it (Weaver & Kintsch, 1991). In addition, the post-test questions had not been used in previous experimental studies; therefore their validity is limited. There were also only 6 questions per text, although the variability in the post-test scores indicated that there was no evidence of a ceiling effect. More questions would have logically tapped into a greater degree of learning from the text, further elucidating the association between interest and learning. Other forms of measuring deep learning from texts (i.e., that require an in-depth analysis of what was read) such as completing diagrams and writing essays on their viewpoints of the subject matter covered in the text could provide a more robust understanding of how interest influences learning from texts.

The findings from gross body movement and interest in Experiment 1 converged with previous findings (Bianchi-Berthouze et al., 2008; D'Mello et al., 2007a, 2007b; Kapoor et al., 2001; Mota & Picard, 2003). However, one limitation

with using gross body movement as an indirect measure of interest is that there are factors other than interest that affect gross body movements. In addition to issues of fatigue, personal preference for sitting, and general comfort level, gross body movements have been associated with several emotional states (Bianchi-Berhouze et al., 2008; Coulson, 2004; D'Mello et al., 2007a). For example, although leaning forward has typically associated with being interested, leaning forward with one's head down has typically been associated with sadness (Coulson, 2004; Schouwstra & Hoogstraten, 1995). In addition, leaning back has been associated with disgust as well as boredom (Wallbott, 1998). The pressure sensors on the Wii Fit™ boards only measure the quantity of pressure placed on the boards; they are unable to detect whether a person is leaning forward with their head up or down. Moreover, the pressure sensors cannot distinguish whether one is leaning back and away from the source of content because of disgust or boredom with the content. For these reasons, one should not use gross body movement as a sole measure of interest.

Future Research Studies

This study raises the interesting question of what causes the positive association between interest and recall. The results from this study indicate that an increased depth of processing, as indicated through increased inference generation, while interested does not explain the positive association between interest and recall. One potential cause could be related to an increase in attention when interested. Although the findings from previous studies on attention and interest have been mixed, future work in disentangling the conflicting results could clarify the role attention has in interest in recall of texts.

A future study that could re-examine the role of attention in interest and recall would involve the allocation of attention or how focused the reader's attention is on the text. Although findings regarding attention as measured through reading times have not provided a clear understanding, other methods may elucidate the issue. Previous studies examining interest and reading times have used self-paced presentation of the text. A study using a fixed paced presentation of the text followed by recall would clarify whether interest prompts a greater focus on attention. If reading times were controlled through fixed-paced presentation of the text and interest continued to predict recall, this would provide evidence that readers choose to allocate their attention differently when interested as opposed to when not interested.

The use of secondary task reaction times to examine the role of attention in interest and recall could also be informative. Attention, as measured through secondary task reaction times, has been indicated to not explain the positive association between interest and recall in previous studies (Anderson, 1982; McDaniels et al., 2000; Shirey, 1992; Shirey & Reynolds, 1988). However, these previous studies using secondary task reaction times used single sentences or narratives, which were relatively easy to read. The role of attention in the positive association between interest and recall of difficult text or texts in which theories are discussed has not been previously examined.

An intriguing question for future study involves the role of inference generation in the positive association between interest and long-term recall of text. Previous researchers have found that topic interest predicts long-term recall of text (Naceur & Schiefele, 2005). Although inference generation did not explain the positive association between interest and short-term recall in this study, inference generation could explain

the positive association between interest and long-term recall. Long-term recall of text, compared to short-term recall of text, is more dependent upon inference generation (Kintsch, van Dijk, & Teun, 1978; Trabasso & Suh, 1993). The connections created through inference generation integrate the information from the text in a manner that facilitates long-term recall of a text more than is necessary for short-term recall (Omanson, Warren, & Trabasso, 1978; Weaver & Kintsch, 1991). Short-term recall of a text can rely upon memory of the surface structure (i.e., the exact wording) of the text; however, memory of the surface structure is typically not integrated into one's long-term memory unless rehearsed (Einstein, McDaniel, Owen, & Coté, 1990; Schmidt, Boshulzen, van Breukelen, 2002). Therefore, unless readers would purposefully rehearse the surface structure of the text they read until prompted to provide a recall at a later time, they would be unlikely to rely upon their memory of the surface structure to write a recall. Instead, the network of ideas of from the text connected through inferences generated when they read would provide the information from the text for long-term recall (Kintsch, 1998). In other words, the information reproduced in the long-term recall of texts is more focused on the overall meaning and ideas than the specific, rote details when compared to short term recall (cf. Bartlett, 1920). For these reasons, a future study in which participants were asked to recall the texts a week or two after their experiment sessions may further explain the positive association between interest and learning from texts through inference generation.

As was previously discussed, it is difficult to have an experimental design in which topic or text-based interest is randomly assigned. However, it would be possible to randomly assign conditions of task-based interest. Task-based interest, like text-based

interest, is a temporary state in which one is engaged in a text because of his or her purpose or the instructions given for reading (Schraw & Dennison, 1994). Task-based interest can be increased by providing instruction that makes the text more relevant for the reader or draws attention to salient aspects of the text (Frick, 1992; McDaniel, et al., 2000; Schraw & Lehman, 2001). For example, task-based interest can be manipulated through encoding instructions that appear to affect a reader's interest through altering that reader's goals for reading (Frick, 1992; McDaniel et al., 2000). A future study in which instructions that affect task-based interest could be designed. Instruction condition could be randomly assigned thereby providing an experimental control. The use of an experimental control in a study using a think-aloud task would allow for a causal link between interest and inference generation to be determined. Therefore, there would be increased evidence that inference generation explains the positive association between interest and accurate answers to comprehension question.

The participants in this study were all native speakers of English without diagnosed reading disabilities taking undergraduate coursework at a reputable university. In other words, these participants were relatively proficient readers. Therefore, the processes involved in interest and learning and texts from these participants may be quite different from a population of struggling or beginning readers. A similar study in the future involving struggling readers would be informative given the importance of interest for learning from texts in this population (Alvermann & Eakle, 2003; Fink, 2008). Specifically, a study on the cognitive processes involved when reading material of interest for students in developmental (remedial) English course would be beneficial. These students are of particular interest because, as is

inherent in being placed in developmental reading courses, they struggle with reading more than other college students. Because of the essential necessity of reading skills for success in postsecondary education, there is a great need to find effective methods of instructing these students (Elder & Paul, 2004). Unfortunately, there is currently a lack of empirical research with this population (Burgess, 2009). Moreover, these students are typically less interested in reading than their peers who are not in developmental courses (Trawick, 1992). Therefore, it would especially useful for reading instructors to understand how students in developmental courses process texts in comparison to mainstream college students. Moreover, if a means of increasing task-based interest could be developed, it would be particularly informative for development English instructors.

There are methods by which the Wii Fit boards could be used more effectively for measuring interest in future studies. Changes in the materials with which the boards were connected to their electrical source, process of connecting the boards via Bluetooth, and the procedure in which the readers read material could provide more data with less noise than the data in Experiment 1. Improvements in the quantity and quality of data could lead to stronger and more significant findings than those that were found in Experiment 1.

Body movement data were not collected from approximately one-third of the readers in Experiment 1 due to problems with the Wii Fit™ boards. The primary reason data were not collected was due to the nature of the connection between the boards and their source of electricity (wires connected the boards to an electrical outlet). The wires were delicate and it was difficult to prevent readers or experimenters from accidentally

disconnecting them during the course of the experiment. This is because access to the electrical outlet required the wires to be near the readers' feet. In future studies, it may be advantageous to determine a better means to provide electricity to the boards.

The second reason body movement data were not collected for all of the readers was because of issues with the Bluetooth connection between the boards and the computer. Each time the computer was powered off, the Bluetooth connection would need to be synced, which was a time-consuming process (between 5-20 minutes). The process of syncing would occasionally be abandoned if not successful after numerous attempts. Also, the Bluetooth connections would periodically disconnect without an apparent cause. The problem with the Bluetooth connection may have been due to the computer used in the experiment. The computer was not equipped with Bluetooth capacity in its hardware; therefore, a dongle was used for Bluetooth connections. This dongle may have been of less than ideal quality and could be the cause of the problems with the Bluetooth connection. This speculation is based on differences in the Bluetooth connection for the computer and the Wii console™. Wii Fit™ boards typically sync with Wii™ consoles in less than a minute and the Bluetooth connection is rarely disconnected. Therefore, a better quality device for Bluetooth connection may lead to less data being lost due to equipment malfunction.

In Experiment 1, readers read the articles one sentence at a time, at their own pace. They advanced to the next sentence by pressing the space bar. The nature of this experimental procedure may have created problems in regards to gross body movements. If the readers had to press the space bar to continue, they may have had to lean forward to do so. If they were bored and leaning back, they would lean forward to press

the space bar may have attenuated the results between leaning back and lack of interest. In addition, if the readers may have needed to move their body to press the space bar. This may have increased the degree of movement for the participant. If readers were sitting still because they were interested, the movement to press the bar may have attenuated the results between sitting still and interest. A future study could avoid this potential problem by displaying the article in its entirety or in sections larger than sentences or by having the pace the sentences are presented determined by the experimenter.

Summary

The findings from this study strengthen our theoretical understanding of how interest relates to learning from texts. Specifically, these findings provide a possible explanation, inference generation, for the cause of the positive association between interest and learning from texts. In addition, these findings support the idea that interest increases the depth at which a text is processed. Understanding how interest prompts inference generation thereby improving comprehension of texts allows for theories on interest and learning to be strengthened. Moreover, knowing how to measure interest through an indirect means with gross body movements allows for future research studies to incorporate multiple measures of interest.

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Appendix A

Experimental Texts

Origins of the Moon

The Apollo spaceflights of the 1970s greatly advanced our understanding of both the moon and the earth, including the question of how our moon originated.

Information gained from the Apollo program allowed us to reject several old theories and pointed towards an important new theory about the origins of the moon.

One of several theories of the moon's origin developed over the past 200 years is the "capture hypothesis."

The theory holds that the earth's gravitational field seized a fully formed moon that came whizzing in from elsewhere in the solar system.

In fact, the chances of the paths of two objects being just right for such a capture are miniscule, so the theory was not widely endorsed even before Apollo.

Moreover, the capture hypothesis would have required earth to have had a large atmosphere in order to have slowed the movement of the moon; most scientists concur that there is not sufficient evidence that such an atmosphere existed during this time.

Testing of the chemical composition of lunar rocks brought back by the Apollo spaceflights put the capture hypothesis theory completely to rest.

It was shown that the moon rocks had quantities of oxygen isotopes similar to rocks on earth indicating that the moon and the earth were approximately the same age and were formed about the same distance from the sun.

The second classic theory of the moon's origins, the "fission hypothesis," was proposed by George Darwin (the second son of Charles Darwin) in the late 1870s.

He hypothesized that the earth was spinning extremely fast during a period after it formed a core when it was relatively young.

The spinning caused it to bulge so much at the equator that a small blob of the earth's crust eventually spun off by centrifugal force, becoming the moon.

This hypothesis can account for the fact that the moon is much less dense than the earth and for the similar quantities of oxygen isotopes between the earth and moon.

However, the fission hypothesis claims that the moon was formed from material near the earth's surface, specifically where the Pacific Ocean is located.

Researchers have since determined that the basin which contains the Pacific Ocean was formed 70 million years ago and the moon is 4.5 billion years old.

Moreover, the moon should have exactly the same chemical composition as the corresponding material on earth for the fission hypothesis to be accurate.

Thus, the fission hypothesis cannot explain Apollo's finding that the earth and moon have different chemical compositions outside of their similarities with quantities of oxygen isotopes.

The third classic theory is the "double planet hypothesis" also called the "co-accretion hypothesis", which states that the moon and the earth formed from the same cloud of gas and dust.

The dust and gas gradually coalesced into the earth and a ring of material formed in orbit around the growing planet; the raw materials for the moon came from the ring.

The double planet hypothesis can account for the similar composition of the earth and moon with respect to oxygen isotopes and explain why the earth and moon are approximately the same age.

However, the theory claims that the two bodies were formed from the same materials in the same fashion which does not explain why the densities of the two bodies are so different.

In addition, the theory cannot explain why the moon's metallic core is so much smaller than that of the earth (earth's metallic core is approximately 50% of its radius; whereas, the moon's metallic core is 25% of its radius).

The theory also does not explain the issue of angular momentum; that is; why the earth rotates as fast as it does or how the supposed ring could have acquired enough circular motion to stay in orbit while the moon formed.

The data discrediting classic theories of the moon's origins prompted astronomers to resurrect and further develop a fourth theory, the "giant impact hypothesis."

This hypothesis states that a very large object, roughly the size of the planet Mars, collided with the earth.

The "impactor" caused debris to be thrown into orbit, which provided the raw material for the formation of the moon.

This theory explains why the moon has proportionally less metallic iron at its core than the earth because the core of the object that collided with the earth stuck to the earth thereby increasing the earth's metallic core.

The similar isotopic composition of the earth and moon is because the earth and the impactor formed in the same region of the evolving solar system.

The earth and the impactor were not formed of identical material, so they would be expected to have different chemical compositions.

The different chemical composition of the earth and moon exists because the material from which the moon was formed came mostly from the impactor.

Most important, the impact hypothesis can explain the most difficult theoretical problem of why the earth rotates as fast as it does.

A colliding body would probably not have struck the earth squarely; rather, it is highly likely that it would have struck the earth off-center at an oblique angle.

Such a blow would have acted like a basketball player's hand glancing off the side of the basketball to keep it spinning on his finger; thereby, speeding up a slowly rotating earth to its current frequency of rotation.

Why American songbirds are vanishing

The steep declines in waterfowl, shoreline birds, and grassland birds over the past several decades are generally well understood.

What is not as obvious is why forest-dwelling migratory songbirds are also vanishing; especially the so-called Neotropical migrants that breed in northern latitudes but migrate to winter homes in the tropics.

The reason for diminishing songbird population is important to understand given the necessity of songbirds in forested ecosystems by pollinating flowers, dispersing seeds, and controlling insect populations.

As reports of decreases in songbird populations accumulated, it was widely noted that the missing species could still be found in large continuous tracts of forests, but not in isolated tracts.

This observation was dubbed the "forest fragmentation effect."

One simple hypothesis to explain the forest fragmentation effect is that they generally prefer larger forest plots as nesting sites and so avoid isolated plots because they tend to be small.

This hypothesis predicts that the density of songbirds' nests in a forest will increase as the size of the forest increases.

However, when researchers set about documenting the presence or absence of songbird species in forest fragments of different size, they obtained mixed and -- sometimes -- contradictory results.

Another hypothesis is that many songbirds are averse to the edges of forests and reject small, isolated tracts because none of the habitat is far enough away from the edges.

There are good reasons why songbirds might want to nest away from the edge of a forest.

Forest margins are brighter, warmer, drier and windier than the interior and support more shrubs, vines and weeds.

This hypothesis was tested by observing the distribution of nesting territories in large forests that either surrounded a reservoir or had swaths cut to accommodate power lines.

The results of the test proved that the hypothesis was wrong.

A third hypothesis derives from the observation that the species whose numbers have declined most drastically are the long-distance, Neotropical migrants.

This hypothesis holds that tropical deforestation in South America (the winter home of the Neotropical migrants) is responsible for the declines, rather than fragmentation of the breeding habitat.

The hypothesis predicts that declines should be greatest for species that winter in regions undergoing rapid deforestation and least for species that winter in relatively unscathed parts of the tropics.

Comparisons of different species of Neotropical migrants do not support the hypothesis. Two specific environmental changes have been identified that appear responsible for at least some of the decline in the songbird population.

First, the suburbs are havens for nest predators such as blue jays, raccoons and opossums, so the dwindling numbers of them in isolated woodlots might be directly due to the activity of these animals.

Because one-fifth of songbird species are ground-nesters, they are particularly vulnerable to raccoons and opossums

To test this hypothesis, one scientist placed quail eggs in artificial nests and set them out in small, medium and large forests, and -- for an undisturbed control site -- in the Great Smoky Mountains National Park.

The results of the experiment confirmed the hypothesis: eggs in isolated woodlots were more likely to be taken by predators than the control.

The second factor responsible for the declining songbird population is an increase in nest parasites.

Parasitic birds lay their eggs in the nests of other species, which often raise the resulting offspring as their own.

A parasite's eggs typically hatch sooner than the eggs of its host, giving the hatchling parasite a head start over its nest mates.

By the time the host's eggs hatch, the parasite is so much bigger than the host's hatchlings that it obtains most of the food brought by the parents and the host's own offspring often starve.

A study in Wisconsin showed that 65 percent of the nests located near forest edges were parasitized by the cowbird.

The accessibility of isolated forest tracts to nest predators and parasites explains why the songbird populations are declining in these areas.

We must also account for the fact that the Neotropical migratory songbirds have declined so much more quickly than other songbirds.

In fact, it is not necessary to hypothesize a mechanism that selects the Neotropical birds out for special treatment because these migrants are naturally at a disadvantage in their breeding efforts.

The Neotropicals have a shorter breeding season and lay fewer eggs than other species. Therefore, any environmental changes that reduce nesting success indiscriminately across all species would hit Neotropical migrants hardest because they have less margin for tolerance.

Appendix B

Comprehension questions for experimental texts

Directions: Type the answer after each question or statement. If you do not know the answer, do not guess; leave the answer blank and continue on to the next question.

Don't worry about spelling or grammar!

“Origins of the Moon”

1. Name one similarity in the physical/chemical composition of the earth and moon. Name one dissimilarity in the physical/chemical composition of the earth and moon.
2. Why was the capture hypothesis of the moon's origins unpopular even before the Apollo spaceflights? What evidence did the Apollo spaceflights provide that completely discredited the capture hypothesis?
3. Describe the double planet hypothesis of the origin of the moon. State one scientific fact or research finding supporting that particular theory.
4. George Darwin developed which theory of the origins of the moon? State one scientific fact or research finding discovered since he developed this theory that discredits the theory.
5. One common criticism of the giant impact theory is that it does not adequately explain the issue of quantities of oxygen isotopes in rocks on the moon and earth. Do you agree or disagree with this criticism? Give a reason or research finding to support your opinion.
6. Suppose, Phobos, a moon of Mars, has different chemical composition than Mars. If there were evidence it was created in a different time and space than Mars, which theory of the origin of the earth's moon could best explain the origin of Phobos? Give one fact or research finding to support your answer.

“Why American songbirds are vanishing”

1. What are the breeding and migration patterns of neotropical songbirds?
2. What is the forest fragmentation effect hypothesis? Has research evidence on nesting behavior supported the forest fragmentation effect hypothesis or not?
3. How do nest parasites affect neotropical songbird populations? Include one fact or research finding in your answer.
4. Research findings have indicated that neotropical songbirds are more affected by changes in their environment in North America than in South America. Why would that be the case? Include two facts or research findings in your answer.
5. Name two issues or problems that neotropical songbirds have in suburbs.
6. What could be an effective method to increase songbird population? Give an example of evidence from research that supports your answer:

Appendix C

Topic Interest Inventories

Directions: Everyone has particular feelings and attitudes about reading certain topics and texts. Here are a number of statements regarding reading about the topics of the text you will read. Please choose a number for each statement to indicate the extent to which you agree or disagree with that statement. Write the number you chose after the statement.

1	2	3	4	5	6	7
Disagree strongly	Somewhat disagree	Disagree a little	Neither agree nor disagree	Agree a little	Somewhat agree	Agree Strongly

Topic Interest Items for “Origins of the Moon”

1. I am interested in reading about the moon.
2. Reading about the moon is boring for me.
3. I am familiar with the topic of the moon.
4. I am engaged when reading about the moon
5. I am interested in reading about astronomy.
6. Reading about astronomy is boring for me.
7. I am familiar with the topic of astronomy.
8. I am engaged when reading about astronomy.

Topic Interest Items for “Why American Songbirds are Vanishing”

1. I am interested in reading about songbirds.
2. Reading about songbirds is boring for me.
3. I am familiar with the topic of songbirds.
4. I am engaged when reading about songbirds
5. I am interested in reading about forestry.
6. Reading about forestry is boring for me.
7. I am familiar with the topic of forestry.
8. I am engaged when reading about songbirds.

Appendix D

Text-based interest questionnaire

Please choose a number for each statement to indicate the extent to which you agree or disagree with that statement. Write the number you chose after the statement.

1	2	3	4	5	6	7
Disagree strongly	Somewhat disagree	Disagree a little	Neither agree nor disagree	Agree a little	Somewhat agree	Agree Strongly

1. The article I just read was interesting.
2. I would be interested in reading more articles by that author.
3. The article I just read was boring.
4. I am interested in reading more articles like the one I just read.
5. I would be interested in reading more articles published in the same magazine as the one I just read.

Appendix E

Instructions given to participants for think-aloud task

In this study, you'll be asked to read one practice and two experimental texts. Unlike other times when you read, you will be asked to "think aloud" as you read each passage and make comments on what you have just read. For example, you may want to make predictions about what you are reading, rephrase what you think the text is saying, share an analogy that describes something in the text that you're familiar with, remark on something in the text that is confusing, explain why something is happening, or say anything else that helps you understand the text you're reading better. At the end of the experimental articles, you will write recalls and take posttests.

The articles will be shown one sentence at a time on the computer screen. So what you do is you read aloud the sentence shown on the computer screen. Then you "think aloud" what that particular part of the article makes you think of. When you're finished, you will press the space bar and go on to the next sentence. Once you have moved past a sentence, you cannot look back at it.

Development of a therapy for meningitis

This is the title of the article. The article will probably explain ideas about how meningitis is treated.

Few frustrations in medicine can match that of a doctor who holds a potent drug within inches of an infection it cannot reach.

That makes sense that doctors would be frustrated if they couldn't treat an infection.

Given the title, meningitis must be an infection that is difficult to treat.

This frustration is rare for doctors treating an infection of the body, but all too common for neurologists treating an infection of the brain.

So infections in the brain must be more difficult to treat than infections in the rest of the body.

The reason is the blood-brain barrier.

I don't know what the blood-brain barrier is.

The walls of blood vessels in the body are composed of loosely overlapping cells that allow many substances to flow into and out of them.

Ok, blood vessels in the body are constructed so substances can flow through them. I think this article will explain how blood vessels in the brain are constructed differently.

In contrast, the walls of blood vessels in the brain are more tightly lined, allowing a few nutrients to permeate them while fending off most other substances.

Ok, so the blood vessels in the brain are different than blood vessels in the body. The blood-brain barrier must exist because the walls of the blood vessels in the brain are more tightly lined.

This characteristic greatly reduces the chances of infection of brain tissues, but it also greatly increases the difficulty of treatment when an infection does occur.

Well, that makes sense. If there is a barrier, substances, like infections, wouldn't travel easily into the brain.

That is why bacterial meningitis is one of the biggest killers of adults and children worldwide. Until very recently, it killed up to one third of its victims.

Wow, that's a very high fatality rate. It must be because it's so difficult to train brain infections and bacterial meningitis is a brain infection.

Of the survivors, more than half suffered brain damage leading to deafness or paralysis.

That's horrible! I wonder how it can be treated.

Now you can try it with the rest of the passage while reading aloud, and we can work together in case you have any questions.