Influences of reading instructions and segmentation on memory over time

by

Kimberly Marie Newberry

B.A., The College of New Jersey, 2014
M.S., Kansas State University, 2019

AN ABSTRACT OF A DISSERTATION

submitted in partial fulfillment of the requirements for the degree

DOCTOR OF PHILOSOPHY

Department of Psychological Sciences
College of Arts and Sciences

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2020

Abstract

People read for many different reasons. Some read for enjoyment, while others read to retain information for school or work. However, reading comprehension is a complex process that varies across individuals. What is considered successful comprehension may depend on different factors, such as cognitive ability (e.g., event model construction in working memory - segmentation; Zacks et al., 2007), situation factors (e.g., reading goals), and text-specific factors (e.g., genre) (e.g., van den Broek, Bohn-Gettler, Carlson, & White 2011; van den Broek, Mouw, & Kraal, 2015). For example, do reader's goals interact with their ability to mentally represent events while reading, and do these factors influence different levels of memory representation, depending on how long the information is retained? The current study investigated the influence of general explicit reading instructions on people's ability to identify meaningful events (segment) in news stories and to remember different levels of information over varying retention intervals, ranging from 5 minutes to 1 month. After being randomly assigned reading instructions, participants read and segmented a series of texts and completed a recognition memory task for one of those texts at each of 4 delays. Generally, it was expected that reading instructions and segmentation would influence memory and that different types of information would show different patterns of forgetting. Overall, the results partially replicated and extended prior work, suggesting that different types of information show different patterns of forgetting, effective encoding is important for retaining those levels of information over time, and reading instructions moderate those relationships.

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Major Professor
Dr. Heather Bailey

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Keywords: reading comprehension, event segmentation, retention

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Acknowledgements

First and foremost, I must thank Dr. Heather Bailey. Without her unwavering kindness, support, flexibility, and intellectual guidance, I would not have made it this far. I am forever grateful and humbled to have been her first graduate student, to have been given the opportunity to learn from her, and I have no doubt that we will continue to be colleagues and friends for years to come.

I would also like to extend sincere gratitude to Dr. Lester Loschky. He was a second mentor to me throughout my graduate career and he played an integral role in the development of many of my research projects. His vast amounts of knowledge and attention to detail greatly improved my approaches to research, writing, and teaching.

A special extension of my gratitude goes to Dr. Joseph Magliano, Dr. Gabriel Radvansky, Dr. Sarah Jane Fishback, and Dr. Meena Kumari for their guidance and support. I was very fortunate to have them all on my dissertation committee and I will be forever grateful for the knowledge, focus, and encouragement they have provided.

I would also like to thank my husband, Dr. John Hutson. Though he did not exactly help develop this project, his support and encouragement at home kept me going. Having been through the process himself, he knew exactly what I needed and when, and he occasionally showed me how to run an analysis - the perks of both being in cognitive psychology.

Finally, I would also like to thank all of the graduate students in the Kansas State University Psychological Sciences Department (2015 - 2020). They helped me with actual tasks, like statistics and feedback on ideas, but they also provided emotional support and encouragement. I will be forever grateful for the relationships that were built in that concrete, windowless building, better known as Bluemont.

Dedication

This work is dedicated to my friends and family. Thank you for your love and support!

Funding

This work was supported by two research awards:

1. 2020 Arts, Humanities, and Social Sciences Grant through the Graduate School at Kansas State University
2. Foundation Fund through the Department of Psychological Sciences at Kansas State University

Chapter 1 - Introduction

People read for many different reasons. Some read for enjoyment, while others read to retain information for school or work. For example, imagine a college student who reads information in a textbook and is expected to remember the information for extended periods of time, ideally to apply it in a future class or job. Depending on the student's goals, they may need to remember specific words or phrases (e.g., terms in biopsychology), and at other times, it may be more important for them to remember a meaningful representation generated from a combination of relevant inferences and prior knowledge (i.e., situation model). Regardless of the reason, what matters is whether the information being read is comprehended by the reader. When the cognitive processes that occur during reading result in a coherent memory representation, reading comprehension can be deemed as successful (van den Broek & Gustafson, 1999). However, reading comprehension is a complex process and it varies greatly from person to person. What is considered a successful comprehension product (e.g., memory) may depend on different factors, such as general cognitive ability (e.g., event model construction in working memory), comprehension factors (e.g., adopting reading goals), and text-specific factors (e.g., genre) (e.g., van den Broek, Bohn-Gettler, Carlson, & White 2011; van den Broek, Mouw, & Kraal, 2015).

While the study of reading comprehension has been at the forefront of much of cognitive psychological research, the research itself has gone through various phases, focusing on different aspects of the process at any given time (van den Broek & Gustafson, 1999). The first wave of research primarily focused on the mental representation of texts, such as causal networks or relationships between events (e.g., Black & Bower, 1980; Kintsch & van Dijk, 1978; Mandler & Johnson, 1977; Trabasso & van den Broek, 1985; van den Broek, 1988; van Dijk & Kintsch, 1983; Zwaan, Magliano, & Graesser, 1995). The second wave focused on the underlying cognitive processes that occur during reading, such as attention allocation and inference generation (e.g., Graesser, Singer, & Trabasso, 1994; Just & Carpenter, 1980; Trabasso & Suh, 1993; van den Broek, 1990). Finally, the third wave (and certainly not the last) focused on the construction of memory representations, which led to the development of computation models, to integrate the research on reading processes and products of comprehension into unified theoretical frameworks (e.g., van den Broek, Young, Tzeng, & Linderholm, 1999). Despite these advances in understanding, much remains to be understood about the relationships between the processes that occur during reading and the resulting product of comprehension. For example, to what extent do a reader's goals interact with their ability to mentally represent events while reading, and do these factors influence different levels of memory representation, depending on how long the information is retained?

With this in mind, the current study expanded on the third wave of reading research and sought to examine the relationships between online reading processes and memory. Specifically, this study investigated the influence of general explicit reading instructions on people's ability to identify meaningful events in narrative texts (i.e., event segmentation; Zacks et al., 2007) and to remember different levels of information over varying retention intervals, ranging from 5 minutes to 1 month. The remainder of this paper is organized as follows: First, research on the underlying components and processes of reading comprehension, including situation model representation and adoption of reading instructions and goals, are discussed. Next, research on the connections between situation model representation, reading goals, and memory for different levels of representation of text is discussed. Finally, the aforementioned research is connected to research on long-term retention, culminating in the research questions which prompted the current study.

Reading Comprehension

Research on reading comprehension has changed quite a bit over the years. Early research focused on the features of mental representations, such as standards of coherence (e.g., meaningful relations between textual elements adopted by the reader; van den Broek, Risden, & Husebye-Hartmann, 1995) and depth of meaning (e.g., Suh & Trabasso, 1993), which was then followed by research on the limits of human cognition (e.g., attention allocation - Just & Carpenter, 1980; inference generation – Graesser et al., 1994) and the consequences these limits have on reading and memory (van den Broek & Gustafson, 1999). The latest focus in reading research has sought to combine years of reading research into cohesive frameworks for understanding the entire reading comprehension process (e.g., McNamara & Magliano, 2009), including the interactive effects of these different processes and the resulting memory representation, on which the current study is based.

Constructing mental representations during reading. A mental representation is a meaningful "structure" of the information being comprehended (Gernsbacher, 1997), that typically goes beyond the information in the text itself (van den Broek & Gustafson, 1999). Mental representations often comprise, not only the words and sentences themselves, but the situations those words and sentences convey (e.g., Zwaan, Magliano, & Graesser, 1995). The following excerpt from *Beanie Baby Craze*, an experimental text used in the current study and borrowed from previous studies (e.g., Radvansky, Zwaan, Curiel, & Copeland, 2001; Fisher & Radvansky, 2018), provides an example of how readers can mentally represent both the specific words and ideas mentioned in the text (from Verbatim example below) and make inferences about information that was not explicitly mentioned (from Inference example below):

> Verbatim: *A local doctor mistook a beanie baby worth several thousand dollars for a chew toy.*
>
> Inference: *Beanie babies often resemble other items, such as chew toys.*

Bartlett (1932) was the first to distinguish between the surface structure and deeper meaning of a text. This distinction was later adopted and revised by Kintsch and van Dijk (1978) who distinguished between microprocesses and macroprocesses in their attempts at consolidating the reading research into a model of text comprehension and production. Further distinction between levels of representation was eventually made, resulting in three levels of text representation; (1) *surface form* – the verbatim structure or exact wording, (2) *textbase* – propositions asserted by a text, and (3) *situation model* – representation of events in the text that include inferences or background knowledge not available or explicitly stated in the text itself (Fletcher & Chrysler, 1990; Kintsch, Welsch, Schmalhoefer, & Zimny, 1990; van Dijk & Kintsch, 1983). Situation models are also known as mental models (Johnson-Laird, 1983) or event models when referring to mental representations of dynamic, experienced events (Radvansky & Zacks, 2014).

An abundance of evidence suggests that readers construct situation models while reading narrative texts (e.g., Anderson, Garrod, & Sanford, 1983; Ehrlich & Johnson-Laird, 1982; Fletcher & Chrysler, 1990; Franklin & Tversky, 1990; Glenberg, Meyer, & Lindem, 1987; Mandler, 1986; Mani & Johnson-Laird, 1982; Morrow, Bower, & Greenspan, 1989; Morrow, Greenspan, & Bower, 1987; Radvansky, Zwaan, Curiel, & Copeland, 2001; Zwaan, 1994; Zwaan, Magliano, & Graesser, 1995; Zwaan & Radvansky, 1998). In constructing these models, readers use standards of coherence to track the relationships between multiple elements (McCrudden & Schraw, 2007; McCrudden, Magliano, & Schraw, 2010; van den Broek, Bohn-Gettler, Kendeou, Carlson, & White, 2011). For example, readers may use combinatorial rules, such as story grammars (e.g., introducing setting and protagonist, development of plot and climax, finishing a goal), to organize their mental representations of events while reading narrative texts (e.g., Colby, 1973; Mandler & Johnson, 1977). However, they may also use relations between other elements to establish coherence, such as causal relations (e.g., Black & Bower, 1980; Trabasso & Sperry, 1985; Trabasso & van den Broek, 1985; van den Broek, 1988, 1990; Zwaan, Magliano, & Graesser, 1995). In fact, research on reading and event comprehension suggests that readers typically track at least five dimensions of situations, including time, space, causation, intentionality, and protagonist, as outlined by the Event Indexing Model (Zwaan, Langston, & Graesser, 1995; Zwaan, Magliano & Graesser, 1995; Zwaan & Radvansky, 1998; see also, Gernsbacher, 1997; Johnson-Laird, 1983; van Dijk & Kintsch, 1983). Unsurprisingly, however, the extent to which readers follow any one situational dimension or particular standard of coherence may depend on multiple factors, including the reading situation (e.g., reading task, instructions) and individual cognitive ability (e.g., reading skills) (e.g., van den Broek, Bohn-Gettler, et al., 2011; van den Broek, Mouw, & Kraal, 2015). The current study focuses on both reading instructions and an underlying cognitive ability: event segmentation (described below).

The Reading Situation

One prominent factor that influences the construction and coherence of a situation model is the purpose of the reading event itself (e.g., van den Broek, Bohn-Gettler, et al., 2011; van Dijk, 1998). For example, what are the task demands surrounding the need for the reader to comprehend a particular text? In school, a student may need to read in preparation for an exam or class discussion. In other cases, they may come across an article that captures their interest. The reading situation comprises a multitude of factors, including the setting in which the reading takes place and the purpose of the reading task (e.g., Brown & Fraser, 1979; van den Broek, Bohn-Gettler, et al., 2011). Some research suggests that the subjective interpretation of the reading situation on the part of the reader limits situation model representation and memory (e.g., Giles & Coupland, 1991; van den Broek, Bohn-Gettler, et al., 2011; van Dijk, 1998). This makes sense, given that the reading process is dynamic and the combination of reading strategies used by the reader changes from moment to moment (e.g., McCrudden, Magliano, & Schraw, 2010; van den Broek, Bohn-Gettler, et al., 2011; van den Broek, Mouw, & Kraal, 2015). Of particular significance to the current study is the importance of relevance and reading goals to situation model representation and memory.

Relevance and reading goals. Ample evidence suggests that reading instructions and goals influence reading comprehension (e.g., Bohn-Gettler & Kendeou, 2014; Lehman & Schraw, 2002; Linderholm & van den Broek, 2002; Lorch, Lorch, & Klusewitz, 1993; Lorch, Lorch, & Morgan, 1987; McCrudden & Schraw, 2007; McCrudden, Magliano, & Schraw, 2010; Narvaez, van den Broek, & Barron-Ruiz, 1999; van den Broek, Fletcher, & Risden, 1993). Surprisingly, only a few theories of reading comprehension account for task-oriented reading that includes processing relevant information (McNamara & Magliano, 2009). For example, the Constructionist Theory suggests that reading goals affect inference generation during reading (e.g., Graesser et al., 1994; McCrudden, Magliano, & Schraw, 2010). Similarly, the Landscape Model includes reading goals in its outline of the standards of coherence that readers maintain while reading (McCrudden, Magliano, Schraw, 2010; van den Broek et al., 2005). However, most relevant to the current study is the Relevance and Goal-focusing Model of text-processing (McCrudden & Schraw, 2007), which states that reading to understand a text is a goal-directed activity and that readers establish a goal to meet the current demand (e.g., reading to learn). Often, the end goal is for readers to build a meaningful mental representation of the text (Gernsbacher, 1997; Kintsch & van Dijk, 1978) in order to form durable memories and "function in industrialized society," (McNamara & Magliano, 2009, p. 298). Readers may adopt different goals while reading, which leads them to focus on different aspects of the text. In terms of relevance, readers may selectively process the information in a text that is most relevant to their goals (McCrudden & Schraw, 2007).

According to McCrudden and Schraw (2007), relevance serves four functions, aimed at guiding comprehension: (1) Relevance is a signal, (2) it increases accessibility of background knowledge, (3) it affects cognitive processes, and (4) it helps determine standards of coherence for allocating resources while reading. For example, reading instructions (e.g., the signal; Reynolds, 1992) help the reader determine standards of coherence for reading a particular text in a particular context (e.g., Lorch et al., 1993; van den Broek et al., 2001; van den Broek, Risden, & Husebye-Hartmann, 1995), which then determines how the reader allocates their attentional and cognitive resources (e.g., Graesser & Bertus, 1998; Lorch et al., 1993; Myers & Brien, 1998; Narvaez et al., 1999; van den Broek et al., 2001) to construct a mental representation of the text in memory (e.g., Lehman & Schraw, 2002).

According to McCrudden and Schraw (2007; see also McCrudden, Magliano, & Schraw, 2010), a relevance taxonomy exists, such that relevance instructions can be either specific or general. Specific instructions are reading instructions that aim to improve comprehension by highlighting or targeting specific information, such as asking a reader to identify a specific person, place, or date, or asking the reader to pay attention to information that answers a particular question; whereas general instructions give readers a prompt, frame, or reference to guide reading (McCrudden & Schraw, 2007; McCrudden, Magliano, & Schraw, 2010). For the purposes of the current study, the focus will be on general instructions (for a review on specific instructions, see McCrudden & Schraw, 2007).

There are two types of general relevance instructions: perspective and purpose. Perspective instructions prompt readers to activate particular schema or broader categories of information (McCrudden & Schraw, 2007). Research using this type of instruction often asks participants to adopt a perspective while reading (e.g., Di Vesta & Di Cintio, 1997; Goetz, Schallert, Reynolds, & Radin, 1983; Kaakinen, Hyona, & Keenan, 2002, 2003; Pichert & Anderson, 1977). For example, Pichert and Anderson (1977) instructed participants to read a narrative from the perspective of either a burglar or homebuyer and then freely recall information about the narrative. The results showed that participants recalled more information that was consistent with their assigned perspective, suggesting that adopting a perspective at encoding influences what information readers find relevant, pay more attention to, and remember later on.

In contrast, purpose instructions prompt readers to engage in different patterns of inference generation based on the reading context (McCrudden & Schraw, 2007). Research using this type of instruction typically evaluates how reading purpose affects online text-processing (e.g., to summarize vs. to discuss vs. to prepare for a test - Braten & Samuelstuen, 2004; relevance vs. no instruction - Lehman & Schraw, 2002; for study vs. for entertainment - Linderholm & van den Broek, 2002; Narvaez et al., 1999; van den Broek, Lorch, et al., 2001). For example, research has shown that reading instructions direct readers to more macro- (global) or micro- (local) level information within a text (Gallini & Spires, 1995) and influence the criteria that are used to maintain or guide coherence during reading (e.g., van den Broek, Bohn-Gettler, et al., 2011; van den Broek, Lorch, Linderholm, & Gustafson, 2001). Research also suggests that directing readers to different structures within a text while reading can influence memory for the text (e.g., Gallini & Spires, 1995; Geiger & Millis, 2004; Linderholm & van den Broek, 2002; Schmalhofer & Galvanov, 1986; van den Broek, Tzeng, Risden, Trabasso, & Basche, 2001). For example, multiple studies have shown that when college-aged readers were instructed to read for study, they engaged in processes, such as paraphrasing, which resulted in better memory. Alternatively, when college-aged readers were instructed to read for entertainment, they did not engage in those processes, which resulted in poorer recall memory (Bohn-Gettler & Kendeou, 2014; Geiger & Millis, 2004; Linderholm & van den Broek, 2002; van den Broek, Bohn-Gettler, et al., 2001). These readers, however, were more likely to generate elaborative inferences and evaluative comments, which indicates that instructions to read for entertainment direct readers attention toward the situation or event model level (Linderholm & van den Broek, 2002).

Interestingly, general purpose instructions, such as reading for study versus reading for entertainment, also influence memory for different levels of representation from text. Schmalhofer and Glavanov (1986) instructed participants to read a text either with the goal of knowledge acquisition (readers would have to apply the knowledge gained from the text) or text summarization (readers would simply have to summarize what they read). They found that readers remembered situation model level information better when reading for knowledge acquisition, but those reading for text summarization remembered textbase information better. Altogether, this research suggests that purposive reading instructions influence the level at which readers process and remember text.

Cognitive Processes

Previous work using reading instructions suggests that both self-imposed, experimenter or teacher provided instructions (a manipulation of reading goals) influence many different cognitive processes during reading, including inference generation (Linderholm & van den Broek, 2002; Magliano, Trabasso, & Graesser, 1999; Narvaez, van den Broek, & Barron-Ruiz, 1999; van den Broek, Lorch, Linderholm, & Gustafson, 2001), reading times (Lorch, Lorch, & Mogan, 1987), comprehension ratings (Lehman & Schraw, 2002), recall (Bohn-Gettler & Kendeou, 2014; Linderholm & van den Broek, 2002; Narvaez et al., 1999; Pichert & Anderson, 1977), eye-movements (Kaakinen & Hyona, 2005, 2008; Kaakinen, Hyona, & Keenan, 2002, 2003) and reading strategies (Braten & Samuelstuen, 2004). However, one cognitive process shown to be important for event representation and memory that deserves more attention in reading comprehension is event segmentation (e.g., Radvansky & Zacks, 2014).

Event segmentation and reading. Theories of event cognition provide explanations for how people comprehend event information through the construction of mental representations of events either experienced (experience or event models - Radvansky & Zacks, 2014; mental models – Johnson-Laird, 1983) or read from text (situation models – van Dijk & Kintsch, 1983; Zwaan & Radvansky, 1998). According to Event Segmentation Theory (Zacks et al., 2007), people temporally parse continuous streams of information into meaningful, discrete units. Specifically, perceptual and conceptual information is used to construct a hierarchical mental representation of the ongoing event in working memory and is updated to reflect changes in the event. When one event ends and a new one begins, working memory is updated or reset so that a new event model can be created to reflect the new unfolding event. At these points in time when change occurs, people typically perceive *event boundaries*, or breaks between the events (e.g., Kurby & Zacks, 2008; Zacks et al., 2007; Zacks, 2019). Research suggests that people tend to agree on the locations of perceived event boundaries and show good inter-subject reliability (e.g., Hard et al., 2006; Newtson, 1973; Speer, Swallow, & Zacks, 2003; Zacks et al., 2001). People even agree with themselves up to one year later (e.g., test-retest; Speer et al., 2003).

Much of the work evaluating event segmentation has been conducted using videos of everyday activities or Hollywood film (e.g., Hard, Tversky, & Lang, 2006; Loschky, Larson, Magliano, & Smith, 2015; Magliano, Radvansky, Forsythe, & Copeland, 2014; Magliano & Zacks, 2011; McGatlin, Newberry, & Bailey, 2018; Newtson, 1973; Newtson, Engquist, & Bois, 1976; Swallow, Zacks, & Abrams, 2009; Zacks et al., 2007). However, more research has begun to investigate segmentation using text (e.g., Kurby & Zacks, 2012; Newberry & Bailey, 2019; Pettijohn et al., 2016; Speer & Zacks, 2005; Zacks, Speer, & Reynolds, 2009), based on the assumption that similar processes are used during event comprehension across modalities (e.g., McNamara & Magliano, 2009; Pettijohn et al., 2016; Radvansky et al., 2017; Radvansky & Zacks, 2014; Zacks, 2019). For example, prior work suggests that event segmentation is a unique cognitive ability (e.g., Sargent et al., 2013) and event boundaries identified during segmentation tend to coincide with the situational changes (time, location, causation, goals, objects, and characters) that readers monitor while reading (e.g., Kurby & Zacks, 2012; Magliano, Miller, & Zwaan, 2001; Zacks, Speer, & Reynolds, 2009; Zwaan, Langston et al., 1995; Zwaan, Magliano, & Graesser, 1995; Zwaan & Radvansky, 1998; Zwaan, Radvansky, Hilliard, & Curiel, 1998).

Given that situational changes signal important shifts in the story and presumably lead to situation model updating (Zwaan & Radvansky, 1998), processing these changes should require additional effort that can be measured by reading times. If extra processing is needed at situational shifts (e.g., at event boundaries when readers presumably update mental representations), then readers should slow down when they encounter changes while reading. Research has demonstrated that this is the case (e.g., Curiel & Radvansky, 2014; Radvansky & Copeland, 2010; Radvansky & Zacks, 2014; Suh & Trabasso, 1993; Zacks, Speer, & Reynolds, 2009; Zwaan, 1996; Zwaan, Magliano, et al., 1995). Additionally, converging evidence using functional magnetic resonance imaging (fMRI; measure of blood flow in the brain) and electroencephalography (EEG; measure of brain waves from scalp) to map transient changes in brain activation to points in time when people segmented stories also suggests that event boundaries align with situational changes (e.g., Ditman, Holcomb, & Kuperberg, 2008; Speer, Reynolds, & Zacks, 2007; Whitney et al., 2009; Xu et al., 2005; Yarkoni et al., 2008). Altogether, this research suggests that event segmentation is a cognitive process that occurs during situation model construction while reading stories.

Event segmentation and reading instructions. Given that event segmentation is a cognitive process that occurs during reading, it would be reasonable to suppose that event segmentation may also be affected by reading comprehension factors, such as reading instructions, that have been shown to influence underlying processes that occur during reading (see *The Reading Situation* and *Cognitive Processes* sections above). To date, only two studies have evaluated the direct influence of reading instructions on event segmentation (Bailey, Kurby, Sargent, & Zacks, 2017; Newberry & Bailey, 2019).

Specifically, Bailey et al., (2017) investigated whether attentional focus towards different situational dimensions (e.g., characters vs. spatial locations) affects how events are segmented. While reading narrative texts, participants were either told they would have to describe the characters afterwards (character group) or that they would have to draw a map (spatial location group). Bailey et al., (2017) found that people in the spatial location group were more likely to segment at spatial shifts in the texts, whereas everyone was likely to segment at character shifts. This suggests that reading instructions may shift reader's attention to information in text that aligns with their reading goals (McCrudden & Schraw, 2007), which may subsequently guide their segmentation or event model construction.

Similarly, Newberry and Bailey (2019) evaluated the influence of perspective on segmentation and memory for a narrative text, based on methods from Anderson and Pichert (1978). Participants were instructed to either read the text from the perspective of a burglar or a homebuyer and, afterwards, they completed free recall and identified boundaries in the text. Newberry and Bailey (2019) found that reading goals influenced how people segmented the text: Participants within each perspective agreed more on the boundaries they identified in the text, compared to participants from the other perspective. Additionally, segmentation was related to memory for the text, such that individuals with higher agreement tended to have better memory. The results of these studies provide some evidence that using reading instructions to direct attention toward different information while reading narrative texts influences where people segment. The current study expanded on this by investigating whether reading instructions influence how readers segment a text, which in turn, may influence memory for different levels of representation.

The Product of Comprehension

Arguably one of the most important aspects of comprehension is memory. In the context of reading, "What is it that readers remember from what they read; what factors influence this memory?" (van den Broek & Gustafson, 1999, p. 16). According to the Event Horizon Model (Radvansky, 2012; Radvansky & Zacks, 2011, 2014), the structure of an event influences how that event is remembered. The Event Horizon Model is comprised of 5 principles – 1) events are segmented into separate event models, 2) the current event model is actively processed in working memory, 3) causal relations between events are stored, 4) memory is facilitated when retrieval of the event is noncompetitive, and 5) memory is impaired when retrieval of the event is subject to interference (i.e., is competitive)(Radvansky, 2012). The current study focused on the first principle.

The first principle is based on research showing that people actively parse incoming information at points in time when situational dimensions change – in other words, The Event Horizon Model subsumes Event Segmentation Theory (e.g., Newtson, 1973; Newtson, Enquist, & Bois, 1976; Pettijohn et al., 2016; Swallow et al., 2009; Zacks & Tversky, 2001; Zacks et al., 2007). Thus, event segmentation should aid comprehension and memory by keeping elements that "go together" in the same mental representation, based on a general principle in memory that "structuring information often improves performance," (Pettijohn et al., 2016, p. 136).

Importantly, many event segmentation studies have found that event boundaries are consequential for memory (Radvansky & Zacks, 2014). Specifically, effective segmentation (*segmentation agreement*: when an individual agrees on the location of event boundaries with other people) is associated with better memory for events (e.g., Bailey et al., 2013; Flores et al., 2017; Newberry & Bailey, 2019; Newtson & Engquist, 1976; Sargent et al., 2013; Zacks & Tversky, 2003), and memory tends to be better for event boundary information (e.g., Ezzyat & Davachi, 2011; Huff, Meitz, & Papenmeier, 2014; Pettijohn et al., 2016; Radvansky & Copeland, 2006; Schwan & Garsoffky, 2004; Speer & Zacks, 2005; Swallow et al., 2009; Zacks, 2019; Zacks, Speer, Vettel, & Jacoby, 2006). Based on Event Segmentation Theory, this memory improvement may be due to the increase in processing activity associated with event boundary perception (Kurby & Zacks, 2008; Speer et al., 2007; Zacks, Braver, et al., 2001). Additionally, according to the Event Horizon Model (e.g., Radvansky, 2012; Radvansky & Zacks, 2014), event boundaries reduce retroactive interference. That is, the identification of event boundaries allows incoming information to be structured such that information from similar contexts are grouped together, which reduces competition of to-be-remembered information at retrieval (e.g., Pettijohn et al., 2016; Radvansky, 2012).

An important question to ask—given the importance of segmentation to memory—is under what conditions do the benefits occur, and how long are these benefits maintained? Much of the research on segmentation and memory has investigated the relationship over short retention intervals (on the order of minutes; e.g., Bailey et al., 2013; Kurby & Zacks, 2011; Newberry & Bailey, 2019; Sargent et al., 2013) or looked specifically at immediate memory for event boundary information (e.g., Ezzyat & Davachi, 2011; Pettijohn et al., 2016; Radvansky & Copeland, 2006; Swallow et al., 2009). These studies generally indicate that at short retention intervals, effective segmentation benefits memory for entire events and that event information, such as an object, is easier to recall or recognize when it is relevant to the current event as opposed to a just-encoded event (e.g., Swallow et al., 2009).

More recently, some work has investigated the segmentation-memory relationship over longer delays. For example, across multiple experiments, Flores et al., (2017) evaluated the extent to which segmentation versus intentional encoding improves memory (recall, recognition, and order memory) for videotaped events, ranging from immediate to 1-month delays. Across experiments, segmentation resulted in better recall performance compared to intentional encoding, for all delays except the immediate delay. However, segmentation only resulted in better recognition accuracy in some experiments and not others. These results generally coincide with previous research showing a relationship between segmentation and memory (e.g., Bailey et al., 2013; Sargent et al., 2013); however, the benefits of segmentation on recall at shorter delays are apparently mixed and the benefits on recognition are less well understood. Additionally, Flores et al., (2017) only evaluated overall memory accuracy for events in video, so the current study will address two questions: Which type of information gets a mnemonic benefit from effective segmentation (e.g., surface form, textbase, event model), based on research suggesting that people construct different levels of representation of events in memory (e.g., Schmalhofer & Glavanov, 1986; van den Broek et al., 2001; van Dijk & Kintsch, 1983; Zwaan & Radvansky, 1998)? And do the relationships change over time?

Retention. Equally important to the study of memory representation is retention, or how long information in memory is retained over time. One of the most renowned findings in human memory research has been Ebbinghaus' (1885) retention (forgetting) curve. The retention curve is typically shown as a negatively accelerating function in which most forgetting occurs within minutes after learning with less information being forgotten as time goes on (Fisher & Radvansky, 2018). Most of the research on retention curves has focused on the function of the curve, such as whether it is best represented by an exponential or power function (e.g., Wixted & Ebbesen, 1991), with much of the research landing on the power function (e.g., Anderson, 2001; Anderson & Tweney, 1997; Averell & Heathecote, 2011; Myung, Kim, & Pitt, 2000; Murre & Chessa, 2011; Rubin, 1982; Rubin & Wenzel, 1996; Wixted & Carpenter, 2007; Wixted & Ebbesen, 1991), which suggests that memory declines rapidly, shortly after learning, before eventually leveling off.

However, an important development in retention research has shown that the power function may not be the "be-all and end-all" function to represent how much information is retained over time (e.g., Fisher & Radvansky, 2018, 2019). The function of the retention curve depends on the type of information represented in memory – surface form, textbase, and situation (event) model (e.g., van Dijk & Kintsch, 1983). For example, earlier work on memory for surface form information, such as verbatim words and syntax, showed that memory for such information lasted for a very short amount of time (on the order of minutes, e.g., Sachs, 1967). Similarly, Kintsch, Welsch, Schmalhofer, and Zimny (1990) tested peoples' memory for texts at all three levels of representation across delays up to 4 days. They replicated the finding that memory for surface form information decays within minutes, but also found that memory for textbase information showed a less steep forgetting curve and memory for situation model information was relatively maintained (Kintsch et al., 1990).

Such research on retention of different levels of representation in memory is possible due to the clever methods developed by Schmalhofer and Glavanov (1986), using signal detection analysis. For each critical sentence from a text, there are four types of recognition probe sentences that assess each level of representation (see Table 1). Memory for surface form information is captured by the difference between memory for verbatim sentences (hits) and memory for paraphrases (false alarms). Memory for textbase information is captured by the difference between memory for paraphrase sentences (hits) and memory for inference sentences (false alarms). Finally, memory for event model information is captured by the difference between memory for inference sentences (hits) and memory for incorrect sentences (false alarms) (Fisher & Radvansky, 2018; Schmalhofer & Glavanov, 1986; see also, Kintsch, Welsch, Schmalhofer, & Zimny, 1990; Radvansky, Copeland, & Zwaan, 2003; Radvansky, Zwaan, Curiel, & Copeland, 2001).

Table 1 - Types of Recognition Sentences

Table 1

Four Types of Recognition Sentences

	Description
Verbatim	Appeared in the text (e.g., *A local doctor mistook a beanie baby worth several thousand dollars for a chew toy*.)
Paraphrase	Idea conveyed by text that did not actually appear in the text (e.g., *A local doctor accidentally thought that a beanie baby worth several thousand dollars was a chew toy*.)
Inference	Conveys idea likely generated by reader based on general knowledge (e.g., *Beanie babies often resemble other items, such as chew toys.*)
Incorrect	Thematically consistent with text, but inconsistent with events described in text (e.g., *Beanie babies are a very sturdy toy*.)

Recent work by Fisher and Radvansky (2018) used the Schmalhofer and Glavanov (1986) method to show that the levels of representation in memory have different patterns of forgetting. Specifically, surface form information was forgotten within an hour, textbase information was forgotten after approximately one week, and event level information showed little forgetting over a three-month period. Further, newer work from Fisher and Radvansky (2019) suggests that rates of forgetting may not always follow the traditional power and logarithmic functions (e.g., Rubin & Wenzel, 1996; Wixted & Ebbesen, 1991). Rather, rates of forgetting may follow a linear pattern when the information is meaningfully complex and well learned, such as when readers have to retain event information from narrative texts.

However, are these rates of forgetting moderated by important factors of comprehension, such as reading instructions or one’s ability to segment effectively? Despite the evidence suggesting that the levels of memory representation are forgotten at different rates, research on segmentation and memory for complex information has neglected to evaluate memory at these different representation levels and over long retention intervals. Thus, a major shortcoming of research on segmentation and memory for complex information is that long-term memory is assessed only after a short retention interval (e.g., Bailey et al., 2013; Boltz, 1992; Hanson & Hirst, 1989; Kurby & Zacks, 2011; Newberry & Bailey, 2019; Newtson & Engquist, 1976; Sargent et al., 2013; Schwan, Garsoffky, & Hesse, 2000; Zacks et al., 2006; Zacks & Tversky, 2001). Additionally, though long-term memory for different levels of representation has been investigated using text (e.g., Fisher & Radvansky, 2018; 2019), they have not included other important factors of comprehension, such as the standards of coherence adopted by the participants (i.e., reading instructions) and their online processing ability (i.e., segmentation), which, based on research from comprehension and event cognition, are factors that influence the representation of events in memory.

The Current Study

In putting it all together, the research to date suggests the following:

1. Reading comprehension is a complex process that varies by individual and is influenced by many different factors (see *Reading Comprehension* above).
2. Mental representations of events read from text are constructed at different levels of meaning and the level at which information is remembered can depend on factors that influence reading processes, such as reading instructions (see *The Reading Situation* above).
3. Event segmentation is a cognitive process that helps the reader construct mental representations of events during reading and event segmentation can be influenced by reading instructions (see *Cognitive Processes* above).
4. Event segmentation is important for memory, such that people who segment better also tend to have better overall memory for those segmented events (see *The Product of Comprehension* above).

5. Memory for different levels of representation is forgotten at different rates (see *Retention* above).

Separately, these findings suggest that reading instructions may influence segmentation, which may, in turn, influence memory for different levels of representation over time. However, as previously mentioned, segmentation is often neglected in reading comprehension studies, segmentation studies neglect levels of representation in memory, and most studies on segmentation and memory for complex information neglect to evaluate memory over long retention intervals. If, as the third wave of reading comprehension suggests, we as a field, are to better understand both the process and product of comprehension in one framework, factors such as those outlined here need to be evaluated within the same study. Thus, the current study integrated the research on reading comprehension, event cognition, and retention by investigating the relationship between reading instructions, segmentation, and memory for different levels of representation from text over long retention intervals. Specifically, participants were assigned different general reading instructions (read for study vs. read for entertainment) prior to reading 4 news stories (expositions written for a general audience). Participants read and segmented each text and their memory for the texts, using the Schmalhofer and Glavanov (1986) method, was tested across 4 retention intervals (immediate, 24 hours, 1 week, 4 weeks).

Chapter 2 - Research Questions and Hypotheses

Purpose

Reading instructions and individual differences in online event comprehension processes such as segmentation, may interact to influence the type of information people retain from text and for how long. The purpose of the current study was to evaluate independent and interactive effects of reading instructions and segmentation on memory for different levels of representation over retention intervals ranging from 5 minutes to 4 weeks. Previous work suggests that reading instructions and segmentation influence memory; however, it remains unclear whether reading instructions influence memory through the online process of segmentation. Additionally, prior work has not investigated the levels of representation in memory that segmentation affects or whether the potential relationships between reading instructions, segmentation, and memory change over longer retention intervals, such as up to one month. The goal of the current study was to investigate these issues to fill these gaps in the literature.

Do reading instructions influence memory?

Based on results from Schmalhofer and Glavanov (1986), readers in the read-for-study group may remember more textbase information, whereas readers in the read-for-entertainment group may remember more event level information. Such a finding would be consistent with the processing results from Linderholm and van den Broek (2002) who found that reading for study was associated with paraphrasing and connecting inferences, whereas reading for entertainment was associated with elaborative inferences, which are associated with event model construction. Note here that these predicted differences are specific to the levels of representation but not overall memory performance. Thus, those who read-for-study may remember more textbase information, whereas those who read-for-entertainment may remember more event level information. However, results from Gallini and Spires (1995) suggest that reading instructions that emphasize the macro-processing of an event will result in better memory for both macro (event level) and micro (textbase) information. Thus, those who read-for-entertainment in the current study could show superior memory for both textbase and event level information. Further, memory for surface form information should be poor for both groups (e.g., Sachs, 1967; Schmalhofer & Glavanov, 1986).

Do reading instructions influence memory over time?

Based on Fisher and Radvansky (2018; 2019), it was hypothesized that memory for surface form information would be above chance at the immediate delay, but drop to chance quickly thereafter, whereas textbase memory would decline after one week, and event level information would be relatively maintained across all delays, perhaps showing some forgetting at the 1-month retention interval. However, it was also hypothesized that these rates may differ depending on reading group. Based on Schmalhofer and Glavanov (1986) and Fisher and Radvansky (2018; 2019), those who read-for-study may remember more surface form information after an immediate test delay, but over longer delays, the difference in memory for surface form information between groups may diminish. Further, if those who read-for-study emphasize processing of textbase information, they may show better memory for textbase information across delays, particularly at the immediate and day delays when textbase information is less subject to forgetting, compared to those who read-for-entertainment. Similarly, if those who read-for-entertainment emphasize processing of event model information, they may show better memory for event level information across delays, compared to those who read-for-study.

Do reading instructions influence segmentation?

If reading-for-study directs readers toward textbase information (finer units of information) and reading-for-entertainment directs readers toward event level information (broader or coarser units of information), then the read-for-study group may segment more often (identify more boundaries) compared to the read-for-entertainment group. However, if reading-for-entertainment activates both macro (event level, or coarser level events) and micro-processing (textbase, or finer ideas at sentence level), the read-for-entertainment group may not segment less often, in which case both groups may exhibit similar frequency of segmentation. If both groups exhibit similar frequency of segmentation, greater attention may need to be turned toward the relationships between segmentation agreement and memory at the event model and textbase levels, such that if the entertainment group shows a relationship between segmentation agreement and textbase memory, this could suggest that macro-level processing directs readers to micro-level processing as well.

Additionally, if the reading instructions are used similarly among participants within each group, segmentation agreement may be higher within group, compared to between groups (see Newberry & Bailey, 2019). That is, a person who is given one type of reading instruction may show higher agreement with people from the same reading group, compared to people from the other reading group who were given a different instruction. Alternatively, if both reading groups similarly monitor event level information while reading or rely on features of the text itself to guide segmentation, their segmentation agreement may not differ. However, it may also be the case that those who read-for-study show poor agreement within their group if they are directed to textbase information and segment more often. This would suggest that they are identifying many different events (perhaps each idea unit or proposition), as opposed to a few, large events (like the read-for-entertainment group, possibly), which would lead to more opportunities to disagree (i.e., worse segmentation agreement).

Does segmentation influence memory over time?

Based on prior work, it was hypothesized that those who segment better would have better memory (e.g., Bailey et al., 2013; Sargent et al., 2013), regardless of reading group. Regarding different levels of representation and based on Event Segmentation Theory and the Event Horizon Model, it was hypothesized that segmentation may more strongly predict memory for event level information, compared to surface form and textbase information. However, Newberry and Bailey (2019) measured memory for text information using idea units, which is the textbase level of representation, and found some support that segmentation was related to memory for idea units. Thus, it is also possible that segmentation may be related to memory for textbase information, but perhaps to a lesser extent compared to event level information.

Do reading instructions influence memory (over time) through segmentation?

Reading instructions may influence memory through segmentation. The extent to which segmentation mediates the relationship may depend on which levels of memory representation the different reading instructions influence. For example, if reading-for-study affects memory for textbase information, then segmentation may mediate that specific relationship. Similarly, if reading-for-entertainment affects memory for event level information, then segmentation may mediate that specific relationship. No relationships were expected for surface form memory because memory for surface form information tends to decay quickly. Additionally, these relationships may depend on delay, such that segmentation mediates the relationship between reading instruction and memory at longer delays, compared to the immediate delay. Alternatively, segmentation may not mediate the relationship between reading instructions and memory, which would suggest that reading instructions do not influence memory through segmentation.

Chapter 3 - Method

Participants

A total of 438 people participated in this study, of which 354 were recruited through Amazon Mechanical Turk (mTurk) (Table 2) for monetary compensation and 84 were recruited through Kansas State University's undergraduate psychology participant pool (Table 2) for research credit in partial fulfillment of a course requirement. The estimated sample size for this study was based on the number of data points per delay condition (48 participants x 4 delays = 192) obtained from Fisher and Radvansky (2018), which was then doubled to account for the reading instruction manipulation in the current study (resulting in approximately 384 participants needed). Of the 438 participants, 213 were randomly assigned to the Read for Entertainment group and 225 were randomly assigned to the Read for Study group (Table 3). The current study implemented a longitudinal, within-subjects, online design, such that participants were asked to participate in 4 separate sessions, occurring at the following delays: immediate (initial session), 24 hours (2nd session), 1 week (3rd session), and 4 weeks (4th session) (for attrition rates see Table 4). All data collection occurred through surveys using Qualtrics. This study was approved by the university's Institutional Review Board.

Table 2 - Participant Demographics

Table 2

Participant Demographics

Sample	*N*	*M* Age	% Female	*M* Yrs Ed	% White	% Black	% Indigenous	% Asian	% Hispanic
Everyone	438	35.03 (12.74)	50.68	14.88 (2.76)	83.56	8.68	2.28	5.48	9.82
mTurk	354	38.78 (11.27)	44.35	15.43 (2.76)	81.92	10.45	1.69	5.93	10.45
SONA	84	19.20 (1.15)	77.38	12.59 (1.07)	90.48	1.19	4.76	3.57	7.14

Note: standard deviation in parentheses.

Table 3 - Reading Group Demographics

Table 3

Reading Group Demographics

Group	*N*	*M* Age	% Female	*M* Yrs Ed	% White	% Black	% Indigenous	% Asian	% Hispanic
Entertainment	213	35.57 (12.25)	45.54	15.05 (2.70)	84.04	8.45	1.88	5.63	10.8
Study	225	35.40 (13.29)	55.56	14.73 (2.81)	83.11	8.89	2.67	5.33	8.89

Note: standard deviation in parentheses.

Table 4 - Attrition Rates

Table 4

Attrition Rates

Sample	Delay	*N*	Attrition Rate (%)
Everyone	Immediate	438	
	Day	341	22.15
	Week	302	31.05
	Month	265	39.5
mTurk	Immediate	354	
	Day	265	25.14
	Week	242	31.64
	Month	208	41.24
SONA	Immediate	84	
	Day	76	9.52
	Week	60	28.57
	Month	57	32.14

Note: cumulative attrition rate

Exclusion criteria. Amazon Mechanical Turk participants had to meet the following criteria in order to have the option to participate: 1) HIT (Human Intelligence Task) approval rate greater than 95, 2) location in the United States, and 3) number of HITs approved greater than 100. After gaining access to participate, mTurk participants also had to pass screening checks (see *Appendix C* for details) before starting the actual experiment, which included a RECAPTCHA (to remove bots) and an English proficiency question. An additional attention check (e.g., Mixing blue and yellow paint together will make what color? Answer red, even though it is the incorrect answer to the previous question.) was also built into the surveys. Participants from both mTurk and the undergraduate participant pool had to be at least 18 years old and speak English as their native language.

To account for time on task, Task Master (Permut, Fisher, & Oppenheimer, 2019) was coded into the Qualtrics surveys. A pilot test of the Qualtrics surveys suggested that Task Master was working and recording time on task, as outlined in Permut et al., (2019). However, during actual data collection, responses from Task Master stopped recording. This failure was attributed to a programming error. Thankfully, as back up, hidden timers were embedded into each question of the survey, so reading times and recognition response times were still able to be recorded. Participants' reading time data at each clause (395 observations across 172 participants) that were greater than 3.5 standard deviations away from the mean were removed on the basis that these individuals were engaged in other tasks while reading those clauses. An additional 22 participants (11 from the entertainment reading group and 11 from the study reading group) whose average recognition memory response times were both less than 2.5 seconds and all one answer choice (e.g., only responding "Yes" or "No" to every recognition probe) were also entirely removed on the basis that these individuals sped through the memory task and thus their responses would not be an accurate measure of their comprehension. Altogether, data from 416 participants (95% of the data) was retained for analysis.

Materials

News stories. Participants read five passages: (1 practice) *On Hallowed Ground*, written by Dave Barry, and (4 experimental) *Determining Identity, The Farmers' Rebellion, New York in the Future,* and *The Beanie Baby Craze* (all texts in *Appendix B*; Fisher & Radvansky, 2018; Radvansky et al., 2001). The experimental passages were expositions written for a general audience. They ranged in length from 516 to 703 words (58 to 85 clauses) and were presented to participants one clause at a time on a computer screen. Reading was self-paced, such that participants clicked a button to advance to the next clause. Passage order was counterbalanced across participants at both encoding and retrieval. *On Hallowed Ground* was always presented first, as the practice text.

Dependent Measures.

Reading time. Participants were instructed to read the passages one clause at a time on a computer screen. Reading was self-paced, such that participants pressed a button to advance to the next clause. Duration (in seconds) between button presses was recorded as a measure of how long participants spent reading each clause of each passage.

Recognition. Four sentence probes (verbatim, paraphrase, inference, and incorrect) were generated for half of the sentences from each passage, based on the procedures used by Schmalhofer and Glavanov (1986) and Fisher and Radvansky (2018) (all probes available in *Appendix B*; see Table 5 below for example). A probe appeared on screen and participants indicated whether they recognized the probe by clicking a button labelled "yes" or "no". Memory scores for each level of representation (surface form, text base, event model) were derived using a signal detection measure (see *Results* below).

Table 5 - Example Recognition Probes

Table 5

Example of Recognition Probes for Sentence from Beanie Baby Craze

	Description
Verbatim	*A local doctor mistook a beanie baby worth several thousand dollars for a chew toy.*
Paraphrase	*A local doctor accidentally thought that a beanie baby worth several thousand dollars was a chew toy.*
Inference	*Beanie babies often resemble other items, such as chew toys.*
Incorrect	*Beanie babies are a very sturdy toy.*

Segmentation. Participants were asked to identify event boundaries in the passages based on a variation of the unitization task employed by Newtson (1973). They were provided with each passage in its entirety and asked to mark between clauses where they believed one meaningful unit of activity ended and a new one began (e.g., Zacks, Speer, & Reynolds, 2009). A practice segmentation task using the practice passage was implemented to acclimate participants to this task; however, they did not receive explicit examples of how to do the task and were encouraged that there was no right or wrong way to do the task. Both the total number of event boundaries identified (*segmentation frequency/count*) and the extent to which individuals agree on the boundaries they identified in the passages (*segmentation agreement*: correlation ranging from 0 to 1) were recorded.

Design and Procedure

A 2 (Reading Instruction: Study vs. Entertainment) by 4 (Retention Delay: Immediate vs. 24 Hours vs. 1 Week vs. 4 Weeks) by 3 (Level of Representation: Event Model vs. Textbase vs. Surface Form) mixed design was used. Reading instruction was between-subjects, as participants were randomly assigned to either read the passages with the intent to read for study or read for entertainment. Those in the read-for-study group were asked to imagine that they are studying for a test and read the text in order to learn facts and be able to summarize them in an essay exam. Those in the read-for-entertainment group were asked to imagine that they are reading for fun and read the text as if they are relaxing at home, browsing through a magazine, and the story catches their eye. Retention delay was within-subjects, as all participants completed the recognition task for one of the four passages at each of the four retention delays. All participants read, segmented, and responded to recognition probes for all four passages. Experimental passage order was counterbalanced across participants at both encoding and retrieval (across the retention delays).

Participants were sent a link that directed them to the experiment. They completed an informed consent form and then instructions appeared on screen. Participants were randomly assigned a reading instruction (read to study or read for entertainment). They were told that reading was self-paced and to press a button to advance to the next clause, continuing until the entire passage was read.

After reading all four passages, participants completed the practice segmentation task on the practice text (*On Hallowed Ground*) as a brief filler task before completing the recognition task that was associated with whichever passage they read last (i.e., immediate delay). After completing the immediate recognition task, participants completed the segmentation task for that passage. They were presented with the passage in its entirety and asked to identify the points in the passage where they believed one meaningful unit of activity ended and another began. The segmentation task was completed after the recognition task so as not to skew retention. At the point of completion of the segmentation task, a screen appeared thanking participants for their time, reminding them to look for an email with a link to the recognition and segmentation measures to be completed for the remaining passages at the subsequent retention delays (24-hours, 1-week, 4-weeks).

During the follow-up experimental sessions that occurred after the 24 hour, 1-week, and 4-week delays, participants clicked on a link that was emailed to them that corresponded to the to-be-tested passage. Participants were immediately instructed to take the recognition test for that particular passage, followed by the segmentation task. This procedure was repeated for each of the remaining sessions. Participants were compensated for completing each experimental session and all participants received debriefing messages about this study at the end of their 4-week session. A flow chart depicting the procedure is provided in Figure 1.

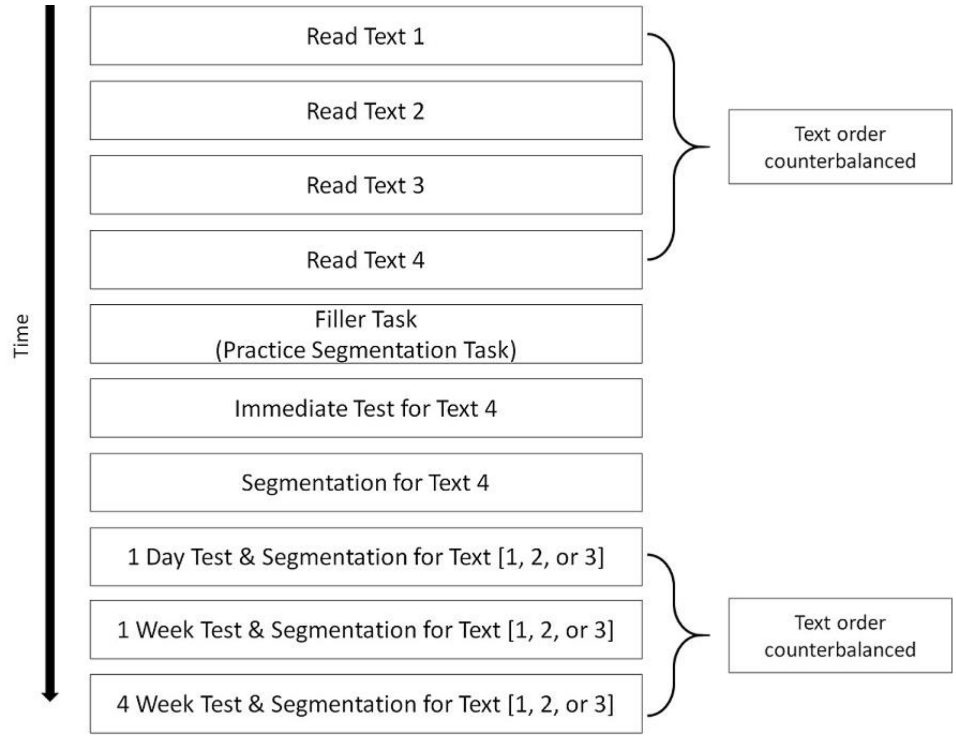

Figure 1. Procedure for the current study.

Chapter 4 - Results

Approach

The main analyses were conducted using t-tests, generalized multilevel modeling, and mediation modeling techniques. The t-tests were used to compared observed means to a hypothesized mean. Generalized multilevel modeling techniques were used to account for non-normal error distributions and error variance associated with random effects, such as inherent differences across individual participants and stories. To ease comparisons, group means for the various measures are presented in tables corresponding to each section. We first described how each dependent variable was scored and then assessed effects of reading instructions (i.e., reading group) on reading time, recognition response time, and segmentation measures. We then assessed the extent to which recognition memory performance for the different levels of representation differed significantly from chance (A' = .50) for each reading group at each delay. Then we evaluated the effects of the full factorial model, including reading instructions, delay, and segmentation ability, on recognition memory performance, for each level of representation. Finally, we end with exploratory analyses investigating relationships between reading time and segmentation ability in the current study with Event Indexing coding of situational changes from Radvansky et al., 2001) and effects of age. Tables summarizing all of the analyses are provided at the end of the results section (Tables 9 and 10). Additionally, supplemental analyses replicating the moderating effects of reading instructions, segmentation, and delay on recognition performance using an alternative recognition measure (d' sensitivity) are available in *Appendix A*.

Main Analyses

Scoring.

Reading time. Reading time was recorded as the number of seconds a participant spent reading each clause in the passages. Reading was self-paced such that participants pressed a button to advance to each new clause.

Recognition performance. Memory scores for each level of representation (surface form, text base, event model) were derived using a signal detection measure of sensitivity, A' (e.g., Fisher & Radvansky, 2018). Prior work suggests A' is preferred for measuring recognition memory (e.g., Snodgrass & Corwin, 1988) because it does not assume homogenous variance, better accounts for instances when participants have hit or false alarm rates of 0 or 1, and is more easily interpretable (0 to 1 scale, with .5 as chance performance). However, Schmalhofer and Glavanov (1986) originally used d' as the measure of sensitivity for the recognition task, thus supplement analyses using d' are provided in *Appendix A.* Four sentence probes (verbatim, paraphrase, inference, and incorrect) were generated for half of the sentences from each passage. A probe appeared on screen (see Table 1) and participants indicated whether they recognized the probe by clicking a button labelled "yes" or "no". Memory for surface form information was captured by the difference between hits on the verbatim sentences and false alarms on the paraphrases. Memory for textbase information was captured by the difference between hits on the paraphrase sentences and false alarms on the inference sentences. Finally, memory for event model information was captured by the difference between hits on the inference sentences and false alarms on the incorrect sentences (Fisher & Radvansky, 2018; Schmalhofer & Glavanov, 1986; see also, Kintsch, Welsch, Schmalhofer, & Zimny, 1990; Radvansky, Copeland, & Zwaan, 2003; Radvansky, Zwaan, Curiel, & Copeland, 2001).

Recognition response time. Similar to reading time, response times for each recognition trial (16 per probe type; 64 total per story) were recorded in number of seconds.

Segmentation. Participants were asked to identify event boundaries in the passages based on a variation of the unitization task employed by Newtson (1973). They were provided with each passage in its entirety and asked to mark between clauses where they believed one meaningful unit of activity ended and a new one began (e.g., Zacks, Speer, & Reynolds, 2009). *Segmentation frequency/count* was recorded as the total number of event boundaries identified in each story. *Segmentation agreement* scores were calculated for each participant by computing a point-biserial correlation for each participant, for each story, using everyone for the comparison group[1] and then scaling the correlations to control for individual differences in the number of event boundaries identified. Agreement scores could range from 0 to 1, with higher values indicating more agreement with the group (for similar methods, see Bailey et al., 2013; Kurby and Zacks, 2011).

Situational changes. Each clause had been previously coded for the number of situational changes as outlined by the Event Indexing Model, in a previous study by Radvansky, Zwaan, Curiel, and Copeland (2001). Thus, each clause received a count of the number of situational changes it contained.

Effects on reading time. Previous work has found mixed results on whether reading instructions influence reading times. For example, Schmalhofer and Glavanov (1986) found that

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[1] Agreement scores can be calculated using different comparison groups, such as everyone, one's own group, or the other group. For analyses comparing whether an individual agreed more with their own group or the other group, "one's own group" was used as the comparison. For analyses investigating overall segmentation differences, "everyone" was used in the comparison group. In the current study, segmentation agreement scores did not vary by group, regardless of the comparison group used.

people who were instructed to read for summarization read more slowly compared to people who were instructed to read to “get the gist”; whereas, McCrudden, Schraw, and Hartley (2006) found no influence of general reading instructions on overall reading times. Additionally, however, prior work has found that readers slow down when they encounter situational changes (e.g., Zwaan, Magliano & Graesser, 1995; Zwaan & Radvansky, 1998). Specifically, Zwaan, Magliano, and Graesser (1995) found that reading times slowed down at time and causal shifts, but only for those who “read for pleasure,” compared to those who “read for memory,” whose attention was otherwise focused on the textbase at the expense of monitoring situational continuity.

To test whether these effects were present in the current study, a generalized gamma (link = log) multilevel model was used to predict reading time at the clause level from the full factorial of the fixed effects of reading group (entertainment vs. study) and number of situational changes, with number of syllables entered as a covariate and participant and story treated as random effects (Figure 2). Reading time did not differ by reading instruction ($p = .57$). A significant main effect of syllable ($t = 94.71$, $p < .001$) and significant main effect of situational change ($t = 13.48$, $p < .001$) were present, such that reading time per clause increased as the number of syllables and the number of situational changes, respectively, increased. However, there was a significant two-way interaction between reading group and situational change ($t = 4.37$, $p < .001$) in which participants who were instructed to read for study read clauses containing more situational changes more slowly than participants who were instructed to read for entertainment (Figure 2). These results support prior work suggesting that readers slow down at clauses containing more situational changes to process the information (e.g., Zwaan & Radvansky, 1998); however, they do not align with the results from Zwaan, Magliano, and Graesser (1995), in that those who read-for-study slowed down, rather than those who read-for-entertainment. These results also partially support McCrudden et al., (2006), as overall reading time did not differ between reading groups (until situational changes were present).

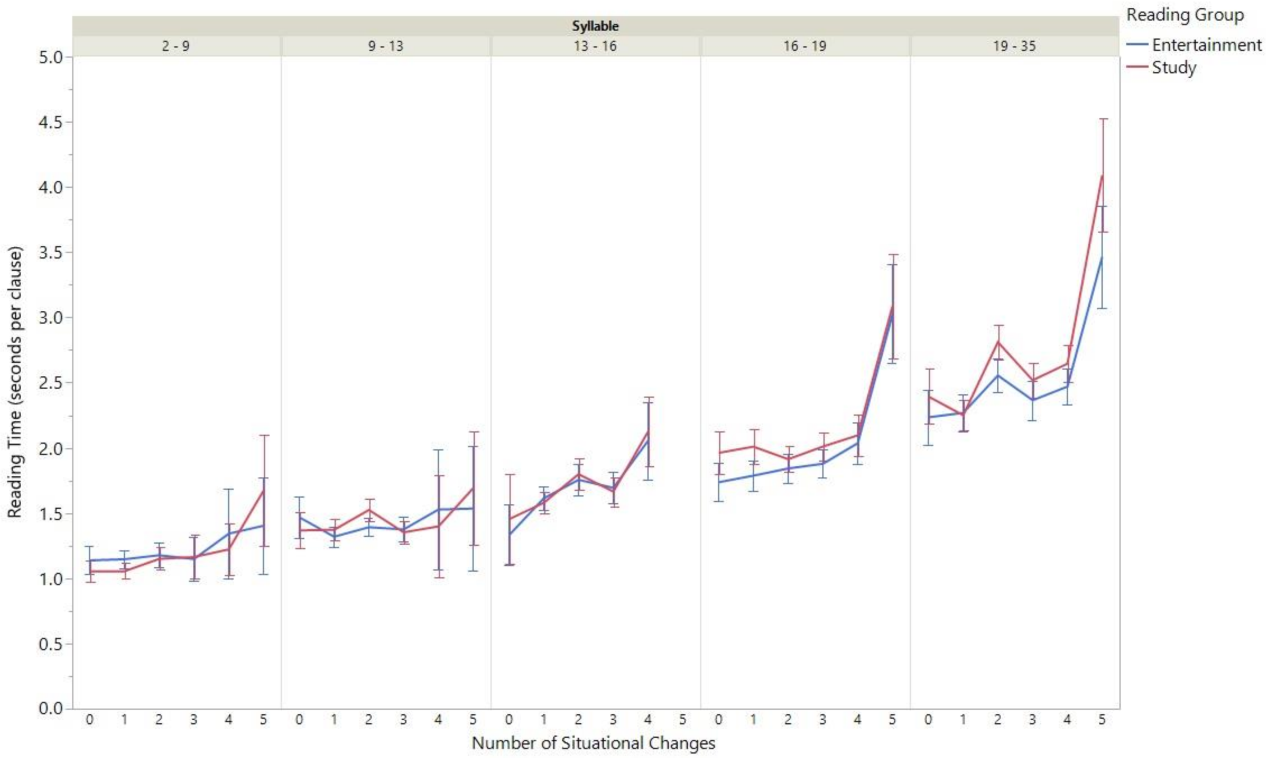

Figure 2. Reading time per clause by number of situational changes, syllable, and reading group. Error bars indicate 95% confidence interval.

Effects on segmentation. Prior work suggests that conceptual factors can influence segmentation (*context*: Loschky, Larson, Magliano, & Smith, 2015; Newberry & Bailey, 2019; *familiarity*: McGatlin et al., 2018; Smith, Newberry & Bailey, 2020; Zacks & Tversky, 2003; *perspective*: Newberry & Bailey, 2019; *goals*: Baldwin, Baird, Saylor & Clark; 2001; Wilder, 1978a; 1978b; Zacks, 2004). In the current study, it was hypothesized that those who read for study might identify more event boundaries than those who read for entertainment, if they were monitoring the textbase level of the texts (clause/idea unit level). A generalized Poisson multilevel model was used to predict segmentation frequency from the fixed effect of reading group and random effects of participant and story. The effect of reading group on segmentation frequency was not significant (read for study: M = 15.82 boundaries; read for entertainment: M = 15.69 boundaries; p = .74). One explanation for this result is that directing the entertainment group toward macro-level processing (i.e., event model) also triggered micro-level processing (e.g., textbase) (Gallini & Spires, 1995), which could have led to both groups identifying a similar number of boundaries, rather than the story group identifying more. Alternatively, both groups may have just monitored event level information similarly or the coarse segmentation measure may not have been as sensitive to top-down differences (see below).

Though both reading groups identified a similar number of event boundaries across the stories, it is possible that the extent to which people agreed on the boundaries differed. This was evaluated in two ways. The first way evaluated whether reading instructions influenced overall segmentation agreement. It was hypothesized that the read for study group would have worse (lower) segmentation agreement compared to those in the entertainment group, if those in the study group were monitoring the textbase level, which would allow more opportunities for disagreement. A generalized linear model was used to predict segmentation agreement from the fixed effect of reading group and random effects of participant and story. The effect of reading group on segmentation agreement was not significant (read for study: M = .75; read for entertainment: M = .75; p = .75). Both reading groups exhibited similar segmentation agreement.

The second investigation on event segmentation evaluated whether reading groups were more likely to agree on the locations of boundaries with readers from their own group, compared to the other group. Previous work has found that when people read from different perspectives (e.g., burglar vs. homebuyer perspectives), they show higher segmentation agreement with members from their own perspective compared to the other perspective (Newberry & Bailey, 2019). A generalized linear multilevel model was used to predict segmentation agreement from the fixed effects of reading group, comparison group (own vs. other), their interaction, and random effects of participant and story. None of the effects were statistically significant (all $p >$ .05), although the interaction between reading group and comparison group was marginally significant (t = -1.89, p = .06). After probing the interaction using the post-hoc Student's t, those in the Entertainment reading group showed slightly higher agreement with their own group (M = .76, SE = .01, CI95% [.75, .77]) than when agreement was calculated using the other group (Study) as the baseline (M = .75, SE = .01, CI95% [.74, .76]). Surprisingly, the Study reading group showed the opposite pattern: slightly higher agreement with the other group (Entertainment) (M = .77, SE = .01, CI95% [.76, .78]) compared to their own group (M = .76, SE = .01, CI95% [.75, .77]). However, these mean differences are negligible (ΔM = .01; Cohen's d = .07). These results could suggest that both groups monitored event structure similarly; however, such interpretation should be made with caution and future studies should consider using other measures of event structure, such as hierarchical alignment, or measuring segmentation more finitely (e.g., coarse vs. fine boundaries; Newberry, Feller, & Bailey, under review) to better examine potential differences in agreement (see *Limitations* below).

Effects on recognition memory.

Recognition response time. A generalized linear multilevel model was used to predict recognition response time (log-transformed) from the full factorial of the fixed effects of reading group, delay, and recognition trial type (verbatim, paraphrase, inference, wrong) and the random effects of participant and story. A main effect of delay was present (t = 3.22, p = .001), such that response times to all recognition trial types were faster at the immediate delay (M = 5.05, SE = .24, CI95% [4.57, 5.52]), compared to the day (M = 6.28, SE = .30, CI95% [5.69, 6.87]), week (M = 5.82, SE = .23, CI95% [5.37, 6.26]), and month delays (M = 6.44, SE = .44, CI95% [5.58, 7.31]), which did not differ statistically (Figure 3). No other effects were present (all $p > .05$). The main effect of delay suggests that memory retrieval was more fluent when the passages were read immediately beforehand, which was to be expected.

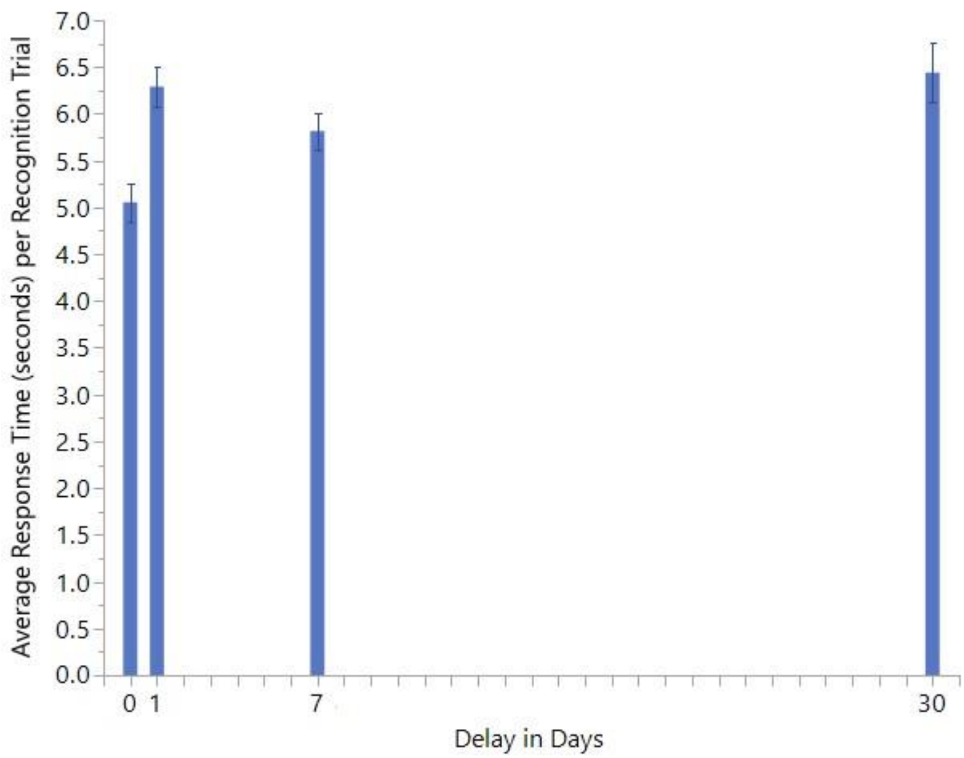

Figure 3. Recognition response time (in seconds) across delay. Error bars indicate 95% confidence interval.

Levels of representation over time. Based on evidence from Fisher and Radvansky (2018), it was hypothesized that, within reading group, memory for each level of representation (event model, textbase, surface form) would decline differently over time. Specifically, it was expected that event model memory would remain above chance across all delays, perhaps showing some decline at the month delay, whereas textbase memory would remain above chance until the week delay and surface form memory would quickly drop to chance performance after the immediate delay. However, it was also hypothesized that these rates may differ between reading groups. Based on Schmalhofer and Glavanov (1986), it was hypothesized that the study group may remember more surface form information at the immediate delay, but this difference would diminish at longer delays (quickly drop to chance). Further, if those in the study group prioritized processing of textbase information, they may show better memory for textbase information across all delays, compared to the entertainment group. Similarly, if the entertainment group prioritized processing of event model information, they may show better memory for event level information across all delays, compared to the study group.

First, a series of one-sample t-tests were conducted to test whether recognition performance at each level of representation differed from chance (A’ = .50) at each delay. These results (Table 6 and Figure 4) appear to replicate the effects from Fisher and Radvansky (2018), such that event model memory was relatively retained across delays, whereas textbase memory declined after one week, and surface form memory quickly dropped to chance after the immediate delay.

Table 6 - One-Sample T-tests of Memory vs. Chance at Each Delay

Table 6

One-Sample T-tests Evaluating Recognition Performance vs. Chance at Each Delay

Reading Group	Level of Representation	Delay	*M*	*SE*	*CI*95%	*t*	*p*
Entertainment	Event Model	Immediate	0.64	0.01	[.62, .67]	11.31	*<.001
		Day	0.67	0.01	[.64, .69]	12.63	*<.001
		Week	0.64	0.01	[.61, .67]	9.96	*<.001
		Month	0.64	0.02	[.61, .67]	9.15	*<.001
	Textbase	Immediate	0.58	0.01	[.56, .61]	6.41	*<.001
		Day	0.56	0.01	[.54, .59]	5.21	*<.001
		Week	0.54	0.01	[.52, .57]	3.16	*.002
		Month	0.49	0.01	[.46, .52]	-0.77	0.44
	Surface Form	Immediate	0.55	0.01	[.53, .57]	5.51	*<.001
		Day	0.53	0.01	[.50, .55]	2.18	0.03
		Week	0.51	0.01	[.49, .54]	1.06	0.29
		Month	0.51	0.01	[.49, .54]	1.05	0.29
Study	Event Model	Immediate	0.67	0.01	[.65, .69]	15.63	*<.001
		Day	0.68	0.01	[.65, .71]	14.05	*<.001
		Week	0.66	0.01	[.63, .69]	12.14	*<.001
		Month	0.65	0.01	[.62, .68]	11.61	*<.001
	Textbase	Immediate	0.58	0.01	[.56, .61]	6.64	*<.001
		Day	0.57	0.01	[.55, .60]	5.75	*<.001
		Week	0.52	0.01	[.49, .55]	1.46	0.15
		Month	0.51	0.01	[.49, .54]	1.12	0.27
	Surface Form	Immediate	0.56	0.01	[.54, .58]	5.71	*<.001
		Day	0.52	0.01	[.49, .54]	1.38	0.17
		Week	0.55	0.01	[.53, .58]	4.77	*<.001
		Month	0.51	0.01	[.49, .54]	1.12	0.26

Note: Recognition performance measured using A' sensitivity. Chance performance = .50. Bonferroni corrected *p*s < .002.

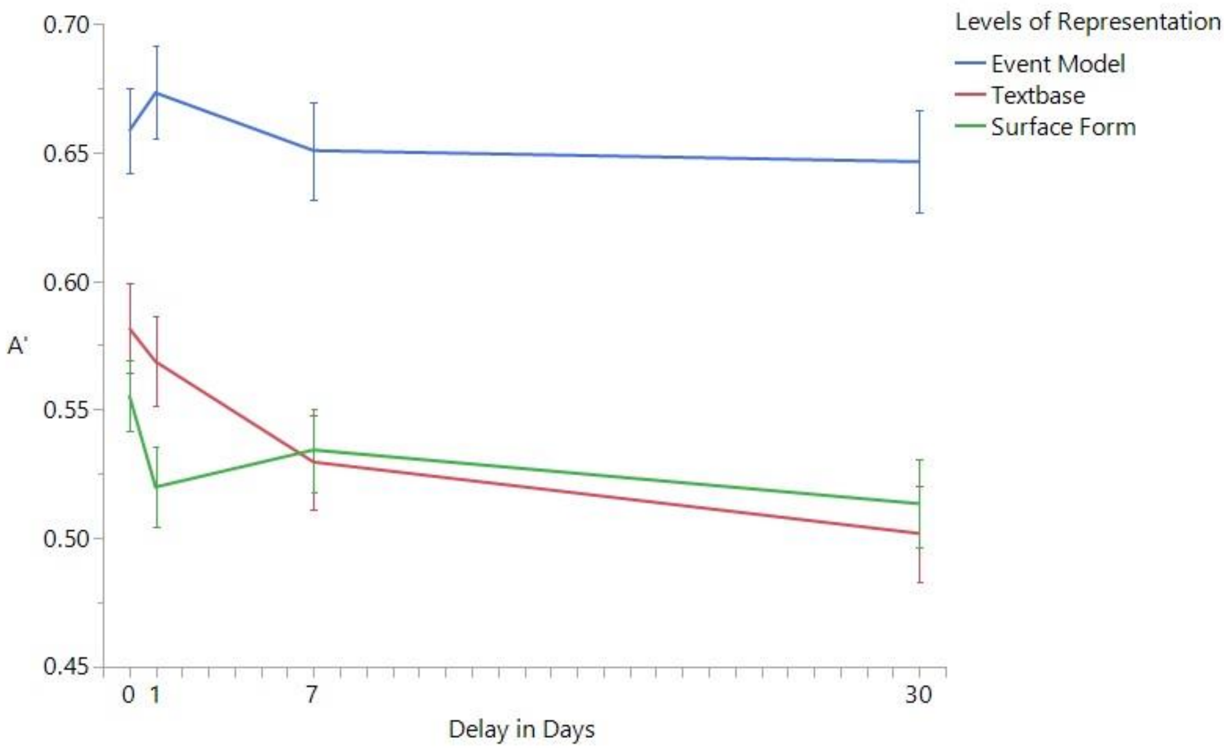

Figure 4. Recognition (A') by level of representation across delay. Error bars indicate 95% confidence interval.

To test the between-subject effects of reading group on recognition performance over time, a generalized linear multilevel model was used to predict recognition performance at each level of representation from the fixed effects of reading group, delay, their interaction, and the random effects of participant and story. At the event model level, a main effect of delay was present (t = -3.45, p = .001), such that recognition performance slightly increased from the immediate delay to the day delay, then decreased slightly across the week and month delays, regardless of reading group (Figure 5). No other effects were present (all $p > .05$).

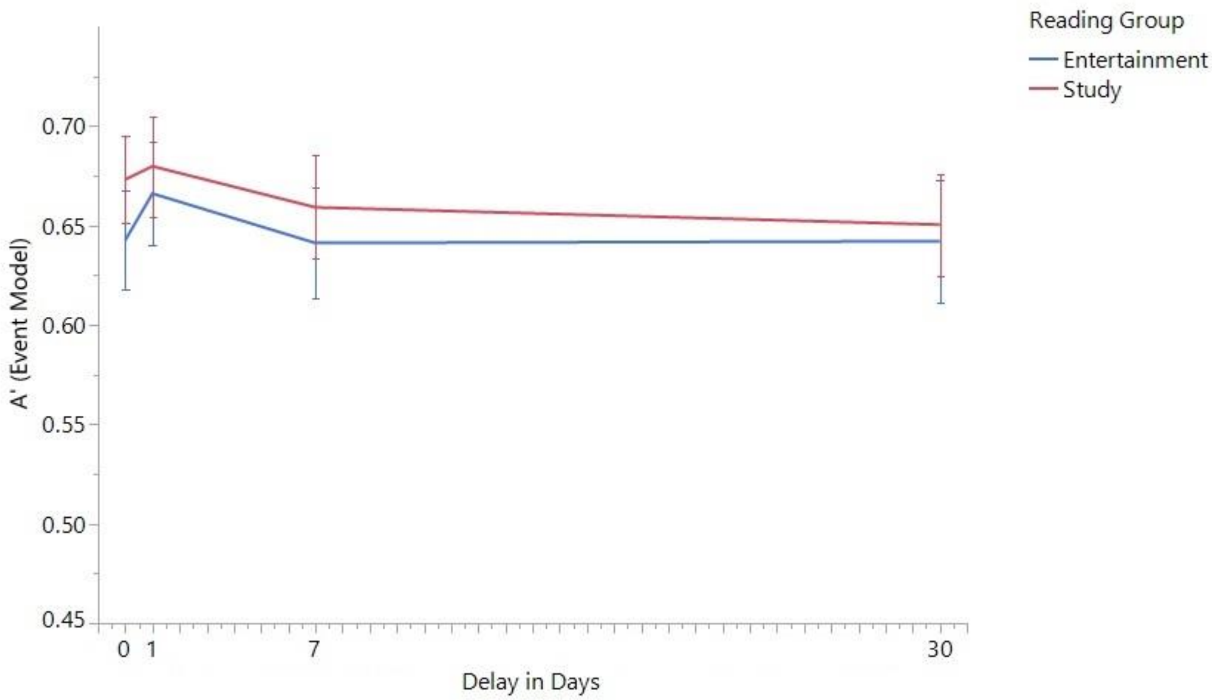

Figure 5. Event model A' by reading group, across delay. Error bars indicate 95% confidence interval.

At the textbase level, a main effect of delay was present (t = -6.50, p < .001), such that recognition performance decreased across delays, regardless of reading group (Table 6). However, the interaction between reading group and delay was marginally significant at the week delay (t = 1.77, p = .08), such that the entertainment group had higher textbase recognition performance at the week delay compared to the study group (Figure 6). No other effects were present (all p > .05).

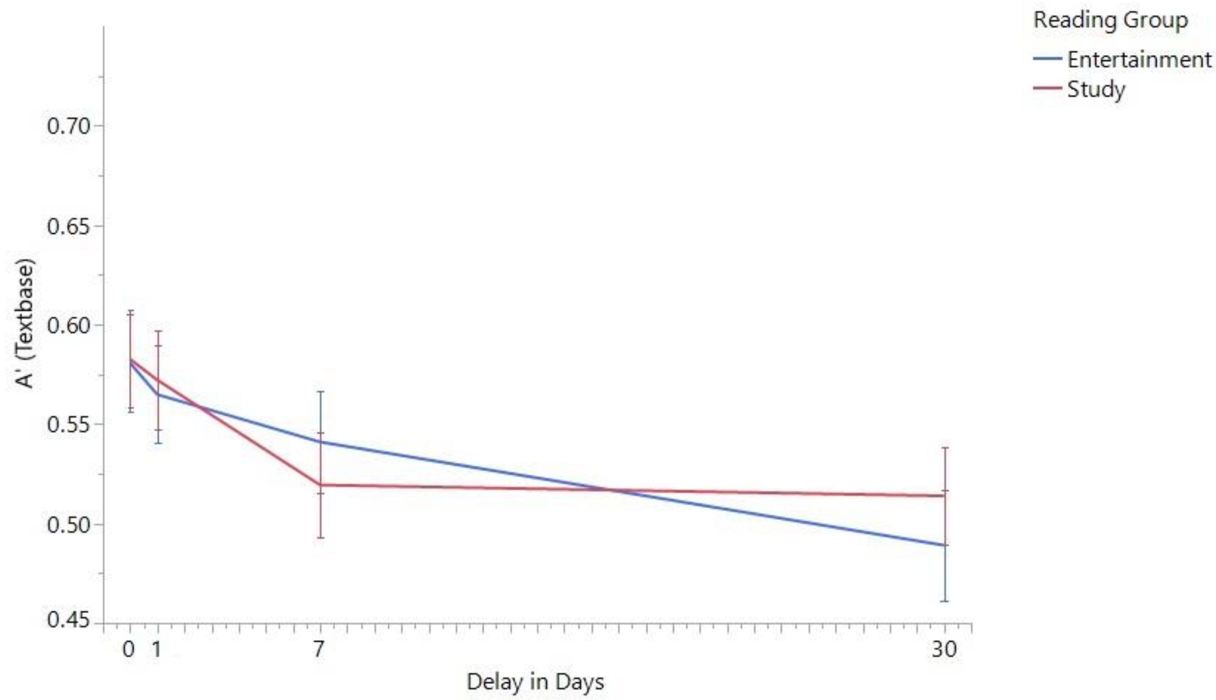

Figure 6. Textbase A' by reading group, across delay. Error bars indicate 95% confidence interval.

At the surface form level, a main effect of delay was also present (t = -2.75, p = .01), such that recognition performance decreased across delays, regardless of reading group. However, the interaction between reading group and delay was significant at the week delay (t = -2.33, p = .02), such that the entertainment group had worse surface form recognition performance at the week delay compared to the study group (Figure 7). No other effects were present (all p > .05).

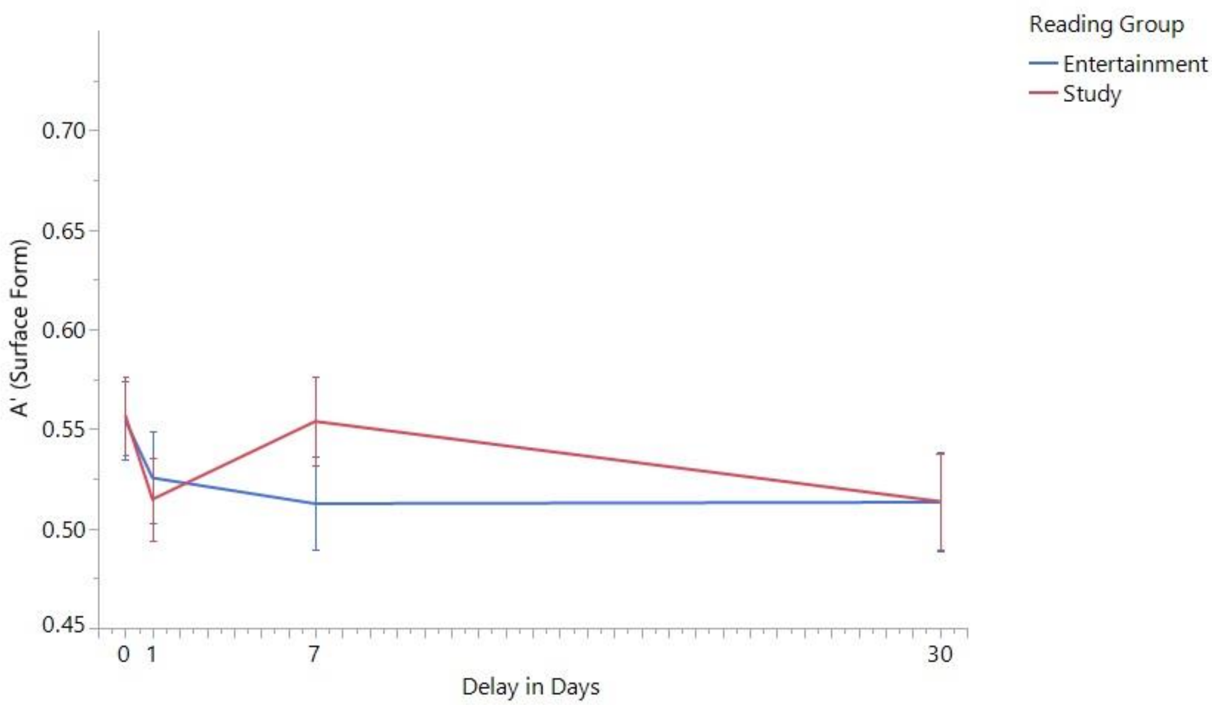

Figure 7. Surface form A' by reading group, across delay. Error bars indicate 95% confidence interval.

Unfortunately, reading group differences in recognition performance were generally not present. However, recognition performance declined over time, replicating patterns of forgetting found in prior work (e.g., Fisher & Radvansky, 2018). Specifically, event model memory was better than textbase memory and surface form memory, across all delays, and textbase memory was better than surface form memory until the week delay. Interestingly, although only marginally significant, at the week delay those in the entertainment group had higher textbase recognition performance whereas those in the study group had better surface form recognition performance. The bump in surface form memory at the week delay does not replicate prior work and should be interpreted with caution.

Segmentation and memory over time. Prior work has shown that segmentation predicts memory up to 1 month (Flores et al., 2017); however, studies investigating this relationship more generally have only evaluated it with overall memory accuracy (e.g., Bailey et al., 2013; Sargent et al., 2013). One of the goals of the current study was to investigate the relationship between segmentation and memory at different levels of representation. Based on prior work, it was hypothesized that those who segment better would have better memory (e.g., Bailey et al., 2013; Sargent et al., 2013), regardless of reading group.

Regarding different levels of representation, it was hypothesized that segmentation would predict memory for event level information, across delay, compared to surface form and textbase information. Although, Newberry and Bailey (2019) measured memory for text information using idea units, which is the textbase level of representation, and found some support that segmentation was related to memory for idea units. Thus, it was also possible that segmentation may be related to memory for textbase information. Unfortunately, we were unable to make comparisons between the levels of memory representation because each level was derived from a different combination of hits and false alarms. Thus, a generalized linear multilevel model was used to predict recognition performance separately at each level of representation from the fixed effects of segmentation agreement, delay, their interaction, and the random effects of participant and story.

At the event model level, a main effect of segmentation agreement was present ($t = 12.76$, $p < .001$, $r = .41$), such that recognition performance increased as segmentation agreement increased. A main effect of delay was also present ($t = -3.55$, $p < .001$), such that recognition performance decreased across delay. Further, the interaction between segmentation agreement and delay was significant ($t = -2.53$, $p = .01$), such that over time, the strength of the relationship between segmentation agreement and event model recognition performance decreased (Immediate: $r = .45$; Day: $r = .46$; Week: $r = .39$; Month: $r = .30$) (Figure 8).

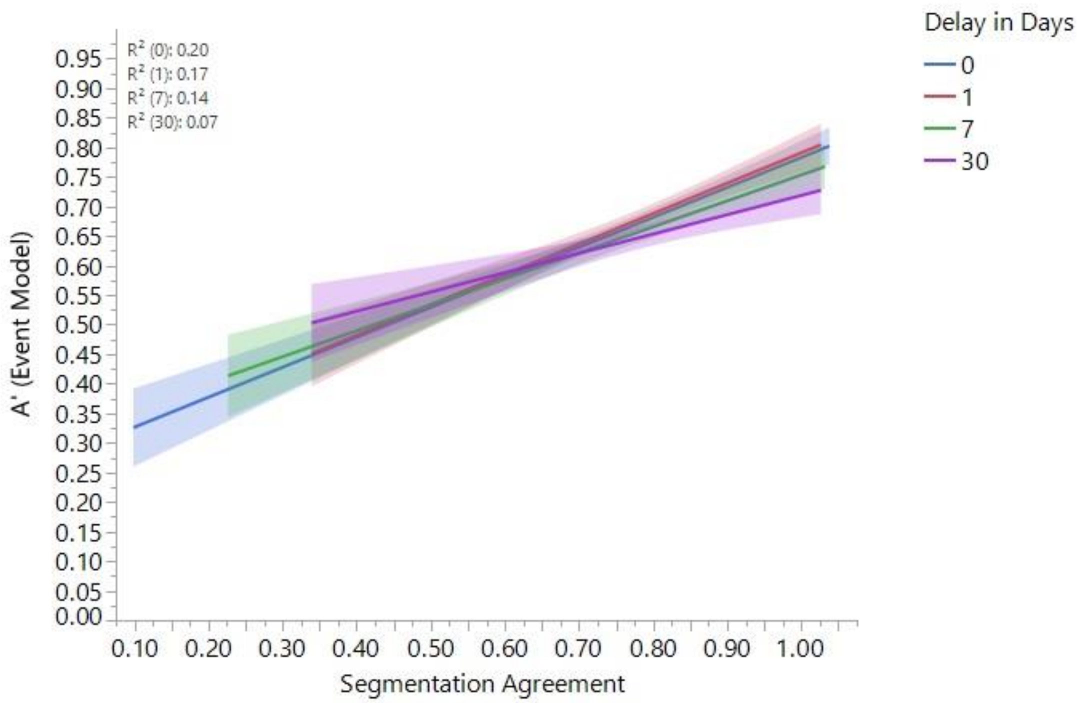

Figure 8. Relationship between segmentation agreement and event model A' across delay. Shaded area indicates confidence of line fit.

At the textbase level, a main effect of segmentation agreement was present (t = 8.43, p < .001, r = .26), such that recognition performance increased as segmentation agreement increased. A main effect of delay was also present (t = -6.67, p < .001), such that recognition performance decreased across delay. The two-way interaction between segmentation agreement and delay was also significant (t = -2.42, p = .02), suggesting that the relationship between segmentation agreement and textbase recognition performance weakened across delay (Immediate: r = .38; Day: r = .23; Week: r = .19; Month: r = .18) (Figure 9).

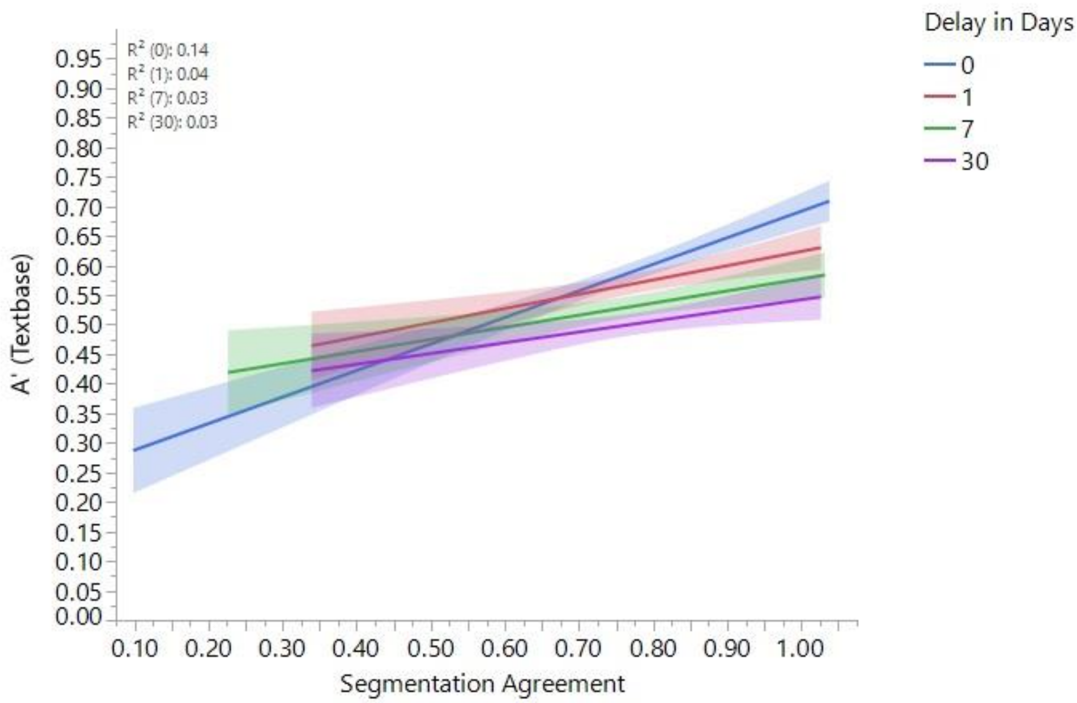

Figure 9. Relationship between segmentation agreement and textbase A' across delay. Shaded area indicates confidence of line fit.

At the surface form level, a main effect of segmentation agreement was present (t = 2.56, p = .01, r = .08), such that recognition performance increased as segmentation agreement increased. A main effect of delay was also present (t = -2.83, p = .01), such that recognition performance decreased across delay. The interaction was not significant (p > .05; Figure 10) (Immediate: r = .09; Day: r = .14; Week: r = .06; Month: r = .07).

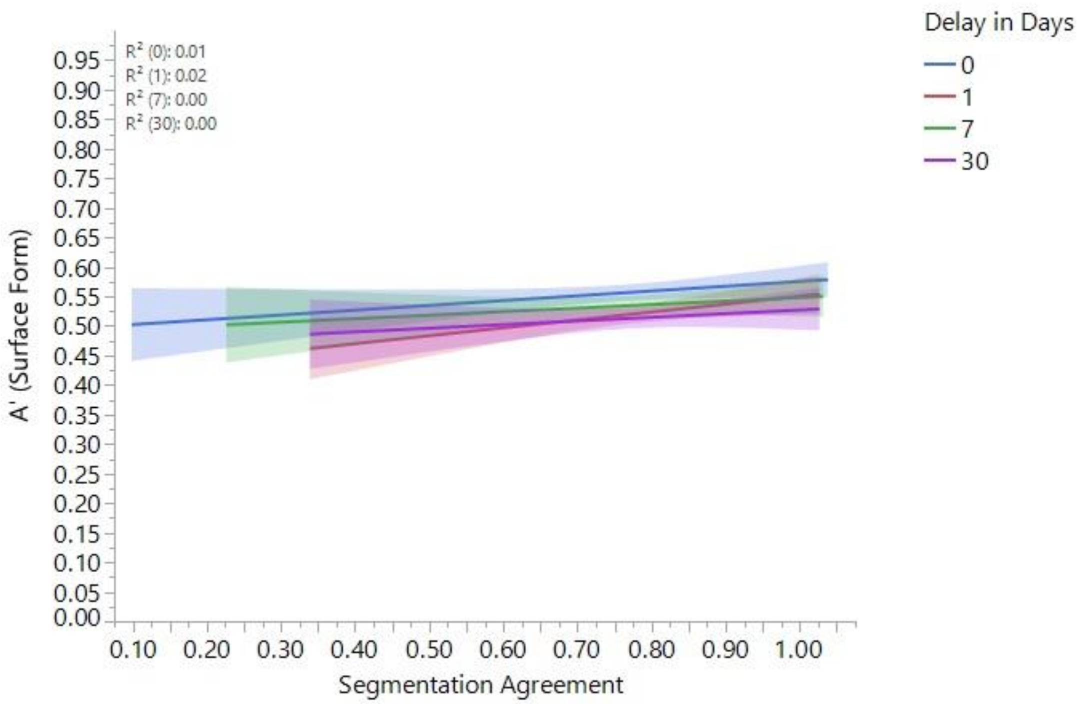

Figure 10. Relationship between segmentation agreement and surface form A' across delay. Shaded area indicates confidence of line fit.

Altogether, these results replicate and extend findings from prior work. Specifically, recognition performance improved with higher segmentation agreement, at all levels of memory representation. Although we could not make direct comparisons across the levels of representation, the segmentation-memory relationship was numerically stronger at the event model level followed by the textbase level and finally the surface form level. Additionally, the relationship between segmentation agreement and recognition performance did not increase in strength with longer delays. In fact, this relationship decreased over time at both the event model and textbase levels and did not change over time at the surface form level. Another interesting effect to note across all three analyses (in Figures 8, 9, and 10), is the increase in the minimum segmentation agreement value across delays. Further inspection of this pattern of results determined that this was due to a difference in the range of segmentation agreement values between participants who completed the entire experiment (came back for all 4 delays; *M* = .79, range .37 to 1.00) and participants who quit or withdrew (did not finish the experiment; *M* = .72, range .14 to 1.00).

Effects of reading group and segmentation on memory over time. One of the goals of the current study was to evaluate whether segmentation explains effects of reading instruction on memory over time. Unfortunately, reading group on its own did not affect memory, suggesting that a mediation model would not be informative. Fortunately, however, moderating effects of segmentation could still be examined by conducting three generalized linear multilevel models (one for each level of representation) to predict recognition performance from the full factorial of the fixed effects of reading group, segmentation agreement, and delay and the random effects of participant and story (Table 7).

At the event model level, as with the results from the previous section, there was a significant main effect of segmentation agreement ($t = 12.83$, $p < .001$, $r = .41$), main effect of delay ($t = -3.58$, $p = .001$), and segmentation agreement x delay interaction ($t = -2.71$, $p = .01$). However, these effects were qualified by a significant three-way interaction between reading group, segmentation agreement, and delay ($t = -2.27$, $p = .02$), such that the strength of the relationship between segmentation agreement and event model recognition performance decreased more over time for the entertainment group, compared to the study group (Figure 11).

Table 7 - Segmentation-Memory (A') Correlations

Table 7

Correlations (r) between Overall Segmentation Agreement and Recognition Performance

Level of Representation	Delay	Entertainment Reading Group	Study Reading Group
Event Model	Immediate	0.50	0.42
	Day	0.49	0.42
	Week	0.34	0.43
	Month	0.24	0.37
Textbase	Immediate	0.25	0.49
	Day	0.17	0.28
	Week	0.14	0.24
	Month	0.15	0.22
Surface Form	Immediate	0.08	0.09
	Day	0.16	0.12
	Week	0.05	0.06
	Month	0.02	0.11

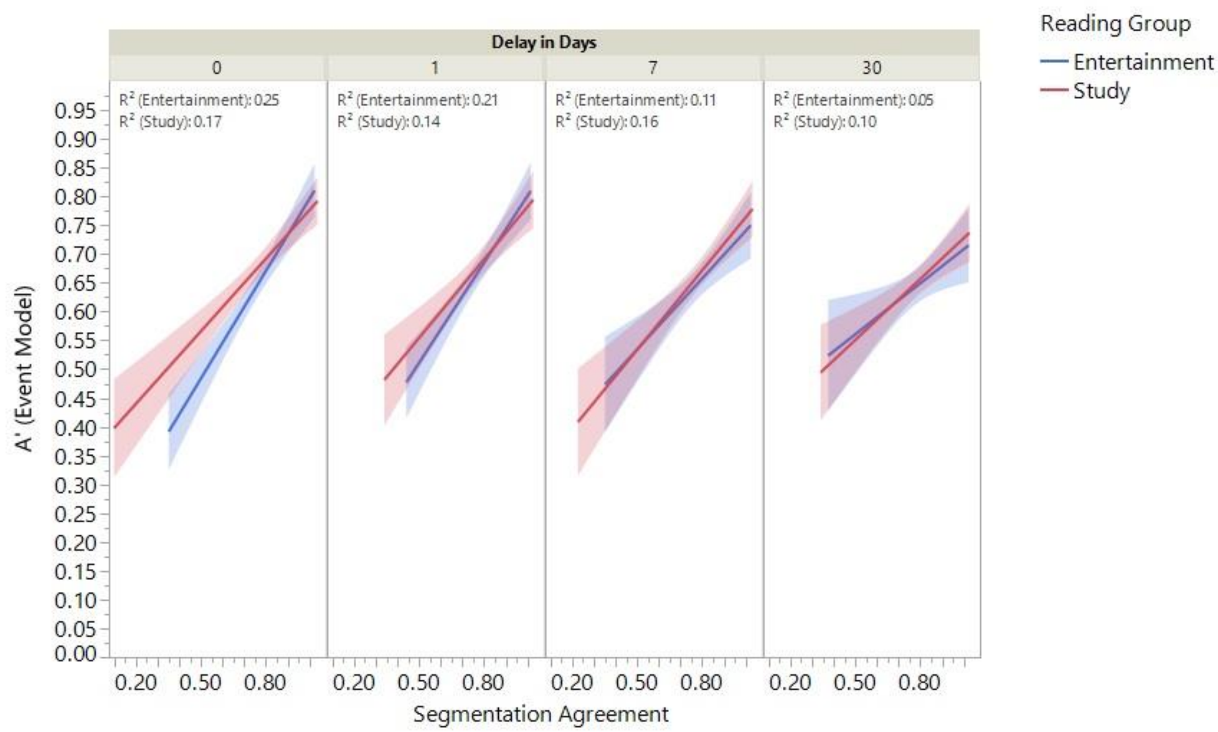

Figure 11. Relationship between segmentation agreement and event model A' by reading group and delay. Shaded area indicates confidence of line fit.

Again, at the textbase level, there was a main effect of segmentation agreement (t = 8.17, p < .001, r = .26), a main effect of delay (t = -6.65, p < .001), and a significant two-way interaction between segmentation agreement and delay (t = -2.28, p = .03). The two-way interaction between segmentation agreement and reading group was also significant (t = - 1.98, p = .05), such that the overall relationship between segmentation agreement and textbase recognition performance was weaker for the entertainment group (r = .17) compared to the study group (r = .33), but this did not interact with delay as in the event model level analysis. No other effects were significant (all p > .05) (Figure 12).

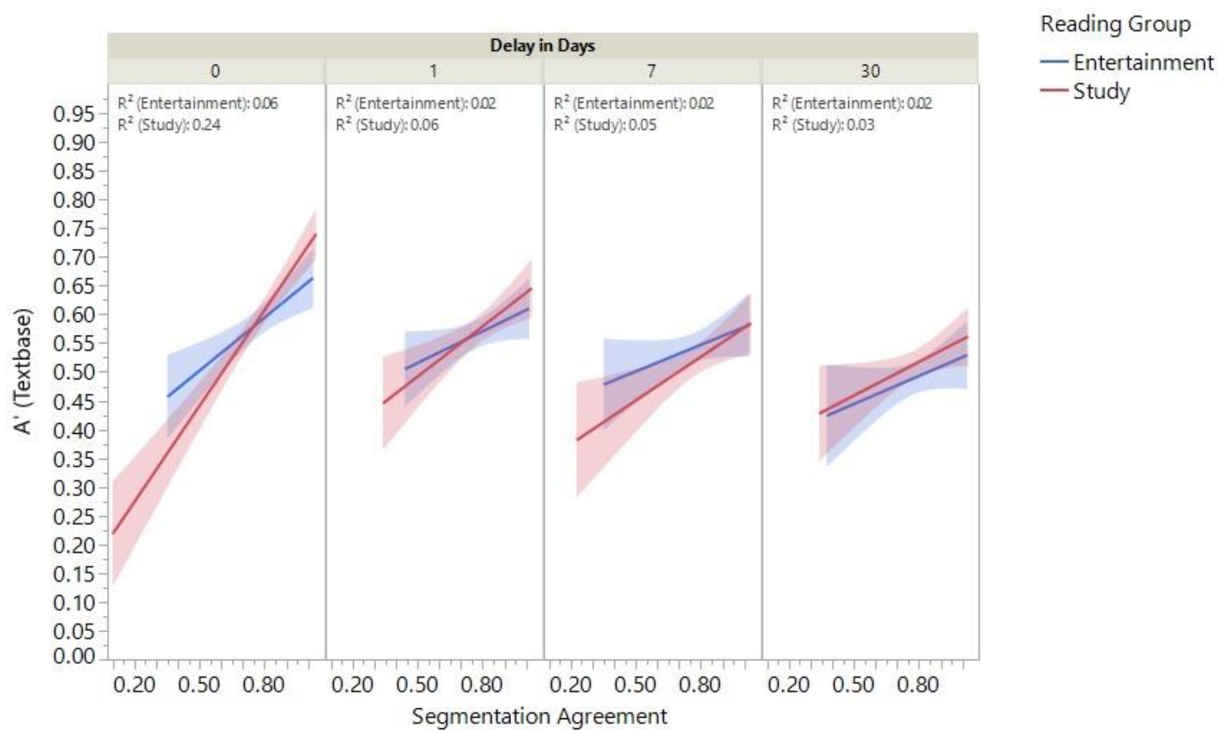

Figure 12. Relationship between segmentation agreement and textbase A' by reading group and delay. Shaded area indicates confidence of line fit.

Finally, at the surface form level, there was a main effect of segmentation agreement (t = 2.54, p = .01, r = .08) and a main effect of delay (t = -2.83, p = .01), but no other effects were significant (all p > .05) (Figure 13). Thus, these effects did not differ between reading groups nor across delays.

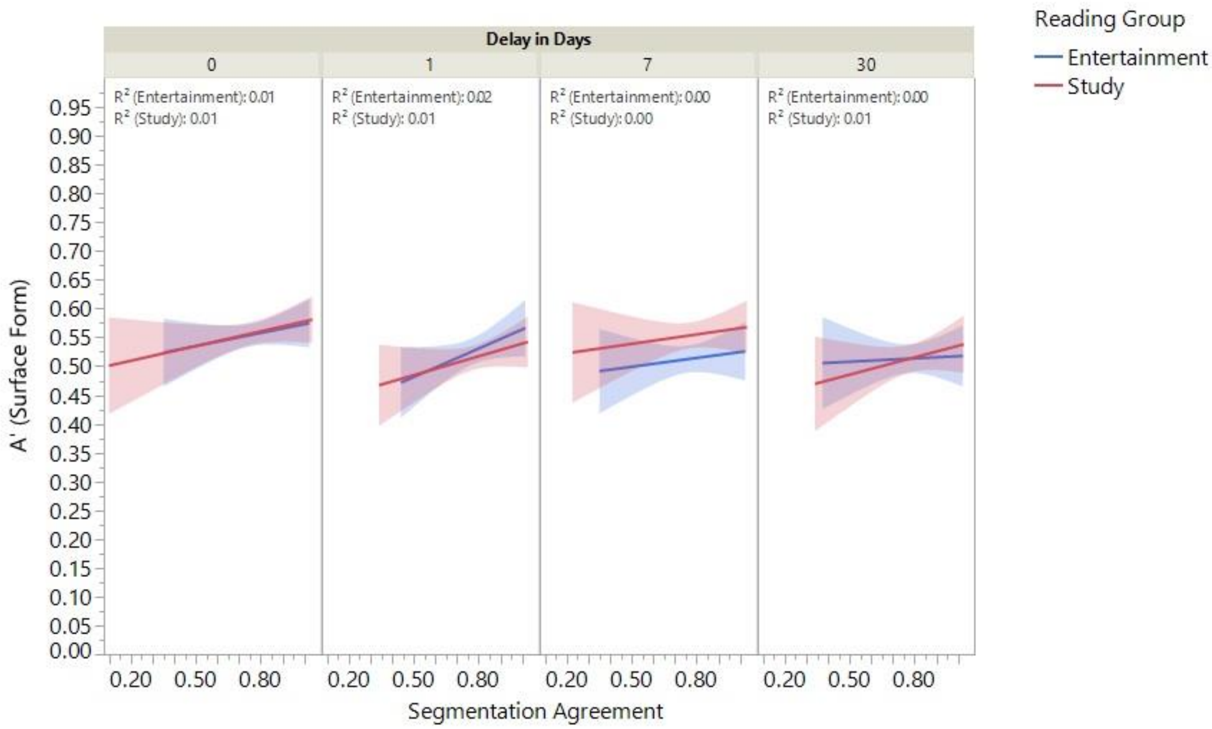

Figure 13. Relationship between segmentation agreement and surface form A' by reading group and delay. Shaded area indicates confidence of line fit.

Altogether, these results suggest that segmentation agreement moderates the relationship between reading group and memory; however, it depends on the level of representation in memory as well as the retention interval. Specifically, segmentation agreement moderated the relationship between reading group, delay, and memory at the event model level, such that the relationship weakened more for the entertainment group, compared to the study group, over time. Segmentation agreement also moderated the relationship between reading group and textbase memory, such that the relationship was weaker for the entertainment group, compared to the study group, but this did not change across delays. Unsurprisingly, segmentation agreement did not moderate the relationship between reading group and memory at the surface form level, as memory for surface form information was poor for everyone.

Exploratory Analyses

Situational changes, reading time, and event boundaries. In the main analyses, we found that reading group interacted with situational change to predict reading time, such that those who read for study slowed down at clauses that contained more situational changes. Given that prior work has shown that event boundaries tend to coincide with situational shifts and longer reading time (e.g., Curiel & Radvansky, 2014; Radvansky & Copeland, 2010; Radvansky & Zacks, 2014; Suh & Trabasso, 1993; Zacks, Speer, & Reynolds, 2009; Zwaan, 1996; Zwaan, Magliano, et al., 1995), we were interested in exploring the situational changes to which readers slowed down and whether there were group-related differences. To evaluate these effects, we used the coding scheme created by Radvansky, Zwaan, Curiel and Copeland (2001), who coded for each type of situational change (space, time, entity, cause, goal – Event Indexing Model; Zwaan & Radvansky, 1998) at the clause level for the same stories. We used these as predictors of the reading time and segmentation data (at the clause level) from the current study.

Linear regressions were conducted for each situational feature to examine whether reading group, situational feature, and their interaction predicted reading time (Bonferroni corrected *p*s < .01 for the 5 regressions). A main effect of each feature type was present (Space: $t = -3.89$, $p < .001$; Time: $t = -21.52$, $p < .001$; Entity: $t = -33.00$, $p < .001$; Cause: $t = -15.77$, $p < .001$; Goal: $t = -18.24$, $p < .001$), such that all readers slowed down at clauses containing each of those situational features. A main effect of reading group was also present (all $p < .001$), such that those in the study group read clauses containing any of those situational changes slower than those in the entertainment group. This does not replicate the main analyses which found no main effect of reading group. A possible explanation is that the main analyses included random effects of participant and story, whereas these did not (models would not converge). Interestingly, interactions between reading group and space (*t* = 2.22, *p* = .03) and reading group and goal (*t* = 2.22, *p* = .03) were marginally significant (based on the corrected *p* values), such that those in the read for study group spent even longer reading clauses containing space (*M* = 2.12) or goal (*M* = 2.16) changes, compared to those in the entertainment group (Space *M* = 1.97; Goal *M* = 2.02) (Table 8). This effect does not replicate prior work which found that reading for entertainment, not reading "for memory", was associated with longer reading times for time and causal changes (Zwaan, Magliano, & Graesser, 1995).

Table 8 - Reading Time and Situational Change

Table 8

Reading Time (seconds per clause) by Presence of Situational Change

Reading Group	Present	Space	Time	Entity	Cause	Goal
Entertainment	Yes	1.97 (.04)	2.03 (.03)	2.10 (.03)	1.90 (.02)	2.02 (.03)
	No	1.67 (.01)	1.61 (.01)	1.51 (.01)	1.61 (.01)	1.64 (.01)
Study	Yes	2.12 (.04)	2.13 (.03)	2.18 (.02)	1.98 (.02)	2.16 (.04)
	No	1.70 (.01)	1.65 (.01)	1.55 (.01)	1.66 (.01)	1.68 (.01)

Note: standard error in parentheses.

To explore whether self-identified event boundaries occurred at clauses containing situational changes and whether reading instruction influenced this effect, generalized logistic multilevel models (Bonferroni *p*s < .01 for the 5 models) were used to predict whether or not a clause was identified as an event boundary from the fixed effects of reading group, situational feature, their interaction, and random effects of participant and story. A main effect of space was present (*z* = 6.72, *p* < .001), such that a clause was more likely to be identified as a boundary if it contained a change in space, and the main effect of goal was marginally significant (*z* = 1.77, *p* = .07). Main effects of entity (*z* = -6.79, *p* < .001) and cause (*z* = -5.45, *p* < .001) were also present, but in an unexpected direction: a clause was less likely to be identified as a boundary if it contained an entity or causal change. This result is not consistent with prior work (e.g., Bailey et al., 2017; Zacks et al., 2009). No other effects were present (all $p > .05$). It is important to note that changes in one situational feature did not occur in the absence of changes in the other features, so these effects should be interpreted with caution. Further, there were no group-related differences in how situational changes influenced the perception of event boundaries.

Age. Research in event cognition has shown that event segmentation differs between younger and older adults (e.g., Bailey et al., 2013; Sargent et al., 2013; Smith et al., 2020; Zacks et al., 2006). Specifically, older adults show worse segmentation agreement. One reason why age-related differences in segmentation are important is because of their relationship with memory. When older adults segment effectively, they also have better memory for the event (e.g., Bailey et al., 2013). This is important because episodic memory declines with age (e.g., Johnson, Storandt, & Balota, 2003; Morrell, Park, & Poon, 1989; Schacter, Koutstaal, Johnson, Gross, & Angell, 1998; Spaniol, Madden, & Voss, 2006; West, Crook, & Barron, 1992). Given that event segmentation predicts memory, it is possible that deficits in segmentation may partially explain deficits in memory. If this is the case, how can we remove those deficits?

Some research suggests that semantic knowledge may alleviate deficits in segmentation and memory. Semantic knowledge (memory for facts and concepts) is one cognitive ability that remains stable, or sometimes improves, with age (e.g., Park, Lautenschlager, Hedden, Davidson, Smith, & Smith, 2002). There is evidence to suggest that older adults are more likely to remember information when it is consistent with their previous knowledge for that information (Castel, 2005; Umanath & Marsh, 2014). Since older adults' event comprehension processes are impaired, it is possible that they may rely on knowledge or experience to comprehend and remember everyday activities—particularly at the event model level (Radvansky, 1999;

Radvansky & Dijkstra, 2007). Recent work suggests that semantic knowledge may diminish these age-related deficits (Smith et al., 2020).

Understanding whether semantic knowledge improves segmentation and memory in older adults is particularly important for application in educational settings, given recent upticks in the number of adults returning to school (a.k.a. adult learners), particularly through online distance education (e.g., Kara, Erdogdu, Kokoc, & Cagiltay, 2019; Moore & Kearsley, 1996). Though highly motivated and task-oriented compared to their traditional college student counterparts (e.g., Caffarella & Merriam, 2000), the natural cognitive decline discussed above puts adult learners at a disadvantage that could influence their learning and memory (e.g., Clark, 1999; Caffarella & Merriam, 2000). Perhaps offering different types of instruction prior to learning can help guide segmentation and memory over time.

Though age was not a main factor of interest in the current study, the sample in the current study included participants whose ages ranged across the lifespan (18 – 70 years; Entertainment: M = 35.57, range 18 – 70; Study: M = 34.5, range 18 – 68; Figure 14).Thus, age was included in exploratory analyses to evaluate how reading instruction, segmentation, and age influence memory over time.

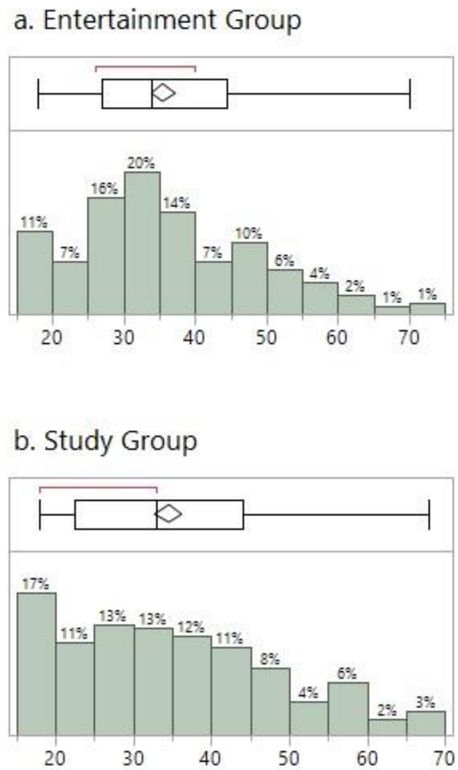

Figure 14. Histograms of age (years) by study group.

In this section, only analyses with effects of age are discussed. Analyses that specifically focus on the effects of segmentation agreement and delay are located in the original models (see *Main Analyses* above). First, a linear regression was used to predict segmentation agreement from the fixed effects of reading group, age, and their interaction. A significant interaction between reading group and age was present (t = 4.14, p < .001), such that segmentation agreement increased with age for those in the entertainment group (r = .07) but not for those in the study group (r = -.05). This small but significant effect suggests that reading instructions affected the relationship between age and segmentation agreement (Figure 15).

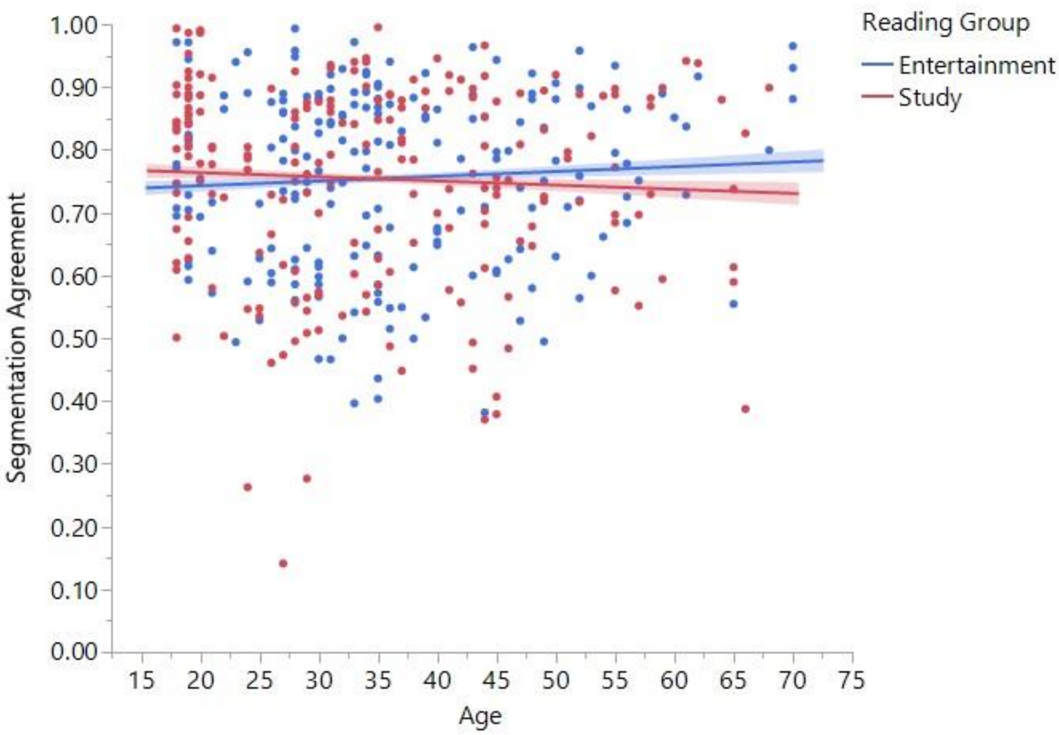

Figure 15. Relationship between age and segmentation agreement by reading group. Shaded area indicates confidence of line fit.

To evaluate effects on memory, three generalized linear multilevel models were used to predict recognition performance separately at each level of representation from the full factorial of the fixed effects of age, reading group, delay, and segmentation, and the random effects of participant and story. At the event model level, no effects of age were present (all $p > .05$). However, the two-way interaction between age and delay trended toward significance ($t = -1.63$, $p = .10$), such that the relationship between age and event model memory decreased across delay. Additionally, the three-way interaction between age, reading group, and segmentation agreement also trended toward significance ($t = -1.58$, $p = .11$), such that the relationship between segmentation agreement and event model memory decreased as age increased, but only for those in the entertainment group (Figure 16).

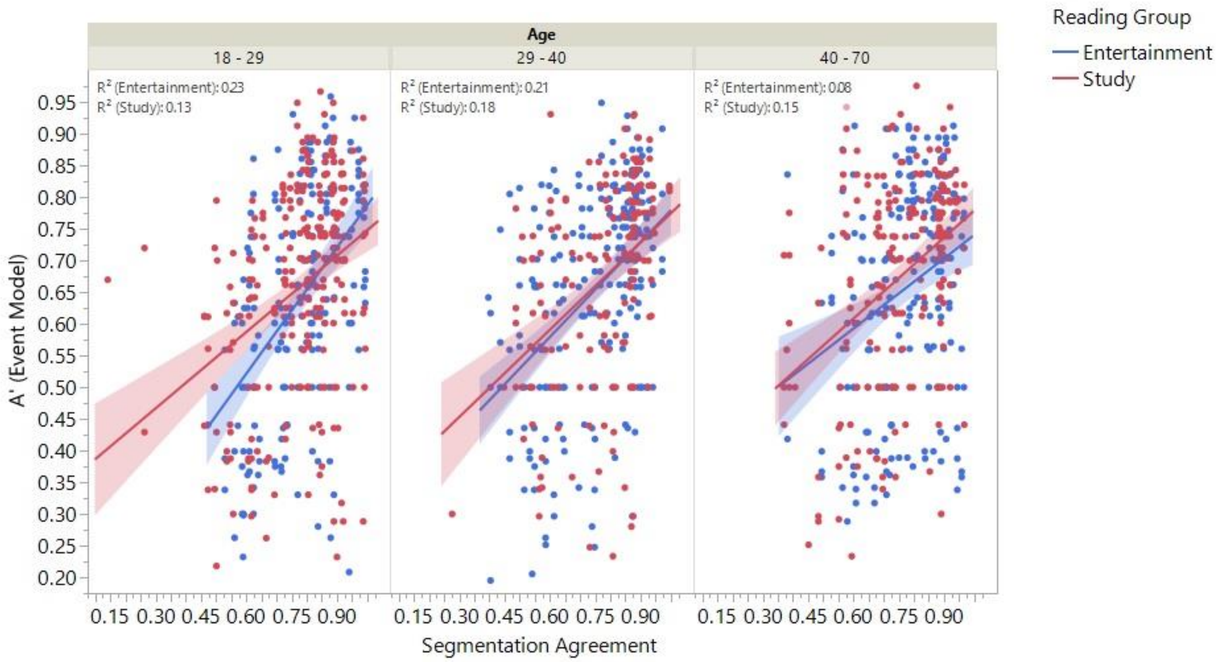

Figure 16. Relationship between segmentation agreement and event model A' by age and reading group. Shaded area indicates fit of the line.

Similarly, at the textbase level, no effects of age were present (all $p > .05$). However, the main effect of age was marginally significant ($t = 1.74$, $p = .08$), such that textbase memory slightly increased with age. This result is surprising and does not replicate prior work that has shown that older adults tend to have worse textbase memory (e.g., Radvansky, Zwaan, Curiel, Copeland, 2001).

Finally, at the surface form level, no effects of age were present (all $p > .05$). However, the two-way interaction between age and delay was marginally significant ($t = -1.71$, $p = .08$), such that the relationship between age and surface form memory decreased across delay. Additionally, the three-way interaction between age, reading group, and delay also trended toward significance ($t = -1.58$, $p = .11$), such that the relationship between age and surface form memory changed across delay, but only for the entertainment group (Immediate $r = -.03$; Day $r =$

.04; Week r = -.03; Month r = -.24; Figure 17). We are unsure how to interpret such age-related changes in surface form memory over time, particularly because performance dropped to chance quickly.

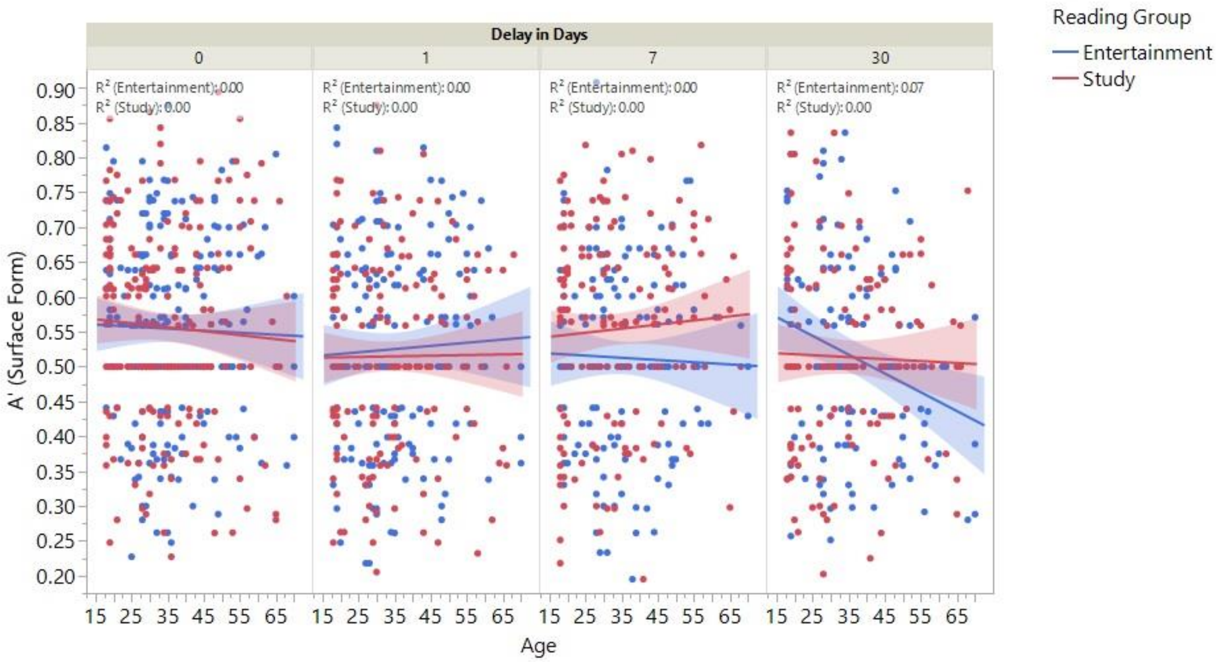

Figure 17. Relationship between age and surface form A' by reading group and delay. Shaded area indicates fit of the line.

Altogether, these results suggest that reading instructions may influence segmentation for older adults; however, none of the age-related effects on memory were statistically significant, though some effects trended toward significance. These effects may be of interest in future studies with better balanced, representative samples of participants across age groups. One possible explanation for the age-related effect on segmentation is that reading for entertainment aligns with older adults' ability to prioritize gist information (Adams, 1991; Adams, Smith, Nyquist & Perlmutter, 1997). This gist-based processing may be older adults' default method of encoding (Flores, Hargis, McGillvray, Friedman & Castel, 2017), which could encourage better monitoring of event level changes (e.g., Radvansky, Copeland, & Zwaan, 2003). This would suggest that a match between reading instruction and one's default encoding method (e.g., reading goals) could improve encoding, particularly for older individuals, which conceptually replicates the idea that semantic knowledge diminishes segmentation deficits (e.g., Smith et al., 2020).

Unfortunately, the effects of age on memory are less clear. Despite showing better segmentation agreement, the entertainment group's relationship between segmentation agreement and event model memory weakened with increasing age. This could suggest that a match between reading instruction and one's default encoding method is not sufficient to diminish age-related deficits in memory. However, it is not clear from the current study why reading for study would preserve the relationship across age.

Table 9 - Summary of Main Analyses

Table 9

Summary of Main Analyses

Measure	DV	IV(s)	Significant Effect (Y/N)
Reading Speed	Reading Time	Syllable	Yes
		Reading Group	No
		Situational Change	Yes
		Reading Group x Situational Change	Yes
Segmentation	Frequency	Reading Group	No
	Overall Agreement	Reading Group	No
	Own vs. Other Agreement	Reading Group	No
		Comparison Group	No
		Reading Group x Comparison Group	No
Recognition Memory	Response Time	Reading Group	No
		Delay	Yes
		Trial Type	No
		Reading Group x Delay	No
		Reading Group x Trial Type	No
		Delay x Trial Type	No
		Reading Group x Delay x Trial Type	No
	Levels of Rep. vs. A' = .05	E: Event Model x all Delays	Yes
		S: Event Model x all Delays	Yes
		E: Textbase x all Delays	Yes (No at 30 days)
		S: Textbase x all Delays	Yes (No at 7 & 30 days)
		E: Surface Form x all Delays	Yes (No at 1, 7, & 30 days)
		S: Surface Form x all Delays	Yes (No at 1 & 30 days)
	Event Model A' (and d')	Reading Group	No
		Delay	Yes
		Segmentation Agreement	Yes
		Reading Group x Delay	No

	Reading Group x Seg Agree	No
	Delay x Segmentation Agreement	Yes
	Reading Group x Delay x Seg Agree	Yes
Textbase A' (and d')	Reading Group	No
	Delay	Yes
	Segmentation Agreement	Yes
	Reading Group x Delay	No
	Reading Group x Seg Agree	Yes
	Delay x Segmentation Agreement	Yes
	Reading Group x Delay x Seg Agree	No
Surface Form A' (and d')	Reading Group	No
	Delay	Yes
	Segmentation Agreement	Yes
	Reading Group x Delay	No
	Reading Group x Seg Agree	No
	Delay x Segmentation Agreement	No
	Reading Group x Delay x Seg Agree	No

Note: E = Entertainment group; S = Study group; Trending = *p* values ~ .10; Marginal = *p* values ~ .08

Table 10 - Summary of Exploratory Analyses

Table 10

Summary of Exploratory Analyses

Measure	DV	IV(s)	Significant Effect (Y/N)
Situational Features & Reading Speed	Reading Time	Reading Group	Yes
		Situational Feature	Yes (all features)
		Reading Group x Situational Feature	Yes (space & goal)
Situational Features & Segmentation	Event Boundaries	Reading Group	No
		Situational Feature	Yes (space & goal)
		Reading Group x Situational Feature	No
Age & Segmentation	Overall Agreement	Age	No
		Reading Group	No
		Age x Reading Group	Yes
Age & Recognition Memory	Event Model A'	Age	No
		Age x Reading Group	No
		Age x Delay	Trending
		Age x Segmentation Agreement	No
		Age x Reading Group x Delay	No
		Age x Reading Group x Seg Agree	Trending
		Age x Delay x Segmentation Agreement	No
		Age x Reading Group x Delay x Seg Agree	No
	Textbase A'	Age	Marginal
		Age x Reading Group	No
		Age x Delay	No
		Age x Segmentation Agreement	No
		Age x Reading Group x Delay	No
		Age x Reading Group x Seg Agree	No

		Age x Delay x Segmentation Agreement	No
		Age x Reading Group x Delay x Seg Agree	No
	Surface Form A'	Age	No
		Age x Reading Group	No
		Age x Delay	Marginal
		Age x Segmentation Agreement	No
		Age x Reading Group x Delay	Trending
		Age x Reading Group x Seg Agree	No
		Age x Delay x Segmentation Agreement	No
		Age x Reading Group x Delay x Seg Agree	No

Note: E = Entertainment group; S = Study group; Trending = *p* values ~ .10; Marginal = *p* values ~ .08

Chapter 5 - Discussion

The current study aimed to integrate, replicate, and extend research from event cognition, reading comprehension, and memory retention by evaluating effects of reading instructions and segmentation ability on memory for different levels of representation over time. In this longitudinal study, participants either read-for-study or read-for-entertainment and segmented a series of stories, then had their memory assessed for the stories across delays ranging from 5 minutes to one month. Despite no direct influences of reading instruction on memory, interesting moderations emerged, suggesting that effects of reading instruction need to be considered in conjunction with other variables that are important for comprehension, such as segmentation and delay. Explanations for these findings are outlined below.

Encoding

How do reading instructions influence reading and event perception? Prior work has shown that reading instructions influence overall reading time (e.g., Schmalhofer & Glavanov, 1986) and readers are sensitive to situational changes (time and causal shifts) when reading for pleasure (e.g., Zwaan, Magliano & Graesser, 1995). The current study did not replicate these findings. Rather, we found that overall, both reading groups read at a similar pace, similar to McCrudden et al., (2006). Further, although both groups were sensitive to situational changes, replicating prior work including Zwaan and Radvansky (1998), participants who read for study were more likely to slow down at clauses containing *many* situational changes—and spatial and goal changes in particular, compared to those who read for entertainment. These effects were unexpected given that people reading for entertainment should, in theory, be tracking event model information (i.e., situational changes) more closely than those reading for study. It is possible that the reading instruction manipulation did not work (e.g., Radvansky et al., 2001);

however, we believe this is unlikely given how the instructions interact with segmentation ability in predicting memory retention. Another possible explanation comes from evidence suggesting that readers do not always slow down at sentences later identified as boundaries. For example, McNerney, Goodwin, and Radvansky (2011) found that sometimes, readers read faster at event boundaries. In these cases, event shifts were strongly predicted by preceding information (e.g., foreshadowing that a character would change location and then the character changes location), suggesting that the boundaries may have been predictable.

Recent research on event cognition has focused on evaluating conceptual effects on the perception of event boundaries using the EST framework. EST posits that semantic knowledge should play a role (along with perceptual cues) in making predictions about future activity and thus influence identification of meaningful event boundaries (Zacks et al., 2007). However, results have been mixed. Some studies suggest that conceptual factors do not influence segmentation (e.g., Hard et al., 2006; Huff et al., 2017; Zacks, Kumar, Abrams, & Metha, 2009), whereas other work suggests that they do (context: Loschky, Larson, Magliano, & Smith, 2015; Newberry & Bailey, 2019; familiarity: McGatlin et al., 2018; Smith, Newberry & Bailey, 2020; Zacks & Tversky, 2003; perspective: Newberry & Bailey, 2019; goals: Baldwin, Baird, Saylor & Clark; 2001; Wilder, 1978a; 1978b; Zacks, 2004).

In particular, recent studies have found that manipulations of reading purpose influence segmentation (e.g., Bailey et al., 2017; Newberry & Bailey, 2019), based on McCrudden and Schraw's goal focusing model (2007), which suggests that reading instructions may influence the information that readers attend to, encode, and remember. Bailey et al., (2017) found that when people were instructed to attend to spatial changes, they were more likely to identify event boundaries that contained spatial changes. Similarly, Newberry and Bailey (2019) found that when instructed to read from different perspectives (e.g., burglar vs. homebuyer), people agreed more on the locations of identified event boundaries with members from their own perspective, compared to the other perspective (Newberry & Bailey, 2019). Based on these studies, we expected reading instructions would influence how people segment text. However, in the current study, segmentation ability did not differ by reading group. Specifically, reading instructions did not have a significant impact on how many events readers perceived in the text (*segmentation frequency*) nor which event boundaries they perceived (*segmentation agreement*).

One explanation for these results is that both groups used similar criteria for identifying meaningful events, perhaps due to both groups monitoring the event model. Some work suggests that people monitor event model information regardless of reading instruction (e.g., Radvansky, Zwaan, Curiel, & Copeland, 2001). Other work suggests that specific types of situational factors are tracked regardless of reading instruction (e.g., entity/character - Albrecht & O'Brien, 1993; Bailey et al., 2017; Glenberg et al., 1987; Rapp, Gerrig, & Prentice, 2001; Therriault, Rinck & Zwaan, 2006; Zwaan, Langston, & Graesser, 1995). Memory results from the current study suggest memory for event model information was highly accurate (significantly better than chance across all delays) regardless of reading instruction, which suggests that both groups monitored event model information at encoding. Further, the exploratory analyses partially support this idea, such that when situational changes were used to identify boundaries, the same types of situational changes were used by both groups.

Another possible explanation is that the segmentation measures used in the current study were not sensitive enough to capture the effects of reading instruction, given that conceptual effects on segmentation tend to be small to moderate in size (e.g., Newberry & Bailey, 2019). Other behavioral measures of segmentation ability exist, such as measuring coarse (large) and fine (small) segmentation frequency, coarse and fine agreement, and hierarchical alignment of fine events within coarse events (e.g., Kurby & Zacks, 2011; Sargent et al., 2013). In fact, a study investigating a strong conceptual manipulation (expertise) note that their effects may not have been observed had they not measured segmentation at both the coarse and fine grains (Newberry, Feller, & Bailey, under review). Had this type of measure been used in the current study, differences at the fine-grain level may have emerged if participants in the study group were more likely to encode textbase information. Unfortunately, the current study was conducted online, which meant time was a commodity, so only one level (presumably coarse) of segmentation was obtained. Additionally, neurophysiological measures of segmentation (e.g., ERPs) may provide a more precise and covert measure of event encoding (Pitts, Bailey, Wisniewski & Zakrzewski, under review). Future studies should consider using a variety of segmentation or other event encoding measures (e.g., hierarchical alignment, think alouds, inference generation) to help the field evaluate which measures are sensitive to which types of conceptual manipulations.

Retrieval

Memory for levels of representation over time. Recent research on forgetting curves suggests that different types of information in memory decline at different rates (e.g., Fisher & Radvansky, 2018; 2019). Specifically, surface form information (the verbatim text) tends to be forgotten quickly and textbase information (idea units or text propositions) tends to be forgotten after one week, whereas event model information (inferences combined with knowledge) tends to show little forgetting over time.

The current study replicated these findings. We found that surface form memory dropped to chance after the immediate delay, textbase memory dropped to chance after one week, and event model memory was relatively maintained across delays, though it was also subject to some slight forgetting at longer delays. Overall, this pattern of results held for both reading groups, although some interesting effects occurred at the week delay: specifically, those in the entertainment group had higher textbase memory, compared to the study group, and those in the study group had better surface form memory. One explanation for the surface form effect could be that those in the read for study group were potentially more sensitive to auxiliary variables (e.g., argument overlap, clause position, word frequency; Radvansky, Zwaan, Curiel, & Copeland, 2001), which are comprised of surface form and textbase factors that direct attention to the text itself.

Another possibility brings us back to the idea that a match between external reading instructions and one's default method of encoding can provide a benefit for comprehension, especially when considering age of the reader. Research suggests that younger adults are more likely to pay attention to textbase information and remember the text itself, compared to older adults (e.g., Adams, 1991; Adams et al, 1997; Radvansky et al., 2001; Spilich, 1983). Despite having sampled across the lifespan, the average age of the participants in the current study was 35 years. It is possible that, like older adults who expect to "get the gist", younger individuals might expect to "focus on the details". If this default method of encoding were consistent with the read for study instructions, that might have inadvertently improved surface form retention for those in the study group. Although, such an explanation is less clear when considering the entertainment reading group because their textbase level memory was better at the one-week delay. An alternative explanation for the effects in the entertainment group comes from research by Gallini and Spires (1995), which suggests that activating macro-level processing (i.e., the event model) also activates micro-levels, such that those who are directed toward the event model may also track the textbase, presumably because the textbase is used as the foundation for constructing the event model. Ultimately, however, the interactions at the one-week delay in the current study were marginally significant, and thus should be interpreted with caution.

Segmentation and memory for levels of representation over time. Segmentation predicts memory (e.g., Bailey et al., 2013; Flores et al., 2017; Sargent et al., 2013; Zacks et al., 2006), but a major criticism of those studies is that these effects have focused on memory accuracy at short delays. The one exception is Flores et al (2017) who found that segmentation predicts memory up to one month. However, this work has only scratched the surface. Why does segmentation affect memory accuracy? What exactly do good segmenters retain over long delays that poor segmenters do not? Research from reading comprehension suggests that people construct mental representations at multiple levels (Fletcher & Chrysler, 1990; Kintsch, Welsch, Schmalhoefer, & Zimny, 1990; van Dijk & Kintsch, 1983). Thus, in the current study, we evaluated which levels of information segmentation benefited, and for how long. Given that segmentation is associated with the process of constructing and updating of mental models, we expected segmentation to benefit memory at the event model level. However, some work suggests that segmentation could benefit the textbase as well (e.g., Newberry & Bailey, 2019).

Results from the current study replicated and extended previous work, such that memory performance improved with higher segmentation agreement, at each delay, up to one month. Further, segmentation agreement predicted memory at all levels of memory representation. Although direct comparisons across the levels of representation could not be made, the segmentation-memory relationship was numerically stronger at the event model level (*r*s = .30-.46) followed by the textbase level (*r*s = .18-.38) and finally the surface form level (*r*s = .06-.14). The relationships at the event model and textbase level were predicted, but the segmentation-memory relationship at the surface form level was not, although these correlations were small and likely only significant given our large sample size.

Further, the segmentation-memory relationship decreased over delay for information at both the event model and textbase level, but not at the surface form level. These effects differ from those found in Flores et al., (2017), who found that segmentation predicted memory more strongly over time (a "testing" effect). However, in their study, memory for each video was tested at each delay. In other words, their participants experienced multiple spaced retrievals over time. The current study did not implement that design. Perhaps if it had, the decline in the segmentation-memory relationship over time may have been prevented or offset.

Importantly, though, these effects of segmentation on memory for the various levels of representation were moderated by reading group. Specifically, the segmentation-memory relationship declined over time for the entertainment group but not the study group. Although the groups' segmentation-memory relationship did not differ statistically, the entertainment group's correlations were initially stronger than the study group's (see Table 7 & Figure 11). The decline in correlations over time may be theoretically significant, such that reading instructions change the way in which event model information is represented in memory over the short-term but not the long-term, or the decline may be due to uninteresting statistical effects, such as regression toward the mean.

If such declines are theoretically significant, one explanation is that the entertainment group was able to extract information at the event model level, but their event model memory was not affected unless they encoded the information effectively. Over time, the benefit of monitoring gist information and effective segmentation on memory dwindled slightly, suggesting that at longer delays, these individuals relied less on their encoded event models, perhaps in favor of some other retrieval cue or strategy to guide event model memory.

This pattern is similar to results found in memory studies testing the Script-Pointer-Plus-Tag (SP + T) hypothesis (Davidson, 1994; Smith & Graesser, 1981; Abelson & Schank, 1977) and its newer variation, the Schema-Copy-Plus-Tag model (SC + T; Graesser & Nakamura, 1982). These explain how schemas influence comprehension for scripted stories (i.e., stories for which individuals have pre-existing knowledge structures involving a series of typical, sequential steps). According to the SP+T and SC+T models, the memory trace includes both information from the generic schema and tags that are constructed for atypical schema information, as well as marginally typical actions (Graesser & Nakamura, 1982). Results from studies investigating these models have found that recognition and recall for atypical items is better at immediate delays, compared to recognition and recall for typical items. Interestingly though, there is an interaction, such that typical items are better recalled at longer delays, while recognition and recall for atypical items remains stable across delays (Davidson, 1994; Smith & Graesser, 1981).

For example, in a study by Hasher and Griffin (1978), the influence of schemas on reconstruction and reproduction of prose passages was assessed. Participants read one of two prose passages and then recalled the passage after either a 5-min, 2-day, or 1-week delay. The passages were written in such a way that two different titles (schemas) could be used for either story. The critical manipulation occurred after the story was read, such that half of the participants were provided with the same title of the story at both encoding and retrieval, whereas the other half received a different (but also appropriate) title of the story (i.e., to invalidate the initial schema). The results of the study showed that participants whose initial schema was invalidated at retrieval were more likely to reproduce the original passage compared to those who retained their schema at retrieval. Participants whose schema was retained had more intrusions related to their schema (i.e., more reconstructive). Altogether, the results of this study, and others, support the idea that the schema becomes more important for memory over time, as memory becomes more reconstructive as opposed to reproductive (Hasher & Griffin, 1978; Smith & Graesser, 1981).

In regard to the current results, the extent to which event model memory became more "reconstructive" over time depended on reading instruction and effective segmentation. Conversely, however, segmentation predicted event model memory for the study group, regardless of delay. One possibility for the lack of a "shift" in retrieval strategy in the study group is that they had been using event models to guide retrieval to a lesser extent from the outset. Rather, the study group may have continuously relied on how they initially encoded the stories, perhaps due to their reading instructions (directing attention toward the textbase information), to guide retrieval. This could explain why, at the textbase level, the study group showed a stronger relationship between segmentation and textbase memory across all delays, compared to the entertainment group, whose segmentation, although positively related to textbase memory, was weaker, presumably because they paid more attention to gist level information. However, it is also possible that reading for study just improved comprehension and memory more generally, which supports some prior work showing that reading for study is associated with more coherence-building encoding and superior memory (van den Broek, Lorch, Linderholm, & Gustafson, 2001).

To better tease apart these types of effects, future studies should consider including a control group (to evaluate effects without explicit reading instructions) and more critically, pair segmentation ability with other informative measures of online comprehension, such as inference generation or think aloud measures. For example, the Constructionist Theory of narrative comprehension suggests that some types of inferences (e.g., causal consequence, subordinate goal-action, state) are not made during reading unless the reader has a specific goal to generate those inferences (e.g., Graesser, Singer, & Trabasso, 1994). Additionally, recent work investigating influences of reading instructions on inference generation appears to be mixed. Some evidence suggests that those who read for entertainment are more likely to produce elaborative inferences (Linderholm & van den Broek, 2002), whereas other evidence suggests that those who those who read for study produce more bridging and elaborative inferences (van den Broek, Lorch, Linderholm, & Gustafson, 2001). Such measures would help expand on our understanding of how reading instructions and segmentation interact to predict memory over time. Importantly, however, the current study is an important first step in examining these complex relationships and it suggests that effects of reading instructions on memory need to be considered in conjunction with other factors known to be important for memory, such as segmentation ability and delay.

What does this mean for theories of event cognition, reading comprehension, and retention?

The current study supports theories of event cognition, reading comprehension, and retention. The Event Horizon Model claims that segmentation should benefit memory (Radvansky, 2012; 2014) and the current study found that segmentation ability predicted all types of memory representations (though numerically stronger at the event model level). This suggests that segmentation boosts memory more broadly, supporting prior work that has shown benefits of segmentation on overall memory accuracy (e.g., Bailey et al., 2013; Flores et al., 2017). This provides more evidence for the idea that segmentation is an important individual cognitive ability that influences comprehension more generally (Radvansky & Zacks, 2014; 2017).

Additionally, the Event Indexing Model (Zwaan & Radvansky, 1998) claims that readers monitor situational changes while reading and the current study provides evidence that readers are sensitive to situational changes. Further, EST (Zacks et al., 2007) and the Goal Focusing Model (McCrudden & Schraw, 2007) claim that conceptual factors should influence online comprehension processes (such as segmentation) by directing attention toward different levels of information. The current study provides additional evidence that, under certain circumstances, reading instructions affect segmentation and its downstream effects on memory. Although there was not an overall reading group effect on segmentation, the reading instructions influenced how segmentation affected long-term memory. Thus, event cognition theories need to better explain how top-down processing can influence how people read or experience events and reading comprehension theories need to include segmentation as an individual cognitive ability that influences online encoding and memory of events read from text. Finally, the current study also provides evidence in growing support for linear patterns of forgetting for complex event information (Fisher & Radvansky, 2018; 2019). In the current study, event model memory showed minimal decline over the span of one month. In contrast to traditional views of forgetting, whereby forgetting has been thought to negatively accelerate (e.g., Ebbinghaus, 1885), retention of meaningfully complex information that has been encoded deeply (such as narrative information) appears to conform to a more linear function (Fisher & Radvansky, 2019).

Altogether, these findings may have implications that extend beyond cognitive theories to application in educational settings. According to the current study, effective encoding matters and individual differences in online text comprehension affect long-term memory differently depending on explicit reading instructions. This highlights the importance of tailoring reading instructions to the desired comprehension outcomes and also highlights the importance of improving or maintaining effective encoding strategies, which may require training (e.g., Gold et al., 2016). One caveat, outlined in the *Limitations* below, is that the reading instructions and texts used in the current study might not generalize as well to education. Typically, in educational settings, the goal is to deeply understand material so that it can be retained and applied or performed over long retention intervals, not "read for entertainment" in the hopes of being found interesting or discussed in casual conversation with friends at a later date. Theories of comprehension make different predictions about how online processing occurs across different types of text (e.g., referential cohesion may affect expository text comprehension vs. causal cohesion may affect narrative or historical text comprehension; McNamara & Magliano, 2009). Thus, future work should consider using reading instruction manipulations that better conform to instructions found in educational settings (e.g., study vs. application), with texts to match (e.g., scientific reports, expository texts, step-by-step instructions) (e.g., Narvaez et al., 1999; Schmalhofer & Glavanov, 1986).

Limitations become Future Directions

The current study was subject to a few limitations. The first limitation concerns the manipulation of the independent variable – reading instructions. The reading instruction manipulation showed some effects, but not others, which makes it difficult to determine whether the lack of effects was due to a spurious null or a true null. Specifically, some evidence from the exploratory analyses suggests that the reading instructions influenced reading time, and some evidence from the main analyses suggests that reading instructions moderate relationships between segmentation and memory; however, the predicted main effects of reading instructions were not found. To better investigate whether the null results in the current study were true, follow-up studies targeting the reading instruction manipulation should be conducted (e.g., adding more detail to the instructions to strengthen the manipulation).

Second, due to design constraints, individual differences measures known to be important for understanding reading comprehension, such as working memory or comprehension ability, were not measured. Previous work suggests that reading instructions may affect online text comprehension strategies differently in people with high versus low working memory ability (Linderholm & van den Broek, 2002). Research also suggests that segmentation ability is associated with working memory ability (e.g., Sargent et al., 2013), thus, accounting for working memory differences might provide more nuanced understanding of the reading instruction moderation effects on the segmentation-memory relationships that were found in the current study.

A third limitation concerns using the unitization task to obtain measures of event encoding. As mentioned previously, reading instructions alone did not directly affect segmentation agreement (which may be due to the reading instruction manipulation, see above); however, the measure of segmentation used in the current study also may not have been sensitive to this type of conceptual manipulation. Other measures of segmentation ability exist, such as hierarchical alignment, which provides potentially better estimates of the structure of the event representation in memory by taking into consideration both coarse and fine grain levels of boundary identification (e.g., Kurby & Zacks, 2011; Sargent et al., 2013). At least one prior study has noted the benefit of differentiating between coarse and fine segmentation when evaluating conceptual effects on segmentation (Newberry, Feller, & Bailey, under review); thus, future studies should consider using more than one type of event encoding measure.

A fourth limitation, echoing the third, concerns the use of alternative online comprehension measures (not segmentation) to tap into people's online mental model construction. Specifically, some work from reading comprehension suggests that the types of reading strategies used during reading, such as whether or not readers make bridging or elaborative inferences, provides meaningful information about what level of representation they may be tracking while reading (e.g., Linderholm & van den Broek, 2002; van den Broek et al., 2001). Additionally, other measures of implicit factors such as situation-based standards of coherence adopted by the reader (reader motivation - Guthrie et al., 2004; e.g., expecting to read in a relaxing environment but asked to read clause by clause (current study); reading goal expectations – Zwaan, 1994) have been found to impact comprehension. Altogether, such measures would be useful for understanding how reading instructions affect representation at encoding and how that encoding maps on to downstream retrieval, as a function of one's segmentation ability and delay.

Finally, a fifth limitation concerns the implications of the current results to education that were briefly mentioned above. While the news stories allowed us to evaluate how reading goals influenced sensitivity to situational changes during reading, perhaps these reading goals would be better suited to expository or educational texts more similar to those used in Schmalhofer and Glavanov (1986). For instance, asking students to read as if they were preparing for a behavioral statistics exam versus asking them to read in preparation to run those statistical analyses on a supercomputer would likely have a strong impact on reading, segmentation, and later memory. Such a study might also be useful for understanding relationships to different types of memory (e.g., recognition vs. recall vs. performance). For example, the Fluid Events Model attempts to integrate segmentation with interactive event perception (e.g., Radvansky, D'Mello, Abbott, &

Bixler, 2016), which might be better suited for understanding the relationship between segmentation and memory in applied settings, where people are actively engaged in the event they are processing, not just passively or just cognitively engaged (such as in remembering information from a story). This would help integrate theories of event cognition with educational theories promoting experiential or experience-based learning (learning through experience; e.g., Andresen, Boud, & Cohen, 2000).

Conclusion

Overall, the current study replicated and extended research from event cognition, reading comprehension, and retention by evaluating the relationships between explicit reading instructions, segmentation, and memory for different levels of information over time. Altogether, this study found that: 1) segmentation is an important individual cognitive ability that influences different levels of memory for text information; 2) reading instructions affect how well segmentation predicts memory at long delays; and 3) event model memory follows a linear pattern.

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Appendix A - Supplemental Analyses

Recognition Effects Replicated Using d’

The main analyses used A’ as the measure for memory performance in order to make comparisons to the forgetting curve analyses conducted by Fisher and Radvansky (2018). However, memory performance was also calculated using d’, as d’ was the measure used by Schmalhofer and Glavanov (1986). Thus, the subsequent analyses investigate the full factorial of the fixed effects of reading group, segmentation agreement, and delay, and random effects of participant and story, on recognition memory using d’. In short, the pattern of results from the main analyses replicated.

A generalized linear multilevel model was used to predict recognition performance at each level of representation from the full factorial of the fixed effects of reading group, segmentation agreement, and delay and the random effects of participant and story (Table 11). At the event model level, there was a significant main effect of segmentation agreement ($t = 12.55$, $p < .001$, $r = .40$), main effect of delay ($t = -4.86$, $p < .001$), and segmentation agreement x delay interaction ($t = -2.97$, $p = .003$). However, these effects were qualified by a significant three-way interaction between reading group, segmentation agreement, and delay ($t = -2.17$, $p = .03$), such that the strength of the relationship between segmentation agreement and event model recognition performance decreased more over time for the entertainment group, compared to the study group.

Table 11 - Segmentation-Memory (d') Correlations

Table 11

Correlations (r) between Overall Segmentation Agreement and Recognition Performance (d')

Level of Representation	Delay	Entertainment Reading Group	Study Reading Group
Event Model	Immediate	.48	.42
	Day	.49	.40
	Week	.33	.37
	Month	.25	.38
Textbase	Immediate	.27	.48
	Day	.18	.30
	Week	.15	.24
	Month	.14	.20
Surface Form	Immediate	.07	.09
	Day	.16	.13
	Week	.07	.05
	Month	.02	.13

At the textbase level, there was a main effect of segmentation agreement (t = 8.38, p < .001, r = .26), a main effect of delay (t = -6.76, p < .001), and a significant two-way interaction between segmentation agreement and delay (t = -2.81, p = .01). The two-way interaction between segmentation agreement and reading group was also marginally significant (t = - 1.79, p = .07), such that the overall relationship between segmentation agreement and textbase recognition performance was slightly weaker for the entertainment group (r = .19) compared to the study group (r = .33), but this did not interact with delay as in the event model level analysis. No other effects were significant (all p > .05). Finally, at the surface form level, there was a main effect of segmentation agreement (t = 2.57, p = .01, r = .08) and a main effect of delay (t = -2.74, p = .01), but no other effects were significant (all p > .05). These effects did not differ between reading groups nor across delays. Altogether, as stated above, the results replicated using d' as the measure of recognition, thus, the same conclusions can be drawn.

Appendix B - Experimental Materials

News Stories from Fisher & Radvansky (2019)

Beanie Baby Craze. *Beanie babies became very popular in Mary's town of Lakewood because they are cute little toys that come in a variety of animals. She purchased them as gifts at Christmas, to give to her children. While most collectors enjoy beanie babies, it is unlikely that they would be valued as highly today as they were in Lakewood last year. For some reason, beanie babies became very popular at this time. Beanie babies were first brought into Lakewood from Los Angeles. In 1996, Ellen Smith told Mary of seeing these toys. She had been quite taken with the cuteness of these stuffed animals. In a few weeks, some toys were shipped out. They were to be sold at toy shops in Lakewood. Months later, in July, a cargo of beanie babies arrived at Jarrod's Department Store. The toys then spread through Lakewood from there. At first, only the children collected and traded beanie babies. Eventually, most of Lakewood was involved in the matter. Some people did not collect and trade beanie babies. They were thought to be uncool. Almost everyone tried to outdo their neighbors by buying rare beanie babies that fetched high prices. A price of sixty thousand dollars was paid for one flamingo beanie baby in 1997. Sixty thousand dollars was also the price of Mary's house. In the neighboring town of Tyndall, a profitable bar was exchanged for one hippo beanie baby. Soon, everyone in Lakewood was working in the beanie baby trade. Ordinary business was being neglected by people throughout the city. People who had been away from Lakewood and then returned during the craze sometimes made mistakes. A local doctor mistook a beanie baby worth several thousand dollars for a chew toy. He gave it to his dog who tore it to shreds. People in Lakewood, like Mary, felt that the great demand for beanie babies would hold forever. Soon, Mary thought, wealthy people all over the Tri-State area would find beanie babies irresistible and would be willing to pay any* *price for them. However, after a while, people realized that the demand for beanie babies was limited mostly to Lakewood. Even in Lakewood, most people were buying beanie babies only to resell them. Even the children were not playing with the rarest toys but were only trying to sell them for profit. Just as in the game of musical chairs where someone must be left standing, so it seemed that someone would be left holding beanie babies that no one wanted anymore. This realization led to a panic. The price of beanie babies fell, and very many people, including Mary, were very much poorer. In 1998, high-quality beanie babies sold for less than five dollars each. Today, it seems that almost every home in Lakewood has some beanie babies. Some of the animals one often sees are frogs, alligators, and the popular parrot beanie baby. Mary thinks that the popularity of the parrot is due to its bright colors and warm feeling that it gives. To people tired of the day's events, a bright cheery beanie baby is a welcome sight.*

Determining Identity. *One of the great espionage problems is the search for a reliable way of determining a person's identity. This is particularly important for agents working abroad. These agents were often forced to make contacts using only sketchy information. Several disasters abroad were caused by poor identification. For example, four years ago, several undercover agents died when they thought that the people they were meeting were their contacts, when in fact they were agents working for the other side. Lead agent, Linda Gill, was shot first. She died within minutes, exposing the mission. Before the rest of the group could react to the obvious danger, two more agents, Max Eagle and James Romney, took a bullet and went down like stones. This prompted the CIA in Washington to create a Board of Identification. This was at the end of Nicolas Elder's term as Agency Head. The Board was empowered to award twenty-thousand dollars to the first person who developed a method of determining identity accurately ninety-nine percent of the time for a wide variety of people. There had been a number of attempts* *to solve this problem. One early idea was to have fingerprints taken at predetermined meeting sites. These sites would be strategically located across the world. A match could be made between a fingerprint and a stored file. The similarity between the two could be used to determine identity. Later, some engineers approached the identity challenge. They considered a retinal scan method. One year, Les Busby discovered that each retina had a different pattern that varied from person to person. Busby reasoned that this could be used as an identification method. This idea was based on the variations in peoples' retinas. These patterns would be distinctive no matter where a person was from. Busby even devised a special retinal scan helmet for people to wear. This method of determining identification captured the imagination of many the agency's administrators. Among those administrators were Cassell, Haynes, Hartley, and Nelson. A final idea was to use the DNA-based computer imaging system. A DNA imaging system is a device of great accuracy that can be used in most everyday situations. Early chemical- and spectral-based DNA identification methods were too cumbersome to be used abroad due to environmental changes. John Harrison was a self-taught computer game programmer. Early last year, Harrison invented and constructed four practical DNA identification systems. He completed his first system in April and submitted it to the Identification Board, but was turned down. The initial test of one of Harrison's systems was made in June. This was done abroad at a diplomatic conference. This first test of a DNA-based system was a grand success. He then built three more instruments, each smaller and more accurate than its predecessor. In August, Harrison's fourth system was tested on a trip to Egypt. It was found to be in error for only one person in a thousand. Although his systems all met the standards set up by the Board of Identification, he was not awarded any money until November, when he received five thousand dollars. A prominent member of the Board was Phil Marks. He* *was more impressed by the engineers. Marks thought that the programmer's device was less reliable than the work of the 'real' scientists. After several months, Harrison was taken under the wing of Senator Morris. Harrison ultimately claimed his reward money the following year. The newer DNA image identification systems are, broadly speaking, small, light-weight devices. A DNA sampling tube is hidden in a purse, briefcase, or clothing. As such, it remains available wherever the agent travels. The recent identification systems may be accurate to within one in ten thousand people.*

Farmer's Rebellion. *Last summer's farmer rebellion was an important episode in our town of Pitman. It stemmed from a set of long-standing grievances. Many farmers had been subjected to severe environmental laws. These laws had been implemented during the term of mayor Judy Copeland, and when her successor Mark Dunn was elected two years ago, some relief had been hoped for and, indeed, promised. When it did not happen, some members of the farming community wanted to fight back. Bob Collins, a well-to-do pig farmer, proposed to blow up the county court house. The goal of the plotters was to blow up the city council, the mayor, the sheriff and the judge in August. This would provide an opportunity for the farmers to take over the county. Collins enlisted his wealthy cousin Billy Hawkins in his scheme and sent him to Montana in April. There, Hawkins hired the services of an anti-government extremist, George Fields. Fields was to carry out the plot when the city council met at the end of the summer. On March 24th a fellow conspirator, Joey Crawford rented an apartment adjoining the court house. The plan was to dig a tunnel through the dividing wall. A second house, for storing explosives, was rented in Lambeth. In April, however, the conspirators were also able to rent a storage cellar that actually ran under the court house. Fields carried 200 pounds of explosives into the cellar and covered them with blankets until the council meeting, when the deed was to be done.*

The conspirators then separated until the next council meeting. The council meeting, meanwhile, had been postponed to August. In the interim, Collins included more conspirators because more support was needed. So, he brought in other conspirators, including another cousin, Frank Tess. Altogether, 13 farmers were directly involved in the plot. A difficulty was that the explosion might kill friendly pro-farmer members of the city council. Tess was particularly anxious. He wanted to warn his brother-in-law, Jim Thorn. On July 26th, Thorn showed a letter to the mayor's lawyer, Steve Flett, who in turn showed it to the mayor. They decided to search the court house and the adjoining buildings. The search was conducted on August 4th, first by Deputy Williams, who actually encountered Fields in the cellar, and saw the piles of blankets, and that night by Todd Billings, a Pitman county sheriff, who discovered the boxes of explosives and arrested Fields, who, under interrogation, confessed and revealed the names of the conspirators. The other conspirators fled from Pitman, but were rounded up in Fair Lake. Collins and Crawford were killed there in town. All of the others that were involved were tried and convicted in November. The plot bitterly intensified government suspicions of farmers. It led to the rigorous enforcement of the Smythe Law, which fined those who refused to adopt government policies. This summer, the city council established August 5th as a public holiday. The day, known as Fields' Day, is still celebrated with bonfires, fireworks, and the carrying of "pigs" through the streets. There are many mysteries about the farmers' rebellion that have never been satisfactorily explained. It is not clear why an intelligent pig farmer like Collins thought that such a scheme would work or why he imagined that if it did work, a small group of farmers could seize the reigns of government. Nor is it clear why the mayor and Steve Flett, his lawyer, immediately interpreted Thorn's letter to mean that an explosion was intended. Also it is odd that although the letter was received on July 26th, the search of the cellar was not carried out until

August 4th. Nevertheless, the detailed confessions that have been made public, including that of George Fields, make it difficult to believe as has been argued, that the whole story was invented by Steve Flett so that he could strengthen his position in the government of Pitman.

New York in the Future. *Recent events in New York's news have reflected both progress and decline. For example, the first technology center was established in 2064 in Brooklyn and handles data access and transfer. At present, seven out of ten people are involved in technological advances. The offices in New York are very overcrowded. The city government had previously sent their technology workers to New Jersey, but they were unable to do so now because that state was overburdened. The city government had other motives for building the centers, as well. The commercial considerations of tapping the potential of this growing business were very tempting. In New York, the fledgling industry struggled at first because the entrepreneurs had little capital and were close to bankruptcy. However, progress was made. Ex-hacker James Ruse showed that one could be a successful network processor in New York. James Stevens was a former police officer who introduced titanium-based technologies to New York. This set the pattern for New Yorkers to want to export their products seen well into the current time. Stevens was a man whose sole aim was economic advance. He sought to gain commercial control of New York. Stevens realized that the best chance for success was to deal in high endurance technologies that were in high demand. The titanium-based products were of an especially high durability and were also of exceptional quality. He also knew that sources of technology from Utah and Vermont were unreliable. Titanium could be stored in warehouses in New York. It was profitable enough, in spite of the high development costs. Stevens had other, less reputable, business ventures. Stevens and other former police officers bought up government stores of goods and managed to establish drugs as the city's primary currency. They almost* *succeeded in bullying the city council into granting them most of the city's land and low-wage labor to run it. No other group had their economic power. They ran the city unchecked by the state government which was more concerned with the debates in Washington and Chicago. This drug monopoly resulted in money being invested within the city, instead of elsewhere. The expansion that took place would not have been possible without the trade monopoly of the "Drug Corps." For twenty years the Drug Corps ruled the streets. However, in 2082, a rebellion occurred. William Black was the governor of the state at that time. He had previously been a senator in the national legislature that turned against him in 2078. As governor, Black had a number of powers to evoke change. He did not like the direction the city was taking with the trade of alcohol and drugs. Black felt that the future of the city lay in financial management. He favored the few citizens who had been previously empowered and were developing products in Buffalo that was about thirty-five miles from the new trade center. Black also passed a law that prohibited the use of drugs as payment. The Drug Rebellion that occurred was rooted in opposition to government policy. Although Governor Black had a number of supporters, they did not live in Albany, which is the seat of the government and so had no influence over the local police forces. Black alienated the Drug Corps by accusing the police of corruption and ineptitude. He wanted to stifle the drug traffic and had Stevens arrested for violation of port regulations on December 16th, 2082. At the trial, Stevens accused the judge of being a swindler and stated that the judge owed him money. Stevens told the court, which was made up of six of his police officers, that the public feared for their property, liberty, and lives. The trial broke up in confusion and Stevens was set free. The next morning he was arrested again. The six police officers asked that he be released but Black refused. Black charged them all with conspiracy, which was his last official act as governor. This provoked Major George Johnston and he* *declared himself lieutenant governor, set Stevens free, and demanded that Black be arrested. The Drug Corps invaded Black's house on January 26th, 2083, placed Black under arrest and took over the administration until his successor arrived. Black's successor was Dr. Larry MacQueed.*

Practice Text

Excerpt from *On Hallowed Ground*, by Dave Barry. *On a humid July day in Pennsylvania, hundreds of tourists, as millions have before them, are drifting among the simple gravestones and timeworn monuments of the national cemetery at Gettysburg. Several thousand soldiers are buried here. A few graves are decorated with flowers, suggesting some of the dead have relatives who still come here. There's a sign at the entrance, reminding people that this is a cemetery. It says: "*SILENCE AND RESPECT.*" Most of the tourists are being reasonably respectful, for tourists, although many, apparently without noticing, walk on the graves, stand on the bones of the soldiers. Hardly anybody is silent. Perky tour guides are telling well-practiced stories and jokes; parents are yelling at children; children are yelling at each other. A tour group of maybe two dozen teen-agers are paying zero attention to anything but each other, flirting, laughing, wrapped in the happy self-absorbed obliviousness of Teenager Land. A few yards away, gazing somberly toward the teen-agers, is a bust of Abraham Lincoln. Lincoln gave his Gettysburg Address here 139 years ago, when the gentle rolling landscape, now green and manicured, was still raw and battle-scarred, the earth recently soaked with the blood of the 8,000 who died, and the tens of thousands more who were wounded, when two armies, 160,000 men, fought a terrible battle on July 1, 2 and 3 that determined the outcome of the Civil War. Nobody planned for the battle to happen here. Neither army set out for Gettysburg. But this is where it happened. This is where, out of randomness, out of chance, a thousand variables conspired to bring the two mighty armies together. And so this quiet little town, because it* *happened to be here, became historic, significant, a symbol, its identity indelibly defined by this one overwhelming event. This is where these soldiers - soldiers from Minnesota, soldiers from Kentucky, soldiers who had never heard of Gettysburg before they came here to die - will lie forever. This is hallowed ground.*

Recognition Probes

The Beanie Baby Craze

Verbatim

1. In a few weeks, some toys were shipped out.
2. At first, only the children collected and traded beanie babies.
3. Ordinary business was being neglected by people throughout the city.
4. Just as in a game of musical chairs where someone must be left standing, so it seemed that someone would be left holding beanie babies that no one wanted anymore.
5. Beanie babies were first brought into Lakewood from Los Angeles.
6. Sixty thousand dollars was also the price of Mary's house.
7. Months later, in July, a cargo of beanie babies arrived at Jarrod's Department Store.
8. Some people did not collect and trade beanie babies.
9. Even the children were not playing with the rarest toys but were only trying to sell them for profit.
10. They were thought to be uncool.
11. Even in Lakewood, most people were buying beanie babies only to resell them.
12. She purchased them as gifts at Christmas to give to her children.
13. A local doctor mistook a beanie baby worth several thousand dollars for a chew toy.
14. She was quite taken with the cuteness of these stuffed animals.
15. People in Lakewood, like Mary, felt that the great demand for beanie babies would hold forever.
16. The price of beanie babies fell, and very many people, including Mary, were very much poorer.

Paraphrase

1. A local doctor accidentally thought that a beanie baby worth several thousand dollars was a chew toy.
2. She was very taken with the stuffed animals' cuteness.
3. People in Lakewood, like Mary, thought that the high demand for beanie babies would last forever.
4. The value of beanie babies fell, and a large number of people, including Mary, were quite a bit poorer.
5. Some toys were shipped out in a few weeks.
6. Ordinary business was being ignored by people all over the city.
7. Initially, only the children traded and collected beanie babies.

8. Just like with musical chairs, where someone is left standing, so it seemed that someone would be left possessing beanie babies that no one wanted anymore.
9. Beanie babies were first brought from Los Angeles to Lakewood.
10. The price of Mary's house was also sixty thousand dollars.
11. In July, months later, a shipment of beanie babies arrived at Jarrod's Department Store.
12. Some people did not trade and collect beanie babies.
13. Even the kids were not playing with the rarest toys but were only attempting to sell them for profit.
14. They were considered to be uncool.
15. Most people, even in Lakewood, were purchasing beanie babies only to resell them.
16. She bought them as presents at Christmas to give to her children.

Inference

1. Beanie babies were valued more highly as a trading commodity than as a child's toy.
2. Beanie baby collectors were thought to be cool.
3. People were only thinking about the value of the beanie babies they bought.
4. Beanie babies made perfect gifts for children.
5. Beanie babies often resemble other items, such as chew toys.
6. Some people found beanie babies very appealing.
7. To many collectors, beanie babies seemed to have an enduring appeal.
8. People, like Mary, had spent too much of their money buying beanie babies that no one wanted after a while.
9. People wanted beanie babies to be available in their town of Lakewood.
10. Many people spent excessive amounts of time trading beanie babies.
11. Beanie babies were first intended as toys for children.
12. It was inevitable that the beanie baby trade in Lakewood would collapse.
13. Beanie babies originated in Los Angeles.
14. The demand for beanie babies caused prices to escalate dramatically.
15. Beanie babies soon became big business.
16. There were some people who did not find beanie babies appealing.

Wrong

1. Many things were introduced into Lakewood from Los Angeles.
2. Some people began using beanie babies as currency.
3. Beanie babies were only available from specialty catalogs and other collectors.
4. Absolutely everyone saw the value of beanie babies.
5. Lakewood homes were often raided for the beanie babies kept there.
6. Beanie baby thieves were fined and jailed.
7. Many people bought beanie babies for their own personal use, to keep forever.
8. People were content with hoarding their beanie babies and never traded them.
9. People often stored the beanie babies in secure places.
10. Beanie babies are a very sturdy toy.
11. It was fairly clear to everyone involved, that beanie babies were a passing fad.
12. The collection of beanie babies had turned out to be a sound investment for most people, like Mary.

13. Beanie baby shipments were often carried by air cargo flights.
14. There were many food shortages at this time.
15. Only the adults seemed to like the beanie babies.
16. The trade and collection of items, like beanie babies, can provide a healthy boost to a local economy.

Determining Identity

Verbatim

1. These sites were to be strategically located across the world.
2. The first test of a DNA-based system was a grand success.
3. Several disasters were caused by poor identification.
4. A prominent member of the Board was Phil Marks.
5. Marks thought that a programmer's device was less accurate than the work of the 'real' scientists.
6. This idea was based on variations in peoples' retinas.
7. Busby even devised a special retinal scan helmet for people to wear.
8. In August, Harrison's fourth system was tested on a trip to Egypt.
9. Early last year, Harrison invented and constructed four practical DNA identification systems.
10. These agents were often forced to make contacts using only sketchy information.
11. Later, some engineers approached the identity challenge.
12. Harrison finished his first system in April and submitted it to the Identification Board, but was turned down.
13. A DNA imaging system is a device of great accuracy that can be used in most everyday situations.
14. The similarity between the two could be used to determine identity.
15. One early idea was to have fingerprints taken at predetermined meeting sites.
16. Harrison ultimately claimed his reward money the following year.

Paraphrase

1. A DNA imaging system is a high precision device that can be used in most everyday situations.
2. Identity could be determined by getting the similarity between the two.
3. One early notion was to have fingerprints taken at predetermined meeting locations.
4. The following year, Harrison finally claimed his reward money.
5. These locations were to be strategically situated across the world.
6. The initial test of a DNA-based system was a large success.
7. Poor identification caused many disasters.
8. Phil Marks was a notable member of the Board.
9. Marks thought that the work of the 'real' scientists was more accurate than a programmer's device.
10. The variation in people's retinas was the basis of the idea.
11. Busby even designed a special retinal scan helmet to be worn by a person.
12. Harrison's fourth system was assessed on a trip to Egypt in August.

13. Early last year, Harrison devised and created four usable DNA identification systems.
14. These agents were often required to meet people using sketchy information only.
15. Later, some engineers attempted to solve the identity problem.
16. Harrison completed his first system in April, but was turned down when he submitted it to the Identification Board.

Inference

1. Harrison was a highly skilled programmer and brilliant inventor.
2. Meeting place information was easier to determine than identification information.
3. Retinal patterns are another means of providing identification information.
4. The Board did not think that Harrison's first device fulfilled the requirements for the award.
5. A DNA imaging system maintains great accuracy even though conditions were more variable than those in the laboratory.
6. The record of a fingerprint on file would be used as a reference.
7. Meetings provided the opportunity to obtain comparison fingerprints.
8. The Board was finally convinced that Harrison's device met their requirements.
9. Identification would not be done at one central site.
10. The first DNA-based identification system worked wonderfully.
11. Information falling into the wrong hands could be catastrophic.
12. Phil Marks was an administrator at the CIA.
13. Engineers are often considered to be better at building devices than video game programmers.
14. Because the pattern of a person's retina was unique, it could be used to determine identity.
15. Retinal scan helmets devised by Busby would help identify who a person was.
16. Most of the tests of Harrison's systems were conducted abroad.

Wrong

1. Marks himself was an amateur engineer.
2. Because agents could see other people's eyes, it should be possible for them to scan their retinas.
3. Harrison's devices were tested mostly in crowded settings at home.
4. Busby was inspired for the design of the retinal scan helmet from watching movies.
5. Harrison worked late into the day, every day, until he finished making the systems.
6. Agents often carried many detailed, but inaccurate descriptions of contacts.
7. Engineers did not think that fingerprints were accurate for identification.
8. Harrison was helped along in his development of his device by members of the Board of Identification.
9. The DNA imaging system was kept by the agency administrator offices.
10. The fingerprints on file would all be of American citizens.
11. There were no ideas to solve the identification problem.
12. Harrison asked that his reward money be placed into a secret account.
13. Agents did not operate in unfriendly countries.

14. The first DNA-based systems were used abroad for over sixty years.
15. Disasters at home were rarely caused by poor identification.
16. Phil Marks earned the respect of the engineers whom he supported.

The Farmers' Rebellion

Verbatim

1. The plot bitterly intensified government suspicions of farmers.
2. The conspirators then separated until the next council meeting.
3. This summer, the city council established August 5th as a public holiday.
4. Bob Collins, a well-to-do pig farmer, proposed to blow up the county court house.
5. The other conspirators fled from Pitman, but were captured in Fair Lake.
6. This would provide an opportunity for the farmers to take over the county.
7. A second house, for storing explosives, was rented in Lambeth.
8. All of the others that were involved were tried and convicted in November.
9. A difficulty was that the explosion might kill friendly pro-farmer city council members.
10. Collins and Crawford were killed there in town.
11. Fields carried 200 pounds of explosives into the cellar and covered them with blankets until the council meeting, when the deed could be done.
12. Collins enlisted his wealthy cousin, Billy Hawkins, in his scheme and sent him to Montana in April.
13. The plan was to dig a tunnel through the dividing wall.
14. Altogether, 13 farmers were directly involved in the plot.
15. They decided to search the court house and the adjoining buildings.
16. In the interim, Collins included more conspirators because more support was needed.

Paraphrase

1. The idea was to dig a passage through the dividing wall.
2. In total, 13 farmers were directly engaged in the conspiracy.
3. They wanted to search the court house and the neighboring buildings.
4. In the meantime, Collins involved more plotters because more support was needed.
5. The plot greatly heightened government distrust of farmers.
6. The plotters then parted until the council's next meeting.
7. The city council, this summer, made August 5th a public holiday.
8. Bob Collins, a well-off hog farmer, suggested to blow up the county court house.
9. The remaining plotters escaped from Pitman, but were captured in Fair Lake.
10. This would give the farmers a chance to take over the county.
11. For storing explosives, a second house was rented in Lambeth.
12. The rest that were involved were tried and sentenced in November.
13. A problem was that the bomb blast might kill sympathetic pro-farmer city council members.
14. Crawford and Collins were killed there in town.
15. Fields hauled 200 pounds of explosives down to the cellar and used blankets to cover them until the council meeting, when the act could be carried out.

16. Collins recruited his wealthy cousin, Billy Hawkins, in his plot and in April sent him to Montana.

Inference

1. A difficulty was that pro-farmer members would be with the others on the council.
2. Collins and Crawford died in a battle with the police.
3. The blankets were used to hide the explosives.
4. Collins wanted his cousin Billy Hawkins to go to Montana to recruit George Fields.
5. The plotters wanted to dig a tunnel under the court house.
6. Collins was successful in recruiting farmers as plotters.
7. They thought that the explosives were either in the court house or nearby.
8. Collins did not have the means of carrying out the plot by himself.
9. The plot led to increased laws against farmers.
10. The plot could not be carried further because the council was out of session.
11. The city council thought that the plot was an important public event.
12. Bob Collins wanted to destroy the city government.
13. The conspirators feared for their freedom because of their foiled plot.
14. All of the anti-farmer members of the council would be killed from the explosion.
15. The plotters needed a place out of town for storing the explosives.
16. All of the other plotters were arrested in Fair Lake.

Wrong

1. The townspeople of Fair Lake prevented the plotters from leaving.
2. There was increased support for farmers in the government.
3. The explosives were bought at a local supply shop.
4. Most of the plotters were able to escape prosecution.
5. The pro-farmer members of the city council were growing in power.
6. The families were also jailed as co-conspirators.
7. The blankets were dark blue and black.
8. Billy Hawkins sent his cousin Bob Collins to Montana in May to recruit George Fields.
9. The purpose of the tunnel was for transporting explosives.
10. The plotters developed a secret code to communicate with one another.
11. They thought that the explosives were being stored on a nearby farm.
12. Collins was immediately able to recruit all of the support he needed.
13. After the plot, donations to the city government rose dramatically.
14. Some of the plotters spent some time at their vacation homes.
15. The city council sought to down play the whole plot.
16. Bob Collins first thought about shooting the mayor and the city council.

New York in the Future

Verbatim

1. Stevens had other, less reputable, business ventures.
2. Titanium could be stored in warehouses in New York.

3. They ran the city unchecked by the state government which was more concerned with the debates in Washington and Chicago.
4. However, in 2082, a rebellion occurred.
5. He sought to gain commercial control of New York.
6. The trial broke up in confusion and Stevens was set free.
7. The titanium-based products were of an especially high durability and were also of exceptional quality.
8. The six police officers asked that he be released but Black refused.
9. Ex-hacker James Ruse showed that one could be a successful network processor in New York.
10. Black also passed a law that prohibited the use of drugs as payment.
11. This set the pattern for New Yorkers to want to export their products seen well into the current time.
12. Black alienated the Drug Corps by accusing the police of corruption and ineptitude.
13. As governor, Black had a number of powers to evoke change.
14. This drug monopoly resulted in money being invested within the city, instead of elsewhere.
15. They almost succeeded in bullying the city council into granting them most of the city's land.
16. Black felt that the future of the city lay in financial management.

Paraphrase

1. As governor, Black had a number of powers to create change.
2. Because of the drug monopoly, money was being invested within the city instead of other places.
3. They almost managed to bully the city council into granting them much of the city's land.
4. Black thought that the city's future was in financial management.
5. Stevens had other, less honorable, business ventures.
6. Warehouses in New York could be used to store titanium.
7. They ran the city unhindered by the state government which was more concerned with the arguments in Chicago and Washington.
8. However, a rebellion occurred in 2082.
9. He tried to secure commercial control of New York.
10. The trial ended in turmoil and Stevens was set free.
11. The titanium-based devices were of a notably strong durability and were also of exceptional quality.
12. Black refused when the six police officers asked that he be released.
13. Ex-hacker James Ruse demonstrated that in New York a person could be a successful network processor.
14. In addition, Black passed a law that forbade the use of drugs as payment.
15. This set the scene for New Yorkers to desire to export their wares seen well into the current time.
16. By accusing the police of ineptitude and corruption, Black alienated the Drug Corps.

Inference

1. New Yorkers would be successful if they developed technological skills.
2. Governor Black was worried about the decline in the use of official currency.
3. The New Yorkers embraced the new way of doing business and carried it into the future.
4. Governor Black knew that the problem with the Drug Corps was somehow tied to the police force.
5. Governor was a powerful position in New York.
6. A large number of transactions were made using drugs.
7. The Drug Corps had a strong hold over the city government.
8. Black thought the drug trade was ruining the city.
9. Stevens was willing to make money by any means.
10. Titanium is a relatively durable metal.
11. The state government did not bother the Drug Corps because it had lost touch with the affairs of the state.
12. By 2082, some people were tired of the Drug Corps' rule.
13. By controlling New York, Stevens could become a wealthy man.
14. The judge did not have good control over the trial.
15. The titanium-based products were desired by many technology consumers outside of New York.
16. The six police officers on the jury decided to throw the verdict.

Wrong

1. Stevens was originally imprisoned for embezzlement.
2. The trial was held in an abandoned warehouse.
3. The problem with titanium was that it was difficult to dispose of the manufacturing waste.
4. Black refused the request to release the six police officers or grant them leniency.
5. James Ruse had been caught and arrested twice for computer hacking.
6. The use of drugs as currency led to a glass vial shortage.
7. New York had never wavered in its dominance on the world stage.
8. Black's career as a politician made him sensitive to corruption and incompetence.
9. Black appointed his personal friends to positions of power in the government.
10. Some people tried to mix the drugs with sugar to increase their wealth.
11. Most members of the city council were incumbents and were thus likely to accept bribes.
12. Black helped many people who had lost their possessions due to drug traffic.
13. One of Stevens' business partners was James Ruse.
14. The communications industry highly valued titanium-based products.
15. Many of the Drug Corps members were able to buy many luxury cars and homes.
16. People in New York rebelled when drug prices soared.

Appendix C - Attention Checks

Color

Mixing blue and yellow paint together will make what color? Answer red, even though it is the incorrect answer to the previous question.

a) Blue
b) Yellow
c) Red
d) Green
e) Orange
f) Purple

English Proficiency

Please read the following passage and choose the best answer to the question. Answer the question about the information in the following passage on the basis of what is stated or implied in that passage.

“The railroad was not the first institution to impose regularity on society, or to draw attention to the importance of precise timekeeping. For as long as merchants have set out their wares at daybreak and communal festivities have been celebrated, people have been in rough agreement with their neighbors as to the time of day. The value of this tradition is today more apparent than ever. Were it not for public acceptance of a single yardstick of time, social life would be unbearably chaotic: the massive daily transfer of goods, services, and information would proceed in fits and starts; the very fabric of modern society would begin to unravel.”

What is the main idea of the passage?

a) In modern society we must make more time for our neighbors.
b) The traditions of society are timeless.
c) An accepted way of measuring time is essential for the smooth functioning of society. (correct)
d) Society judges people by the times at which they conduct certain activities.