5-1-2014

The Formation of Situation Models in Multimedia

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THE FORMATION OF SITUATION MODELS IN MULTIMEDIA

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2006

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2008

A dissertation submitted in partial fulfillment

of the requirements for the

Doctor of Philosophy - Psychology

Department of Psychology

College of Liberal Arts

The Graduate College

University of Nevada, Las Vegas

May 2014

THE GRADUATE COLLEGE

We recommend the dissertation prepared under our supervision by

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entitled

The Formation of Situation Models in Multimedia

is approved in partial fulfillment of the requirements for the degree of

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May 2014

ABSTRACT

When people read traditional text-based stories, they construct mental representations of the described state of affairs, called situation models, to connect various details of events (e.g., time, space, entity) in memory (Zwaan & Radvansky, 1998). According to the cognitive theory of multimedia learning (Mayer, 2005; 2011), stories presented as pictures and text generate independent channels of mental representations that can work hand-in-hand or separately to acquire and remember the materials presented. This dissertation consisted of two experiments that were used to further explore how the two modalities affect what is being mentally represented in memory. In Experiment 1, participants were presented with a story called *The War of the Ghosts* through pictures-only, text-only, or a combination of text and pictures, followed by an immediate recall test of the story and a second recall test after a two day delay. In Experiment 2, they were asked to also identify whether they detected situation changes in the story as they read or viewed the information. Experiment 2 was conducted to examine whether the changes (e.g., space, time, entity) in people's situation models influenced their memories during the two day recall task. The findings from these two experiments showed that the type of multimedia source people are presented with can affect how well they can form strong situation models and retrieve accurate details of the story. In addition, the results showed that multimedia can alter the way information is organized when creating a coherent mental representation in memory.

ACKNOWLEDGEMENTS

I would like to express my gratitude to the following people who have helped me in completing this dissertation:

To Dr. David Copeland, thank you for your endless guidance and support throughout my graduate career. Your training and mentorship have taught me to be more open-minded, creative, analytical, independent, and humble. It is because of you that I continue to have a strong passion for research.

To my committee members, Dr. Mark Ashcraft, Dr. Colleen Parks, and Dr. Tara Emmers-Sommer, thank you for your invaluable time and feedback in helping me think more critically about my experiments.

To Pj Perez, thank you for the wonderful artwork that you have created for *The War of the Ghosts* story. Without your help, my experiments would not have been possible to conduct.

To my wonderful lab mates in the Reasoning and Memory Lab, thank you for the fun and laughter that you have given me throughout the past six years. I would like to specifically thank Dr. Jeremy Ashton Houska, Dr. Paul Schroeder, Dr. Nicole Bies-Hernandez, Kathleen Larson, Michael Palena, and Roseanne Dancel for helping me get through the stressful times of this project.

Lastly but most importantly, I would like to thank my family. I am truly blessed to have them in my life. Their encouragements have helped me to get through the ups and downs of completing this dissertation. Thank you!

DEDICATION

To my father,

Willy Gunawan

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CHAPTER 1

INTRODUCTION

People construct mental representations called situation models to comprehend and connect various events (e.g., locations, time, and entity) of a story in memory (Zwaan & Radvansky, 1998). With society's increasing use of multimedia, in which presentations are given in a variety of visual and verbal structure, the ability to form situation models may be influenced by how the information is given. Most studies examining situation models for narratives have relied on traditional text-based reading and rarely on other interactive formats (e.g., illustrated narratives). Only recently, cognitive researchers have begun to study situation models using video games (Magliano, Radvansky, & Copeland, 2007), virtual environments (Radvansky & Copeland, 2006a), films (Magliano, Miller, & Zwaan, 2001; Zacks, Speer, & Reynolds, 2009), and children's storybooks (Magliano, Kopp, McNerney, Radvansky, & Zacks, 2012). However, even with these multimedia sources, further research is needed to understand what is actually formed in people's situation models (i.e., the details they imagine and retrieve in memory). Previous studies have mainly focused on how these mental representations affect online processing through judgment tasks and response times only.

The purpose of this dissertation was to examine how people's mental representations through text only, pictures only, or the combination of text and pictures affect what is stored and remembered in memory. Specifically, this dissertation explored the possible strengths and challenges of creating and managing situation models by giving people a recall task. This investigation of situation models in memory was not only based on accuracy but also on the errors that people committed when creating these mental representations. Due to the reconstructive nature of memory (Bartlett, 1932), in which recollection can be skewed by false representations, the use of multimedia can either promote greater accuracy during recall or exacerbate people's memory performance. By examining situation models for multimedia, the findings helped to provide a deeper understanding of the underlying mechanisms associated with the formation and organization of mental representations in memory.

Multimedia has been a study of interest in education, communications, and cognitive science. Mayer (2005; 2011) proposed a comprehensive model known as the cognitive theory of multimedia learning to assess how encoding text and pictures allow mental representations to be created for later retrieval. However, the question of how these mental representations operate in multimedia remains ambiguous. Explanations of how pictorial and textual representations function on their own or integrate into a coherent representation are limited because this theory only provides a broad assumption that people benefit in learning by constructing mental representations with pictures and text. In this dissertation, a comic book format was used to narrate a story known as *The War of the Ghosts* (Bartlett, 1932) to explore a new theory of situation models and memory in multimedia. Specifically, the following questions were addressed. As people access information through pictures and text, how do they form separate mental representations for each of these modalities so that memories are stored? Is there an organizational structure for forming mental representations for pictures and text that enables memories to be maintained? Also, how do processing pictures and text impact the accuracy of what is retained from people's mental representation (particularly when using a narrative that is known to produce altered / reconstructed memories)? Finally, to what extent do people integrate the information from these two sources?

The Cognitive Theory of Multimedia Learning

Mayer (2005; 2011) refers to the understanding of how people learn through words and pictures in various forms of presentation as the cognitive theory of multimedia learning (see Appendix A). This theory incorporates the modal model (Atkinson & Shiffrin, 1968) which consists of three memory systems: sensory memory, working memory, and long-term memory. Sensory memory involves attending to and holding briefly the multimedia presentation (i.e., the words or pictures) through the eyes and ears. The information is then sent to working memory where it is the central work of multimedia learning. The words and pictures are filtered and managed in working memory so that certain pictorial and textual information is used to construct the mental representations necessary to understand what has been processed. Long-term memory plays the role of maintaining prior knowledge (e.g., one's schema) to assist with the mental representations produced in working memory. From these three memory stores, the process of multimedia learning is guided by three cognitive assumptions: (1) dual channels, (2) working memory capacity limitations, and (3) active processes of constructing mental representations for pictures and text.

Cognitive Assumptions of Multimedia Learning

Dual channels. Multimedia learning involves the selective encoding of information through *presentation modes* and *sensory modalities* (Mayer, 2005). These two information-processing sources activate their own separate dual channels. The presentation modes focus on the materials that are presented using pictures and words.

According to Paivio's (1969) dual coding hypothesis, people maintain memory codes for pictorial and textual representations during learning. If words provide high visual imagery and concrete associations with images (e.g., the word 'book'), people are able to strengthen their retention for those words. However, if words are represented in an abstract way and generate no strong associations to a particular image (e.g., the word 'freedom'), those words are capable of being retained but may be challenging to store for later retrieval. In contrast, images alone do not exhibit a similar problem like abstract words because they can stand as an independent pictorial code that can also trigger a verbal code in memory (Paivio, 1975; Reed, 2006). Thus, memories for pictures tend to be stronger than words, often generating a picture superiority effect (see also Paivio & Csapo, 1973). The effect enhances people's memories by offering distinctive images that are easily conveyed as meaningful and additive to words. Although the picture superiority effect has been well-supported in many studies, there are some cases in which the verbal code can alter memories for images. For instance, people who are unable to describe an ambiguous picture (e.g., an unknown shape) may use a label or description to remember the information better instead of relying on the picture itself (Brandimonte, Hitch, & Bishop, 1992; Carmichael, Hogan, & Walter, 1932; Schooler & Engstler-Schooler, 1990).

The other information-processing source that incorporates a dual channel assumption involves the sensory input. Multimedia learning can be perceived through either seeing or hearing. These two sensory modalities are important because they emphasize what information to take in for mental representations to be constructed from the sensory memory to working memory. Although the use of auditory and visual information can enhance learning, both modalities can function separately during the encoding process. For the purpose of this dissertation, the main focus will be on the visual channel, in which text and images are processed and stored for comprehension and retention.

Limited working memory capacity. Mayer (2005) uses several theories to address the fact that information taken in as pictures and text from sensory memory can be held at a limited capacity in working memory. Specifically, he borrows his limited capacity assumption from Baddeley's working memory model (Baddeley, 2001; Baddeley & Hitch, 1974) and Sweller's (1998) cognitive load theory. In Baddeley's model, text and pictures are channeled in through different components, such as the phonological loop and visual sketchpad, so that information can be stored temporarily to connect and hold other new items in working memory. For instance, text can be held in working memory as sound in the phonological loop or sight in the visual sketchpad. Pictures, on the other hand, can only be held in working memory as images; therefore, it can only be stored in the visual sketchpad. When an overwhelming amount of text and pictures are processed in working memory, certain information can be lost or held poorly for later retrieval. Thus, the inability to process all of the information may disrupt the possibility of creating a complete and coherent mental representation for text and pictures.

In another perspective of how working memory consists of a limited capacity, Sweller (1994) proposed that people can overload their mental resources due to an intrinsic load, germane load, or extraneous load. The intrinsic load examines the difficulty and complexity of understanding the content. When the intrinsic load is high, people have a challenging time learning the information. For instance, processing spatial locations of objects through text descriptions may be much more difficult to retain than processing them using pictures (Copeland & Radvansky, 2007). The germane load is focused on the efforts required to process and create new schemas to enhance learning. This type of load is often associated with motivation and interests. When people are given some form of practice to apply their prior knowledge to other examples of a problem, this strategy can increase their germane load, reducing the mental resources needed in their limited working memory capacity (Paas & van Gog, 2006). The extraneous load involves the demands of retaining the to-be-presented information. That is, irrelevant information can occupy one's mental resources, reducing the learning process and the ability to build important mental representations. An example would be to distract people with unnecessary text onscreen during a narrated animation, causing them to attend to other information other than what is important through the animation itself (Mayer & Moreno, 2003).

Active processing. The last assumption of the cognitive theory of multimedia learning is that people are active processors when building a coherent mental representation from pictures and text. Mayer (2005) posited three essential processes for information to be retained and understood. They are *selection*, *organization*, and *integration*. These processes do not necessarily follow a linear fashion as all three processes can happen simultaneously. Selection begins when words and pictures are presented through the sensory memory via the ears and eyes. During this selection phase, the information is distinguished as either sounds or images in working memory. As these sensory inputs provide information to working memory, organization is engaged. The words and pictures are organized as separate mental representations through a verbal model and pictorial model. For people to make sense of the materials that they are given, the verbal and pictorial models must integrate or make connections with the information for coherence. People's schema, or prior knowledge, from long term memory is also integrated during this process.

Limitations of the Cognitive Theory of Multimedia Learning

There are several limitations to the cognitive theory of multimedia learning. First, although multimedia can be applied to various materials, most studies conducted by Mayer and his colleagues are typically associated with learning a scientific process (e.g., how batteries or the brake systems work) and do not examine learning in other instances like reading stories. Thus, their findings are informative for materials using instructional (e.g., procedural or fact-based knowledge) but not necessarily descriptive (e.g., stories) designs. Differences in the type of information given may alter how mental representations are created. For instance, people who perceived text narratives as literary were likely to slow down in reading times and show disruptions in their situation models than those who perceived text narratives as a newspaper (Zwaan, 1991; 1994). Second, the multimedia learning theory focuses greatly on practical issues, such as how pictures and text should be organized for an effective presentation (see examples of various multimedia principles from a book chapter written by Mayer, 2011). Although these practical issues are important, this dissertation focused more on the theoretical aspect of constructing pictorial and textual mental representations for multimedia learning. Lastly, the process by which the representations of pictures and text are organized or integrated with prior knowledge is not clearly specified in the theory. This last limitation needs further clarification as suggested from some researchers, such as Reed (2006), and is discussed further in a later section of this dissertation.

Forming Mental Representations

In studies that have examined comprehension for text narratives, researchers suggest that there are three levels of mental representations that are distinct yet not mutually exclusive during online reading: the (1) surface structure, (2) propositional textbase, and (3) situation model (Kintsch, 1994; van Djik & Kintsch, 1983). The most basic level of the three mental representations is known as the surface structure. At this level, people focus primarily on the words themselves, processing the sentences in a verbatim-like manner. A surface structure representation is thought to be temporary, and although some are capable of retaining the exact wording in long-term memory (e.g., see Murphy & Shapiro, 1994 on jokes and Rubin, 1995 on songs and poems), most people will often reconstruct the content based on the gist, or the main idea of the story (e.g., Bartlett, 1932). This type of reconstruction leads to the next level of mental representation called the propositional textbase, in which meaning is represented based on propositions, or idea units. In contrast to the surface structure, the propositional textbase operates conceptually, focusing on the semantic meaning explicitly mentioned in the text without relying on the sentences word-for-word. For example, Bransford and Franks (1971; 1972) presented participants with a list of propositions like the following:

The ants were in the kitchen.

The ants ate the jelly.

The jelly was sweet.

The jelly was on the table.

The propositional textbase representation would be based on each of those statements, but it would not necessarily be based on the exact words (like the surface structure). For example, people may remember that, “Inside of the kitchen, there were some ants.” They may also remember that there was “sweet jelly”. The last and highest level of mental representation is known as a situation model (Johnson-Laird, 1983; Zwaan & Radvansky, 1998). At this level, people process sentences beyond the propositional structure by inferring from the described state of affairs and elaborating on the facts given. Specifically, people can take on an active role in the story by placing themselves in the perspective of the characters and their surroundings (e.g., the time frame that the story takes place, the location of which the events are happening, or the objects that the characters are carrying). With the above example about the ants in the kitchen, people might integrate all of those ideas into a common representation and may possibly expand on it by drawing inferences, such as inferring that the ants climbed up the table legs to reach the jelly.

The construction of situation models involves three separate components that influence each other as a way to connect the story together in memory. The components are referred to as (1) the current model, (2) the integrated model, and (3) the complete model (Zwaan & Radvansky, 1998). The current model is activated as readers attend to the specific sentences given at hand. As new knowledge is retrieved from the current model, the integrated model plays an important role in maintaining coherence. The integrated model acts as a global model so that recent and previously relevant information are linked together in working memory. Specifically, there are two functions that occur in the process known as updating and foregrounding. When people encounter new information in a narrative, updating allows them to incorporate the information accessed from the current model with prior knowledge stored from the integrated model. Updating is necessary because people are able to outline the direction and progression of the story (Sanford & Garrod, 1990). Foregrounding is associated with updating by providing retrieval cues for the connection between the current and integrated models. The purpose of foregrounding is to keep important facts and ideas in mind so that readers can assess and fill in the events that are being focused or resolved with relevant pre-existing information. Once an entire story has ended, a complete model is produced and stored in long-term memory. Although a model may seem "complete," people cannot assume that the model is final. Readers may later reflect on a story and reconstruct or develop a new model for that story, reactivating the current and integrated models.

The Importance of Situation Models

The formation of situation models, or mental representations of the described state of affairs, is an important process for understanding narratives because situation models allow people to connect different aspects (e.g., time, location, characters, and objects) of a story that could affect how information is retrieved during recall. Unlike the surface structure or propositional textbase, in which these mental representations rely solely on the information given in the sentences, situation models require people's imagination and their interpretation of the information conveyed. However, people's interpretation of their situation model may often be influenced by their schema. To differentiate these two concepts, a situation model is based on the specific descriptions or experiences made within a story, whereas a schema is based on prior experience or general knowledge that is perceived as stereotypical (Zwaan & Radvansky, 1998). For instance, in the story being used for this dissertation called *The War of the Ghosts*, two young men from Egulac are hunting seals in a river. In a situation model based on the text, people would imagine these two young men going out to a river to hunt for seals, as it is described in the sentence. However, it is possible that the situation model can be influenced by a reliance on a schema based on the readers' past experiences or memories. For example, some people may imagine two males going to a body of water to go fishing. In this case, the two young men can be identified as boys or young adults, the body of water can be recognized as a lake or river, and the fishing can be considered as hunting for seals or any type of fish. According to van Dijk and Kintsch (1983), a schema can be used as a building block to guide or create a situation model. Thus, situation models allow people to make inferences based on actual information given in the narrative and general ideas from memory, such as schemas.

Studies examining situation models have been shown to affect people's cognitive processing. In text narratives, research has shown that readers slow down in reading times when they view changes to a story (e.g., Zwaan, Magliano, & Graesser, 1995). The increase of reading times occurs because people are updating, or making the connection of new information in working memory (i.e., the current model) with prior knowledge from long term memory (i.e., the integrated model), to create a well-formed situation model. Zwaan, Langston, and Graesser (1995) suggested that these changes are monitored based on different aspects of the story, referred to as the Event Indexing model. Some of these aspects or event dimensions in the story are time, space, entity, causality, and goals. For example, in a study by Therriault, Rinck, and Zwaan (2006), they had participants focus either on time, space, or characters while reading through each sentence of a story. The researchers found that although the participants were asked to monitor only one particular event dimension, the reading times slowed down for changes occurring in the sentences for the other dimensions as well. This finding suggests that forming situation models involves updating changes of various aspects of a story simultaneously to organize the information in memory and to provide coherence.

The understanding of how situation models are constructed through pictures or the combination of pictures with text in narratives is limited thus far. One study conducted by Magliano, Kopp, McNerney, Radvansky, and Zacks (2012) found that older and younger adults were capable of forming situation models of children's storybooks through a judgment task. In their study, they had participants identify whether a situation had changed when given the storybooks through text only or pictures only without giving them any instructions as to the definition of the changes. The goal of the experimenters was to examine whether participants were able to identify changes for space, time, characters, emotions, and goals while reading or viewing the story. The results indicated that the older and younger adults' judgments were consistent with shifts in all of the event dimensions (except for emotions in the older adult group) during their comprehension of the story. This finding implies that situation models are mostly preserved for pictures and text as people age.

The effects of using text and pictures to construct situation models have also been observed in recognition memory. Radvansky and Copeland (2006b) demonstrated that separate mental representations for text and pictures can cause differences leading to a fan effect, which is the interference that occurs when retrieving information that cannot be integrated into a single representation. They found that the fan effect occurred more for text than pictures because separate mental representations are activated. Specifically, whereas the use of text will require more of a situation model-based process, pictures can be viewed as a surface form or perceptually-based process. In this case, the surface form of pictures is characterized by unique details of the objects and locations that cannot be mentally represented in different ways by a person like when one is reading text. As a result, recognition was faster for pictures than text. Similarly, Copeland and Radvansky (2007) reported that how people retrieve mental representations for spatial directions of objects for pictures relative to text can increase accuracy and improve response times, especially for older adults. Unlike the use of text, in which effort is needed to form a situation model to integrate spatial information, the use of images can activate a picture superiority effect, in which the retrieval is enhanced by perceiving distinct and meaningful images. Thus, images may possibly facilitate the process of creating a visual mental representation without people having to create it themselves.

Unlike most studies, in which situation models are assessed through processing time, judgments, or recognition, the purpose of this dissertation was to explore the mental representations that are created from an illustrated narrative by using a recall procedure. To examine how situation models are influenced by pictures and text, people were instructed to recall what they read and / or viewed in a comic book style narrative. The comic book format was used because the text and pictures were uniquely integrated in a story and were not presented separately, such as in a children's storybook where the sentences are typically shown independently from the pictures. In comic books, readers must rely on the dialogues and narrative text boxes to put context to the illustrations given (McCloud, 1993). Additionally, only a few studies have incorporated comic books as a way to understand situation models. For instance, Cohn, Paczynski, Jackendoff, Holcomb, and Kuperberg, (2012) used short image-only comic strips to examine how people rely on the structure (e.g., the order of the panels and the meaningfulness of the images) of a visual narrative to produce coherence. However, like other studies, their work often used processing time and a recognition task (see Cohn, 2012 for details about the structure). A theoretical approach for how situation models affect memory through multimedia like comic books is addressed later.

Situation Models and False Memories

Although research examining situation models are not often associated with false memories, people can still be susceptible to having false mental representations. For instance, people may rely on their schema, or prior knowledge that conveys stereotypical information, to construct their situation models. As a consequence, they may omit original details and elaborate on non-existent facts during recall. Bartlett (1932) noted that distortions can be caused by rationalization, or people's interpretation of what they perceive is true for an event. Three active processes are involved in making these rationalizations. First, the importation or transfer of outside sources from memory, such as creating symbolisms for events that are not clearly understood, can be used to justify what is going on in a narrative to provide meaning (e.g., the assumption that "something black came out of his mouth" can symbolize a man's soul or dying breath in the *War of the Ghost* story). Second, unclear details of a narrative can cause people to transform abstract concepts into concrete ones (e.g., the assumption that "something black came out of his mouth" was just something foaming at the mouth). Lastly, people's biases and interests may influence how people rationalize information to create connections of various events so that they are able to make sense of the story.

Text narratives can often be used to express ideas or beliefs that can alter people's mental representation. For instance, Loftus and Pickrell (1995) had people read through events that occurred in their childhood life but also included a false event about them being lost in the mall. Interestingly, about 25% of the participants were likely to falsely believe and recall that they had gone through the lost-in-the-mall experience as a child. In addition, the way text is conveyed to retrieve information can also have a detrimental effect on people's situation models. For example, Loftus and Palmer (1974) distorted people's responses of a car accident by incorporating various verbs in their interrogation. Specifically, the students saw a film of a car accident and were later asked questions about the speed of the vehicles and whether they saw broken glass in the accident. When the researchers replaced the word "hit" with other verbs, such as "smashed," "collided," "bumped," or "contacted," many students were likely to alter their estimation of the speed of the vehicles. Some even concluded that there was broken glass (when in reality, there was none) for the stronger verbs. Thus, the text used to produce memories can often influence the mental representations that people have based on minor changes to descriptions of an original event.

Information given in a pictorial form can also influence the possibility of people creating false mental representations. In a study by Wade, Garry, Read, and Lindsay (2002), the researchers interviewed participants several times about their childhood life using a set of real pictures, but with one fake picture of them being on a hot air balloon. They found that 50% of the people were likely to report the fake picture to be true. This result may be due to the eventual familiarity of the image and the belief of pictures being a credible source. False mental representations can also be generated using real pictures. Lindsay, Hagen, Read, Wade, and Garry (2004) showed participants a real photograph of their grade school class and gave them a fake story about a prank they pulled by putting Slime, a children's toy that consist of a green goopy substance, in their teacher's desk drawer. The findings demonstrated that with suggestibility and greater confidence, false memories can still be produced even when the pictures themselves are genuine. Also, people may likely blend in the actual picture to their own imagination of the event.

Research has also shown that although the combination of text and pictures can enhance memory (David, 1998), these two modalities can still elicit false memories. For instance, Garry, Strange, Berstein, and Kinzett (2007) asked students to pretend that they were newspaper editors reviewing three articles. In the study, they were given a picture for each article before or after they read the stories. When students read the stories and were given a picture afterwards, they were likely to generate false representations of the stories in a surprise memory test. For example, in one of the stories they reviewed, there was a hurricane that struck a community and caused property damages. However, some students reported that there were also statements about personal injuries occurring even when there was no evidence of this information in the text or picture. This finding suggests that people can often use pictures as a strong resource for speculating a fact that does not exist.

An Approach for Understanding Situation Models, Memory, and Multimedia

Relative to past studies of text narratives, situation models may operate differently when giving people pictures and text for narratives. According to Mayer's (2011) cognitive theory of multimedia learning, the two multimedia presentations can function as independent mental representations (i.e., causing people to remember through text only or pictures only) or work together to develop a complete understanding of the information given. However, how does multimedia influence what is being mentally represented and remembered? To investigate the processes involved, separate theories for situation models are addressed for narratives that are presented as text only, pictures only, or the combination of text and pictures. Specifically, the focus is on whether text and pictures enhance or degrade the formation of situation models, which can possibly influence people's memory performance.

In text narratives, people rely on situation models to construct their own mental images of the descriptions made from the story. Information can be organized by focusing on changes that occur for space, time, characters, and objects so that events are linked together and updated in long term memory. Memory accuracy may depend on people's attention to specific details of their situation models. Information that stays true to their situation models in a narrative should increase accuracy. However, these mental representations can be altered by outside factors, such as forgetting and schematic processing, which can disrupt the coherence of a narrative. Past research has shown that people do not retain memory for the text itself very long, so if details are lost, people may rely more on inferences or reconstructive processes to get the gist or main idea of the story as retrieval cues. As a result, some information may be omitted and details might be elaborated to fit the overall idea of the story in memory.

In contrast, situation models may take on a more passive role for pictorial narratives because the mental representations are already created by the images given.

Although people are capable of organizing images for space, time, characters, and objects to connect details of a story, they may rely more on their interpretation of the images and not from actual details that would be given in a text format. Memories for pictures are generated perceptually, causing people to rely on the surface form (i.e., the images that they see) and the propositional textbase (i.e., the general idea of what the images convey) to form their mental representations. Yet, pictures may not necessarily reduce the quality of what they remember in a narrative. With the picture superiority effect, people can imagine and generate stronger images for a story because they have direct knowledge of what is perceived in the story. It should be noted, though, that this picture superiority effect can still be prone to errors during recall because people may construct a different situation model depicted from what they see and their schema (Schnotz & Bannert, 2003).

The integration of pictures and text may create a different dynamic for situation models in memory. Not only can people generate mental images from reading the text, they can also use pictures to assist them with retrieval cues about the events in the narrative. Four possibilities can occur with integrating pictures and text. First, people can use these two presentation modalities together to fill in gaps of missing information between their mental representation and their perceptual representation in memory. Therefore, there may be an additive effect of organizing various events, such as space, time, and entities, through constructing situation models and processing details perceptually. As a possible consequence, false memories may be reduced because of a support system that establishes what is known about the story. Another possibility would be that people may fail to produce memory accuracy through situation models because they may rely greatly on the pictures and not on what was mentally represented during reading. With the picture superiority effect, the images may generate ideas that may not be associated to the actual narrative. People may use their own interpretations of the pictures they remember to connect the events of the story together rather than relying on the text to also guide them with their mental representations. Thus, they may speculate from the pictures given because of not processing accurate details derived from the text. The third possibility of integrating text and pictures is the greater reliance on textual information that is mentally *mis*represented due to schemas or rationalization. The pictures may then be used as an additional form of speculation to confirm what they mentally *mis*represented through the text. A final possibility would be that memory accuracy is reduced due to the lack of attention given to both text and pictures. As a result, a complete situation model is unable to be formed because both multimedia sources are not fully encoded when they are presented with the illustrated narrative. This last possibility is less likely to occur because the participants are given the chance to read and view the story twice (a procedure used by Bartlett [1932] when studying memory with *The War of the Ghosts*). By doing so, this procedure allows them to update their mental representations with pertinent information that might have been neglected during prior reading or viewing.

Overview of the Experiments

Two experiments were conducted in this dissertation. In Experiment 1, participants were presented with a Native American Indian folktale known as *The War of the Ghosts* through text only, pictures only, or a combination of text and pictures to assess how situation models influence memory in a recall task. The focus was to evaluate whether people's situation models cause them to maintain accurate information or produce errors (elaborations) with the multimedia method that they were given. In Experiment 2, the same procedure was used except that participants were asked to also identify whether there were changes in the story as they go through each panel one at a time. Their responses of whether the changes occurred within the story were recorded to examine if identifying certain changes alter how mental representations are constructed for pictures and text or if they notice changes differently. Additionally, their responses for where changes occur in the story were used to examine accurate and false memories. Experiment 2 expanded on the understanding of situation models in multimedia by using the Event Indexing model (Zwaan, Langston, & Graesser, 1995; Zwaan, Magliano, & Graesser, 1995) which focuses on changes occurring for time, space, characters, and objects, when reading or viewing an illustrated narrative.

CHAPTER 2

EXPERIMENT 1

The purpose of Experiment 1 was to assess how well situation models are constructed and retrieved in memory over a two day period. Participants were assigned randomly to a text-only, pictures-only, or text-pictures group, in which they were presented with a story known as *The War of the Ghosts*. After reading and / or viewing the illustrated narrative, they were given two separate recall tests, once on the first day, shortly after reading, and a second one 48 hours later. In examining the participants' memory performance over time, two possibilities were predicted to occur during the two recall tests. The first possibility was that memory for details would decline from the immediate test to the delayed test. Ebbinghaus's (1885 / 1913) forgetting curve showed a significant decline in memory, when testing immediately versus after 48 hours. In Ebbinghaus's self-study of his memory for nonsense syllables, he was only able to recall 27.8 percent of the original items after two days.

Researchers have argued that this drastic decline in retention after 48 hours may be due to how meaningful the information was during encoding; Ebbinghaus's memory may have decreased because he was studying meaningless consonant-vowel-consonant items. This argument leads to the second possibility of an increase in the participants' memory performance over time. Erdelyi and Becker (1974) demonstrated a memory improvement, known as hypermnesia, when repeatedly testing people with a list of words and pictures. Although they did not show too much change in recall for words, they found an increase in recall for pictures. This result may be due to a picture superiority effect; however, other researchers (e.g., Mulligan, 2005; Payne & Roediger, 1987) have observed hypermnesia for words, suggesting that deeper levels of processing and retrieval effort can influence memory improvements. Hypermnesia may also occur due to a more careful and thorough search for new items in memory when people have exhausted their search and retrieval of all old items (Gunawan & Gerkens, 2011). In another study related to hypermnesia, Erdelyi (1998) conducted an experiment with nine participants using *The War of Ghosts* in a text narrative format. He showed that participants recalled fewer details after a ten week gap but showed memory improvements when they were given more repeated recall tests after those ten weeks. The limitations to his study were that he only observed the hypermnesia effect based on the number of correct words (not facts or ideas) and interpreted the results to justify Freudian concepts.

In the current experiment, the recall test findings were assessed through the recollection of idea units or propositions, examining correct recall (i.e., information that was accurate) and elaborations (i.e., information that was false or misremembered). In addition, a general assessment of how long people processed information through response times from the text-only, pictures-only, and text-pictures versions were conducted. A costs and benefits analysis was also performed to assess how the length of time processing the story can affect people's correct recall and elaborations. The results were used to determine whether the use of text and / or pictures as multimedia sources affect people's situation models and memory.

Hypotheses

Correct Recall

Session (Day 1 and 2). When examining correct recall based on the two sessions, participants were predicted to recall more idea units in Day 1 than in Day 2 for all three narrative conditions. This prediction came from Ebbinghaus's (1885 / 1913) theory of normal forgetting and the finding of Erdelyi's (1998) study using a text version of *The War of the Ghosts*, in which there was a drastic decline in recall after the first testing in ten weeks. However, there may also be the possibility of hypermnesia, or a memory improvement, in Day 2 for the text-pictures group. Specifically, the text-pictures group may be able to generate a picture-superiority effect and a stronger situation model due to greater retrieval cues from the text and pictures.

Presentation (Text-Only, Pictures-Only, vs. Text-Pictures). The text-pictures group would recall more correct idea units than the text-only and pictures-only groups because the combination of text and pictures may provide a stronger cue to form a complete situation model during recall. This presentation method can also be thought of as "ready-made" dual coding because the information is presented in both formats. In addition, it was predicted that the text-only group would recall more correct idea units than the pictures-only group because they would be able to interpret the story according to what was originally written on the text, creating an accurate situation model than the pictures-only group. That is, the pictures-only group may not be as accurate when recalling the text verbally because they may be relying on their interpretation of the main ideas in each picture.

Session X Presentation. Two possibilities were given for the interaction between session and presentation. For the first possibility, participants in the text-pictures and text-only groups would recall more idea units than the pictures-only group during Day 1, whereas participants in the text-pictures group would only recall more idea units than the text-only and pictures-only groups during Day 2 due to the strength of the mental representations created when text and pictures were combined. Another possibility would be that participants in the text-pictures and the text-only groups would recall more idea units than the pictures-only group during Day 1, but all of the groups would recall fewer idea units during Day 2 because mental representations are not resistant to forgetting and /or the reconstruction of memory.

Elaborations

Session (Day 1 and 2). Due to the reconstructive nature of human memory, people would make more elaborations (false idea units) in Day 2 than in Day 1, supporting the findings by Bartlett (1932) and Bergman and Roediger (1999). Several factors may contribute to these elaborations, such as rationalization, schematic processing, normal forgetting, and speculations / inferences made from one's point of view of the story.

Presentation (Text-Only, Pictures-Only, vs. Text-Pictures). The text-pictures group should recall fewer false idea units than the text-only and pictures-only groups because of the combination of pictorial and textual cues given to mentally represent the story. However, the text-only and pictures-only groups should recall a similar number of false idea units because they would rely on their schemas more to mentally represent uncertain details. The text-only group would use more of their own imagination to create a different mental image of the story to connect the events together, whereas the pictures-only group would use more of their own interpretation to make sense of the story without any text given to them.

Session X Presentation. It was thought that an interaction would occur between session and presentation. For Day 1, participants in both the text-pictures and text-only groups would recall fewer false idea units than the pictures-only group because of their ability to encode information that is relevant to the text. The pictures-only group would rely more on their schemas and their interpretation of the story because they only have pictures to understand the narrative. However, for Day 2, the text-pictures group would only show fewer false idea units relative to the text-only and pictures-only groups because the text-pictures group would have the advantage of using both the text and pictures for retrieval cues. The text-only and pictures-only groups were left with one type of mental representation to guide them through their memory of the story.

Response Times of the Multimedia Sources

The ability to form situation models may be associated with how much time people process information from the multimedia sources. Response times were measured based on the number of minutes people read or viewed the story.

Encoding (First and Second Time). People were predicted to be slower for the first time they read / viewed the narrative than the second time because more effort would be required to form a complete situation model for the story when they are first introduced to it. The decrease in response times for the second time would be due to people having an established representation of the story after reading it once (Zwaan et al., 1995).

Presentation (Text-Only, Pictures-Only, vs. Text-Pictures). Response times would be slower for the text-pictures group than the text-only and pictures-only groups because in addition to having to form a situation model for the story, they must integrate both text and pictures to build a consistent understanding of the storyline. The text-only group would process the story longer than the pictures-only group because they must use their own effort to create mental images of the story. The pictures-only group only needs to use their perceptual representation to process the information, allowing them to process the information more quickly (Copeland & Radvansky, 2007; Radvansky & Copeland, 2006b).

Encoding X Presentation. There would be no significant interaction between encoding and presentation because the text-pictures, text-only, and pictures-only groups would show a similar pattern when reading / viewing the story the first time to the second time. Specifically, response times would be slower for the first time and faster for the second time. Across the three presentation groups, however, the presentation group would encode the story longer than text-only and pictures-only groups and the text-only groups would process the story longer than the pictures-only group.

The Costs and Benefits of Multimedia on Situation Models and Memories

A costs and benefits analysis was conducted to determine whether the length of time going through the text-only, pictures-only, or text-pictures version of the story influenced the accuracy and elaborations produced in people's situation models and memories. The following formula was used to create an efficiency score for each participant:

$$Efficiency\ Score = \frac{Correct\ Recall\ (Accurate\ Idea\ Units) - \ Elaborations\ (False\ Idea\ Units)}{Total\ Reading\ or\ Viewing\ Time\ (Minutes)}$$

The mean efficiency scores were compared among the three presentation groups. Scores that ranged higher would represent situation models and memories that were more accurate based on the amount of time people took to process the material. Scores that ranged lower or in the negative numbers would represent situation models and memories that were driven by elaborations (i.e., more false idea units) based on the amount of time that people processed the story. From the three groups, the text-pictures group should have a higher mean efficiency score than the text-only and pictures-only groups because the amount of time spent on text and pictures together would provide a stronger retrieval cue for constructing a more complete mental representation, strengthening people's memories for the narrative. The text-only group would have the next highest mean efficiency score compared to the pictures-only group because they would spend time relying on their mental images for the text without being guided by any visual cues to remember the information. The pictures-only group would have the lowest mean efficiency score because, while people may passively and rapidly view the pictures to interpret the story without any information from the text, this would likely increase the likelihood of elaborations.

Method

Participants

There were a total of 60 students (25 males, 35 females; $M_{age} = 20.75$, $SD_{age} = 5.128$) from the University of Nevada, Las Vegas, who participated in Experiment 1. They were recruited through the Department of Psychology's subject pool. The participants were randomly assigned to one of three presentation modalities: the text-only group ($n = 20$), the pictures-only group ($n = 20$), or the text-pictures group ($n = 20$).

Materials

Participants were presented with a Native American Indian folktale called *The War of the Ghosts*, taken from Bartlett's (1932) original experiment. A brief questionnaire at the end of the experiment was used to ensure that they were not familiar with the story when beginning the experiment and did not search for the story on the Internet or any outside sources throughout their participation in the experiment. The complete story is shown below. The numbers in parentheses represent the segmented sentences for each panel in the story (see Appendix D for details of the illustrated narrative).

(1) One night, two young men from Egulac went down to the river to hunt seals,

(2) and while they were there, it became foggy and calm.

(3) Then they heard war-cries,

(4) and they thought: "Maybe this is a war-party".

(5)They escaped to the shore,

(6) and hid behind a log.

(7) Now canoes came up,

(8) and they heard the noise of paddles,

(9) and saw one canoe coming up to them.

(10) There were five men in the canoe,

(11) and they said: "What do you think? We wish to take you along.

(12) We are going up the river to make war on the people."

(13) One of the young men said, "I have no arrows."

(14) "Arrows are in the canoe," they said.

(15) "I will not go along.

(16) I might be killed.

(17) My relatives do not know where I have gone.

(18) But you," he said, turning to the other, "may go with them."

(19) So, one of the young men went,

(20) but the other returned home.

(21) And the warriors went on up the river to a town on the other side of Kalama.

(22) The people came down to the water,

(23) and they began to fight,

(24) and many were killed.

(25) But presently the young man heard one of the warriors say, "Quick, let us go home: that Indian has been hit.

(26) " Now he thought: "Oh, they are ghosts."

(27) He did not feel sick,

(28) but they said he had been shot.

(29) So, the canoes went back to Egulac,

(30) and the young man went ashore to his house,

(31) and made a fire.

(32) And he told everybody and said: "Behold I accompanied the ghosts, and we went to fight.

(33) Many of our fellows were killed,

(34) and many of those who attacked us were killed.

(35) They said I was hit,

(36) and I did not feel sick."

(37) He told it all,

(38) and then he became quiet.

(39) When the sun rose, he fell down.

(40) Something black came out of his mouth.

(41) His face became contorted.

(42) The people jumped up and cried.

(43) He was dead.

In Experiment 1, the story was shown as text without pictures (i.e., text-only), pictures without text (i.e., pictures-only), or a combination of text and pictures (i.e., text-pictures). For all three groups, the story was broken down into 43 panels (i.e., pictures and / or text that were enclosed within a frame). The information for each panel was created by segmenting the story sentences following a similar structure provided by Mandler and Johnson (1977).

For the pictures-only and text-pictures versions of the narrative, the pictures were drawn in black and white ink by Pj Perez, who is a professional comic artist (http://pjperez.com/) from an independent American comic book publishing company based in Las Vegas, NV, known as *Pop! Goes the Icon* (http://www.popgoestheicon.com/). The artist was instructed to draw images that followed the exact portrayal of the story, and experimenters in the Reasoning and Memory Lab (the author of this dissertation, another doctoral student, and a professor) consulted with the artist during the drawing process to monitor for any discrepancies found in the interpretation of the illustration.

Design

A 2 (Session: Day 1 and 2) X 3 (Presentation: Text-Only, Pictures-Only, or Text-Pictures) mixed factorial ANOVA was conducted. Session was a within-subjects variable, and presentation was a between-subjects variable. The dependent measures were the recall propositions (idea units) that were accurate or elaborated (false). For correct recall, there were a total of 127 accurate idea units possible. A 2 (Encoding: First Time and Second Time) X 3 (Presentation: Text-Only, Pictures-Only, or Text-Pictures) design was also used for response times when analyzing how long the presentation groups processed the story. Encoding was a within-subjects variable, and presentation was a between-subjects variable. In addition, a one-way between-subjects ANOVA was used to compare the presentation modes for efficiency scores.

Procedure

The experiment was a two part session, with a 48 hour delay between sessions. For the first session, students were seated in front of the computer and randomly assigned to one of three groups: the text-only group, the pictures-only group, or the text-pictures group (see an example of the presentations on Appendix B). Participants in the text-only group were instructed to read through the story twice without any illustrations. Participants in the pictures-only group were instructed to carefully view the same story twice with pictures only. Participants in the text-pictures group were asked to read through the story and view the pictures twice – the panels that were shown in this group were formatted in a comic book style (i.e., the text and pictures were integrated and not separated like a children’s storybook). For all three groups, the story was presented one panel at a time on the computer, using the E-Prime experiment presentation software (Schneider, Eschman, & Zuccolotto, 2002). To advance to the next screen, they had to press the space bar; a 250 millisecond delay was included between each panel so that participants were aware of the transitions. After being presented with the story, the students were given a ten minute distracter task, playing Solitaire. Participants were then asked to recall the story that they were presented with by typing on a computer, taking as much time as they needed to remember. The recall test was conducted on the Internet using the Qualtrics experiment presentation software (Qualtrics, 2013; http://www.qualtrics.com). The instructions were taken from a study by Bergman and Roediger (1999), but with some slight modifications depending on the presentation group the participants were assigned. See Appendix C for the recall instructions. In addition, a reflection questionnaire was added at the end of the recall test, asking them to rate how much attention they made for processing the multimedia sources in the story (see Appendices F and G).

Once they completed the tasks for the first session, they were told that they would receive an email two days later for another recall session. In the second session, the participants were given a link to a Qualtrics website with instructions for the recall test. They were asked to type their recall of the story and to be as accurate as possible. Again, there was no time limit. After they completed the recall task, a reflection questionnaire asking them to rate their use of the text and / or pictures for remembering the story was given (see Appendices F and G) followed by a debriefing to inform the participants of the purpose of the study. Note that all of the ratings for the reflection questionnaires will be addressed in the General Discussion.

Scoring. The participants' recall for both sessions were scored based on the correct idea units for each panel. There were 127 correct idea units possible that the participants could remember. Ideas that were relevant to one of the 43 panels were counted as accurate, whereas ideas that did not correspond to any of the panels in the story were counted as elaborations (i.e., false idea units).

Results & Discussion

Experiment 1 consisted of three types of analyses. In the first analysis, the focus was on correct recall (i.e., correct idea units) and elaborations (i.e., false idea units). People were given two recall tests after reading *The War of the Ghosts* story, one immediate and another one 48 hours later. Overall, people took an average of 8.209 minutes for the first recall test and 7.866 minutes for the second recall test. In the second analysis, people's response times in minutes during the first and second reading and / or viewing of the story were assessed. In the last analysis, a costs and benefits analysis was conducted to obtain efficiency scores. These efficiency scores would determine whether the amount of accuracy or elaborations and the response times to process the story for each respective presentation group had an influence on people's situation models and memory performance. All of the results were based on ANOVAs; post hoc tests were based on Bonferroni's adjusted or pairwise comparisons (all *p*s < .05).

Correct Recall

Session (Day 1 and 2). As predicted, people recalled more correct idea units in Day 1 (M = 46.033, SE = 1.866) than in Day 2 (M = 42.133, SE = 2.001), demonstrating a forgetting effect proposed by Ebbinghaus (1885 / 1913), F (1, 57) = 22.002, MSE = 20.739, $p < .001$, $\eta_p^2 = .278$ (see Figure 1). Although Ebbinghaus studied meaningless consonant-vowel-consonant information and showed forgetting, the current finding also suggests that meaningful information through text or pictures in a story can still be vulnerable to normal forgetting.

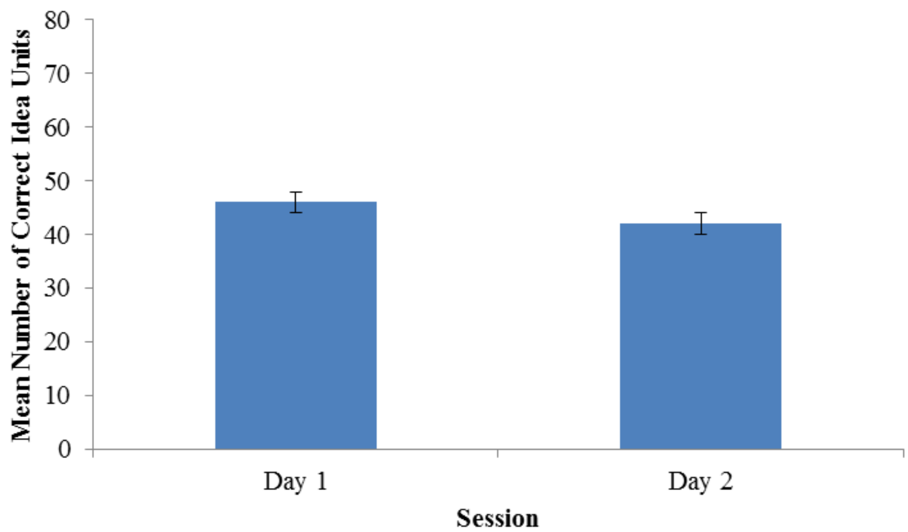


Figure 1. People recalled more correct idea units in Day 1 than in Day 2. Error bars represent standard errors.

Presentation (Text-Only, Pictures-Only, vs. Text-Pictures). There was a statistically significant difference among the three presentation groups, F (2, 57) = 51.992, MSE = 428.234, p < .001, η_p^2= .646 (see Figure 2). The text-pictures group (M = 63.225, SE = 3.272) recalled more correct idea units than the text-only (M = 51.300, SE = 3.272) group, which recalled more correct idea units than the pictures-only group (M = 17.725, SE = 3.272), all ps < .05. This finding supports the hypothesis that presenting text and pictures together provides a stronger contextual cue for forming a more accurate situation model. That is, when they produce mental representations from the text, their perceptual representation from the pictures may help to prevent any confusion or misunderstanding. The images in the narrative can contribute to their comprehension and memory of the story by allowing people to also form specific mental representations of what they should create for the text.

Additionally, the text-only group recalled more idea units than the pictures-only group due to having more contexts, or meaning, for the story. Another important factor is that with contextual cues given through text only, the group must rely heavily and actively on their mental images to maintain and organize information in memory. Unlike the text-pictures group, in which pictures assist with the processing of the information, the text-only group must use greater effort in forming their own situation models. A lack of attention to certain details of the story may have caused them to remember less than the text-pictures group.

In contrast, the pictures-only group recalled fewer idea units because they had to rely more on their own interpretation of the story. Although the picture superiority effect may have played a role in helping people to encode the details of the story, their perceptual representation was limited to not having contextual cues for the narrative. Contrary to what was predicted about people being passive in forming their own mental representations when pictures are only given, they were able to construct a new situation model for the pictorial narrative. Through speculating and using their schemas, they connected the story together with their own new meaning.

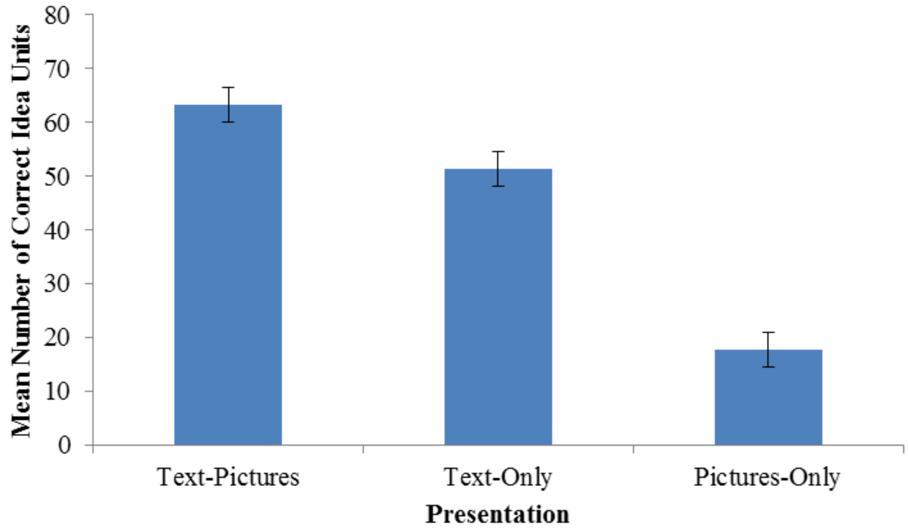


Figure 2. The text-pictures group recalled more correct idea units than the text-only and pictures-only groups; the text-only group recalled more correct idea units than the pictures-only group. Error bars represent standard errors.

Session X Presentation. A significant interaction was observed between session and presentation, F (2, 57) = 3.654, MSE = 20.739, p = .032, η_p^2= .646 (see Figure 3). Normal forgetting occurred for the text-pictures and text-only groups and not for the pictures-only group between Day 1 and Day 2. The text-pictures group recalled more correct idea units in Day 1 (M = 65.550, SE = 3.231) than in Day 2 (M = 60.900, SE = 3.465), t (19) = 3.261, p = .004, and the text-only group recalled more correct idea units in Day 1 (M = 54.400, SE = 3.231) than in Day 2 (M = 48.200, SE = 3.465), t (19) = 3.233, p = .004. Again, this finding suggests that meaningful information is not resistant to normal forgetting. Because situation models are typically tested immediately or just once, not much has been researched exploring multiple sessions, especially for a recall task. However, in a study by Copeland, Radvansky, and Goodwin (2009), they showed that forgetting can still occur in situation models when people read an autobiographical story and are given memory tests for events about the protagonist after an eight to nine day delay. Interestingly, they were also able to find reminiscence bumps (i.e., enhanced memories for distinct accomplishments or events in a person's life), showing that not all situation models easily dissipate in memory. However, as for the current experiment, the short story did not have a logical chronology or a life-altering event that people could rely on to maintain the situation models over time. Therefore, the decrease in recall from Day 1 to Day 2 for the text-pictures and text-only groups may suggest that distinct retrieval cues are necessary to hold onto specific details in memory. No significant difference in recall was observed in the pictures-only group for Day 1 (M = 18.150, SE = 3.231) and Day 2 (M = 17.300, SE = 3.465), t (19) = 1.188, p = .249. Because the pictures-only group relied more on their perceptual representation to interpret the story, they were limited to recalling accurate information during both days. Another possibility to consider here is that the lack of a drop-off for this group may have been to a floor effect, as much less information was correctly recalled by this group.

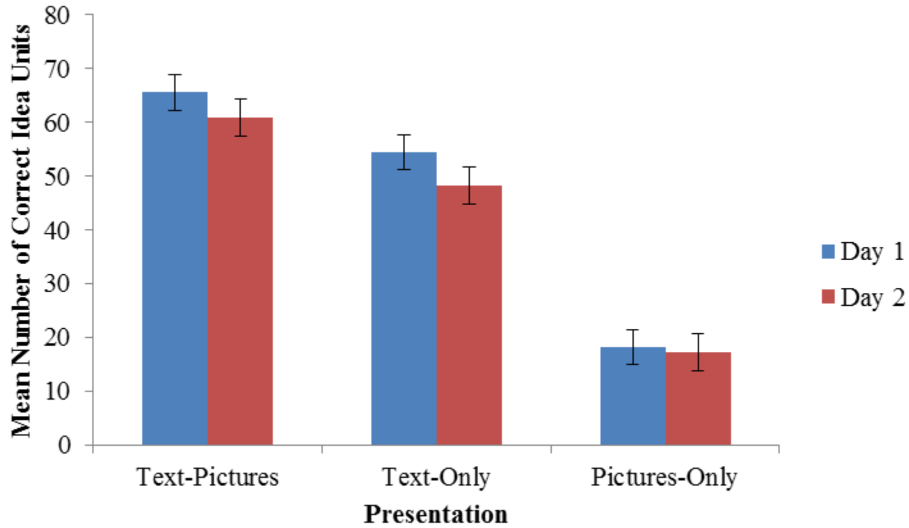


Figure 3. Normal forgetting in the number of correct idea units occurred for the text-pictures and text-only groups but not for the pictures-only group between Day 1 and Day 2. Error bars represent standard errors.

Elaborations

Session (Day 1 and 2). Contrary to what was predicted, there was no statistically significant main effect for session, F (1, 57) = .696, MSE = 3.460, p = .408, η_p^2= .012 (see Figure 4). They recalled a similar number of false idea units for Day 1 (M = 7.317, SE = .351) and Day 2 (M = 7.600, SE = .433). Although a null effect was shown, this finding still suggests that elaborations do exist. People are still likely to distort information as a way to make sense with what happened in the story over time (Bartlett, 1932).

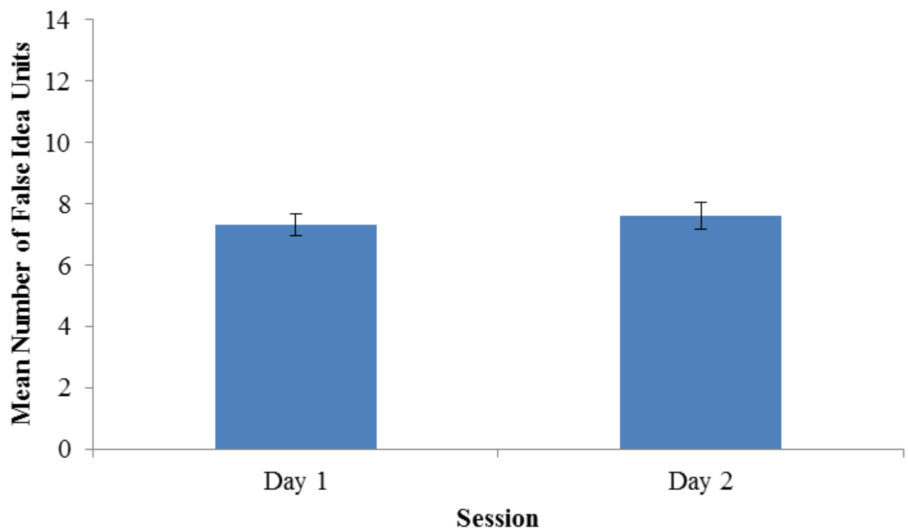


Figure 4. People elaborated similarly for Day 1 and Day 2. Error bars represent standard errors.

Presentation (Text-Only, Pictures-Only, vs. Text-Pictures). The results revealed a significant main effect for presentation, F (2, 57) = 25.118, MSE = 15.193, $p <$ .001, η_p^2= .012 (see Figure 5). The pictures-only group (M = 11.025, SE = .616) had more elaborations than the text-pictures (M = 5.675, SE = .616) and text-only (M = 5.675, SE = .616) groups, all ps < .001. No statistical differences were found between the text-pictures and text-only groups, p > .05. Without having accurate details from the text, the pictures-only group had to rely more on their perceptual representation, using their schemas to form a new and coherent mental representation for the story. As Wade et al. (2002) found in their study, people can often blend in pictures with their imagination, causing them to falsely recall information.

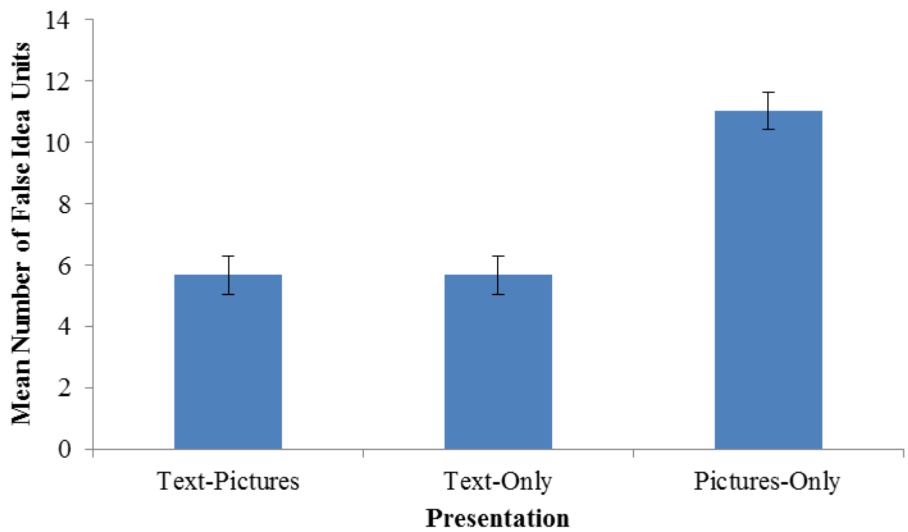


Figure 5. The pictures-only group recalled more false idea units than the text-pictures and text-only groups. Error bars represent standard errors.

Session X Presentation. A statistically significant interaction was found between session and presentation, F (2, 57) = 3.593, MSE = 3.460, p = .034, η_p^2= .112 (see Figure 6). The text-pictures group recalled more elaborations or false idea units in Day 2 (M = 6.450, SE = .750) than in Day 1 (M = 4.900, SE = .608), t (19) = 2.259, p = .036. However, no statistical differences were observed for the text-only and pictures-only groups between Day 1 and Day 2. The text-only group recalled a similar number of false idea units for Day 1 (M = 5.750, SE = .608) and Day 2 (M = 5.600, SE = .750), t (19) = .281, p = .782, and the pictures-only group recalled a similar number of false idea units for Day 1 (M = 11.300, SE = .608) and Day 2 (M = 10.750, SE = .750), t (19) = 1.037, p = .313. Note that the pictures-only group still had the most elaborations compared to the text-pictures and text-only groups for both days. However, the finding for the text-pictures group having more elaborations on the second recall test demonstrates that the combination of text and pictures are not impervious to false memories. Garry et al. (2007)

suggested that people can use pictures as a way to speculate and confirm details that may not exist in the text.

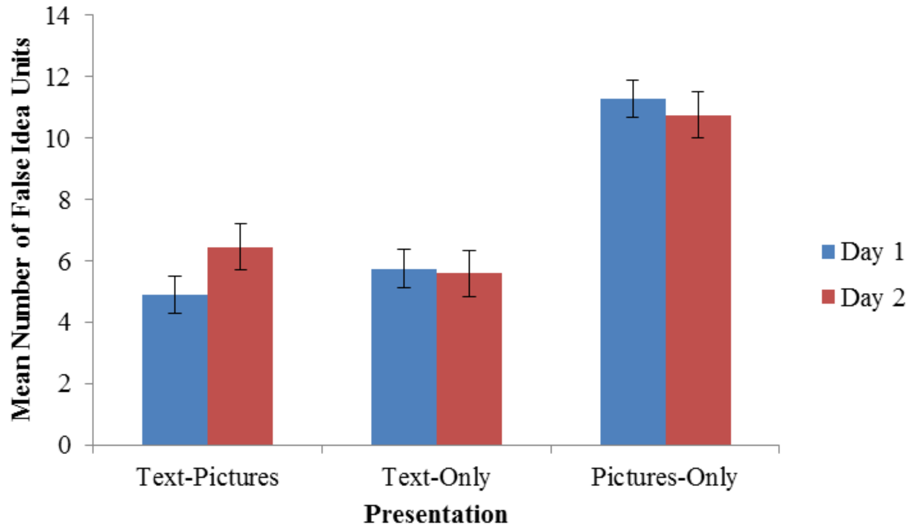


Figure 6. The text-pictures group recalled more false idea units from Day 1 to Day 2, whereas no increase in elaborations was observed in Day 1 and 2 for the text-only and pictures-only groups. Error bars represent standard errors.

Response Times of the Multimedia Sources

Encoding (First and Second Time). As predicted from the hypothesis, people were much slower in minutes for the first time (*M* = 3.182, *SE* = .147) encoding the story than the second time (*M* = 2.566, *SE* = .157), F (1, 57) = 13.119, *MSE* = .867, $p < .001$, η_p^2= .187 (see Figure 7). This finding supports the study by Zwaan, Magliano, and Graesser (1995), in that people are slower to process information for the first time because they must build a new situation model of the narrative.

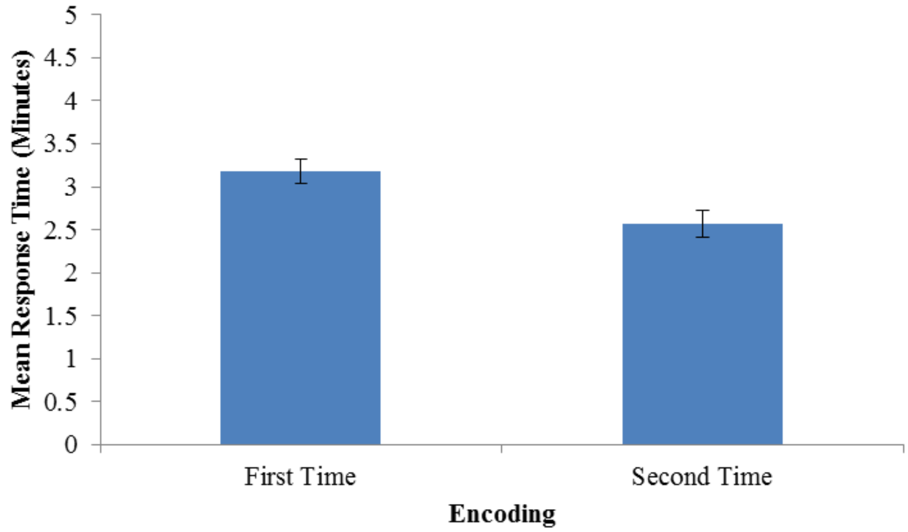


Figure 7. People took longer to process the story the first time than the second time. Error bars represent standard errors.

Presentation (Text-Only, Pictures-Only, vs. Text-Pictures). There was a significant main effect for presentation, showing differences in response times among the three presentation groups, F (2, 57) = 14.730, MSE = 1.913, p < .001, η_p^2= .341 (see Figure 8). Contrary to what was predicted, the text-pictures (M = 2.928, SE = .219) and pictures-only (M = 3.685, SE = .219) groups were slower than the text-only group (M = 2.010, SE = .219), all ps < .05. There were no differences found between the text-pictures and pictures-only groups, p > .05. The text-pictures group may have taken longer to process the story because people must integrate information from the text and pictures together to get a more complete situation model in memory. With the longer response times for the pictures-only group, this finding may suggest that not all perceptual representations are processed rapidly. Because the pictures-only group did not have any context to understand the storyline, they may have taken longer so that they can form their own situation models for the narrative.

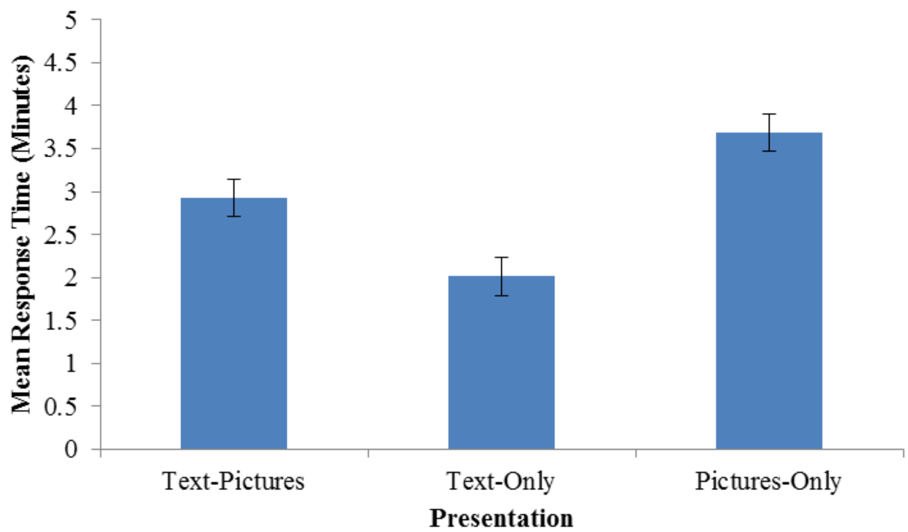


Figure 8. The text-pictures and pictures-only groups processed the story longer than the text-only group. Error bars represent standard errors.

Session X Presentation. There was no significant interaction between session and presentation, F (2, 57) = .779, MSE = .867, p = 464, $\eta_p{}^2$= .027 (see Figure 9). The text-pictures (First Time: M = 3.254, SE = .255; Second Time: M = 2.602, SE = .272), text-only (First Time: M = 2.179, SE = .255; Second Time: M = 1.840, SE = .272), and pictures-only (First Time: M = 4.113, SE = .255; Second Time: M = 3.257, SE = .272) groups were slower during the first time encoding and faster during the second time encoding the story. Again, this pattern supports the finding by Zwaan, Magliano, and Graesser (1995) that mental representations are more established in the first than the second processing of the narrative.

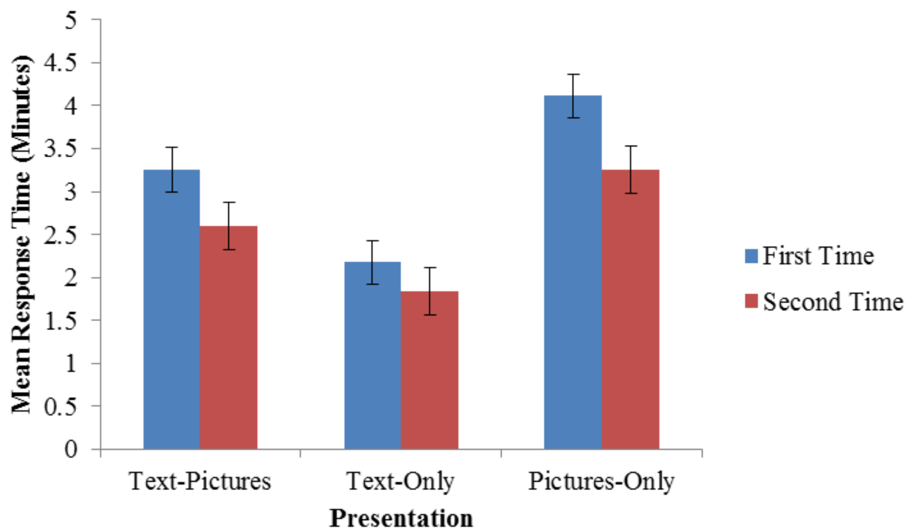


Figure 9. The three presentation groups were slower during the first time reading / viewing the story than the second time. Error bars represent standard errors.

The Costs and Benefits of Multimedia on Situation Models and Memories

The costs and benefits analysis was performed on the multimedia sources to determine whether the amount of time to process the story (i.e., in minutes) also influenced people's accuracy or elaboration in producing their situation models and memories. An efficiency score was computed for the text-pictures, text-only, and pictures-only groups using the following formula:

$$Efficiency\ Score = \frac{Correct\ Recall\ (Accurate\ Idea\ Units) - \ Elaborations\ (False\ Idea\ Units)}{Total\ Reading\ or\ Viewing\ Time\ (Minutes)}$$

Scores that range higher on the efficiency score would represent more accurate situation models and memories based on the amount of time it takes them to process the multimedia source. Scores that range lower on the efficiency score would represent more elaborated or inaccurate situation models and memories for the story.

The efficiency scores were statistically significant among the three presentation groups, F (2, 57) = 68.686, MSE = 39.069, p < .001, η_p^2= .707 (see Figure 10). The pictures-only group (*M* = 1.877, *SE* = 1.398) had the lowest efficiency score, lower than both the text-pictures (*M* = 23.008, *SE* = 1.398) and text-only (*M* = 20.666, *SE* = 1.398) groups, all *p*s < .001. There was no significant difference between the text-pictures and text-only groups; both showed high efficiency scores, *p* = .723. Even though processing time was longer for the pictures-only group, this occurrence did not deter them from making more elaborations. This finding may suggest that with pictures alone, people will use their own interpretation to satisfy their understanding of the story. However, processing time for the text-pictures and text-only groups may be important because it may allow them to build a stronger situation model for the context that they are given. Thus, this processing allows them to accurately recall details more.

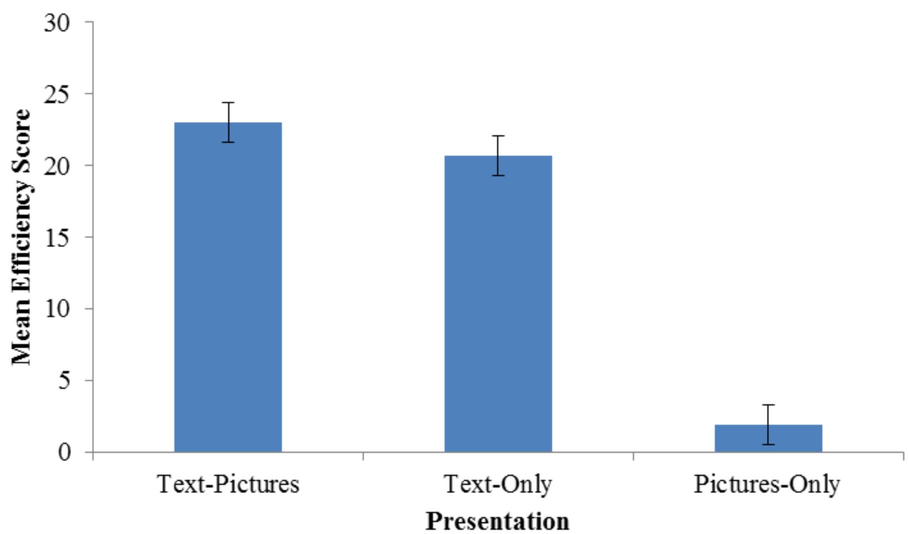


Figure 10. The text-pictures and text-only groups had higher efficiency scores than the pictures-only group. Error bars represent standard errors.

CHAPTER 3

EXPERIMENT 2

The purpose of Experiment 2 was to expand on the findings of Experiment 1 by examining how people process narrative changes for pictures and / or text. Experiment 2 consisted of four parts. For the first part, the focus was to compare people's correct recall (i.e., recalling accurate idea units) and elaborations (i.e., recalling false idea units) when presented with text-only, pictures-only, or text and pictures. These results were used to help determine whether the results from Experiment 1 can be replicated. For the second part, the focus was on what people monitor during their online reading or viewing of the comic book story. They were asked to make judgments during the story to determine if they observed certain changes in the events that caused them to form specific mental representations. The findings were based on their judgments for situation changes and response times for their online reading / viewing. For the third part, response times were assessed to determine whether there were differences in the text-only, pictures-only, and text-pictures groups when processing information to create situation models. For the fourth part, a costs and benefits analysis was performed to determine whether the length of time processing the narrative had an effect on people's accuracy or elaborations of the story.

When forming situation models, Zwaan, Langston, and Graesser (1995) suggested that people monitor various aspects, such as space, time, characters, and objects to guide them through the story to maintain coherence. This theory is known as the Event Indexing model. Studies have demonstrated that when people identify these dimensional changes throughout the progression of a narrative, they are likely to slow down in their ability to process the information. This slowdown occurs because people update, or link new information with relevant details already stored in long-term memory, to allow for comprehension. However, further research is needed to determine whether the formation of situation models for text only, pictures only, or text and pictures requires the same organization of these event indices to mentally represent the details of a story for later retrieval. The question remains of whether updating situation changes or shifts in the story allow the maintenance of certain mental representations to exist during recall over time.

Hypotheses

Correct Recall and Elaborations

The hypotheses for correct recall (accurate idea units) and elaborations (false idea units) were based on the outcome from Experiment 1. In examining correct recall, people would recall more correct idea units or propositions on Day 1 than on Day 2 due to normal forgetting. For the presentation modalities, the text-pictures group would recall more correct idea units than the text-only and pictures-only groups because the combination of text and pictures allows people to construct a stronger and more complete situation model. Additionally, the text-only group would recall more correct idea units than the pictures-only group because of more context and effort used to create a situation model. An interaction between session (Day 1 vs. Day 2) and presentation (text-only, pictures-only, and text-pictures groups) for correct recall was expected. The text-pictures and text-only groups would recall more idea units than the pictures-only group on Day 1, but the text-pictures group would recall more idea units than the text-only and pictures-only groups on Day 2. This interaction would suggest that the text-pictures group would have a stronger support system in creating a complete situation model than if text and pictures are presented separately.

In examining elaborations, people would recall similar false idea units on Day 1 and Day 2 because all of the groups are prone to forgetting and using their schema to connect the events of the story. When examining the presentation modalities, the pictures-only group would make more elaborations than the text-pictures and text-only groups. This main effect would occur because the pictures-only group would rely more on their schemas and interpretation of the story instead of the details found in the text. An interaction between session and presentation was predicted for the elaborations. The pictures-only group would recall more false idea units than the text-pictures and text-only groups on Day 1 and Day 2 because of their reliance on their own schemas and imagination to form a coherent story.

Judgments and Response Times

To examine judgments and response times for the Event Indexing analysis, regression analyses were performed. Because judgment responses were a categorical variable, logistic regressions were used. Also, because response times were a ratio variable, multiple regressions were used. Each person’s judgments or response times were set as an independent criterion and the event dimensions / situation shifts (i.e., space, time, characters, and objects) that were coded by the experimenter were set as the predictors. The predictors were forced entered into each regression and then the standardized regression coefficients (beta weights) for each dimension were extracted from each participant’s analysis to determine the variance taken into account between the predictors and the criterion. Because there was no way of standardizing beta weights in logistic regressions on SPSS, a formula was used to create the beta weights for judgments (see Appendix E; King, 2007). The beta weights for judgments and response times were analyzed using single sample *t*-tests to determine whether people detected situation changes for the dimensions. Beta weights that were significantly different than zero demonstrated that the dimensional shifts were reliably detected (Lorch & Myers, 1990).

For the judgment responses, there were two analyses conducted, once for the first time they read and / or viewed the story and the second for the next time that they read and / or viewed the story. During the first time when the participants were presented with the story, it was predicted that the text-pictures group would be able to detect changes for space, time, characters, and objects because they would rely on both pictures and text to update their mental representations for the changes. However, the text-only and pictures-only groups may not have the same advantage as the text-pictures group. For instance, for the text-only group, they may ignore changes for objects when they do not involve an explicit functional relationship in the story (e.g., a man using arrows to go to war; see Radvansky & Copeland, 2000 for details about functionality). For the pictures-only group, they may not be able to detect character changes because they were not given any other details about the characters beyond the images that they see for the first time. However, during the second time of reading and / or viewing the story, the text-pictures, text-only, and pictures-only groups were predicted to show judgments that reflected the situation changes similarly because they would be able to fill in parts of the situation model that they neglected to see during the first presentation (i.e., they would improve after having read / viewed the story once to give them a better understanding of the story).

The response times were also analyzed for the first and second time they read and / or viewed the story. Research has shown that updating situation shifts causes people to slow down in their processing time so that new information can be integrated with prior knowledge in memory. For both times that the story was presented, the text-pictures, text-only, and pictures-only groups would be expected to slow down for most of the event dimensions. However, certain situation shifts, such as space, may not follow the same pattern at least for the first time when they are shown the story (Zwaan et al., 1995). Instead, processing changes in location during the construction of a situation model may be due to automaticity or people's common experience of transitioning from one location to another (Radvansky & Copeland, 2010). Another issue to take into account would be the possibility that response times may be associated with judgment responses. Thus, for the text-only group, response times may be rapid during the first time reading because of the lack of functionality that would be perceived during processing. In addition, for the pictures-only group, the response times may be fast for character changes because they may perceive all of the characters as similar throughout the story.

Response Times of the Multimedia Sources

Based on the outcome of Experiment 1, people should have a slower response time (i.e., an increase in minutes) to process the story for the first time than the second time reading / viewing the story because they need to build up a situation model. Once mental representations have been established, they are likely to process the story more quickly for the second time than the first time due to familiarity. Zwaan, Magliano, and Graesser (1995) found that people would attend to other information (e.g., certain event dimensions) that they did not attend to during the first time. When examining the presentation groups, the findings from Experiment 1 suggest that the text-pictures and pictures-only groups should process the narrative longer than the text-only group. Specifically, the text-pictures group should take longer because they must integrate the text and pictures into a well-connected story. The pictures-only group should take longer to process the information because they must use their perceptual representation to create their own meaningful situation model. The text-only group should take less time than the other two presentation groups because they only need to create mental images based on what they read only. No significant interaction was predicted to occur between encoding and presentation because the three presentation groups would process first reading / viewing longer and the second reading / viewing quicker.

The Costs and Benefits of Multimedia on Situation Models and Memories

As in Experiment 1, the following formula was used to assess how people's correct recall and elaborations were influenced by the amount of time they spent processing the text-only, pictures-only, and text-pictures version of the narrative.

$$Efficiency\ Score = \frac{Correct\ Recall\ (Accurate\ Idea\ Units) - \ Elaborations\ (False\ Idea\ Units)}{Total\ Reading\ or\ Viewing\ Time\ (Minutes)}$$

A high efficiency score represented situation models and memories that were more accurate after the length of time reading and / or viewing the story. A low efficiency score meant that the situation models and memories were greatly affected by elaborations (more false idea units) based on the amount of time processing the story. The text-pictures and text-only groups would have the higher mean efficiency scores relative to the pictures-only groups because of the context that they are able to rely on when processing the story. In contrast, the pictures-only group would show the lowest mean efficiency score because they would use their perceptual representations more, causing them to elaborate on the story.

Method

Participants

Sixty students (26 males, 34 females; M_{age} = 19.50, SD_{age} = 2.198) from the University of Nevada, Las Vegas were recruited through the Department of Psychology's subject pool for research credit and did not take part in Experiment 1. They were randomly assigned to one of three presentation modality groups: text-only (n = 20), pictures-only (n = 20), or text-pictures (n = 20). None of the participants were familiar with the story that they were presented.

Design

A 2 (Session: Day 1 and 2) X 3 (Presentation: Text-Only, Pictures-Only, vs. Text-Pictures) mixed factorial ANOVA was performed with session being a within-subjects variable, and presentation being a between-subjects variable. The dependent measures were the recall of the propositions or idea units for accurate and elaborated memories of the story. For correct recall, there were a total of 127 accurate idea units possible. A 2 (Encoding: First Time and Second Time) X 3 (Presentation: Text-Only, Pictures-Only, vs. Text-Pictures) mixed factorial ANOVA was conducted to examine the response times people take to process the story based on their respective multimedia presentation. Encoding was a within-subjects variable, and presentation was a between-subjects variable. A one-way between-subject ANOVA was also performed to examine the efficiency scores or the costs and benefits of processing the story through text-pictures, text-only, or pictures-only.

In addition, an a priori analysis was conducted separately for the text-only, pictures-only, and text-pictures version of the story to determine whether people identified situation shifts in the story for space, time, and entity (i.e., characters and objects). For each of the dimensions, a “0” indicated no shift or change in the panel and a “1” indicated a shift or change in the panel. These changes for each dimension were used for regression analyses to later determine whether people’s judgments and response times corresponded to the changes that occur for space, time, characters, and objects in the narrative.

Space. Space was identified as a change in location. If the event took place in the same area between two panels, then the second panel would be coded as a “0”, indicating that there was no shift or change. In contrast, if the event took place in a different area from the previous panel, then the second panel was coded as a “1”, signifying that there was a spatial shift. Different perspectives of the same location (e.g., a different “camera angle” within the same area) for the pictures-only or text-pictures version were not be considered as a spatial shift.

Time. Time was defined as changes that occur in the sequence of the story. This dimension was often represented through the actions presented in the narrative. For instance, if the two young men were not hunting seals anymore and are hiding behind a log, this action was considered a temporal change. When the panel did not show a change in time, the panel was coded as a “0”. When the panel showed a different time than the previous panel, the panel was coded as a “1”.

Entity (Characters and Objects). Entity was identified as changes in the entrance of a character or object. Thus, entity was broken down and classified as two separate variables. Coding was based on when they entered or were present for the first time in a given event. For character, a situation change was identified if the character was out of sight during an important action sequence but entered into the scene again. For the pictures-only or text-pictures version, there was no shift if two characters had a direct conversation with each other but one of the characters disappeared temporarily from the current panel. For object, a situation change was observed if the object entered with a purpose in the story (e.g., arrows to make war) or if prominent characters were carrying or focusing on the object. An object that was out of sight during a panel but re-entered during a later scene in the pictures-only or text-pictures version were identified as a shift. In general, a panel was considered a “0” if the same characters or objects were in the panel and a “1” if new characters or objects entered in the panel.

Other Variables. Although the main focus of the regression analyses in the Event Indexing model is the situation changes for the event dimensions mentioned above, other variables, such as the number of items viewed in each panel for pictures and the number of syllables for text, were included for response time purposes. These two variables were used to ensure that they did not confound the outcome of the regressions by influencing delays in response times when people processed information for materials that were either presented in text or pictures. Therefore, they were added into the analyses when necessary. For the items in the panels, they were counted individually based on clothing (e.g., necklaces, vest, pants, etc.), paraphernalia (e.g., weapons, canoes, paddles, etc.), and location items (e.g., sky, trees, river, etc.). For the number of syllables, every word in the sentence or phrase of each panel was counted.

Materials and Procedure

Similar to Experiment 1, Experiment 2 consisted of two sessions. During the first session, the participants were seated in front of a computer and randomly assigned to the text-only, pictures-only, or text- pictures version of the Native American Indian folktale known as *The War of the Ghosts* (Bartlett, 1932). The participants in each of the groups indicated that they were not familiar with the story before taking part in the experiment. As in Experiment 1, a questionnaire at the end was used to make sure that they also did not search for the story on the Internet or from other outside sources throughout the duration of this experiment. Different reflection questionnaires were also given after each recall test in Day 1 and Day 2, asking participants to rate their attention and use of either the text and / or pictures for remembering the story (see Appendices F and G). Note that these reflection questionnaires are only addressed in the General Discussion section. The story was presented in 43 panels, shown individually on a computer screen using the E-Prime software. As they went through the story, the participants were instructed to identify whether there was a change in the event or situation in each panel. They were asked to use their best judgment for what constituted a change without the experimenters giving a specific definition for a situation change. This procedure was similar to a study conducted by Magliano et al. (2001), in which participants were asked to identify changes in a film they watched without any explanation of what the experimenters interpreted as situation changes. For this experiment, if there was no change in the panel, they had to type ‘S’ on the keyboard (later coded as “0”) for same event or situation. If a change occurred in the panel, they had to type ‘N’ on the keyboard (later coded as “1”) for new event or situation. By typing ‘S’ or ‘N,’ they were able to advance to the next panel on the computer screen. After they completed two readings / viewings of the story, they played Solitaire on the computer for ten minutes as a distracter. Then, they were asked to recall the story that they were shown by typing it online through Qualtrics without any time restrictions. Once they completed the recall task, the experimenter notified them that their second session would take place two days later. For the second session, participants were given a link for Qualtrics via email, asking them to go to the webpage to recall the story that they were presented previously. The recall test had no time limit. After they completed the recall task, the participants were taken to the debriefing webpage to inform them of the purpose of the study.

Results & Discussion

Experiment 2 was similar to Experiment 1 except that the organization of situation models was further explored using the Event Indexing model. There were four types of analyses conducted in this experiment. In the first analysis, people's memory performance was assessed using correct recall (i.e., correct idea units) and elaborations (i.e., false idea units). Like in Experiment 1, there were two recall tests, spread out in a two day period. Overall, people took an average of 7.607 minutes to recall the first test and 7.107 minutes to recall the second test. In the second analysis, the Event Indexing model, in which people were instructed to monitor situation changes in the story, was performed. This procedure measured their judgments and response times as a way to determine whether people's detection of situation changes correspond to changes in space, time, characters, and objects. In the third analysis, response times in minutes were assessed to examine whether processing is affected by the type of multimedia source (i.e., text-pictures, text-only, or pictures-only). In the last analysis, a costs and benefits analysis was conducted to measure efficiency scores for the three presentation groups. All analyses were performed using ANOVAs, and post hoc tests were derived from Bonferroni's adjusted or pairwise comparisons.

Correct Recall

Session (Day 1 and 2). There was a significant main effect for Session (Day 1 and Day 2), F (1, 57) = 19.322, MSE = 16.908, p < .001, η_p^2= .253 (see Figure 11). People recalled more correct idea units in Day 1 (M = 39.217, SE = 1.483) than in Day 2(M = 35.917, SE = 1.343), demonstrating a normal forgetting effect as proposed by Ebbinghaus (1885 / 1913).

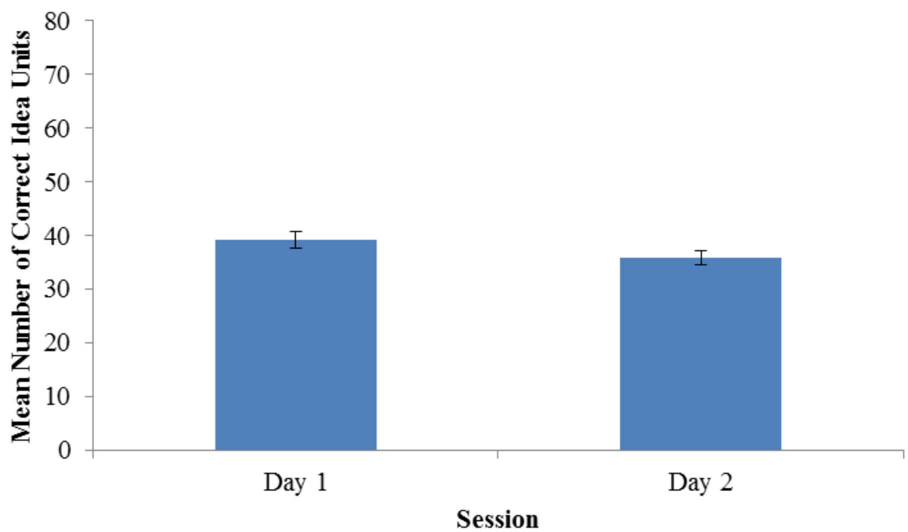


Figure 11. People recalled more correct idea units in Day 1 than in Day 2. Error bars represent standard errors.

Presentation (Text-Only, Pictures-Only, vs. Text-Pictures). A significant main effect was observed for the three presentation groups, F (2, 57) = 110.914, MSE = 223.297, p < .001, η_p^2= .796 (see Figure 12). Specifically, the results showed that the text-pictures group (M = 62.075, SE = 2.363) recalled more correct idea units than the text-only group (*M* = 38.300, *SE* = 2.363), and the text-only group recalled more correct idea units than the pictures-only group (*M* = 12.325, *SE* = 2.363), all *p*s < .001. When giving people text and pictures to encode the story relative to giving them only one of the multimedia sources, their recall accuracy was high, suggesting that context, or meaningfulness, and the integration of text and pictures can strengthen people's situation models and memory. Although the text-only group did not recall similar correct idea units as the text-pictures group, the text-only group still exhibited strong memory accuracy. This finding indicates that context is not only an important factor but that the mental effort to create an accurate situation model in text promotes greater encoding and storage in memory. Like Experiment 1, the pictures-only group continued to recall fewer correct idea units. This pattern suggests that when perceptual representations are only available, people do not necessarily have a complete understanding of the story to create an accurate situation model.

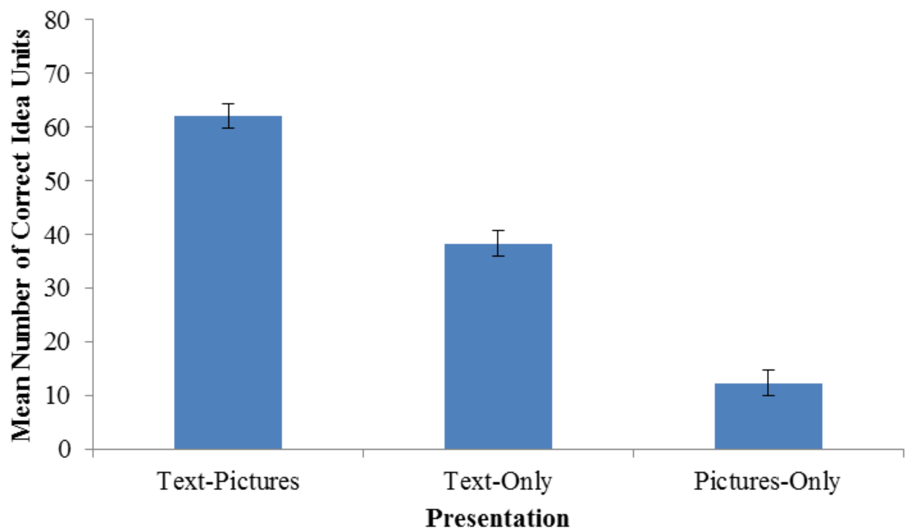


Figure 12. The text-pictures group recalled more correct idea units than the text-only and pictures-only groups; the text-only group recalled more correct idea units than the pictures-only group. Error bars represent standard errors.

Session X Presentation. A significant interaction for correct recall was found between session and presentation, F (2, 57) = 10.692, MSE = 223.297, p < .001, η_p^2= .273 (see Figure 13). There was a marginally significant decrease in recalling correct idea units for the text-pictures group from Day 1 (M = 63.450, SE = 2.568) to Day 2 (M = 60.700, SE = 2.327), t (19) = 1.771, p = .093. The text-only group also recalled fewer correct idea units from Day 1 (M = 42.200, SE = 2.568) to Day 2 (M = 34.400, SE = 2.327), t (19) = 5.193, p < .001. No recall differences of correct idea units were found for the pictures-only group between Day 1 (M = 12.000, SE = 2.568) and Day 2 (M = 12.650, SE = 2.327), t (19) = 1.771, p = .093. People in the text-pictures and text-only groups recalled slightly fewer correct idea units in Day 2 compared to Day 1. This finding suggests that situation models are not as easily maintained over time without the use of strong retrieval cues. In studies examining situation models, recognition probes have typically been used to activate memories of their mental representations, specifically in some form of immediate testing. However, this study used subsequent recall tests, requiring people to make their own retrieval cues. As a result, their situation models showed degradation over a two day period. As stated earlier when discussing the results of Experiment 1, the pictures-only group showed no difference in forgetting between Day 1 and Day 2 because their recall for the correct idea units during both days was already low. Although there may have been a picture superiority effect for the pictures-only group, their perceptual representations was not enough to interpret the details of the story accurately.

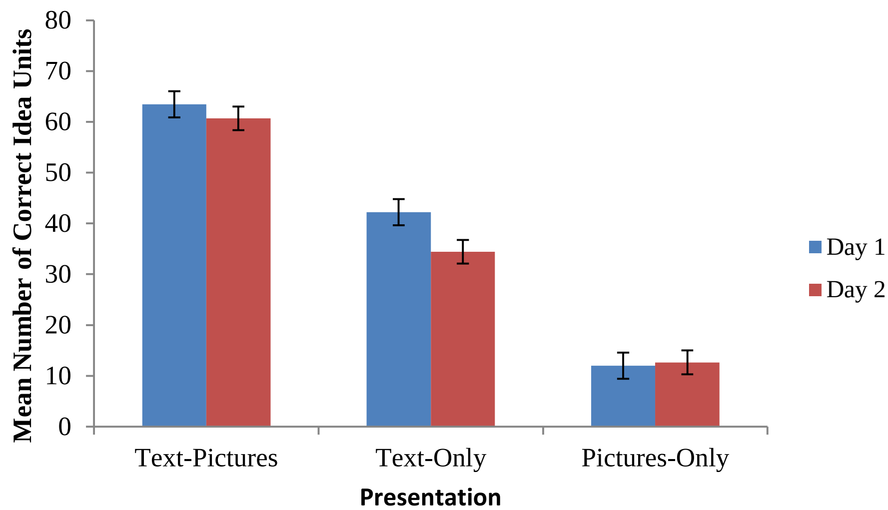


Figure 13. The text-pictures and text-only groups recalled fewer correct idea units in Day 2 than in Day 1 relative to the pictures-only group, showing normal forgetting. Error bars represent standard errors.

Elaborations

Session (Day 1 and 2). In examining elaborations, there was a significant main effect for session, F (1, 57) = 8.010, MSE = 2.922, p = .006, η_p^2= .123 (see Figure 14). People recalled more false idea units in Day 2 (M = 8.417, SE = .429) than in Day 1 (M = 7.533, SE = .363). This outcome was not like Experiment 1 although it should be noted that in Experiment 1 it was a null effect, not an opposite effect. This pattern was similar to other studies, in which more elaborations occurred over time (e.g., Bergman & Roediger, 1999). Bartlett (1932) suggested that these elaborations are due to rationalization and distortions to make information more understandable.

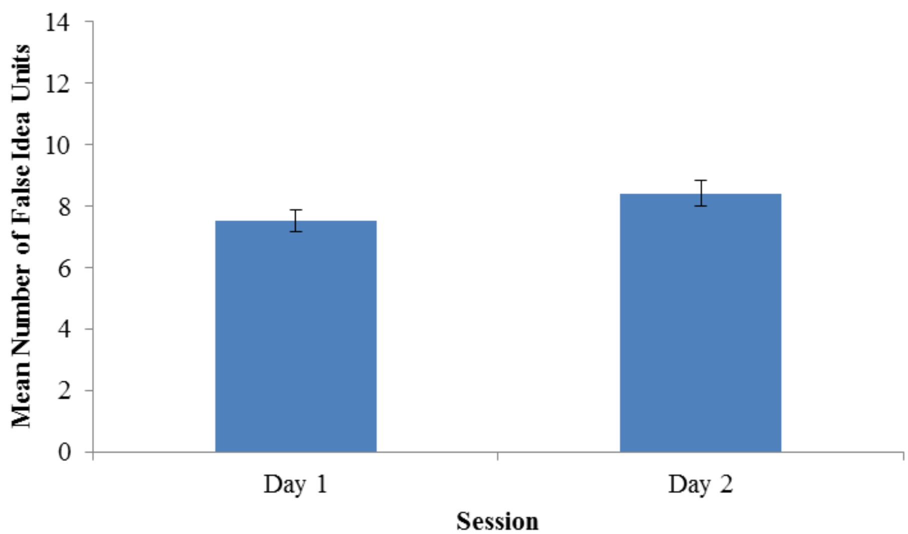


Figure 14. People recalled more false idea units in Day 2 than in Day 1. Error bars represent standard errors.

Presentation (Text-Only, Pictures-Only, vs. Text-Pictures). A significant main effect was also found for the three presentation groups, F (2, 57) = 6.188, MSE = 16.035, p = .004, η_p^2= .178 (see Figure 15). People in the pictures-only group (M = 9.775, SE = .633) made more elaborations than the text-pictures (M = 6.850, SE = .633) and text-only groups (M = 7.300, SE = .633), both ps < .05; the text-pictures and text-only groups showed no significant difference in elaborations, p > .05. This finding was similar to Experiment 1, demonstrating that without context, people are more likely to make more false idea units to make sense of the story. The pictures-only group had to rely on their perceptual representations to create their own meaningful mental representation.

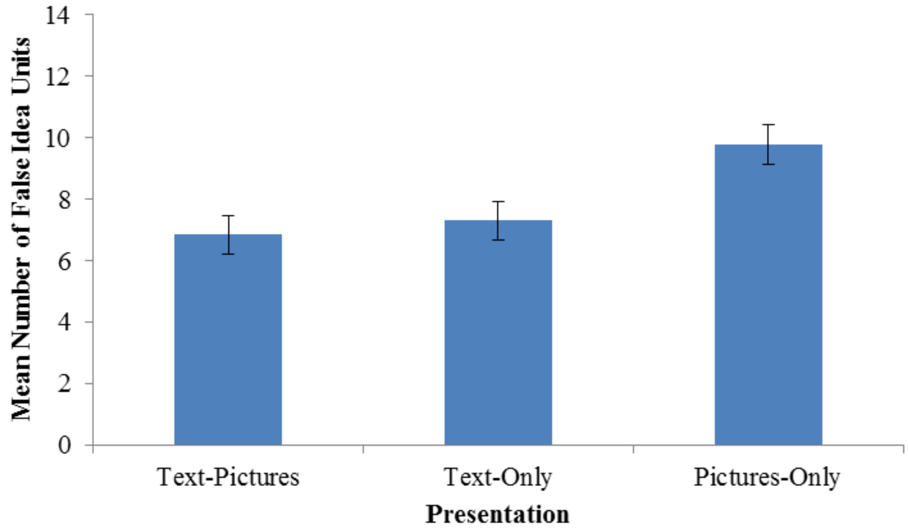


Figure 15. The pictures-only group recalled more false idea units than the text-pictures and text-only groups. Error bars represent standard errors.

Session X Presentation. There was a significant interaction between session and presentation for elaborations, F (2, 57) = 3.510, MSE = 2.922, p = .037, η_p^2= .110 (see Figure 16). The text-pictures and text-only groups made more elaborations in Day 2 than in Day 1 compared to the pictures-only group. The text-pictures group showed an increase in false idea units recalled from Day 1 (M = 6.000, SE = .628) to Day 2 (M = 7.700, SE = .744), t (19) = 2.635, p = .016, and the text-only group showed a similar pattern from Day 1 (M = 6.700, SE = .628) to Day 2 (M = 7.900, SE = .744), t (19) = 2.303, p = .033. No significant difference in elaborations was observed for the pictures-only group in Day 1 (M = 9.900, SE = .628) and Day 2 (M = 9.650, SE = .744), t (19) = .575, p = .572, but they still recalled the highest number of false idea units for both days than the other two presentation groups. Contrary to what was observed in Experiment 1, the text-only group (like the text-pictures group) elaborated more in Day 2. This outcome may suggest that they may not be resistant to false recall either. Although accuracy is high for the text-pictures and text-only groups, elaborations may be used as a way to connect information that may not make sense or that people do to recover information that has been forgotten. For the pictures-only group, their elaborations were both high for both days because they had to rely on their interpretation of the pictures to comprehend what is going on in the narrative.

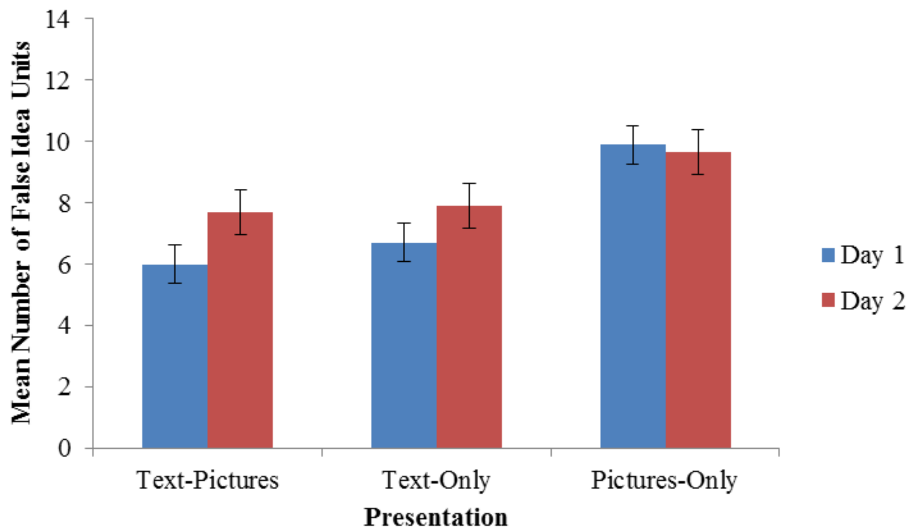


Figure 16. The text-pictures and text-only groups recalled more false idea units from Day 1 to Day 2 than the pictures-only group. Error bars represent standard errors.

Judgments and Response Times

Text-Pictures Group. For the judgment responses during the first reading / viewing of the story, the beta weights from the single sample *t*-test showed significance for time, t (19) = 2.654, p = .016, and characters, t (19) = 4.705, p < .001 (see Table 1). As changes occurred in the panels for time (B = .133) and characters (B = .094), people were likely to identify situation changes as well. During the second reading / viewing of the story, judgment responses were significant for space, t (19) = -2.698, p = .014, time, t (19) = 4.006, p < .001, and characters, t (19) = 3.783, p < .001 (see Table 1). Although space was significant, the beta weight showed that people's judgments were less likely to correspond to location changes when they were present (*B* = -.076). However, when changes occurred for time (*B* = .187) and characters (*B* = .166), their judgments corresponded to those changes.

In examining response times for the text-pictures group, two other variables were included in the regression model before the beta weights were analyzed. They were items in the panels (i.e., the number of items pictured in each panel) and the number of syllables. These variables were added to make sure that they did not influence the response times for the other beta weights. That is, rather than slowdowns in response times being due to situational shifts, they could simply be a result of superficial characteristics such as the number of items or number of syllables; thus, these factors were also included in the analyses.

Using the single sample *t*-test for the first reading and viewing of the story, the findings showed a significant difference for time, t (19) = 4.663, $p < .001$, characters, t (19) = 6.525, $p < .001$, items in the panels, t (19) = -3.361, $p = .003$, and syllables, t (19) = 14.069, $p < .001$ (see Table 1). The beta weights for time (*B* = .221) and characters (*B* = .212) indicated that as changes occurred for these event dimensions in the story, people were likely to slow down due to an updating effect. In addition, they were likely to slow down when more syllables were present in the panel (*B* = .448). However, for the number of items in the panels, the beta weight showed that people were still faster to respond even when there were more items in the pictures that they processed (*B* = -.123). During the second reading and viewing of the story, the single sample *t*-tests revealed a significant difference in response times for space, t (19) = -4.061, $p < .001$, time, t (19) =

3.043, p = .007, characters, t (19) = -2.663, p = .015, and syllables, t (19) = 12.349, p < .001 (see Table 1). For space, even though the beta weight for the event dimension was significant, people were likely to respond faster when locations changed in the story (B = -.136). Similar to the first reading and viewing of the story, people were slower for changes for time (B =.120) and characters (B = .091) when they occurred in the story. They were also likely to slow down when the number of syllables increased in the panels (B = .345).

Table 1

Judgment and Response Time Beta Weights for the Text-Pictures Group

Event Indices	**Judgments (First Reading / Viewing)**	**Judgments (Second Reading / Viewing)**	**Response Times (First Reading / Viewing)**	**Response Times (Second Reading / Viewing)**
Space	-0.002	-0.076*	-0.094	-0.136**
Time	0.133*	0.187***	0.221***	0.120**
Characters	0.094***	0.166***	0.212***	0.091*
Objects	-0.072	-0.011	0.033	-0.007
Items in the Panels	----	----	-0.123**	0.032
Syllables	----	----	0.448***	0.345***

Note. * p < .05, two-tailed. ** p < .01, two-tailed. *** p < .001, two-tailed.

Text-Only Group. The single sample t-tests for the first reading judgments showed a significant difference for space, t (19) = 4.123, p < .001, and time, t (19) = 2.844, p < .01 (see Table 2). As changes occurred for space (B = .070) and time (B = .067) in the story, they were able to detect situation changes as well. A similar pattern was observed for the second reading judgments, in which people detected situation changes when there were changes for space (*B* = .202), *t* (19) = 2.830, *p* = .011, and time (*B* = 154), *t* (19) = 3.183, *p* = .005 (see Table 2).

For response times, the number of syllables was added into the regression analyses before extracting the beta weights for each participant. Using the single samples *t*-tests, significant differences were found for the beta weights for the first reading of the story in space, *t* (19) = 4.590, *p* < .001, time, *t* (19) = 2.940, *p* = .008, characters, *t* (19) = 2.439, *p* = .025, and syllables, *t* (19) = 9.546, *p* < .001 (see Table 2). People were likely to slow down when event changes were present for space (*B* = 157), time (*B* = .078), and characters (*B* = .094) due to having to update new information into their situation models. They were also slower when the number of syllables increased in the story. For the second time reading through the story, the single samples *t*-tests revealed no significant differences for the event indices (*p* > .05) except for syllables, , *t* (19) = 10.819, *p* < .001 (see Table 2). As more syllables were present in the panels, they were likely to slow down (*B* = .524).

Table 2

Judgment and Response Time Beta Weights for the Text-Only Group

Event Indices	**Judgments (First Reading)**	**Judgments (Second Reading)**	**Response Times (First Reading)**	**Response Times (Second Reading)**
Space	0.070**	0.202*	0.157***	0.014
Time	0.067**	0.154**	0.078**	0.012
Characters	0.016	0.005	0.094*	-0.052
Objects	0.019	0.018	0.040	-0.027
Syllables	----	----	0.459***	0.524***

Note. * *p* < .05, two-tailed. ** *p* < .01, two-tailed. *** *p* < .001, two-tailed.

Pictures-Only Group. For judgments, the beta weights were only significant for space, t (19) = -2.658, p = .016, and objects, t (19) = -2.861, p = .010, during the first viewing (see Table 3). Although both event dimensions were statistically significant, the patterns showed that people did not detect situation changes when shifts in location (B = -.198) and objects (B = -.057) were present. No significant differences were observed in the event indices for the beta weights during the second viewing of the story, p > .05 (see Table 3).

For response times, the number of items shown in each panel was included in the regression analysis to ensure that the beta weights were not influenced by the length of time people took to process the story. The beta weights from the single sample *t*-tests were only significant for space, t (19) = 3.420, p = .003, characters, t (19) = 5.494, p < .001, and items in the panels, t (19) = - 2.958, p = .008, for the first viewing (see Table 3). When there were changes for space (B = .174) and characters (B = .208), people tended to slow down to update new mental representations into their memory. Although the variable for items in the panels was significant, the beta weight indicated that people were faster to respond to the panels regardless of how many items were in the pictures (B = -.084). There were no significant differences detected for the second time they viewed the pictures in the story, p > .05 (see Table 3).

Overall, from the three presentation groups, object shifts were not as prominent when detecting situation changes in people's judgments and response times. A possibility for why object changes did not correspond to their situation models is that they did not have a functional relationship to the characters (Radvansky & Copeland, 2000) or there were not a lot of object changes that occurred for people to notice as a situation change while reading or viewing the story. In addition, the results showed many inconsistencies for the other event dimensions. This issue will be discussed in the General Discussion.

Table 3

Judgment and Response Time Beta Weights for the Pictures-Only Group

Event Indices	**Judgments (First Viewing)**	**Judgments (Second Viewing)**	**Response Times (First Viewing)**	**Response Times (Second Viewing)**
Space	-0.198*	-0.124	0.174**	0.065
Time	0.102	0.064	0.016	-0.059
Characters	-0.003	-0.028	0.208***	0.014
Objects	-0.057**	0.119	0.048	-0.005
Items in the Panels	----	----	-0.084**	0.026

Note. * $p < .05$, two-tailed. ** $p < .01$, two-tailed. *** $p < .001$, two-tailed.

Response Times of the Multimedia Sources

The response times in minutes were assessed to examine whether people's ability to form situation models is associated with the length of time people process the text-pictures, text-only, or pictures-only version of the story.

Encoding (First and Second Time). Similar to Experiment 1, people took longer to process the story during the first time (M = 3.362, SE = .136) relative to the second time (M = 2.162, SE = .098) reading / viewing the story, F (1, 57) = 87.222, MSE = .495, $p < .001$, η_p^2= .605 (see Figure 17). This finding is similar to the study by Zwaan, Magliano, and Graesser (1995) when they gave participants text narratives twice. This finding suggests that people take longer to process the first reading / viewing of the story to build some form of situation model, whereas they take less time to process the second reading / viewing of the story because they are now re-establishing the information that they have already created in their situation model.

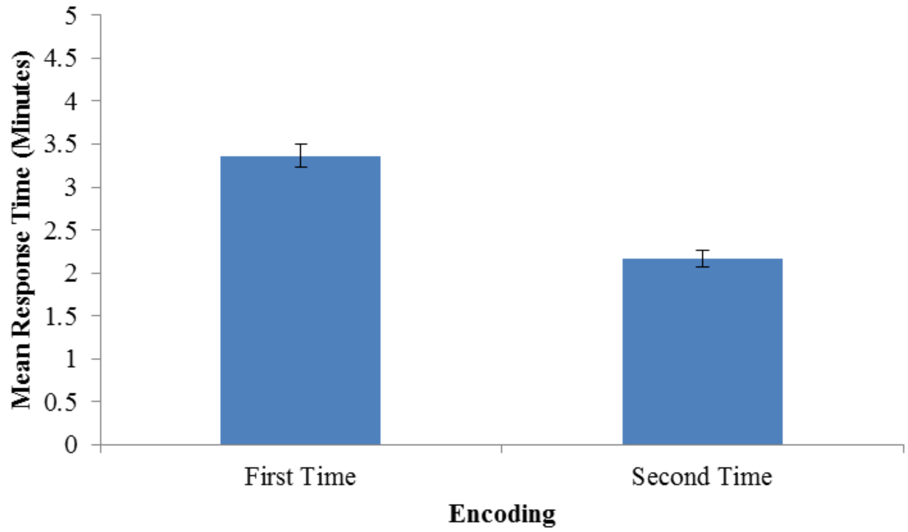


Figure 17. People took longer processing the story during the first time than the second time. Error bars represent standard errors.

Presentation (Text-Only, Pictures-Only, vs. Text-Pictures). There was a significant main effect for presentation, F (2, 57) = 12.305, MSE = 2.388, $p < .001$, η_p^2= .302 (see Figure 18). However, unlike Experiment 1, the text-pictures (M = 3.357, SE = .173) and text-only (M = 2.783, SE = .173) groups processed the story much longer than the pictures-only (M = 2.146, SE = .173) group, all ps < .05. In addition, there was a marginally significant difference observed between the text-pictures and text-only groups, p = .067. One possibility for why the outcome of the pictures-only group occurred was that instead of people focusing on the story itself, they may have attended to whether there were changes in the situation of the story without putting much effort in creating some form of context or meaning. However, the patterns for the text-pictures and text-only groups were similar to Experiment 1. The text-pictures group took longer to process the story than the text-only group. The findings suggest that the integration of text and pictures affects how information is processed in memory. Specifically, they must use their mental representations for the text and ensure that the pictures correspond to their own created mental images of the story and vice versa. Unlike the text-pictures group, the text-only group only relied on their mental images only, causing no delays in encoding the details of the narrative.

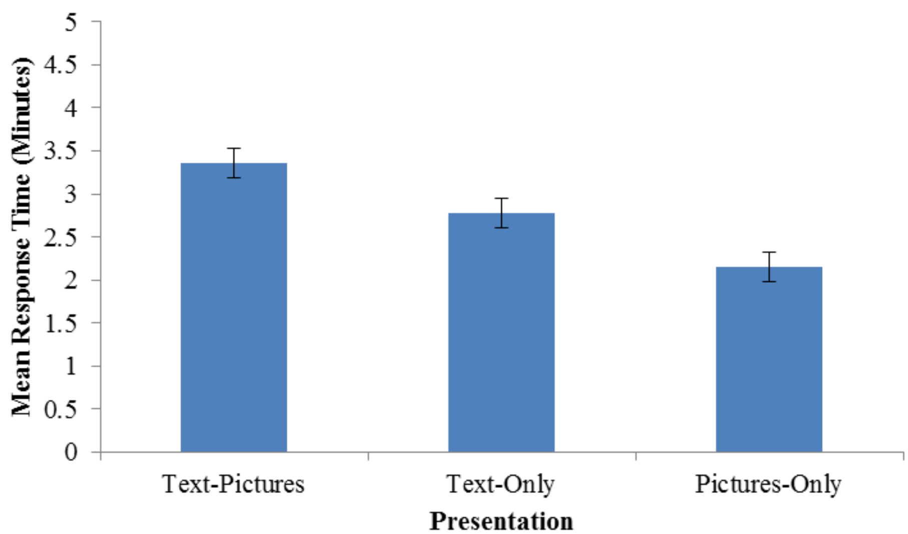


Figure 18. The text-pictures group processed the story longer than the text-only and pictures-only groups, followed by the text-only group processing the story longer than the pictures-only group. Error bars represent standard errors.

Encoding X Presentation. There was no significant interaction between encoding and presentation, F (2, 57) = .650, MSE = .495, p = .526, η_p^2= .022 (see Figure 19). The text-pictures (First Time: M = 4.005, SE = .236; Second Time: M = 2.710, SE = .169), text-only (First Time: M = 3.438, SE = .236; Second Time: M = 2.128, SE = .169), and pictures-only (First Time: M = 2.642, SE = .236; Second Time: M = 1.650, SE =

.169) groups processed the story longer during the first time of reading / viewing than the second time, showing a pattern similar to the study by Zwaan et al. (1995).

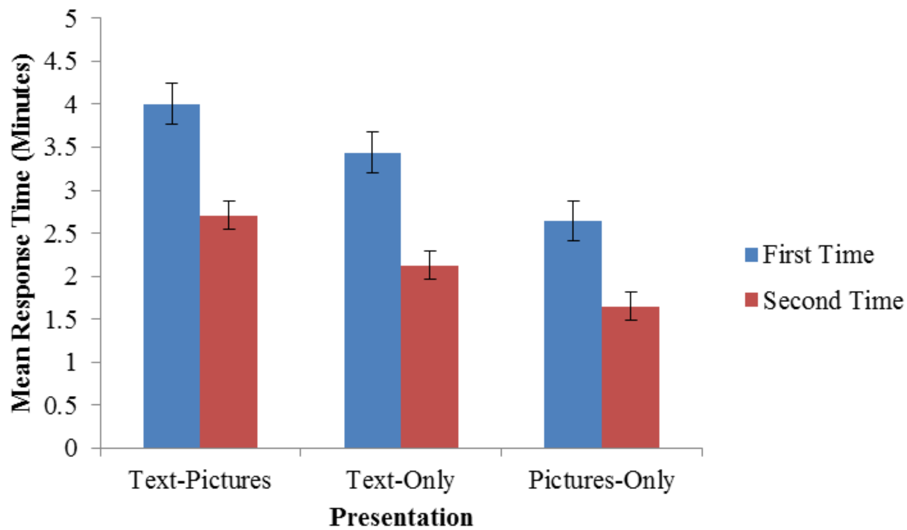


Figure 19. All of the presentation groups read / viewed the story longer during the first time than the second time. Error bars represent standard errors.

The Costs and Benefits of Multimedia on Situation Models and Memories

A costs and benefits analysis was conducted to examine if the length time to process the text-only, pictures-only, and text-pictures story affects the accuracy or elaborations of people's recall. Efficiency scores were assessed by using the following formula:

$$Efficiency\ Score = \frac{Correct\ Recall\ (Accurate\ Idea\ Units) - \ Elaborations\ (False\ Idea\ Units)}{Total\ Reading\ or\ Viewing\ Time\ (Minutes)}$$

High efficiency scores showed that people's situation models and memories were accurate when processing the story. Low efficiency scores showed that their situation models and memories were driven more by elaborations or inaccurate details.

There was a statistically significant difference among the three presentation groups, F (2, 57) = 65.439, MSE = 19.902, p < .001, η_p^2= .697 (see Figure 20). The pictures-only group (M = 1.302, SE = .998) had the lowest efficiency scores, significantly lower than the text-only group (M = 11.553, SE = .998), $p < .001$, which was significantly lower than the text-pictures group (M = 17.223, SE = .998), $p < .001$. Like Experiment 1, this result suggests that the pictures-only group may rely greatly on elaborations to understand the story. Even with a low processing time, the pictures-only group will organize and interpret the narrative in their own way. However, the text-pictures group had a significantly higher mean efficiency score than the text-only group. This difference suggests that by processing both text and pictures as well as identifying changes occurring in the story, people are able to encode and organize more details for their situation models in memory.

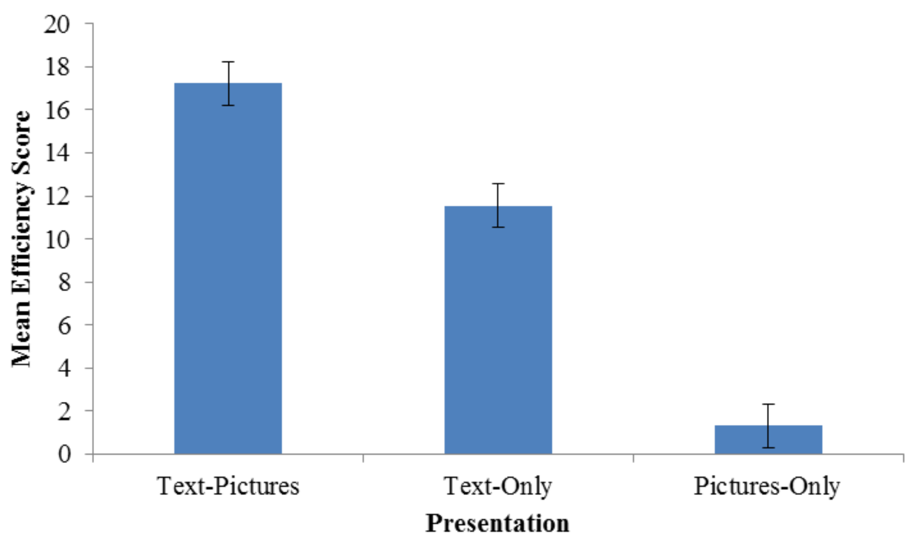


Figure 20. The text-pictures group had the highest mean efficiency score than the text-only and pictures-only group; the text-only group had a higher mean efficiency score than the pictures-only group. Error bars represent standard errors.

CHAPTER 4

GENERAL DISCUSSION

In this dissertation, Experiments 1 and 2 were conducted to examine how people form situation models in multimedia through text and pictures. Using Bartlett's (1932) *The War of the Ghosts* story, people were tested on their recall for the narrative during a two day period. The findings showed that they had normal forgetting and more elaborations (e.g., schemas, rationalizations, distortions) from Day 1 to Day 2, which is consistent with previous studies that have found that memories continue to be reconstructive when the narrative is given visually (as in reading through text only) or aurally (see Kellogg, 2007; Ross & Millsom, 1970). In addition, previous studies have shown that people were likely to forget information from the text and then create false memories, regardless of whether they were told to retell or remember the story (Bergman & Roediger, 1999). This dissertation differed from those studies in that it used a manipulation that has yet to be investigated, which is the use of an illustrated version of the narrative to understand how information is stored and retrieved during subsequent recall tests. In addition, this dissertation focused on how both accurate and false memories are influenced by textual or pictorial mental representations.

A New Perspective on Situation Models and Multimedia

According to Mayer's (2005) cognitive theory of multimedia learning, people can process information and create mental representations using both a verbal and pictorial model. To put it simply, the verbal model is considered as situation models that are text-based information, and the pictorial model is considered as situation models that are image-based information. Mayer indicated that these two models can work together or separately depending on how the information is presented. For instance, when text and pictures are shown together, people can integrate or independently use their verbal and pictorial models for comprehension. Similarly, when text or pictures are presented individually, they can activate the verbal or pictorial models alone, respectively. However, this theory is limited in that there is not much information detailing how these verbal and pictorial models operate to create those mental representations so that information is stored in memory.

In this dissertation, the purpose was to specifically identify how mental representations for text and pictures are created during the processing of information into their verbal and pictorial models. If these mental representations are created, another aspect to consider was to investigate how they are organized, stored, and maintained over time. The findings from Experiments 1 and 2 provided a new perspective for understanding the cognitive theory of multimedia learning in the realm of narratives. To thoroughly discuss the function of how situation models are constructed and remembered through multimedia, the focus will be divided into the encoding process and the storage / retrieval process.

To examine the encoding process, people were asked to rate at the end of their first recall session about whether they attended to the text and / or pictures in the story (see Appendices F and G). These questions were used to ensure that some form of processing was involved based on the multimedia presentation that they were given. Because the descriptive responses were similar in both experiments, they were assessed altogether. For the text-pictures group, people rated their attention to the text and pictures similarly, showing that there was no bias for one multimedia mode over the other. When given only one type of modality (i.e., text or pictures), people also rated highly for their respective groups. That is, the text-only group rated highly for attending to the text in the story, and the pictures-only group rated highly for attending to the pictures in the story. Thus, this finding is consistent with Mayer's (2005) theory in that people do channel in mental representations into their verbal or pictorial models when information is selected from the text or pictures.

However, unlike Mayer's theory, the findings from people's correct recall and elaborations may suggest that there is much more to how the encoding process works. For the verbal model, it seems that people are capable of creating their mental representations easily from the text due to having contextual cues for the story. Specifically, the text-pictures and text-only groups had high memory accuracy because they had unambiguous details of what was happening in the narrative (provided in the text). If pictures are also involved with the text, their memories are strengthened by the integration. However, Mayer's pictorial model may operate more differently than how it is proposed. Currently, the pictorial model is considered as a single representation for any images being processed. Contrary to this idea, the pictorial model may actually be organized into two types of representations; they are perceptual and situation model-based. Perceptual representations are specific, in that information is derived by the details of the images during encoding; this may allow for picture-superiority effects to occur. However, this type of representation may play a passive role for encoding because the focus is only on what was seen. The situation model-based representation requires much more effort because people must draw inferences and create some form of context to make sense of the narrative. When no textual information is available, people may start to embellish on what is going on in the story to create a coherent situation model. As a result, unlike retrieving accurate mental representations from the text in the verbal model for the text-pictures and text-only groups, the pictures-only group may elaborate or use their situation model-based representation to help describe and connect their understanding of their perceptual representation.

When examining the storage and retrieval process, people were also given questions during the second recall session about whether they relied on their textual or pictorial information to remember the story (see Appendices F and G). Based on the descriptive responses, the text-pictures group's ratings were about the same on average (although the patterns appear to show a slightly higher rating for the pictures). Another slight difference in ratings was observed for the text-only and pictures-only groups. Specifically, based on their average ratings, the pictures-only group rated higher for using pictures to remember the story than the text-only group for rating their use of textual information for memory retrieval. This pattern may suggest that perceptual representations, such as images, can strengthen people's memories, allowing the possibility for a picture-superiority effect. Although people are able to rely on text and pictures to help them remember the story, they are not necessarily resistant to normal forgetting. As a result, they may rely more on their schemas to help them organize details that could allow them to connect the story in a coherent manner. This assumption can be supported by the fact that the text-pictures and text-only groups recalled more false idea units after a two day period. The pictures-only group did not show any forgetting for correct recall (although they showed a floor effect in both their recall tests) and they did not show an increase in elaborations, suggesting that contextual cues are very important to maintain accuracy.

The Event Indexing Model

In Experiment 2, the Event Indexing model was incorporated into people's reading and / or viewing of the story by taking their judgment responses and response times. Zwaan, Langston, and Graesser (1995) indicated that people simultaneously monitor various changes in the events of a story to help organize and form situation models. This dissertation focused on space, time, characters, and objects for situation changes in the story. From the results, while people were more likely to monitor time and character, people were less likely to detect changes for objects (except for the pictures-only group in the first viewing for judgment). This finding may suggests that objects are not as meaningful or important in connecting information into people's situation models compared to the other event dimensions. Some researchers have also found this similar result in their experiments, suggesting that object changes are not as recognizable if they do not exhibit a strong functional relationship to the story (Radvansky & Copeland, 2000). With spatial changes, people also showed inconsistent judgments and response times. However, Radvansky and Copeland (2010) have argued that detecting shifts in space may be an automatic process because of people's day-to-day experience in changing from one location to another. Therefore, people's recognition of spatial changes can often come and go.

In examining other results of the Event Indexing model, the text-pictures, text-only, and pictures-only groups showed different patterns for judgments and response times in detecting the event dimensions. The findings showed that not all judgments corresponded to the slowing down of response times for the event indices and vice versa. Sometimes, they were able to judge a situation change without slowing down in response times to update or connect new information with prior information in memory. At other times, they were able to slow down to update situation changes for certain event dimensions, but judgments were not observed. Time and characters were two of the event indices that exhibited these opposite patterns. This inconsistency questions the credibility of the methods used to measure the Event Indexing model. Note that the proper methods were performed according to how previous researchers conducted their experiments (e.g., Magliano et al., 2012; Zwaan et al., 1995) and so, the lack of reliability cannot be questioned by the procedural design of this dissertation. A possibility would be that people do monitor changes for events, but they do not focus on all of the event indices simultaneously as suggested by Zwaan and his colleagues (Zwaan, Langston, & Graesser, 1995; Zwaan, Magliano, & Graesser, 1995). Rather, people are inclined to attend to certain situation changes because they stand out more or are more prominent in the story than the other situation changes. Therefore, they are able to identify those changes automatically through judgments instead of response times. However, further research is needed to understand how response times might slow down without people identifying those changes from judgments. Other than this dissertation, these Event Indexing model studies have typically used only one method or the other and not both.

Processing Time and Efficiency Scores

When people are given the opportunity to read and / or view a story multiple times, they are likely to process the narrative longer during their first encoding than during a subsequent time. This result from Experiments 1 and 2 was similar to a study by

Zwaan et al. (1995), demonstrating that building a situation model for a story at the beginning is an important process for how information is stored in memory. Once details of people's situation models are established, they are less likely to spend time re-encoding the story. In general, the text-pictures group spent longer processing the narrative than the text-only group because the integration of both multimedia modes allows people to construct a better understanding of their situation models (as indicated by a combination of higher numbers of correct recalls as well as judgments and response times that corresponded to situational shifts). The text-only group had to rely on one form of mental representation, facilitating the effort required to create a coherent situation model. Based on the consistency in performance by this group, it seemed as though they received all of the necessary information for comprehension from the text. In contrast, there was a large amount of variability in processing time for the pictures-only group. They were slower than the other presentation groups in Experiment 1, but then they were faster than the other presentation groups in Experiment 2. This finding may suggest that when people are instructed to view the story only, people's focus will be more on making sense of the pictures. However, when they are instructed to identify situation changes while viewing the story, they may have become frustrated with the lack of coherence from trying to interpret the story from the pictures in order to make situational judgments, and, hence, sped up their processing just to get through the task more quickly.

In examining the costs and benefits of reading and viewing the story with people's recall, efficiency scores were generated. High efficiency scores represented greater accuracy with the amount of time encoding the story for the multimedia sources, whereas low efficiency scores represented greater elaborations with the amount of time encoding the story based on the presentation modality. In Experiments 1 and 2, the text-pictures group had the highest efficiency score followed by the text-only group, and the pictures-only group clearly showed the lowest efficiency score. This outcome suggests that although the combination of text and pictures may cost people with a slight slowdown in their processing time, they benefit by recalling more accurate details and fewer elaborations. Using both types of multimedia presentations together (i.e., text and pictures) might be an ideal way of comprehending the story and achieving coherence in memory. When only text is given, people suffer slightly in memory accuracy but not in elaborations because the text still provides strong contextual cues for understanding the story and storing information in memory. However, there was greater cost with presenting people with pictures only. Although they may spend longer or fewer minutes in processing the story (see earlier points about variability in processing times), the lack of context and meaningfulness of the story handicaps their ability to accurately recall details from memory. Pictures seem to only be helpful perceptually when more information is given to them about how to interpret those images.

A Contribution to Bartlett's (1932) *The War of the Ghost* Story

Bartlett's (1932) work in showing that people reconstruct stories in their memories over time through repeated testing has been replicated for many decades. Many researchers (e.g., Bergman & Roediger, 1999; Gauld & Stephenson, 1967; Kellogg, 2007; Ross & Millsom, 1970) have tested *The War of the Ghost* narrative in various ways from how information is encoded (i.e., through reading or hearing the story) to how information is retrieved (i.e., through speaking or writing about the story). In all of these studies, the findings have supported Bartlett's concepts of schemas, rationalizations, and distortions. However, little has been done to investigate other methods, such as the use of illustrations that are also common for presenting information today. Unlike previous experiments, this dissertation involved a comic book format that allowed people to form different mental representations as a way to remember the story. Although situation models can be associated with false memories, cognitive psychologists have yet to address how these two constructs influence each other. By using multimedia through text and pictures, the results provided a new direction for how situation models affect memory accuracy and comprehension. One important contribution of this dissertation was that, while text and pictures (i.e., the comic book format) can significantly increase recall of correct details, this format is still susceptible to elaborations / false recalls.

Limitations and Future Directions

In this dissertation, there were several limitations that could be explored further in future studies. For instance, unlike the materials used in the current experiments, comic book stories are typically conveyed in a non-redundant way in regard to the text and pictures. That is, people usually infer what is happening in the story without having the text and pictures represent the same information. Comic artists design illustrated narratives in this manner because they are able to add more information without wasting space in the panels (Eisner, 2008; McCloud, 1993). I experienced this firsthand when I first began to work with the comic artist who helped create these materials, as he often had a tendency to sketch drafts that were non-redundant. Some examples of being non-redundant for *The War of Ghosts* story would be to show the characters fighting in a battle in the picture without the text repeating what is going on in the story (i.e., mentioning that there is a war) or to state that someone has died in the text without showing the character dead in the picture. By manipulating the text and pictures of the panels, the findings would help clarify whether people are capable of forming separate mental representations in memory.

Along this line, another possible limitation for this study was that people were only tested using verbal recall. To better investigate the reliance on separate verbal and pictorial memory representations, versus an integrated representation, if the frames were altered to be less redundant across text and pictures, then a memory test could be designed to examine if people could differentiate whether specific information was conveyed exclusively by either the text or pictures. Using this method may reveal insights into how people store and / or integrate information from multimedia.

Another future direction to explore is to distinguish between perceptual and situation model-based representations in the pictures-only group. For example, many of the participants claimed that the Indians were hunting in a lake instead of a river hunting for animals. In the experiments, it is unclear if this was due to a true elaboration or if it was a misperception of the picture. By norming what people actually perceive in the pictures as they view them, the criteria for what is considered a correct or false idea unit may have changed. Specifically, there may have been a greater reduction in people's elaboration for the story in the pictures-only group because the finding would demonstrate more of a picture superiority effect based on their actual interpretations of the pictures.

The inconsistencies observed for judgments and response times in the Event Indexing model suggest that better methods are needed to determine whether people organize and store certain situation changes for space, time, characters, and objects in memory. One way to avoid the same methods used in this dissertation and previous studies is to ask people whether there are situation changes occurring in the panels as they read and / or view the story. In addition, they would be asked to explicitly state what those changes are if they are present. By doing so, there would be a better understanding of whether people simultaneously monitor various event dimensions when processing the narrative. Thus far, there has yet to be a study implementing this type of procedure.

Lastly, future studies should apply the cognitive theory of multimedia learning to other stories in a comic book format beyond reading and / or viewing *The War of the Ghosts.* Bartlett's (1932) narrative is unique in that the structure of the story is not as logical and easy to follow (Mandler & Johnson, 1977). Therefore, people were prone to elaborating or making false memories to connect the story meaningfully. The challenge of comprehending a story without much coherence may also explain why people showed inconsistencies for judgments and response times when monitoring situation changes for the story. However, this assumption must also be explored.

Conclusion

The ability to construct accurate situation models may be dependent on the multimedia presentation given. In this dissertation, the findings were assessed to expand on the cognitive theory of multimedia learning for narratives. When text and pictures were processed together, people had a stronger support system in memory to create more accurate mental representations than false ones. This effect was due to having better contextual or meaningful cues from the text that corresponded to the pictures. In addition, the text-only group was able to create more accurate details to their situation models because the context that they were given also required them to put more effort in encoding specific details of their mental images in memory. Although the text-pictures and text-only groups were able to recall more correct idea units, these two presentation groups were still prone to normal forgetting due to the lack of retrieval cues available across the recall tests. As a result, they were still likely to elaborate on information over time on certain ideas that they may have forgotten. As for the pictures-only group, they exhibited low memory accuracy, high elaborations, variability in response times, and inability to clearly identify situational shifts. Because they were only able to rely on their perceptual representation, they needed to interpret the pictures in their own way to make sense of the narrative across the two recall tests. Overall, the organization and formation of situation models may be influenced by the type of multimedia source given, causing people's accurate and false memories to vary.

Appendix A

The Cognitive Theory of Multimedia Learning

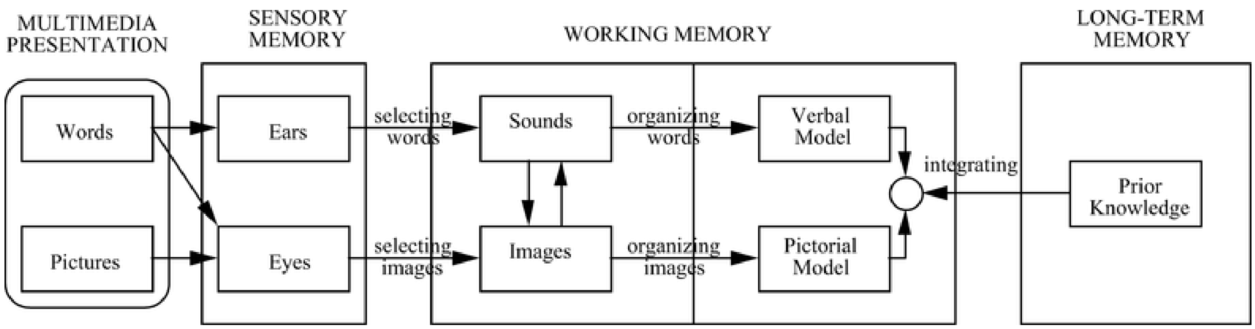


Image was taken from Mayer (2005).

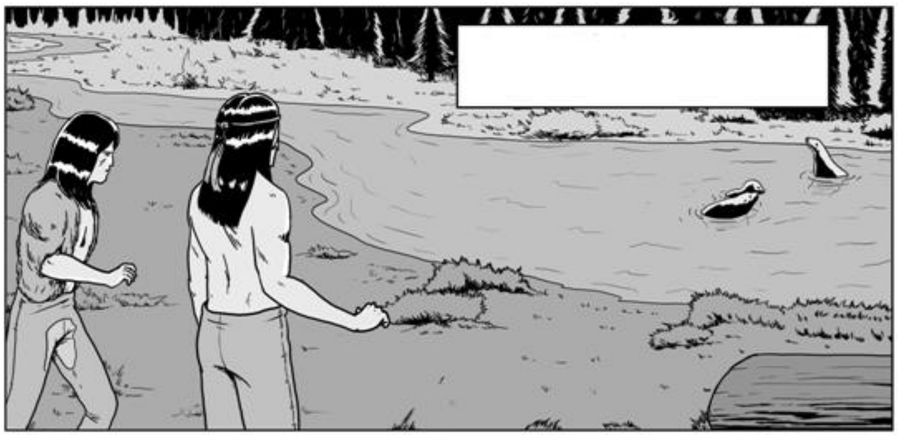
Appendix B

An Example of the Presentation Modalities

Text-Only Group:

One night, two young men from Egulac went down to the river to hunt seals…

Pictures-Only Group:



Text-Pictures Group:

Appendix C

Recall Instructions

Text-Only Group:

Please type up the story you read [previously / two days ago] in the space below as best as you can. Please try to reproduce it exactly. It is very important that you be as precise as you can. Try to use exactly the same words as they appeared in the story as much as possible. Where you cannot remember the exact wording, be sure to at least get the facts and events exactly correct. Do not invent facts to make it a better story; imagine that you are giving a statement to a policeman and accuracy is important. If you cannot remember something, don’t guess. When you are through, please notify the experimenter that you are done.

Pictures-Only Group:

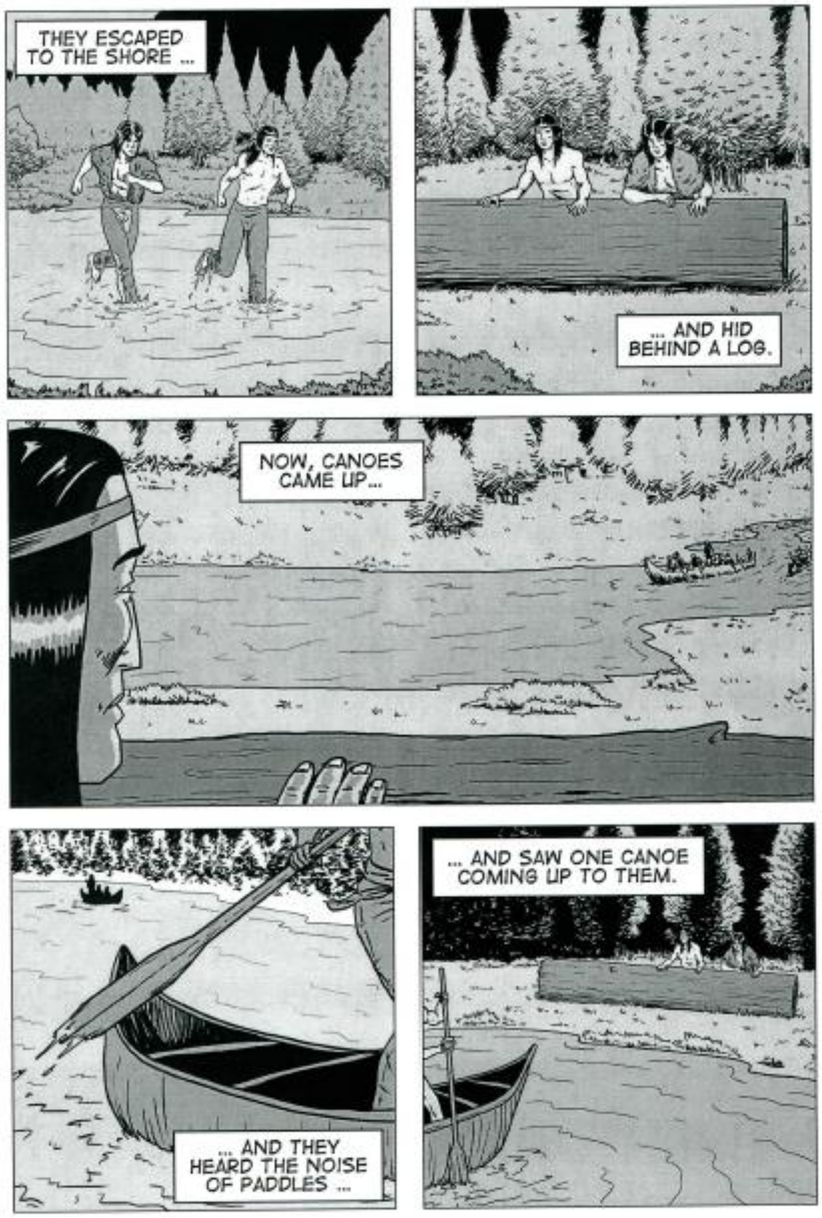
Please type up the picture story you viewed [previously / two days ago] in the space below as best as you can. Please try to reproduce it exactly. It is very important that you be as precise as you can. Try to remember the details of each picture as they appeared in the story as much as possible. Do not invent facts to make it a better story; imagine that you are giving a statement to a policeman and accuracy is important. If you cannot remember something, don’t guess. When you are through, please notify the experimenter that you are done.

Text-Pictures Group:

Please type up the story you read [previously / two days ago] in the space below as best as you can. Please try to reproduce it exactly. It is very important that you be as precise as you can. Try to use exactly the same words as they appeared in the story as much as possible. Where you cannot remember the exact wording, be sure to at least get the facts and events exactly correct. Do not invent facts to make it a better story; imagine that you are giving a statement to a policeman and accuracy is important. If you cannot remember something, don’t guess. When you are through, please notify the experimenter that you are done.

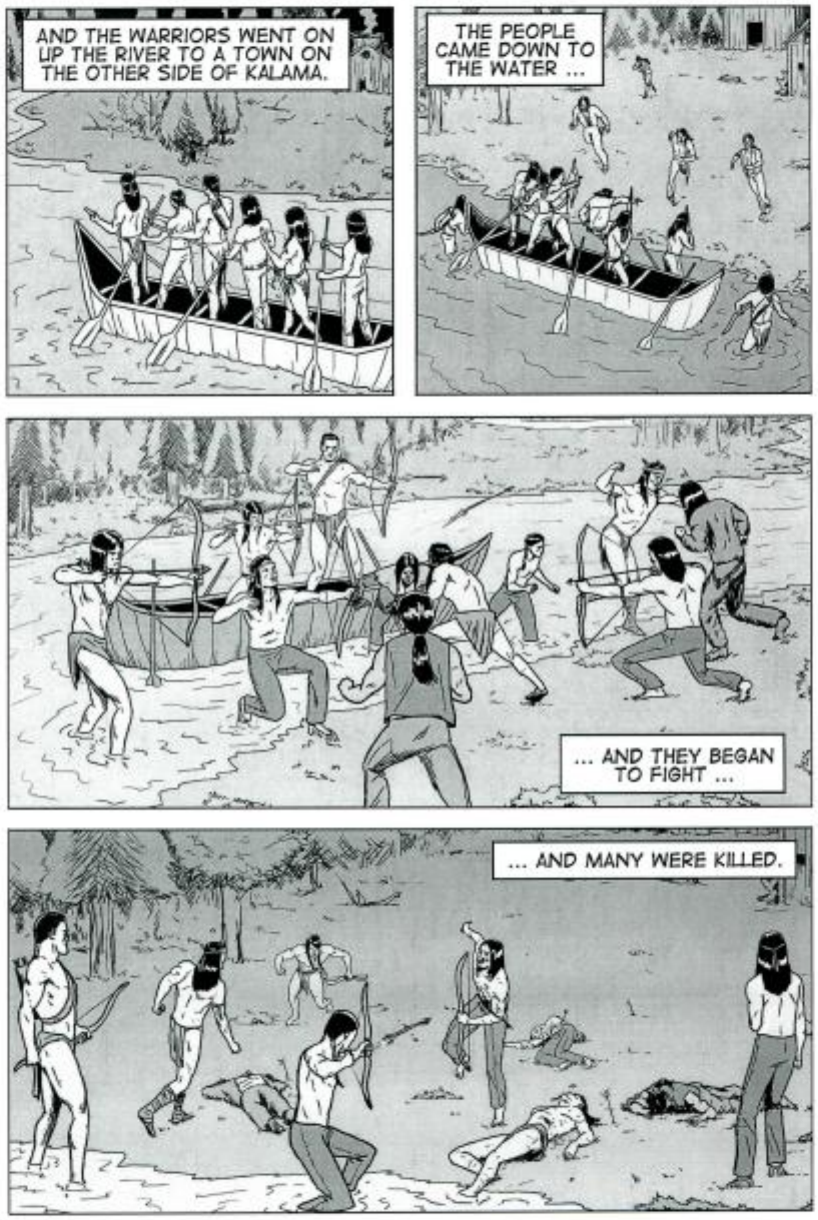
Appendix D

The Illustrated Narrative

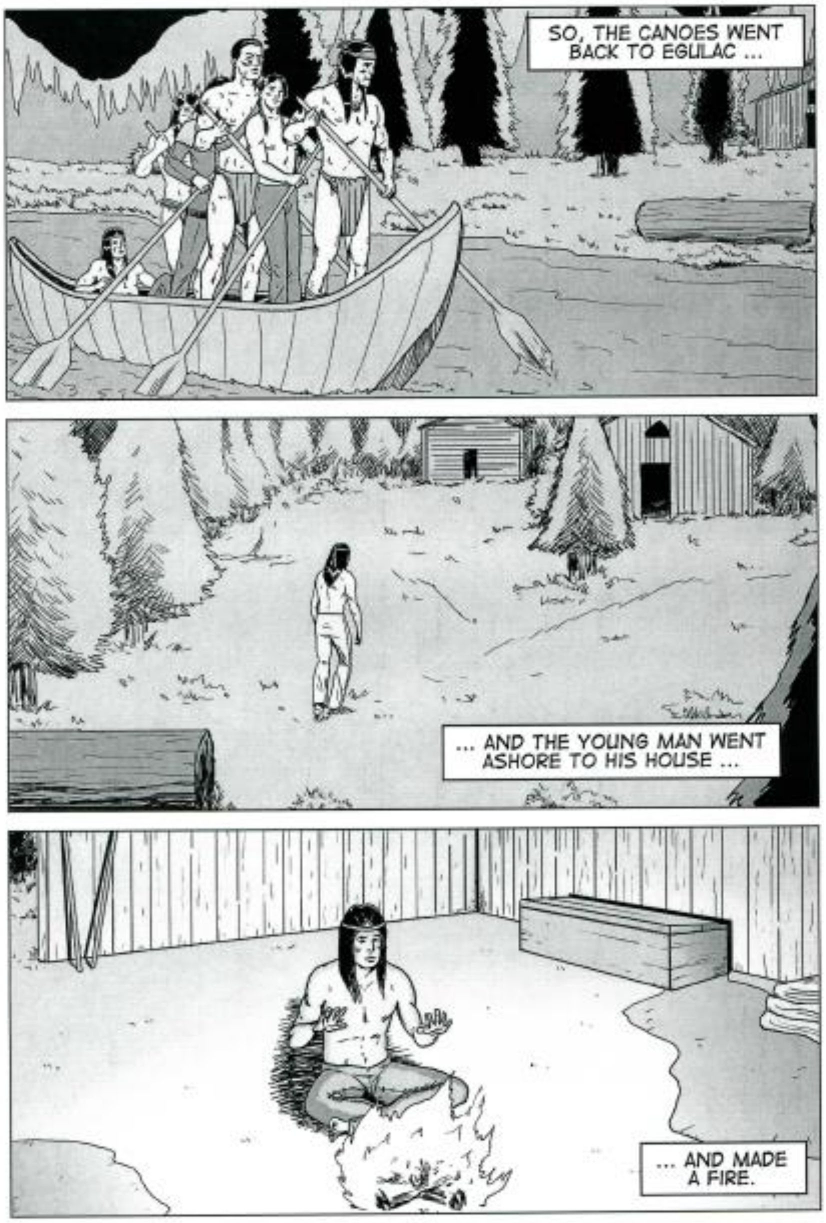

THEY ESCAPED TO THE SHORE ...
... AND HID BEHIND A LOG.
NOW, CANOES CAME UP...
... AND THEY HEARD THE NOISE OF PADDLES ...
... AND SAW ONE CANOE COMING UP TO THEM.


THERE WERE FIVE MEN IN THE CANOE ...
... AND THEY SAID...
WHAT DO YOU THINK? WE WISH TO TAKE YOU ALONG.
WE ARE GOING UP THE RIVER TO MAKE WAR ON THE PEOPLE.
ONE OF THE YOUNG MEN SAID ...
I HAVE NO ARROWS.
ARROWS ARE IN THE CANOE.
... THEY SAID.


I WILL NOT GO ALONG.
I MIGHT BE KILLED.
MY RELATIVES DO NOT KNOW WHERE I HAVE GONE.
BUT YOU ...
... HE SAID, TURNING TO THE OTHER ...
... MAY GO WITH THEM.
SO, ONE OF THE YOUNG MEN WENT ...
... BUT THE OTHER RETURNED HOME.


AND THE WARRIORS WENT ON UP THE RIVER TO A TOWN ON THE OTHER SIDE OF KALAMA.
THE PEOPLE CAME DOWN TO THE WATER ...
... AND THEY BEGAN TO FIGHT ...
... AND MANY WERE KILLED.


BUT PRESENTLY, THE YOUNG MAN HEARD ONE OF THE WARRIORS SAY...
QUICK, LET US GO HOME: THAT INDIAN HAS BEEN HIT.
NOW HE THOUGHT:
OH, THEY ARE GHOSTS.
HE DID NOT FEEL SICK ...
... BUT THEY SAID HE HAD BEEN SHOT.


SO, THE CANOES WENT BACK TO EGULAC ...
... AND THE YOUNG MAN WENT ASHORE TO HIS HOUSE ...
... AND MADE A FIRE.


AND HE TOLD EVERYBODY AND SAID ...
BEHOLD, I ACCOMPANIED THE GHOSTS, AND WE WENT TO FIGHT.
MANY OF OUR FELLOWS WERE KILLED ...
... AND MANY OF THOSE WHO ATTACKED US WERE KILLED.
THEY SAID I WAS HIT ...
... AND I DID NOT FEEL SICK.
HE TOLD IT ALL ...
... AND THEN HE BECAME QUIET.


WHEN THE SUN ROSE, HE FELL DOWN.
SOMETHING BLACK CAME OUT OF HIS MOUTH.
HIS FACE BECAME CONTORTED.
THE PEOPLE JUMPED UP AND CRIED.
HE WAS DEAD.

Appendix E

Standardizing Beta Coefficients for Logistic Regression

Cell A1 = Enter the mean predicted probability for the dataset

Cell A2 = Enter the unstandardized beta weight for the predictor

Cell A3 = Enter the sample standard deviation for the predictor

Cell A4 = Calculate the standardized coefficient for the predictor using the following formula:

```
=(1/(1+EXP(-(LN(A1/(1-A1))+0.5*A2*A3))))-(1/(1+EXP(-(LN(A1/(1-A1))-0.5*A2*A3))))
```

Repeat for each participant and predictor.

This formula for Microsoft Excel was taken from King (2007, p. 9).

Appendix F

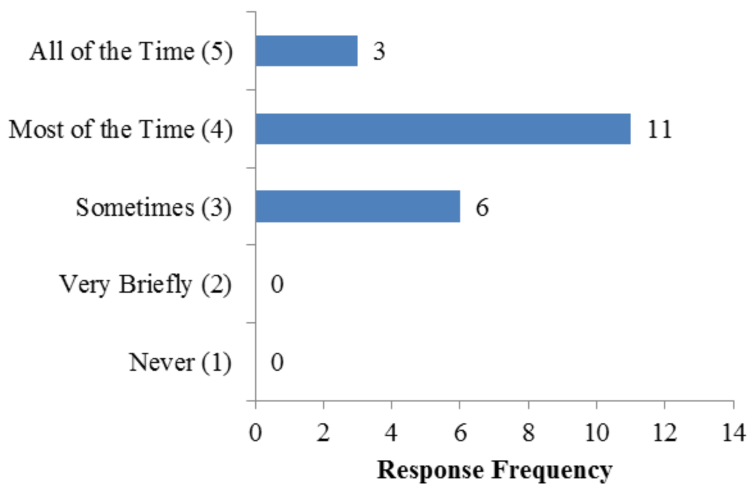
Reflection Questions for Experiment 1

Numbers in parentheses represent the values of the rating responses.

Text-Pictures Group

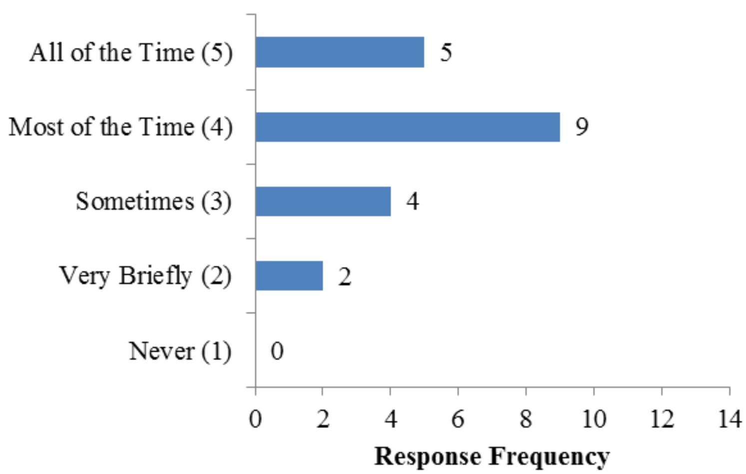
Recall Session 1:

When presented with the story, how much attention did you give to processing the words?



Mean Rating Response = 3.85

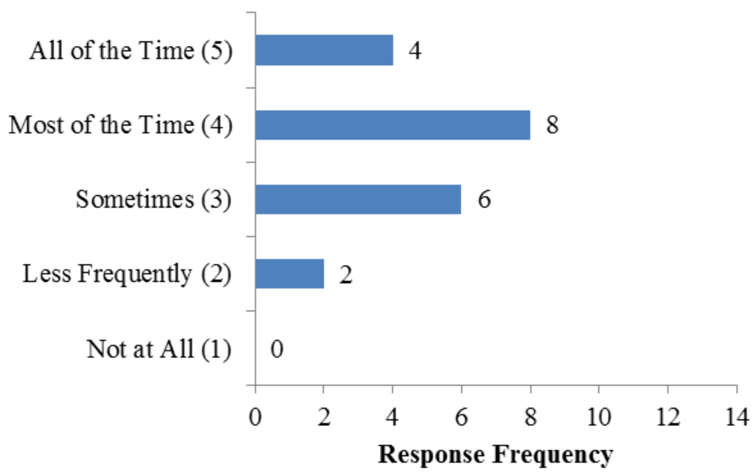
When presented with the story, how much attention did you give to processing the pictures?



Mean Rating Response = 3.85

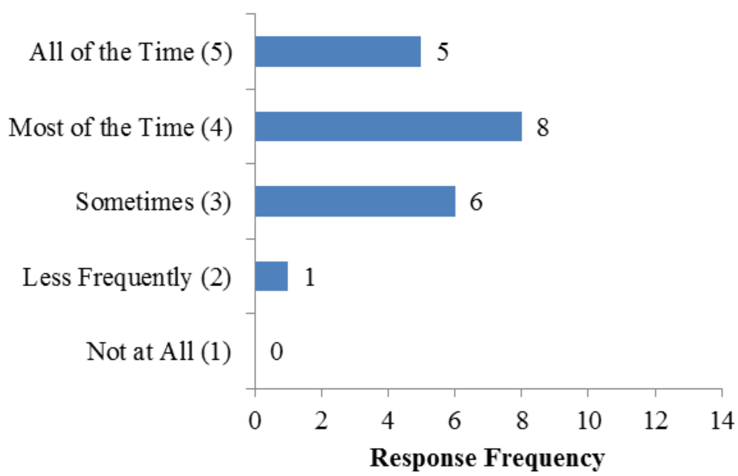
Recall Session 2:

How much did you rely on the words from the story to help you remember?



Mean Rating Response = 3.70

How much did you rely on the pictures from the story to help you remember?

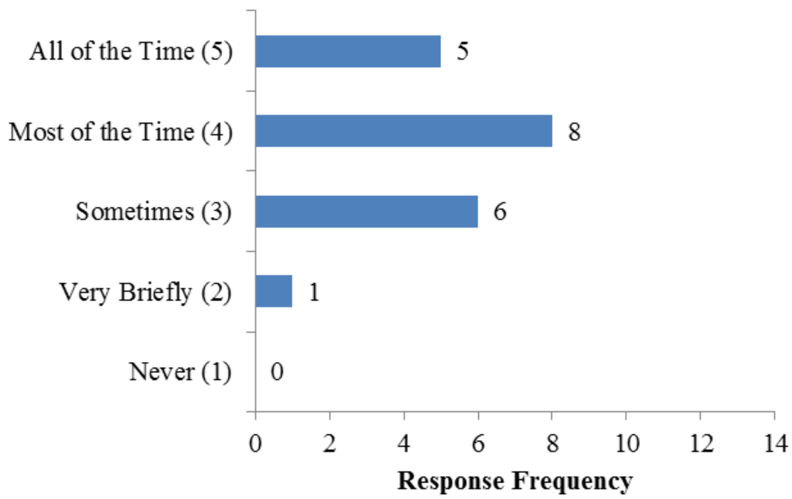


Mean Rating Response = 3.85

Text-Only Group

Recall Session 1:

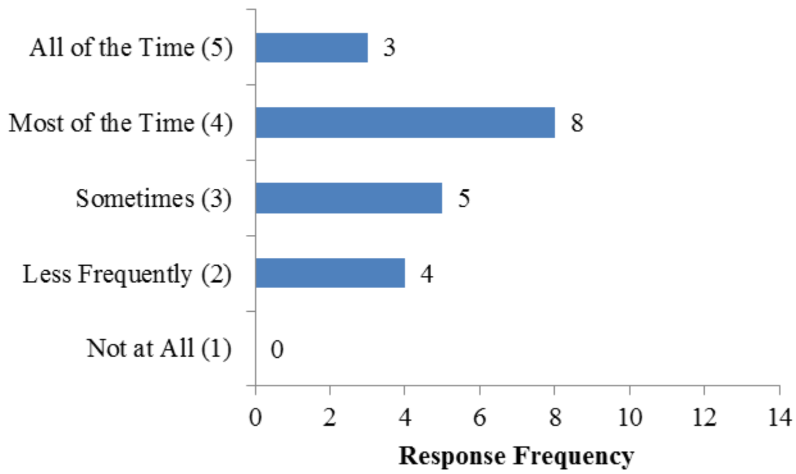
When presented with the story, how much attention did you give to processing the words?



Mean Rating Response = 3.85

Recall Session 2:

How much did you rely on the words from the story to help you remember?

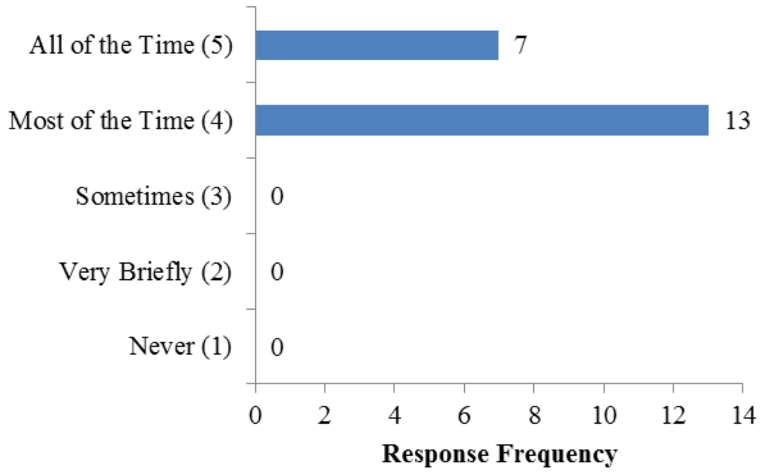


Mean Rating Response = 3.50

Pictures-Only Group

Recall Session 1:

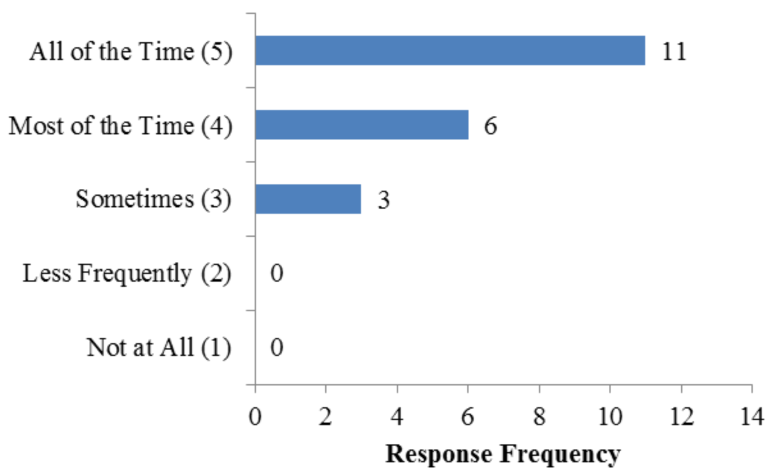
When presented with the story, how much attention did you give to processing the pictures?



Mean Rating Response = 4.35

Recall Session 2:

How much did you rely on the pictures from the story to help you remember?



Mean Rating Response = 4.40

Appendix G

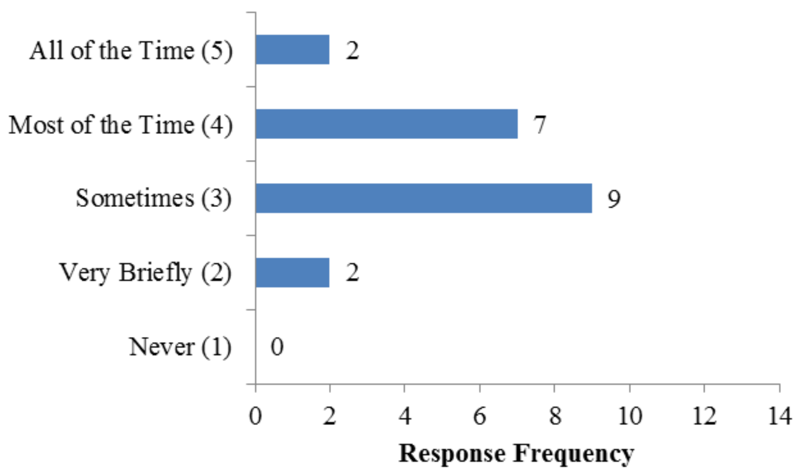
Reflection Questions for Experiment 2

Numbers in the parentheses represent the values of the rating responses.

Text-Pictures Group

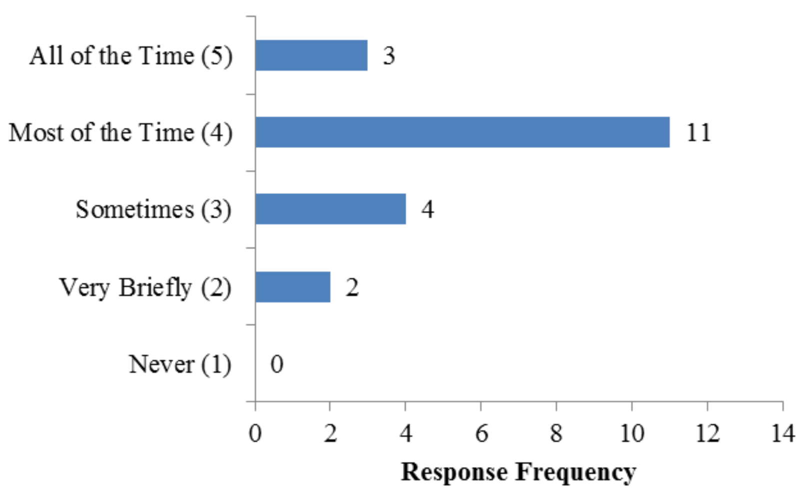
Recall Session 1:

When presented with the story, how much attention did you give to processing the words?



Mean Rating Response = 3.45

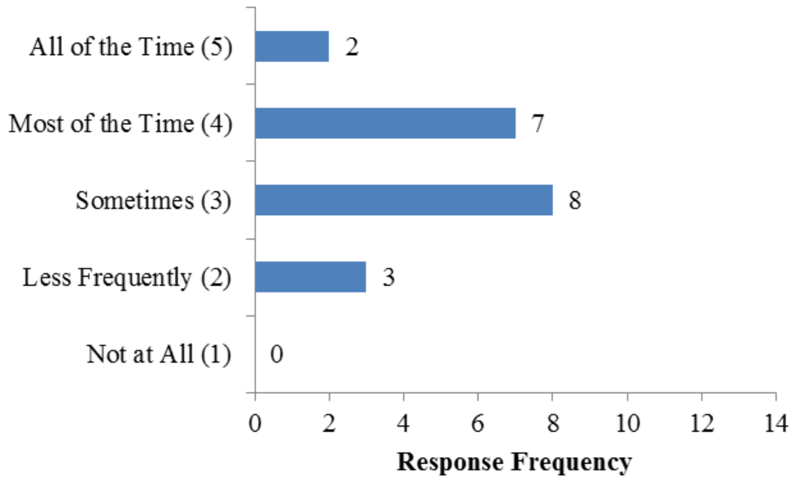
When presented with the story, how much attention did you give to processing the pictures?



Mean Rating Response = 3.75

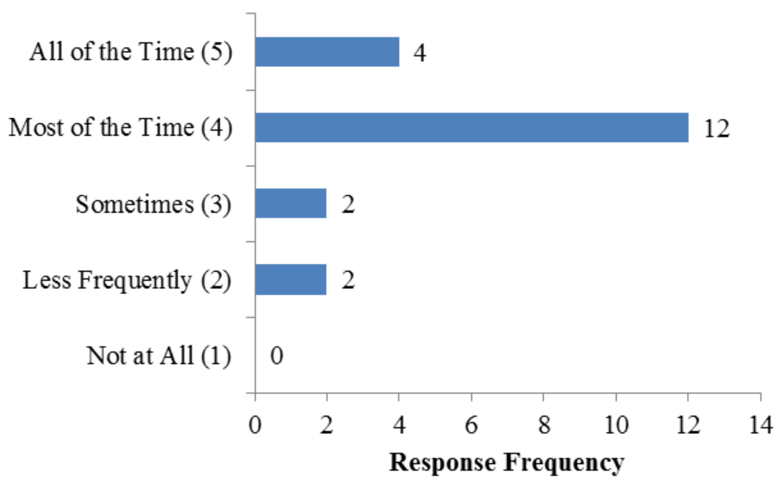
Recall Session 2:

How much did you rely on the words from the story to help you remember?



Mean Rating Response = 3.40

How much did you rely on the pictures from the story to help you remember?

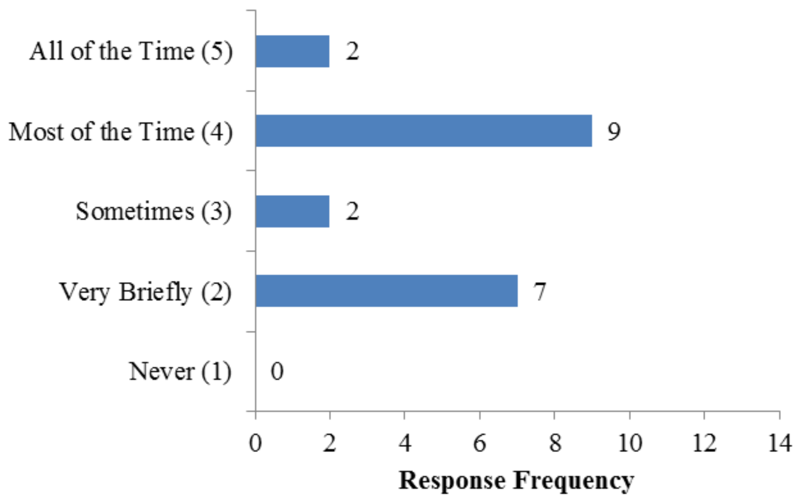


Mean Rating Response = 3.90

<u>**Text-Only Group**</u>

Recall Session 1:

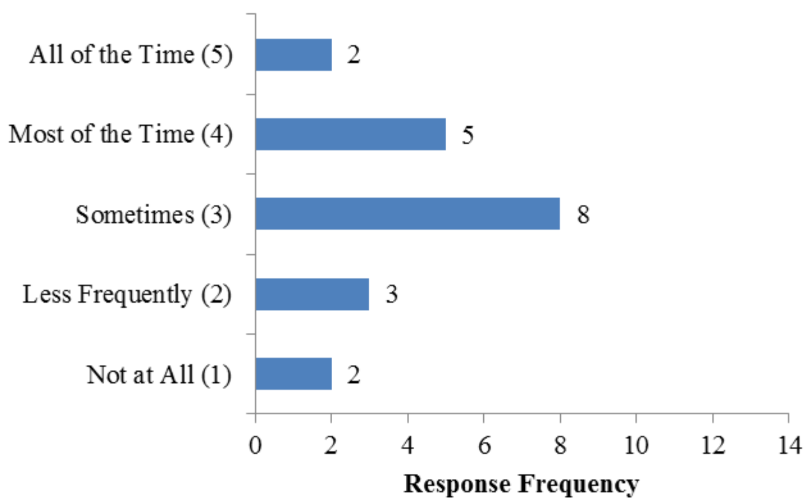
When presented with the story, how much attention did you give to processing the words?



Mean Rating Response = 3.30

Recall Session 2:

How much did you rely on the words from the story to help you remember?

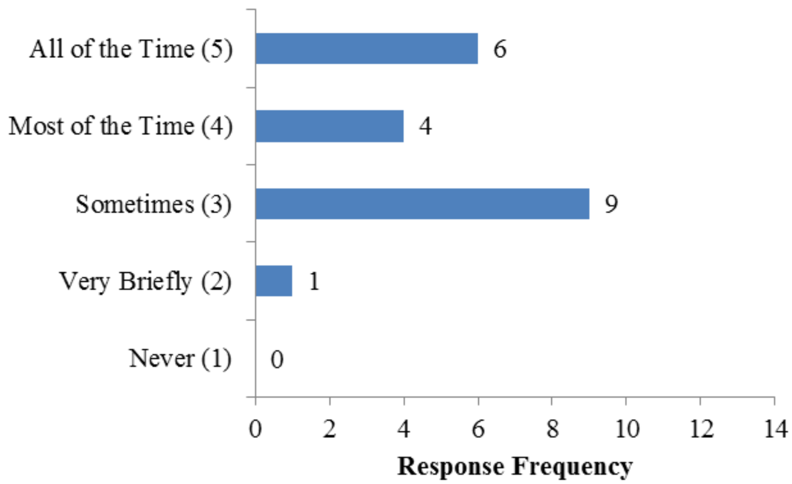


Mean Rating Response = 3.10

Pictures-Only Group

Recall Session 1:

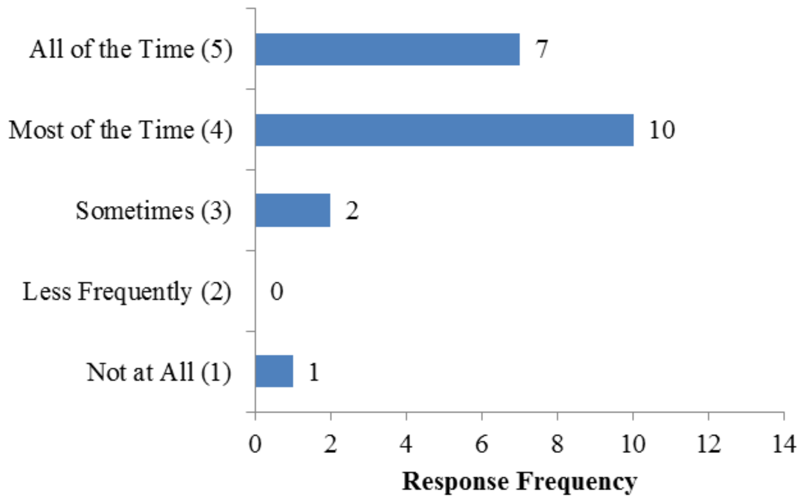
When presented with the story, how much attention did you give to processing the pictures?



Mean Rating Response = 3.75

Recall Session 2:

How much did you rely on the pictures from the story to help you remember?



Mean Rating Response = 4.10

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Curriculum Vitae

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JOURNAL PUBLICATIONS

Copeland, D. E., **Gunawan, K.**, & Bies-Hernandez, N. J. (2011). Source credibility and syllogistic reasoning. *Memory & Cognition, 39*, 117-127.

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Schroeder, P. J., Copeland, D. E., & **Gunawan, K.** (August, 2010). Comprehending spatial relations under survival conditions. Paper presented at the Society for Text and Discourse 20th Annual Meeting, Chicago, IL.

Gunawan, K., & Copeland, D. E. (March, 2010). Adaptive memory in a directed forgetting task. Paper presented at the Graduate and Professional Student Association's 2010 Research Forum, Las Vegas, NV. (Awarded with Honorable Mention)

Houska, J. A., Copeland, D. E., & **Gunawan, K.** (March, 2009). The mating effect in adaptive memory. Paper presented at the Graduate and Professional Student Association's 2009 Research Forum, Las Vegas, NV. (Awarded with Honorable Mention)

POSTER PRESENTATIONS

Gunawan, K., Osman, A. B., Copeland, D. E., & Larson, K. G. (November, 2012). Mental representations of characters in narratives: Managing information from text and images. Poster presented at the Psychonomic Society 53rd Annual Meeting, Minneapolis, MN.

Gunawan, K., Copeland, D. E., Schroeder, P. J., & Bies-Hernandez, N. J. (November, 2011). The detection of event shifts in sequential art. Poster presented at the Psychonomic Society 52nd Annual Meeting, Seattle, WA.

Copeland, D. E., **Gunawan, K.**, & Bies-Hernandez, N. J. (May, 2011). Source credibility and syllogistic reasoning. Poster presented at the Association for Psychological Science 23rd Annual Convention, Washington, DC.

Gunawan, K., & Copeland, D. E. (November, 2009). Adaptive memory in a directed forgetting task. Poster presented at the Psychonomic Society 50th Annual Meeting, Boston, MA.

Gunawan, K., Copeland, D. E., & Houska, J. A. (May, 2009). The effects of directed forgetting on adaptive memory. Poster presented at the Association for Psychological Science 21st Annual Convention, San Francisco, CA.

Gunawan, K., Hickey, L., Crabtree, N., Yimenu, B. T., & Gerkens, D. R. (April, 2009). Incubation effects on hypermnesia following memory blocking. Poster presented at the Western Psychological Association 89th Annual Convention, Portland, OR.

Gunawan, K., Kordbacheh, N., Hebein, C., & Gerkens, D. R. (April, 2008). Metacognitive judgments affect memory recovery in repeated recall tests. Poster presented at the Western Psychological Association 88th Annual Convention, Irvine, CA.

Gerkens, D. R., Flores, Y., & **Gunawan, K.** (April, 2008). Experimentally blocking memorable autobiographical memories. Poster presented at the Western Psychological Association 88th Annual Convention, Irvine, CA.

Sorgi, A. M., Gerkens, D. R., & **Gunawan, K.** (April, 2008). Emotion and its impact on memory blocking, recovery, and accuracy. Poster presented at the Western Psychological Association 88th Annual Convention, Irvine, CA.

Gunawan, K., & Gerkens, D. R. (October, 2007). Hypermnesia: Recovery of blocked memories in free and forced recall tests. Poster presented at the ARMADILLO 17th Annual Conference, San Antonio, Texas.

Gunawan, K., Goode, T., Hebein, C., & Gerkens, D. R. (May, 2007). The effects of repeated recall testing: Can we remember more? Poster presented at the Western Psychological Association 87th Annual Convention, Vancouver, BC, Canada.

Hunt, C. E., Sorgi, A. M., **Gunawan, K.**, Walsh, S. E., & Gerkens, D. R. (April, 2006). Individual differences in dissociative experiences and recovered memory accuracy. Poster presented at the Western Psychological Association 86th Annual Convention, Palm Springs, CA.

PEER REVIEWS

Editor, *Undergraduate Update*, APSSC, 2011 – 2012
Student Grant Competition, APSSC, 2010 – 2011
Student Research Award, APSSC, 2008 – 2011
RISE Research Competition, APSSC, 2008 – 2009

TEACHING EXPERIENCE

Lecturer, University of Nevada, Las Vegas, 2010 – 2012
Course: General Psychology
Graduate Assistant, University of Nevada, Las Vegas, 2008 – 2009
Course: Physiological Psychology
Graduate Assistant, California State University, Fullerton, 2006 – 2008
Courses: Cognitive Psychology Lab, Research Methods

AWARDS, GRANTS, AND FELLOWSHIPS

Patricia Sastaunik Scholarship (UNLV, 2013 – 2014), $2,500.00
Board of Regents' Graduate Scholar Award (UNLV, 2011), $5,000.00
Graduate and Professional Student Association Grants (UNLV)
    Fall 2012 – $350.00
    Fall 2011 – $450.00
    Summer 2011 – $150.00
    Spring 2009 – $300.00
    Fall 2009 – $650.00
Associated Student Incorporation Student Research Grant (CSUF, 2008), $426.00

Graduate Equity Fellowship (CSUF, 2007 - 2008), $2,500.00
Outstanding Graduate Student of the Year, CSUF, 2008
The National Dean's List, 2005 – 2006
Outstanding Psychology Student Scholarship (Mt. San Antonio College, 2004), $300.00

SERVICE/PROFESSIONAL ACTIVITIES
Past-President, APSSC (2013 – 2014)
President, APSSC (2012 – 2013)
Undergraduate Advocate, APSSC (2011 – 2012)
Cognitive Emphasis Representative, Experimental Student Committee, UNLV (2010 – 2011)
Psi Chi Chapter Liaison, Experimental Student Committee, UNLV (2010 – 2011)
Membership and Volunteers Officer, APSSC (2009 – 2010)
Graduate Subject Pool Coordinator, Dept. of Psychology, UNLV (2008 – 2010)
UNLV Campus Representative, APSSC (2008 – 2009)
Graduate Cohort Representative, Experimental Student Committee, UNLV (2008 – 2009)
CSUF Campus Representative, APSSC (2006 – 2007)
President, Psi Chi Psychology Honor Society, CSUF (2005 – 2006)
Psi Chi Representative, Council of Honor Societies, CSUF (2005 – 2006)
Membership Coordinator, Psi Chi Psychology Honor Society, CSUF (2004 – 2005)
President, Psi Beta Psychology Honor Society, Mt. San Antonio College (2003 – 2004)
President, Mt. San Antonio College Psychology Club (2003 – 2004)

AFFILIATIONS
American Psychological Association
- Division 2: Society for the Teaching of Psychology
- Division 3: Experimental Psychology

Association for Psychological Science
- Association for Psychological Science Student Caucus (APSSC)

Golden Key International Honor Society
Psi Beta Psychology Honor Society
Psi Chi Psychology Honor Society
Rocky Mountain Psychological Association
Society for Text and Discourse
Western Psychological Association