THE INFLUENCE OF TIMELINE ORIENTATION AND PRESENTATION MODE ON MENTAL MODEL CONSTRUCTION AND JUDGMENT FORMATION

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Interdisciplinary Studies
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David Sarmento
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THE INFLUENCE OF TIMELINE ORIENTATION AND PRESENTATION MODE ON MENTAL MODEL CONSTRUCTION AND JUDGMENT FORMATION

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APPROVED BY THE DEAN OF GRADUATE STUDIES AND VICE PROVOST OF RESEARCH:

__________________________
Eun K. Park, Ph.D.

APPROVED BY THE GRADUATE ADVISORY COMMITTEE:

__________________________
Neil H. Schwartz, Ph.D.
Graduate Coordinator

__________________________
Wolfgang Schnotz, Ph.D., Chair

__________________________
Neil H. Schwartz, Ph.D.

__________________________
Martin van den Berg, Ph.D.
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ABSTRACT

THE INFLUENCE OF TIMELINE ORIENTATION AND PRESENTATION MODE ON MENTAL MODEL CONSTRUCTION AND JUDGMENT FORMATION

by

David Sarmento

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The present study was designed to determine whether the orientation of a timeline used to describe a series of events, or the modality with which the timeline is presented, have any influence on mental model construction or judgment formation. Ninety undergraduate students were instructed to assume the role of a juror. Then, participants were asked to learn about a medical malpractice case. Next, participants were shown a timeline in one of three orientations (horizontal, vertical, or diagonal) in one of two modalities (static-sequential or animated). Results revealed no differences between or within groups on mental model construction. However, participants in animated conditions, regardless of timeline orientation, judged the hospital staff, in this case the defendant, significantly higher on guilt rating scales than those in the static-sequential
condition. In addition, participants in the animated condition judged some specific actions of the hospital staff as significantly more inappropriate than those in the static-sequential condition. Thus, while presentation modality and timeline orientation may not have a direct effect on mental model construction, it is possible that presentation modality has an influence on the ease with which a juror can construct a story, or influence the perceptual salience of the presented timeline. Implications for the use of animation in the litigation domain are discussed.
CHAPTER I

INTRODUCTION

Background

Advances in multimedia technology, and the incorporation of similar technologies into business and education environments, has changed the way professionals, scholars, and pupils learn and interact. One increasingly used form of multimedia is animation (Ploetzner & Lowe, 2012). A main draw to the use of animation centers on the idea that, while non-animated graphics may facilitate comprehension and memory, animated graphics should be able to do the same, but more adeptly display change over time (Tversky, Morrison, & Bétrancourt, 2002). Although animation research is relatively new, it has been used in a number of fields to teach complex systems, including but not limited to: mechanical, biological, physical, meteorological, and geological (Ploetzner & Lowe, 2012). Often it is used within those domains as a way to guide attention by way of cueing, or to explain a complex process (c.f. de Koning, Tabbers, Rikers, & Paas, 2010a; Mayer, Hegarty, Mayer, & Campbell, 2005).

One area that has not commonly investigated the influence of multimedia—and particularly animation—is litigation (Feigenson, 2010)—specifically, how the use of animation in the courtroom may affect the judgments and decisions jurors make when evaluating courtroom material. Thus, the present investigation was designed to determine
whether animated cues within a visualization depicting a timeline of events affect comprehension and judgments in a litigation context.

Challenges in Visualization and Animation Research

Unfortunately, research in animation is challenged by, among other things, an inconsistency within the research community of what actually defines animation and its functions (Tversky et al., 2002). This lack of unification has occasionally led to contradictory results on learning and performance outcomes among different investigations—particularly those involving animated visualizations (c.f. Anglin, Vaez, & Cunningham, 2003; Tversky et al., 2002).

It is no surprise that the problems with animation extend to the field of litigation. Certainly, the body of research in multimedia in litigation is much smaller than it is in other fields—particularly education (Feigenson, 2010). However, multimedia has been shown to affect factors in litigation, such as jury decision-making. For example, it has been shown that the recorded confessions jurors view can significantly affect their ratings of guilt depending on whether the camera was pointed at the interrogators or at the defendant (Lassiter, Geers, & Apple, 2002). It has also been shown that an attorney who used a Power Point with statistical graphs was seen as more credible, resulting in stronger judgments in favor of the side for which the attorney was arguing, regardless if it was plaintiff or defendant (Park & Feigenson, 2013). Specifically with regard to animations, the use of animations was shown to more than double jurors’ hindsight bias versus texts accompanied by diagrams in a simulated traffic case (Roese, Fessel, Summerville, Kruger, & Dilich, 2006).
Animations are often used in litigation because attorneys view animations as persuasive, and think that animations “present information in a vivid, attention-getting manner” (Dunn, Salovey, & Feigenson, 2006, p. 229). Apparently, the logic behind attorneys’ beliefs is that the more vividly a scenario is depicted, the easier it is for a jury to imagine that the scenario actually occurred, rendering more credible the witness or attorney corroborating the story (Dunn et al., 2006). Dunn et al. (2006) conducted a study to determine whether animations had any significant affect versus a diagram on a plane crash investigation. The animation depicted the plane crash as it allegedly occurred, and the diagram depicted key parts of the plane wreckage and their location. The results indicated that when the plaintiff presented an animation, and the defense presented a diagram, the verdicts given by jurors were significantly in favor of the plaintiff (Dunn et al., 2006). However, when the plaintiff presented a diagram, and the defense presented either a diagram or an animation, the verdicts were in favor of the defendant (Dunn et al., 2006). Moreover, participants in the study rated the animations as significantly more important in influencing their verdict than the diagrams, and also rated the animations as aiding in visualizing key aspects of the case significantly more than the diagrams (Dunn, et al., 2006).

In two studies, Kassin and Dunn (1997) tested the efficacy of animations versus oral testimony to persuade jurors in a case in which jurors had to decide between death due to an accident or suicide. In experiment one, the plaintiff and the defendant both used the same style of animation to illustrate their point. The results indicated that, when using the animation, the plaintiffs received nearly three times the favorable judgment versus the oral testimony (Kassin & Dunn, 1997). In study two, the plaintiff
and defendant again used the same style of animation to illustrate their point, versus an oral testimony, but also varied the physical evidence in favor of the plaintiff or the defendant. Results indicated that, when the plaintiff’s animation was viewed with pro-plaintiff evidence, the jury voted in favor of the plaintiff. Interestingly, when the pro-defendant evidence was used, and participants viewed the plaintiff animation, the participants voted in favor of the plaintiff, even though the animation was in direct contradiction to the evidence (Kassin & Dunn, 1997).

While the examples above illustrate that animation can be useful in a courtroom, other investigations also show that animations have no effect on juror decision-making. Dunn et al. (2006), for example, showed that an animation had no significant effect on verdict determination, regardless of the fact that participants rated the animations as significantly more important to their decision than the diagram (Dunn et al., 2006). Bennett, Leibman, and Fetter (1999) failed to show an affect as well. They showed mock jurors a videotape of expert testimony—one in which the expert used several animations, and one in which the expert only used verbal testimony to describe a car accident. The results indicated that there was no difference in guilt assignment or damage awards between the testimony aided by animation and the testimony that was simply a verbal presentation (Bennett et al., 1999).

While the findings presented above are interesting, they are also mixed. Thus, it is difficult to assess the reasons why one form of multimedia—whether PowerPoint use or animation—is more effective than another for a given case. More importantly, it is very difficult to determine how members of a jury integrate the information presented to
them into an assessment of responsibility or damage awards to either party (e.g., Kassin & Dunn, 1997).

Problems in Jury Decision Making

Many theories of jury decision-making attempt to predict how a juror will decide on a case based upon the juror’s demographics, similarity to the defendant, pre-deliberation and post-deliberation outcomes, or case characteristics (Devine, Clayton, Dunford, Seyer, & Price, 2001; Salerno & Diamond, 2010). Other theories focus on the individual juror using an information integration model or a Bayesian model in which algorithms are used to calculate the probability of a juror’s decision based on each piece of evidence presented relative to the juror’s personal characteristics (MacCoun, 1989). The problem is that both types of models do not have the ability to truly assess a juror’s subjective cognitive process when forming a decision (Devine et al., 2001).

Pennington and Hastie (1991) proposed a model based on explanation, rather than the use of probability, to explain how a jury cognitively stitches together the evidence presented in court to determine a verdict. The model assumes that a juror applies causal reasoning to summarize the evidence presented during a trial to create an explanation of the case (Pennington & Hastie, 1992). There are three main phases of this model: 1) story construction, 2) learning about different verdict options, and 3) matching the constructed story with the correct verdict option. In story construction, a juror integrates knowledge from a specific case along with prior knowledge of similar cases or events, and knowledge of story structures into one or more coherent stories of how the events of the case may have progressed. Next, the juror must learn relevant laws, and the
consequences for all parties involved, based on each possible verdict. Finally, the juror must match the story he or she finds most coherent with the verdict he or she deems most appropriate (Pennington & Hastie, 1992). In general, this means that the ease with which a coherent story can be constructed may mediate the effectiveness of evidence, judgments of confidence, and witness credibility (Pennington and Hastie, 1992).

This story model has some empirical support (e.g., Pennington and Hastie, 1986, 1988, 1992), but does not make any specific determinations on how multimedia may affect the way evidence is perceived, how easily it can be integrated into a story, or how it will effect a particular juror’s verdict determination. However, it seems reasonable to assume that, because multimedia has been used in education to teach learners new information, borrowing the findings of multimedia from education could be used inform the way jurors learn about a case.

Text-Graphic Processing Research

A possible way to understand how multimedia can be integrated into the story model is to examine how text and graphics are integrated into the mental models students construct when they are attempting to learn. The assumption is that the story model jurors construct in a courtroom is fundamentally the same as the cognitive model a learner constructs in a typical learning environment. For example, in the courtroom, jurors learn primarily through verbal narrative and graphics or documents. In the classroom, students learn from verbal lectures and graphics, and with text documents.

The way learning outcomes are affected by the varied integration of text, graphics, and audio has been studied extensively in education (e.g., Carney & Levin,
2002; Levin, Anglin & Carney, 1987; Levie & Lentz, 1982). Results from many of these studies indicate that the combination of text and graphics, or the combination of graphics and narrated text, can significantly improve text comprehension versus text or narration alone (e.g., Balluuerka, 1995; Levin & Berry, 1980; Mayer, 1997, 2001; Mayer & Moreno, 1998, 2002, 2003). It has also been shown that these comprehension gains can be seen across age groups. For example, Rasco, Tennyson, and Boutwell (1975) tested college, high school, and 4th and 5th graders for comprehension performance after reading a text paired with a strategy drawing, or not, across three experiments. The results showed that all three age groups in the text-and-picture condition outperformed those in the text-only condition (Rasco et al., 1975).

On the other hand, while there can be advantages to pairing images with text or narration, comprehension gains are not always uniform. Comprehension gains are sometimes only shown when the combination of text and graphics is properly implemented for a specific learning task. For example, Schnotz and Bannert (2003) conducted a study in which 60 university students were assigned two tasks under one of three conditions: a text, a text and a world map with demarcated time zones, or a text and circle time zone diagram depicting the earth from the North Pole. The first task was to find time differences between two given locations on the map, and the second asked the students to determine why time differed when circumnavigating the globe (Schnotz & Bannert, 2003). The results indicated that, for the time difference task, the text only group performed the best, followed by the world map group, and finally the circle diagram group (Schnotz & Bannert, 2003). For the circumnavigation task, the circle group had the best performance, followed by the text only group, and finally the world map group
This study revealed that the combination of text and graphics may not yield higher performance than text alone in all cases, and that the type of graphic used relative to the target task is important to consider. Further, not only does the appropriate visualization depend on the given task, the prior knowledge of the learner impacts the utility of a given visualization as well. Mayer and Gallini (1990) conducted three experiments in which participants were given descriptions of pumps, generators, or brakes that were text only, text and static images with labeled parts, text and static images with labels for each step of the system, and text with static images with labeled parts and labeled steps. Results indicated that learners who viewed the image with labeled parts-and-steps outperformed all other conditions on conceptual knowledge and creative problem solving tasks, but not on verbatim recall and non-conceptual knowledge tasks (Mayer & Gallini, 1990). Interestingly, though, these findings were most consistent for learners with low prior knowledge, rather than learners with high prior knowledge (Mayer & Gallini, 1990). The idea that text-and-graphic combinations are more effective for low prior knowledge learners than high prior knowledge learners has been found in other studies as well (e.g., Levie & Lentz, 1982; Levin & Mayer, 1993; Mayer & Sims, 1994; Ollerenshaw, Aidman & Kidd, 1997).

A well-known model for text and graphic integration that can potentially explain the results above is Schnotz’s (in press) Integrated model of text and picture comprehension (ITPC). ITPC organizes text and graphic processing in a series of stages. Briefly described, stimuli enter the cognitive system commonly through either the ear or the eye into either the visual register or auditory register. Next, stimuli are subjected to feature analysis or phonological/graphical input analysis, relative to modality. These
analyses result in different patterns relative to modality in working memory, such as visuo-spatial patterns, which equate to the subjective perception of the image. The patterns are then used in either depictive processing, which is the processing of sound or visual pictures, or descriptive processing, which is the processing of written or spoken words, by selecting relevant perceptual structures. Depictive processing results in a mental model, and descriptive processing results in a propositional representation. Mental models can be inspected and propositional representations can be gleaned from them, and propositional representations can be integrated through model construction to enhance or create those mental models. Long-term perceptual, lexical, and conceptual knowledge can be integrated into the propositional representation, mental model, or at the model construction or inspection stages (Schnotz, in press).

The ITPC provides important design heuristics to guide the construction of instructional displays. For example, in cases when animation is combined with written text, ITPC suggest that narration should be used rather than written text to ensure that the viewer’s visual perception system is not tasked with both reading and watching the animation (Schnotz, in press). Another guideline is that, if there are multiple informationally equivalent ways in which information can be visualized, one must use the form most appropriate for the target task (Schnotz, in press; Schnotz & Bannert, 2003). For example, given the limited capacity of both the channels within which information is inputted into working memory, one must carefully consider the form of multimedia used for complex processes. Previous studies have shown that technical processes with simple annotated drawings of a machine in different operational states (e.g., Mayer & Gallini, 1990) produce better target learning outcomes than an equivalent, non-annotated image.
It is easy to imagine that the capacity of the input channels of working memory may be too limited for a learner to fully understand information that is especially complex—as information tends to be in litigation. Thus, it is reasonable to think that a different medium, such as a properly designed animation that shows events, rather than describing the events through annotation, may be better suited when a complex series of the events needs to be communicated.

Animation and Cueing Research

Dynamic multimedia displays, or animations, and cueing are often seen together. Animations are generically defined as a progressive series of varying, artificially composed, images that engender the perception of change over time through the alteration of a dimension, attribute, or characteristic (Bétrancourt & Tversky, 2000; Gonzales, 1996; Mayer & Moreno, 2002; Schnotz & Lowe, 2008). Although the basic characteristics of an animation are fairly well established, the functions of animations are more difficult to identify.

Ploetzner and Lowe (2012) conducted a meta-analysis of 223 articles to characterize the types of animations and their affect on learning. Narrowing down to 44 articles in 14 different domains, the researchers revealed that the influence of animations on learning can be traced to: (a) the animation’s presentation, (b) the control the user has over the presentation, (c) the degree to which cues in the animation scaffold a user’s attention to it, and (d) the number of times and conditions under which the animation is viewed (Ploetzner & Lowe, 2012). The scaffolding component may be the most critical
in guiding learners with low subject prior knowledge through unfamiliar animations because of the cues the animations afford during viewing.

Cues may occur visually through the use of movement or visual changes to a display, such as adding arrows, (e.g., de Koning et al., 2009), sound (e.g., Boucheix & Guignard, 2005) or a combination of both visual and auditory cues. In their review, de Koning et al. (2009) argued that cues have three main functions: (1) selection cues that guide attention to one or more areas of an animation, (2) organizational cues that emphasize the structure of an animation, and (3) integration cues that emphasize relationships within or between different aspects of an animation. Learning outcomes have been positively influenced when visual and auditory cues are combined, (e.g., Boucheix & Guignard, 2005) and when visual cues are presented alone (e.g., de Koning, Tabbers, Rikers & Paas, 2007; Fischer & Schwan, 2008).

However, learning outcomes are not always improved by using animation. For example, Lowe, Schnotz, and Rasch (2011) conducted an investigation in which participants were given eight sequenced images of a kangaroo hopping in either an animated, static-sequential, simultaneous, or no graphic presentation. After viewing the animation, participants were given the same eight images and asked to put them into a correct sequence, beginning with the kangaroo’s take off and ending with landing. Results indicated that the participants in the animated condition were not only significantly outperformed by the participants in the static-sequential group, but they performed comparably to the group that received no graphic prior to the task (Lowe et al., 2011).
Further, learning outcomes from animation cannot always be improved through the use of cueing. Lowe and Boucheix (2011) conducted an investigation with a simple animation showing the mechanism that is used to strike a piano string. Two types of cues were used; color cueing, and what the authors refer to as, “anti cueing,” which is defined as making less salient portions of the animation more faint as a way to divert attention to more salient areas (Lowe & Boucheix, 2011). On both a physical demonstration task, and through eye tracker data analysis, the results indicated that cued animations were no more or less effective than uncued animations, with one exception; color cues did draw more attention to certain aspects of the animation, but only during the first viewing (Lowe & Boucheix, 2011). The reduction in efficacy of cues over time, or the ability for cues to guide attention without positively effecting learning outcomes, has also been shown in other investigations (e.g., de Koning et al., 2010a; Kriz & Hegarty, 2007).

While it is difficult to identify the conditions under which animation and cueing improve learning, the nature of the investigations in which animation and cueing are generally more restricted. Most animation studies use animation to show a mechanical, meteorological, biological, geological, etc. process in a similar way to the investigations mentioned above (e.g., de Koning et al., 2007; Fischer, Lowe, & Schwan, 2008; Lowe, 2003; Lowe & Boucheix, 2011). In these cases, the concept of time is not central to the learning of a system or process, but rather time is only relevant to the time it takes for subject matter to be shown—i.e., a heart takes time to beat, and gears take time to turn. That is to say, the learning objective of most animations is the processes that occur over time, rather than the length of time within which a process occurs.
With regards to a field like litigation, the temporal relationship of events can be extremely important. For example, the sooner paramedics arrive on scene after a car accident, the sooner they will be able to tend to victims, and the victims therefore have a higher the probability of survival. In this example, the speed with which care is delivered to victims is central to the case, regardless of the mechanics of the actual car accident. As such, the way in which time can be visualized is important to how animations are used to describe the relationship of events across time.

Spatiotemporal Visualizations

Ainsworth and Van Labeke (2004) distinguish between three fundamental representations of time: (1) time-persistent representations that show the values of one or multiple variables in relation to time, such as in a line graph; (2) time-implicit representations that show one or more variables, but without a direct relationship to time, such as a graph that shows change in population density on one axis and population in raw numbers on another axis, with the plot line portraying time through movement; and (3) time-singular graphs that show one or more variables at one instant in time. However, these ways of representing time do not explicitly state exactly how time should be conveyed, for example, in directionality.

Tversky (2011) extensively outlines the ways in which time has been displayed throughout history and across cultures. Tversky (2011) explained that time is represented horizontally in the majority of situations, with a possible reason for this preference based in motion, which for humans, is largely horizontal (Tversky, 2011). As Tversky (2011) notes, motion through space takes time, and humans often categorize
movement or distance with time, for example “It’s about a five – ten minute bike ride to
get there.” Whether the left side of the horizontal display represents past or future can
depend on writing or reading direction in a given culture, but a general horizontal
preference has been shown across all cultures (Tversky, 2011). For western language
speakers, Tversky (2011) states that time is thought of in a left/past-right/future manner.
The same horizontal left-right orientation has been shown in a number of studies (c.f.
Ouellet, Santiago, Israeli, & Gabay, 2010; Santiago, Lupiáñez, Pérez, & Funes, 2007).

Tversky (2011) also notes that time is sometimes visualized vertically, but
with no clear convention on the directionality of time. For example, man is positioned at
the top of vertically oriented evolutionary diagrams, but the oldest languages are at the
top of linguistic trees (Tversky, 2011). An examination of reading and writing direction
shows that many written languages, including western languages, begin at the top of the
page, with lines of text written horizontally, with each successive line written below the
preceding line (Tversky, 2011). It has also been shown that, in a study of adults
conducted in a western culture, after an individual listens to a text, they can locate a word
above chance level when asked to write where they believe the word would have fallen
on a blank piece of paper if the text had been written. The assumed logic behind this
placement is that: “the word came earlier in the text, so it must be higher up on the page”

While time is sometimes mapped in a vertical manner, Tversky (2011) notes
that the vertical axis is much more likely to be used to map evaluative concepts such as
quantity, strength, or quality. For example, Tversky, Kugelmas and Winter (1991) asked
American, Hebrew, and Arabic children as young as four, and college students, to
perform a number of tasks related to visuospatial ordering. Participants were presented with a square piece of paper and asked to place stickers on the paper for different types of relationships such as quantity, time, and preference. All three groups readily mapped temporal concepts to the horizontal axis (Tversky et al., 1991). When asked to perform tasks related to quantity or preference, participants across groups sometimes mapped the concepts to the horizontal axis, and sometimes mapped them to the vertical axis. Interestingly, when participants mapped things like quality and preference to the vertical axis, the values that were either more preferential or higher in quantity were always at the top of the page, with the less preferential and lower quantity at the bottom of the page (Tversky et al., 1991). By extension, it seems that a similar type of evaluative mapping may exist for diagonal lines, especially when a top-left to bottom-right mapping, similar to how graphs of quantity over time show decline, i.e. in the stock market (Tversky, 2011).

As time, quality, and quantity seem to have preferential spatial mappings, it is easy to imagine that the way in which a series of events or concepts are displayed may change the way these events and concepts are perceived by the viewer. Specifically, how events are displayed in litigation could have an impact on how the events are perceived by jurors. For example, a simple way attorneys often display the temporal relationship of events across time is through timelines. Timelines have been used successfully in a number of areas (Tversky, 2011), and are often used in court (Bloom & Powdernaker, 2006). Commonly, at least in western cultures, timelines are displayed horizontally, with a left/past-right/future orientation. However, given that the vertical orientation is sometimes used for time, but more readily mapped to evaluative concepts, it seems
possible that describing a series of events with a vertically oriented timeline may impact the way jurors perceive the importance of events versus whether the events are described using a more commonly seen horizontal timeline.

Present Investigation

In the present investigation, we asked learners to view a PowerPoint presentation about a medical malpractice case centered on a series of events during the labor and delivery of a child. Participants were shown one of three different orientations of the same timeline of this event series—one vertical, one horizontal, and one diagonal. The timelines were presented in either a static-sequential or animated modality. Each timeline was accompanied by a concurrent audio narration with a more in-depth description of the timeline than what was shown on screen. The content of the timelines and narrative was derived from a medical malpractice case being litigated in the State of California. The case referred to the alleged mishandling of a childbirth and subsequent injury to the child. It is essential to note that the narrative and timeline were constructed to be slightly prosecution-biased. As such, the intention of the timeline and narrative was to imply guilt on the part of the defendant, rather than an innocent or neutral implication. After viewing, participants were asked to write a reflective essay containing everything they remembered from the timeline and narrative, as well as any personal thoughts or feelings they had on the presentation they were shown. Additionally, to measure comprehension of core concepts and judgments of guilt, we asked participants to answer a series of questions pertaining to the legal foundations of the case, as well as their
subjective evaluation of the guilt of the defendants. Participants were also asked to return one week later and perform the same tasks.

The structures for the timeline visualizations were informed by the guidelines set out in ITPC. Regarding the conditional use of multimedia, we were guided by Schnozz (in press), in assuming that jurors inherently have low prior knowledge, as each case is unique and must be learned individually. Thus, we assumed that the timeline would potentially aid in initial mental model construction, and may further be used to update the mental model with deeper information provided from the narrative (e.g., Hochpöchler et al., 2013). With regards to the structure of the visualization (Schnozz, in press), we agreed with Tversky (2011) that time is most commonly conceived or visualized in a left/past-right/future manner, especially in western cultures. We reason that, while time is less commonly visualized vertically (Tversky, 2011), a top/past-bottom/future orientation is plausible based on the direction western cultures read and write stories on a page. Finally, while it is not typically mapped to time, potentially due to the construction of the visual feature detection system (e.g., Howard, 1986; Tversky, 2011), we reason that time represented diagonally, if visualized with a top/left/past-bottom/right/future structure, could function in a way that combines both the horizontal and vertical spatiotemporal biases present in the horizontal and vertical timelines. This latter reasoning led us to hypothesis one; the diagonal timeline, across modalities, will lead to better recall of events presented in the timeline, and the best mental model construction, resulting in a more coherently constructed story, and therefore higher ratings of guilt, and confidence in those ratings.
With regard to presentation modality, we assumed that the task of being a juror requires a substantial amount of learning about novel events and laws over time to form a judgment. Relative to this assumption, we have strived to adhere to Ploetzner and Lowe’s (2012) taxonomy of expository animations in an attempt to guide learners through the case material. Expository animations are theoretically well suited for use in litigation as they are adept at displaying change, a series of events, or interaction of different elements over time. While it is not clear if animations truly have an advantage over static graphics, we contend that this may be due to informationally-inequivalent graphics or taxonomies (Tversky et al., 2002), or animations not being correctly constructed for a specific learning outcome (e.g., Schnotz & Bannert, 2003). Further, we have used animation only when necessary for the purpose of cueing to guide attention. The use of cueing to guide uninformed learners through an explanatory animation seems to be a classic use of research findings (de Koning, Tabbers, Rikers, & Paas, 2009). Thus, we used a form of the “spotlight” cue (de Koning et al., 2009) alternatively referred to as “anti-cues” (Lowe & Boucheix, 2011), by changing the shades of the hues in which events are shown when the events are the focus of the narration or not, or bringing events into focus gradually when they are introduced. It should be noted that, on the static-sequential timeline, the change in shade was also present, but did not occur smoothly through animation, but rather as a single, simultaneous change. The shade change in both conditions was kept consistent to keep the two conditions as similar as possible, only changing the way in which the events were delivered to the learner. Additionally, we used movement cues (de Koning et al., 2009) to guide learners though the animation when the scale of the timeline changed, and to introduce a critical period of time on the
The manipulation of animated cues led us to hypothesis two; the animated cued timeline, across orientations, will lead to better mental model construction, and therefore better understanding of how the events presented on the timeline are related, resulting in a more coherent story than the static-sequential timeline, and therefore higher ratings of guilt, and higher confidence in those ratings.

Both the animated and static-sequential timelines resulted in visualizations with a linear temporal structure. Information was introduced piecemeal in both visualizations with concurrent auditory narration and a small amount of redundancy between narration and on-screen information to account for learners’ relative lack of prior knowledge and limited working memory capacity.

Our intention of following the guidelines set out by ITPC (Schnitz, in press) and Ploetzner and Lowe (2012) was to ensure that learners coherently construct both a propositional representation and mental model of the legal case. By doing so, we expected learners to be able to integrate into a coherent story for judgment formation what they learned about the case. Therefore, we expected an interaction between timeline orientation and presentation modality. Thus, Hypothesis three predicted that the diagonal animated timeline will lead to the construction of a better mental model than any other condition, and learners in this condition will recall more events correctly than learners in all other conditions. This mental model will reflect a more coherent story, and therefore higher ratings of guilt, and higher confidence in those ratings, than any other condition.
CHAPTER II

LITERATURE REVIEW

Introduction

The way in which humans process visual information has often been the topic of investigation. Typically, visualizations, and the way learners’ process them, are studied in the learning domain. However, visualizations, such as dynamic and interactive displays, are now employed in numerous different domains that warrant investigation. One domain that is often not considered is the field of litigation, specifically juror learning and decision-making. Jurors are required to not only learn novel information about a series of events that they cannot directly witness, they also must decide between two versions of the events, and further make a decision relative to a set of laws pertaining to the case. Not only is being a juror a learning task, it is likely a very difficult learning task. The following is a review of relevant research and theoretical findings in the areas of human short-term and long-term memory storage, learning from multimedia, the effect of animation and cueing on learning, spatiotemporal biases in multimedia, multimedia research in litigation, and judgment formation in litigation.
Working Memory

Baddeley’s Model of Working Memory

A well-known model's short-term memory store is Baddeley’s Model of Working Memory. Baddeley’s model is comprised of four parts; the Phonological Loop, the Visuospatial Sketchpad, the Episodic Buffer, and the Central Executive (Baddeley, 2003). The theory operates on the dual-channel assumption, which is, “Humans possess separate information processing channels for verbal and visual material” (Mayer & Moreno, 2003). Although this is not the original version of working memory as proposed by Baddeley and Hitch (1974), it has been revised to better account for more recent research findings.

The Phonological Loop

The phonological loop in Baddeley’s model is the system in which auditory stimuli is processed. It is comprised of two sub-systems, the phonological store and the articulatory rehearsal system. The phonological store can hold memory traces of heard auditory information for a few seconds (Baddeley, 2003, p. 830). These memory traces can be renewed or refreshed by being re-articulated, or rehearsed. The articulatory rehearsal process is very similar to sub-vocal speech (Baddeley, 2003, p. 830). These two subsystems act as a place for auditory information to be momentarily held for future processing. Since these systems have a limited capacity, only a certain amount of information can be attended to or articulated at a time, as is evidenced by the word-length effect and the serial order effect (Baddeley, 2003). In addition to these functions, the phonological loop is active in bringing language-based long-term memories from long-
term memory (LTM) into working memory where the information can be operated on in a conscious way.

**The Visuospatial Sketchpad**

The visuospatial sketchpad is the parallel system to the phonological loop for visual stimuli. Similar to the phonological loop, it has a limited capacity, in this case three or four visual objects (Baddeley, 2003). Because visual information is sometimes more externally persistent than auditory information, detailed visual retention can sometimes be redundant (O’Regan, 1992). Regardless of this redundancy, the characteristics of objects within the visuospatial sketchpad can compete with one another (Baddeley, 2003). Retention of visual information is “dependent on the binding together of constituent features, a process that requires attention” (Baddeley, 2003, p. 830). Therefore it is often required that an individual allocates a certain amount of attention to visual stimuli, as well as auditory stimuli, for stimuli information to enter working memory. Similar to the phonological loop, the visuospatial sketchpad also functions as a way to bring visual information from LTM into working memory.

**The Central Executive**

The central executive portion of working memory is, in general terms, the center of organization of the processing occurring in working memory. Although it serves a very important purpose, Baddeley (2003) states the central executive is least understood of the four components of working memory. The central executive serves as the driving and controlling force behind where and when attention is directed. The central executive also aids in the implementation of routine actions and processes without consuming a
large portion of working memory, in addition to directing attention to other, less practiced processes that require more conscious effort.

The Episodic Buffer

The last piece of Baddeley’s working memory is the episodic buffer. The episodic buffer is a “limited capacity store that binds together information to form integrated episodes” (Baddeley, 2003, p. 836). These “episodes” are the combination of information brought into working memory by the two slave systems, the phonological loop and the visuospatial sketchpad. As such, the episodic buffer allows information from these two systems to be brought into conscious awareness. The processes of the episodic buffer are controlled by the central executive’s ability to direct attention. In fact, Baddeley states, “The buffer was presented as an entirely separate subsystem, but could be regarded as the storage component of the executive” (2003, p. 836).

What is most important to note for the design of instructional materials is that human short-term store has a limited capacity. This capacity is rather small, and effective instructional design must be aware of the limits of short-term store. If a learner is given a visualization or multimedia presentation that is not designed to eliminate unnecessary demands on working memory, it is possible that learning goals will not be met.

Long Term Storage

Two theories have been the subject of much of the research on long-term storage in the past several decades. Those two theories are Schema theory and Dual-Coding theory. The two theories are complementary in some ways but each has their own following.
Dual Coding Theory

Dual coding theory (Paivio, 1986) is a theory of cognition that attempts to describe the way in which humans process both linguistic and non-linguistic information, and the manner in which the two interact (Sadoski, Paivio, & Goetz, 1991). Dual coding theory states that cognition is a system composed of two separate, but interconnected, sub-systems, one for processing non-verbal stimuli and information, and the other for processing linguistic information. The nonverbal system is often referred to as the imagery system, as “its functions include the analysis of scenes and the generation of mental images (visual as well as in other modalities such as auditory, haptic, and affective)” (Sadoski et al., 1991, p. 473). On the other hand, the system dealing with linguistic and language information is called the verbal system. These systems can function on their own, in conjunction with one another, or simultaneously (Sadoski et al., 1991).

In the model, visual stimuli and verbal stimuli enter thorough the sensory organs, called sensory systems in Dual Coding theory, and activate mental representations through representational connections. These representations are referred to as logogens in the verbal system, and imagens in the nonverbal system (Sadoski et al., 1991). Both logogens and imagens are organized in a hierarchical, probability-driven order that is shaped through experience of the individual, which are known as associative structures (Sadoski et al., 1991). Although both logogens and imagens are shaped through experience, logogens are stored so that they can be easily processed sequentially, and imagens are stored in groups called nested sets.
Relations between the logogen and imagen systems are called “referential connections” (Sadoski et al., 1991, p. 473). These connections allow an imagen to evoke a logogen, and vice versa, although that is not always the case. These referential links are shaped through experience, just as the inner system links. In theory, the more an individual is exposed to certain stimuli, the more often a set of connections is activated, and thus the more likely either a logogen or imagen will be brought into mind. Having verbal and nonverbal information stored in this manner allows for a great flexibility in cognition, which Sadoski et al. (1991) claimed accounts for a great variety of cognitive processing.

Schema Theory

Schema theory hypothesizes that memories are encoded and stored as a general set of abstracted characteristics. For example, one may have the schema for an airport; there is a long road in front of the airport that you can get dropped off at, and many signs displaying different airline names. Inside, there is a long row of computers for people to check their bags and get their boarding passes. Further inside, there is the security checkpoint, never devoid of a line of people, and so on and so forth. If an individual references a specific example of a schema, for instance San Francisco International Airport (SFO), noting that SFO has a particularly complicated parking structure and they got lost in it once, that specific schema is called an instantiation. An instantiation is a solidified example of a schema stored in its interpreted form (Alba & Hasher, 1983).

Four main processes govern schema theory: Selection, abstraction, interpretation, and integration. Selection is the initial process in which incoming stimuli
are either attended to, or sometimes ignored, for internal representation. Abstraction stores the overall meaning of the stimuli, but without specific, concrete details. Interpretation occurs when relevant prior knowledge and past experiences are joined with the incoming stimuli to help better understand and frame the incoming stimuli. Integration is the packaging of the new and prior information into a unit to be stored in memory. Once a schema is stored, it can be accessed at a later time. When that occurs, the schema is reconstructed from its relevant parts. However, as a schema is reconstructed each time it is accessed, it may be incomplete or incorrect due to the fact that it was not stored in its entirety in the first place (Alba & Hasher, 1983).

There is still a debate as to which theory provides a better analysis of how humans process and store information. Many have criticized one or the other (e.g., Alba & Hasher, 1983; Sadoski et al., 1991). Others have combined them with different theories (e.g., McVee, Dunsmore, & Gavelek, 2005). Although there is no complete agreement in the field as of now, what is important for the present investigation is that individuals must be given clear multimedia presentations to store them correctly. The links between salient objects in a multimedia presentation must be strong enough so that, regardless if one stores information as a series of logogens and imagens, or as schema, the information they learn is durable and accurate enough to think with in the future.

Text-Graphic Processing

Schnotz’s Integrated Model of Text and Picture Comprehension

One model of text-graphic integration is Schnotz’s (In press) Integral model of Text and Picture Comprehension (ITPC). The model carefully considers established
research from a number of different areas with the aim of providing a model of text-
graphic comprehension that can exist alongside, and be integrated into, extant research
(Schnotz, in press). Specifically, the model take into account concepts from semiotics,
text and picture processing research, and concepts from cognitive neuropsychology
(Schnotz, in press).

There are four main assumptions in ITPC. The first assumption is that text-
graphic processing and comprehension are subdivided into three distinct systems
including sensory registers, working memory (e.g., Baddeley, 1986), and long term
memory. The second assumption is that both verbal and pictoral information are
transmitted through limited-capacity channels to working memory for further processing.
The third is that, within working memory, there are two distinct but interconnected
subsystems: a descriptive subsystem, which processes language-based stimuli through
parsing, and a depictive subsystem, which processes image-based (either visual or
auditory in the case of non-speech auditory stimuli) content. While stimuli, for example
written text, is initially passed through one of the subsystems, for example the descriptive
subsystem, it is also passed through the other subsystem afterwards, for example the
depictive subsystem. Finally, the fourth assumption of ITPC is that text and picture
comprehension are active processes that require a learner to build coherent knowledge
structures from stimuli, as well as integrate that knowledge with information in long-term
memory (Schnotz, in press).

Within the three systems (i.e., sensory registers, working memory, and long-
term memory) two overarching processes occur; perceptual surface structure processing
and semantic deep structure processing (Schnotz, in press). Perceptual surface structure
processing describes the transfer of stimuli from the source to working memory, which involves either verbal phonological or graphemic feature analysis in the case of spoken word and written text, and non-verbal graphemic analysis in the case of pictures and or auditory stimuli other than understandable language, with either resulting in an input pattern in working memory (Schnotz, in press). Perceptual surface processing occurs nearly entirely outside of working memory, while semantic deep structure processing occurs nearly entirely within working memory. Semantic deep structure processing is the processing that must be done on the inputted verbal or non-verbal stimuli to construct propositional representations (verbal) or mental models (non-verbal) (Schnotz, in press). Finally, semantic deep structure processing also incorporates long-term memory into the newly constructed propositional representation or mental model.

In sum, stimuli are subjected to three different analyses or processes before being consolidated into either mental models or propositional representations. Briefly, if verbal language is to be understood, it is inputted through the ear into the sensory register, where it is quickly subjected to phonological input analysis to identify any discernable phonemes and organized into phonological lexical patterns (Schnotz, in press). From there, descriptive processing parses phonemes into words, words into sequences, and sequences into sentences which finally results in a propositional representation of the verbal stimuli (Schnotz, in press). This propositional representation can then either construct or elaborate of or upon a mental model (Schnotz, in press).

The processing of written language progresses in a similar manner. However, it enters the cognitive system through the eye and is subjected to graphemic input analysis rather than phonological input analysis (Schnotz, in press). In skilled reading, this
leads directly to graphemic lexical patterns, and further processing through parsing, resulting in a propositional representation than can then be consolidated into a mental model (Schnotz, in press). However, in unskilled readers, graphemic lexical analysis does not occur directly, and a learner must convert strings of letters in to phoneme strings rather than directly parse the information (Schnotz, in press).

The processing track for non-verbal sound comprehension is slightly different. If non-verbal sound is to be understood, it enters into the cognitive system in the same manner as verbal sound. However, it is subjected to non-verbal acoustic feature analysis, which results in sound patterns in working memory, which are the conscious perceptual experiences of the sound. Next, rather than being sent to the descriptive subsystem, sound patterns are sent to the depictive subsystem for further analysis and consolidation into mental models (Schnotz, in press). From there, the mental model can be encoded into a propositional representation. As non-verbal sounds are non-lexically based, they are considered sound pictures, and are therefore not inputted directly to propositional representations.

The processing of visual images beings with the stimuli entering through the eye, and it is then subjected to visual feature analysis to produce recognizable visuospatial patterns in working memory (Schnotz, in press). Next it is processed by the depictive system through visual structure mapping and then consolidated into a mental model, which can then be inspected to form a propositional representation (Schnotz, in press).

Based on the ITPC model, Schnotz provides a number of guidelines for multimedia design. First, multimedia should only be sued when leaners have sufficient
cognitive abilities to process both text and pictures or animation. Second, multimedia designs should only utilize pictures that are semantically related. Next, written text should be presented in close spatial proximity to pictures and verbal text should be presented in close temporal proximity to pictures. Additionally, pictures should not be presented after semantically related texts, but concurrently or the picture should be presented prior to the text. Further, multimedia should not be used if learners’ have enough knowledge and ability to construct a mental model from one source alone. Also, when presenting multiple modalities (e.g., written and spoken text), visual and auditory information should not be repeated. Next, when using animation, spoken text should utilized to avoid splitting attention between reading and examining the picture. When using static pictures, the design should take into account the amount of the time learner will have to process the text, the complexity of the text, and the complexity of the picture before deciding which modality to use so that the limited capacity of working memory is not expelled needlessly. Finally, all pictures are not created equally (e.g., Schnotz & Bannert, 2003) and care should be taken to properly select the picture presented.

**Mayer’s Multimedia Learning**

Another theory that attempts to describe text-graphic learning is Mayer’s Cognitive Theory of Multimedia Learning (Mayer, 2001). The theory is based on three assumptions: The dual channel assumption, limited capacity assumption, and the active processing assumption. The dual channel assumption in Mayer’s theory is the same as mentioned previously. The limited capacity assumption is, “There is only a limited amount of processing capacity available in the verbal and visual channels” (Mayer & Moreno, 2003, p. 44). The active processing assumption is, “Learning requires substantial
cognitive processing in the verbal and visual channels” (Mayer & Moreno, 2003, p.44). Based on these three assumptions, Mayer outlines a tripartite model of multimedia learning. The first component of the model is sensory memory, which has a very limited capacity. Information is entered into this component through the ears and eyes.

The second part of Mayer’s theory is that there is a place for an individual to do conscious, cognitive work called working memory. Working memory is comprised of both shallow and deep representations, with the shallow representations being sounds or images being attended to by the learner, and the deep representations being more complex verbal and pictoral models constructed by the learner (Mayer & Moreno, 2003). Finally, there is long-term memory as the third part of the model. Between each part there are cognitive processes that occur to move information from one part of the model to the next. From sensory memory, individuals select pertinent words and images to be processed further in working memory (Mayer & Moreno, 2003). It is important to note that words can enter the system either through the eyes or through the ears, in the form of written or verbal text. Once relevant images or words are selected and brought into working memory, images and sounds have the ability to cross channels. For example, the sound of a fire engine siren can bring to mind the image of a fire engine, and vice versa. Once stimuli have been attended to in their shallow representation, they are organized into deep representations, which are coherent verbal or pictoral models of the incoming stimuli (Mayer & Moreno, 2003). Information from the verbal and pictoral channels are then combined with information from long-term memory. At this point this individual has received stimuli through either the ears, eyes, or both, selected relevant stimuli for further processing, incorporated the new information across modalities, built a model of each
piece of information in each channel, and incorporated those models with knowledge stored previously in LTM.

The theory also outlines three different types of cognitive processing that the learner may engage in multimedia learning; Essential processing, incidental processing, and representational holding. Essential processing is the type of processing that is required to make sense of, and make meaning from, multimedia material. Incidental processing occurs when information that is nonessential to the goal of the learning task or material is attended to. Finally, representational holding is the process that is required to hold information in working memory, or attend to it (Mayer & Moreno, 2003).

Mayer and Moreno (2003) expanded upon the principles of this theory and provided some different effects that can be seen in research to help guide design of multimedia presentations. Although nine effects are provided, only the ones that pertain to a non-viewer controlled environment will be presented here. Those include; the modality effect, the segmentation effect, the coherence effect, the signaling effect, the special and temporal contiguity effects, and the redundancy effect. The modality effect states that, “better transfer occurs when words are presented as narration rather than as on-screen text” (Mayer & Moreno, 2003, p. 46). Although in many cases it may not be possible to eliminate on-screen text entirely, it is important to narrate when applicable. The segmentation effect states that learners learn better when information is broken up into smaller, manageable pieces than when it is delivered in a continuous stream (Mayer & Moreno, 2003). This is important to note especially when there is a vast amount of information, as learners may not be able to follow or retain all the important elements of a presentation if it presented too rapidly. The coherence effect relates the idea that
external stimuli and information should be kept at a minimum to reduce incidental processing of extraneous material. The signaling effect states that learners learn more effectively when there are cues to guide them through the presentation of material. The spatial and temporal contiguity effects state that learners learn more effectively when presentations are displayed in close proximity in distance, as well as animations and narration are more effective when presented concurrently. Finally, the redundancy effect states that learning can happen more effectively if narration is not represented in text form at the same time, and vice-versa.

While this is only two different ways of looking at how individuals’ process and work with external graphic and text displays, there is no doubt that there isn’t a holistic agreement of how learning from multimedia occurs. Both sets of guidelines are strong; the point is that multimedia representations must be constructed very carefully. However, the general theme from either theory is that it is that presented multimedia information is clear and concise enough to allow an individual to interpret it and combine it with existing mental models, or to create a new model. If displays are too confusing or overly complex, they may not be processed in a way that will allow a viewer to construct an accurate model of the material.

Animation Research

“Animation should, in principle, be effective for expressing processes such as weather patterns or circuit diagrams or the circulatory system or the mechanics of a bicycle pump” (Tversky et al., 2002, p. 250). Although this is a main hope for many in
the cognitive sciences and education field, the research has shown that animations are not universally beneficial for all types of learning and knowledge acquisition.

Schnottz and Rasch (2005) conducted two studies on the effect of animation on knowledge acquisition. In one study, the learner was presented with a simulation or a non-manipulative animation that showed the different time zones on earth. These animations were tested against static graphics depicting the same information. In the second study, only the simulation and manipulative animations were compared. The results of the two studies showed that the ability to manipulate the images enabled high-functioning learners to acquire knowledge more effectively, and the simulation images had a facilitating effect for low-level learners (Schnottz & Rasch, 2005). The enabling effect of the animation allows learners to perform additional cognitive processing (Schnottz & Rasch, 2005). The facilitating effects of the simulation allow the learner to expel less effort and do less cognitive processing (Schnottz & Rasch, 2005). However, it was discovered that the facilitating effects had reduced effortful processing to such a level that learners did not perform necessary functions to properly encode the information.

Lowe (2003) conducted a study with 24 undergraduate students comparing animated meteorological maps with static maps. The students were given time to study their respective material and were then tasked with their predicting weather patterns on a different static map (Lowe, 2003). It is important to note that none of the students were educated in the meteorology (Lowe, 2003). The result indicated that, although the students presented with the animated map sometimes had better predictions than those who were presented the static map, the predictions were limited by what was most
perceptually salient in the animation (Lowe, 2003). Lowe (2003) attributes this to a field-ground effect, where the dynamic animation of the weather attracted most of the attention and the ground of the landscape served as a less salient, contextual background.

The mixed findings of the two studies above are not isolated in the body of research as a whole. In a meta analysis, Tversky et al. (2002) discovered several problems with animation research in general. They found that, in many cases, information in the animated material was not equivalent to that presented in the static material (Tversky et al., 2002). This creates problem when trying to compare the two styles of media presentation. The authors also found some studies did not allow manipulation of static materials when manipulation of animated materials was allowed (Tversky et al., 2002). While manipulation is made easier with animation, adding it as an independent variable does not directly compare the abilities of animation versus static graphics to convey information.

Tversky et al. (2002) presented two principles for animation design to help the learner better understand the presented information: the congruence principle and the apprehension principle. The congruence principle states that “The structure and content of the external representation should correspond to the desired structure and content of the internal representation,” (Tversky et al., 2002, p. 257). The apprehension principle states, “The structure and content of the external representation should be readily and accurately perceived and comprehended,” (Tversky et al., 2002, p. 258). These two principles may be used in conjunction with multimedia design principles as an important tool to ensure graphics are perceived as intended, both in content and in structure.
Although animation research does not always yield positive findings, or is not always conducted with equivalent stimuli, it can also be an effective way to improve learning outcomes. In a meta-analysis of 26 studies, Höffler and Leutner (2007) discovered that animated pictures yielded a medium size advantage over their equivalent static counterparts. Further, when eliminating interactive animation studies, non-interactive animations still held a small to medium sized advantage over static pictures (Höffler & Leutner, 2007).

As it stands today, animation is gaining more ground in learning and instruction research. As methods and content are revised to better apply past research findings, it is reasonable to think that animation may serve as an effective tool to enhance and improve learning outcomes. One effective way to reduce the disparity in research findings may be to better categorize the type of animations used. This may allow for a more clear understanding of the circumstances under which an animation format may be better suited to improve learning outcomes. For example, when once must explain how a complex system works, it may be best to employ a type of animation that is adept at explaining complex concepts.

**Expository Animations**

Ploetzner and Lowe (2012) created a taxonomy for expository animations through the analysis of 44 investigations in 14 different fields of study. Ploetzner and Lowe state that expository animations are designed “to provide an explicit explanation of the entities, structures, and processes involved in the subject matter to be learned” (2012, p. 782). It is stated that there are four characteristics of animations, each with their own subcategories: presentation, or attributes of the animation itself; user control, scaffolding,
and configuration, which are all external supplemental characteristics of expository animations (Ploetzner & Lowe, 2012).

Presentation describes the basic characteristics of an expository animation in six sub-categories. These subcategories include: representations employed, abstraction, explanatory focus, viewer perspective, spatio-temporal structure, and duration. Representations employed describes the category of representations used within the animation, including visual representations and auditory representations. Abstraction more specifically describes the exact type of representation employed in the animation, such as an iconic representation or realistic pictures. Explanatory focus describes the main goal of the animation. Viewer perspective is concerned with describing the number of perspectives shown to the viewer, whether it is only one or many. Spatio-temporal arrangement describes the density of visual elements within the animation, how those elements are organized, the frame-rate of the animation, how the elements are introduced throughout time in relation to the animation as a whole and to one another, and also the duration of the animation (Ploetzner & Lowe, 2012).

The user control category allows for definition of the way a user of an animation may be able to control is playback, if allowed at all. Specifically, if users can control speed of playback, pause, restart, etc. Also, this category takes into account the fact that users may be able to zoom or change the perspective of the animation.

Scaffolding is a way to categorize how exactly an animation cues the viewer during the animation in order to aid perceptual, cognitive, and metacognitive processes. Animations may be unfamiliar to some viewers, and can take many forms, so it is important that the viewer be able to understand the animation (Ploetzner & Lowe, 2012).
Finally, configuration refers to how the animation is shown to the viewer, for example if the animation is shown only once or if it is repeated, or if it is accompanied by additional text or other animations.

The taxonomy does not provide specific guidelines for implementation of expository animations, but it is reasonable to utilize guidelines set out by theories of text-graphic processing and multimedia learning (e.g., Schntoz, in press; Mayer, 2005) while still abiding by the taxonomy. Ploetzner and Lowe (2012) note that animation research is relatively young compared to text-graphic or multimedia, and it is valuable to integrate new research into comprehensive taxonomies.

**Cueing in Animation**

Ploetzner and Lowe (2012) state that learners or viewers of animations may have difficulty processing animations effectively. A common way to help learners use animation more efficiently is through cueing. Cueing uses manipulations of color (e.g., Boucheix & Guignard, 2005), directional arrows (e.g., Fischer et al., 2008), movement (e.g., Lowe & Boucheix, 2008) or other visual manipulations to help the viewer better interpret the animation being presented (de Koning et al., 2009). De Koning et al. (2009) conducted a review of how cueing has been implemented, either successfully or unsuccessfully, in animation research.

The resulting framework from the review indicated three functions of cueing: 1) selection, or cues that guide attention to specific locations within an animation, 2) organization, or cues implemented with the intention of emphasizing structure, and 3) integration, which are cues that emphasize the relationships between and/or within elements of an animation, but not the structure of the animation itself (de Koning et al.,
However, how cues are used may be critical to the success of an animation, and some impart greater successes on learning outcomes than others.

Cueing has been shown to positively affect learners’ comprehension in a variety of different environments. Huk, Steinke and Floto (2010) were able to improve learning outcomes by using arrows and different colored elements within an animation, in addition to a display of technical terms, to guide attention and relate elements within a complex science animation. Boucheix and Guignard (2005) were able to improve learning performance by implementing simultaneous visual cues, through the use of color, and verbal cues, by way of narration, to successfully guide attention to important information, as well as explain relationships between elements in a technical animation pertaining to the function of gears. Further, de Koning and colleagues (2007) conducted an investigation on the efficacy of the “spotlight effect” cue, or changing the luminance of the element within the animation that is to be focused upon, to guide attention. The results indicated that learners who viewed the cued animation versus learners who viewed an uncued animation had higher scores on learning tasks related to the cued elements within the animation. Interestingly, though, learners’ who viewed the cued animation also scored higher on learning tasks for information that was not cued. While it is not clear why this occurred, it may be possible that simply having a cued animation, regardless of the specific elements that were cued, increased the learners’ attention to all of the elements within the animation.

In some cases, cueing fails to influence learning outcomes, but does increase attention to relevant elements within an animation. For example, in de Koning et al., (2010b), eye tracking equipment was used to more precisely understand how learners
visually search a cued animation. Results indicated that, while learners did fixate on the visual cues, as well as the elements of the animation that were being cued, they showed no improvement in learning outcomes over learners that did not view a cued animation.

While cueing may not always have a positive effect on learning outcomes, it is clear that it has potential to guide a viewer’s attention to relevant elements within an animation. Also, learning outcomes do not need to be the only target of cueing. As noted by de Koning et al. (2009), organization and integration cues are not fully understood and require much more investigation. As this is the case, the complete effects of cueing on other aspects of text-graphic integration, such as mental model construction, may not be fully understood. This could be critically important when attempting to explain a series of events over time, such as in a court case. For example, if it is important to a case that jurors know one event took place before another, and the events are presented in an animation, it may be effective to implement cues to emphasize the relationship of the two events. However, in this example, it is also important how the relationships of events to time itself are visualized.

Visualizations of Time

Tversky (2001) notes that, while information has been depicted in numerous ways throughout history, modern technology has rapidly increased the number of ways in which change over time is depicted. One side effect may be that, one of the simplest ways to depict time, namely timelines, has not been the focus of research in the modern era of research.
Time is often thought of on either horizontal or vertical plane, but most commonly it is thought of on a horizontal plane, and as such depicted in a horizontal way (Tversky, 2011). The readiness to map the horizontal to time can be seen nearly universally across age, race, and culture (Tversky et al., 1991; Tversky, 2011). However, the direction time is depicted, either from right to left or left to right, appears to be culturally dependent. Further, it seems to be directly related to the direction of reading and writing (Tversky, 2011). For example, Tversky (2011) notes that western language speakers more readily map time in a left/past-right/future manner, whereas Arabic speakers more readily mapped time in a left/future-right/past manner. These directions correspond to the reading and writing direction in either culture.

While the horizontal plane is most typically mapped to time, there are instances that the vertical is as well, for example with geological time or family trees (Tversky, 2011). Unfortunately, the universal nature of the time direction does not hold up as well as horizontal time. For example, in evolutionary trees, humans are typically depicted at the top of the tree, indicating the most recent evolution, with the predecessors in succession below, but in some family trees, the oldest generation is located at the top (Tversky, 2011). Based on these disparities in time depiction, it is easy to imagine that, depending on the content of a case, or the domain of a case, that the way in which a series of events are depicted across time may affect the way jurors perceive the presented information.
Multimedia Research in Litigation

Research in litigation is not often concerned with the use of multimedia in the courtroom (Feigenson, 2010). Although there is a relative lack of research in comparison to the learning sciences, it is not to say none exists. Lassiter et al. (2002) conducted an investigation with the aim of better understanding how camera angle affected judgments of guilt when jurors saw videotape of interrogations. Authentic videotapes from a homicide investigation were shown to mock jurors. The videos had one of two perspectives; one with the camera focused solely on the defendant, and the other with the camera focused solely on the interrogators. The results revealed that those who viewed the video with the perspective focused on the defendant rated significantly higher levels of guilt than those who viewed the video focused on the interrogators (Lassiter et al., 2002). In another study, Park and Feigenson (2013) showed mock jurors a video of lawyers using PowerPoint to describe statistical information. The results revealed that jurors judged in favor of the attorney that used PowerPoint, and found them more credible than the attorney that did not use PowerPoint. Further, the result was shown regardless of if the attorney using the PowerPoint was arguing for the plaintiff or the defendant (Park & Feigenson, 2013).

Although these are just two examples of how multimedia can affect judgment in litigation, it is clear that the way in which information is shown to a jury can have an effect on judgment outcomes. As this is the case, it is important to consider how information is presented in court, and the effect that it may have on the jury. It is also important to consider how the presented information will be integrated with a juror’s prior knowledge for evaluation against relevant laws for use in judgment formation.
Pennington and Hastie’s Story Model of Jury Decision Making

Although there is extensive research on the cognitive and perceptual processes behind the interpretation of, and learning from, multimedia and text-graphic displays, there is little research on how these processes influence judgment formation and decision-making. Decision-making theories have been developed for different domains, different contexts of decision-making, and individual or group decision-making. Few, however, take into consideration the unique position of an individual while serving on a jury. The story model for Judicial Decisions (Pennington & Hastie, 1981) attempts to describe the way in which members of a jury decide on a verdict in a case. Pennington and Hastie (1981) hypothesize that juries form the evidence they are shown into a narrative with causal and intentional relationships. Once a narrative has been constructed based on the presented evidence, its organizational structure is used as a tool to facilitate comprehension and verdict determination (Pennington & Hastie, 1992). The model consists of three main parts: Story Construction, Verdict Representation, and Story Classification.

Story Construction

Trials require jurors to make sense of information given in a slightly different format than most information one is required to learn. Specifically, Pennington and Hastie (1992) give three examples of how an active, constructive comprehension process may be more difficult in, rather than out, of the courtroom: (a) there is a large volume of evidence presented over the course of days, weeks, months, and occasionally years; (b) information is presented in a question-and-answer style between an attorney and a
witnesses, but also in a manner similar to a lecture, and (c) statements made, or pieces of evidence shown, cannot be taken as isolated pieces of information, as they are interwoven with other statements and pieces of evidence that will influence the verdict as a whole. In order to integrate information of these different sources, the model states that jurors go through two different stages to construct and evaluate their narratives, namely story construction, as well as acceptability and confidence.

Forming the constructed story into a familiar structure requires that a juror orchestrate three types of knowledge into a narrative: 1) Knowledge presented during the specific case; 2) prior knowledge a juror has about similar cases or situations; 3) generic and commonly held beliefs about, “what makes a complete story (e.g., knowledge that human actions are usually motivated by goals)” (Pennington & Hastie, 1992, p. 190). In general, this means that jurors must take small pieces of information presented in court and form them into coherent, higher-order episodes. During this construction, jurors will infer, whether borne from their own thoughts or suggested by an attorney, whether different pieces of the story or discourse are important, or if some pieces are missing. In the end, the story will be based on the presented evidence and with inference based on an individual’s knowledge and experience of human action sequences.

Acceptability and confidence refer to the process of selecting the appropriate story out of a number of possible versions constructed in a jurors mind. For example, in a case discussing damages due to a car accident, it may quite plausible that the accident occurred in the exact way either party has described, but it is up to the juror to select which story makes the most sense. To do so, the theory states a jury refers to coverage,
coherence, and uniqueness. Coverage and coherence affect both acceptability and confidence, while uniqueness only affects confidence.

Coverage is the amount of a story that is accounted for by the presented evidence (Pennington & Hastie, 1992). The greater the coverage, the more acceptable a story is to a juror, and the higher the confidence a juror has in that story as an explanation of a series of events (Pennington & Hastie, 1992). Coherence describes the extent to which a story is internally consistent, plausible, and complete. Whichever story is highest in these three categories is likely to be accepted, and accepted with a higher confidence, than another story. Uniqueness describe the phenomenon that, when more than one story is judged as coherent by a juror, he or she will have more difficulty choosing which story best describes a series of events because the two stories are similar to one another. That is to say, the more different the stories are from one another, the more easily a juror can select which story fits the series of events most (Pennington & Hastie 1992).

Verdict Representation

Once a juror has selected a story, they must learn the different possible verdicts so that they can select the most appropriate verdict relative to their selected story. Typically, this will be given in the form of jury instructions. However, these instructions may also be mixed with a juror’s prior knowledge of similar cases and verdicts, and also may differ between case types. For example, in criminal cases, according to Pennington and Hastie (1992), a juror must consider Identity, mental state, circumstances, and actions (Kaplan, 1978) of a defendant relative to the possible verdict determinations. Once a juror has decided which verdict representation correctly
categorizes the selected story, an appropriate verdict may then be selected through Story Classification.

**Story Classification**

The final stage of the story model is the process of classifying the accepted story into the correct verdict category. This combines both of the previous steps, including each individual procedural instructions that describe the circumstances of legal terminology, i.e. “beyond a reasonable doubt.” In the model, the process of determining which verdict is most appropriate for the selected story is referred to as “goodness of fit” (Pennington & Hastie, 1992, p. 189). If the accepted story does not meet the “goodness of fit” threshold for a given verdict category, for example “guilty,” then the best-match verdict category is “not guilty,” and vice-versa.

While the above model does appear to provide a richer explanation of jury decision-making than a purely probability-based model, it does not take into account the influence of the type of evidence presented. For example, it does not make specific claims about which type of evidence most influences a juror’s decision-making or story construction process. Given that the structure, design, and implementation of multimedia influence learning outcomes in the classroom, it is reasonable to think that manipulating the same factors in the courtroom could have an influence on judgment formation.
CHAPTER III

METHODOLOGY

Design

Two factors, Timeline Orientation and Presentation Modality, were combined to yield six experimental between-subjects cells. The resulting design was a 3 Timeline Orientation (Horizontal vs. Vertical vs. Diagonal) X 2 Presentation Modality (Animated vs. Static-Sequential).

Participants

Ninety undergraduate volunteers (73 percent female, 26 percent male, mean age = 22.9, SD = 6.18) were conveniently sampled from a midsized university in the western United States, and randomly assigned to one of the six between-subject experimental conditions. Demographic data of the participants revealed that their primary language was English (89%), with the next highest being both Spanish and Hmong (3.3%), and the remaining 5.4 percent split between Japanese, Korean, and Punjabi. Participant majors were distributed across a number of subject areas, with 56% reporting Psychology as their major. The remaining 44% were distributed across ten majors, with Criminal Justice being the highest (5.5%). Of the total number of participants, only eight had ever served on a jury.
Experimental Materials

The experimental materials used in this investigation consisted of three experimental texts—a text describing a legal case, two expository texts, and an event narrative—in addition to a graphic timeline, a measure of comprehension, a perceptual rating scale, a confidence rating scale, and a demographic data sheet.

Experimental Texts

Legal Case Description. A 47-word legal case description was constructed to describe an active medical malpractice suit currently being litigated in the State of California. The description stated that the parents of an infant injured during birth were suing the hospital and staff members who were involved in the infant’s delivery. The description stated that the parents believed the hospital staff failed to use appropriate practices and precautions during the birth, resulting in the infant’s injury. Finally, the description stated that the hospital refuted the claim, citing that the injuries to the couple’s infant were unavoidable, and not due to the hospital staff’s performance.

Expository Texts. Two expository texts were constructed—one to present essential information about medical malpractice and the other to present information about vacuum-assist devices used in childbirth—specifically, vacuum extractors.

The medical malpractice text contained 148 words comprising five sentences with a Flesch-Kincaid reading level of 11.2, and was created to describe a specific type of medical malpractice: medical negligence. The text outlined two types of medical negligence; 1) insufficient care, and 2) breach of duty. Insufficient care referred to incidents during which a medical professional fails to provide a level of care consistent with what can be reasonably expected at a common medical facility. Breach of duty
stipulates that the actions taken by a medical professional must be shown to have directly led to injuries of a patient. Only one of these types must be proven in order for a medical professional to be charged with medical negligence. Information for this text was derived from various Internet sources and distilled to the most important elements of medical malpractice.

The vacuum extractor text contained 144 words comprising eight sentences with a Flesch-Kincaid reading level of 8.6 and consisted of a physical description of a vacuum extractor and the three most essential guidelines for its use according to the American Congress of Obstetrics and Gynecology. Specifically, the text stated that three things must be certain before a vacuum extractor is used during birth: 1) the mother’s pelvis is large enough for the child to pass through safely; 2) the cervix is fully dilated; and, 3) the vacuum extractor will expedite delivery. The vacuum extractor text also indicated that the parents believed their infant’s injuries were directly caused by improper use of a vacuum extractor.

**Event Narrative.** The event narrative was constructed in two parts. Part 1 was developed as a chronological description of the labor and delivery events leading up to the infant’s birth. It was based the official hospital record. The official hospital record was used to construct an unbiased, chronological description of how the labor and delivery progressed. Six events from the record were selected as the most important, and rewritten into seven statements. The first statement was an introduction to the content that would be covered in the narrative, followed by six statements describing the events (see Table 1).
### Table 1

**Narrative Text, Timeline Keywords, and Changes to Timeline Display**

<table>
<thead>
<tr>
<th>Event Narrative Statements</th>
<th>Keyword Descriptions</th>
<th>Visual Changes to Timeline</th>
</tr>
</thead>
<tbody>
<tr>
<td>A – “We are going to examine a period of time from the middle of labor, when the birth was progressing normally, to the end of labor, when an emergency C-Section was performed. All events are taken from the official hospital record, and nothing has been added or omitted.”</td>
<td>None</td>
<td>Timeline 1 Appeared</td>
</tr>
<tr>
<td>B – “At 8:58pm, the mother entered the second stage of labor, and was to begin pushing soon.</td>
<td>1a – &quot;8:58pm - 2nd stage of labor, to begin pushing”</td>
<td>Keyword 1a appeared</td>
</tr>
<tr>
<td>C – “At 9:10pm, the mother began actively pushing”</td>
<td>1b – &quot;9:10pm – Pushing”</td>
<td>Keyword 1b appeared, Keyword 1a faded to gray</td>
</tr>
<tr>
<td>D – “At 10:36pm, the mother was repositioned and deemed to be pushing effectively.”</td>
<td>1c – &quot;10:36pm - Repositioned. Pushing Effectively.”</td>
<td>Keyword 1c appeared, Keyword 1b faded to gray</td>
</tr>
<tr>
<td>E – “At 10:45pm, the first vacuum extraction was attempted, but failed.”</td>
<td>1d – &quot;10:45pm - 1st V.E. attempt”</td>
<td>Keyword 1d appeared, Keyword 1c faded to gray</td>
</tr>
<tr>
<td>F – “At 11:10pm, the doctor evaluated the success of pushing, as well as the health of the mother and the child”</td>
<td>1e – &quot;11:10pm - Dr. evaluated pushing and health”</td>
<td>Keyword 1e appeared, Keyword 1d faded to gray</td>
</tr>
<tr>
<td>G – “At 12:22am, another attempt at vacuum extraction failed, and the mother was sent to the Operating Room for an emergency C-section.”</td>
<td>1f – &quot;12:22am - V.E. failed - to OR”</td>
<td>Keyword 1f appeared, Keyword 1e faded to gray</td>
</tr>
<tr>
<td>H – “The last four events of the birth are of particular importance”</td>
<td>None</td>
<td>Keywords 1e, 1c, 1d and 1d faded from gray to black</td>
</tr>
<tr>
<td>J – “To recap, at 10:36pm, the mother was repositioned. This is normal and can help the birthing process.”</td>
<td>None</td>
<td>No visual changes</td>
</tr>
<tr>
<td>K – “To recap, at 10:45, a vacuum extraction was attempted, but failed.”</td>
<td>None</td>
<td>No visual changes</td>
</tr>
<tr>
<td>L – “To recap, at 11:10pm, the doctor evaluated the success of pushing, as well as the health of the mother and the child.”</td>
<td>None</td>
<td>No visual Changes</td>
</tr>
<tr>
<td>“From this point, 72 minutes passed before it is noted that a final attempt at vacuum extraction failed, and that the mother was being sent to the operating room for an emergency C-section. The prosecution argues that the child was injured during this 72-minute period.”</td>
<td>2a – “72 Minutes”</td>
<td>Red rectangle/parallelogram and keyword 2a appeared</td>
</tr>
<tr>
<td>M – “After the birth, a note was inserted into the official hospital record that there was a third undocumented vacuum extraction attempt during this 82 minute period. The prosecution claims that the vacuum extraction should not have been attempted 3 times, as it did not expedite the delivery, and a C-section should have been performed earlier. Therefore the prosecution is arguing “insufficient care” since the hospital staff failed to provide care at the appropriate time. The Defense argues that three attempts at vacuum extraction are very common and that the C-section was performed only after it was deemed unsafe to proceed with additional vacuum extraction attempts.”</td>
<td>2b – “Untimely Treatment → Insufficient Care”</td>
<td>Keyword 2b appeared</td>
</tr>
<tr>
<td>N – “We also know from information contained in the official hospital record that the staff was unsure as to whether the mother’s pelvis was large enough for the child to pass through safely, and whether the mother’s cervix was fully dilated. The prosecution claims that if the hospital staff had taken the proper precautions to ensure that the mother’s pelvis was large enough for the child to pass through safely, and to verify that the mother’s cervix was fully dilated, the child would not have been injured. Therefore, the prosecution is arguing “Breach of Duty” since the hospital staff did not take the proper precautions during the birth. The defense denies this claim and states that the hospital staff took all of the proper precautions prior to using the vacuum extractor and the injury to the child was an unfortunate, but unavoidable, event.”</td>
<td>2c – “Insufficient precaution → Breach of Duty”</td>
<td>Keyword 2c appeared</td>
</tr>
</tbody>
</table>
Part 2 contained content from the two expository texts described above that was adapted to construct a slightly prosecution-biased argument connecting the actions of hospital staff with the two types of medical negligence. The argument totaled seven statements (see Table 1). The first (H) statement was used to note that events (D) through (G) had particular importance in the case. The next three (I-K) statements were used to recap events (D) through (F) to ensure that all details of the events could be easily understood. Next, one (L) statement introduced a 72-minute gap in time between events (F) and (G) to indicate that the prosecution believed the infant was injured during that period of time, followed by a recap of event (G). Next, two cause-and-event statements (M, N) were sequentially introduced. The first indicated that the hospital staff had not provided appropriate treatment in a timely manner, and therefore had not delivered a level of care that could reasonably be expected at a common medical facility, and were thus guilty of medical negligence by way of insufficient care. The second indicated that the hospital had not followed the proper precautions prior to using the vacuum extractor, therefore directly causing injury to the infant, and thus were guilty of medical negligence by way of breach of duty.

**Graphic Timelines**

Two graphic timelines were constructed as progressive linear visual aids to the event narrative. Timeline 1 corresponded to part 1 of the event narrative, and Timeline 2 corresponded to part 2 of the event narrative. The timelines were presented sequentially and accompanied by a concurrent audio recording of the event narrative. Both timelines were constructed using Microsoft PowerPoint, and each was presented on a single slide.
Timeline 1 measured 990 pixels long and was drawn with a 2-point weight black line horizontally across the screen. It was positioned 268 pixels from the bottom of the slide, 541 pixels from the top of the slide, and 40 pixels from either side of the slide. It represented five hours in total, beginning on the left side at 8:30pm and extending to the right side to 1:30am. Perpendicular, 2-point weight black demarcations were placed at every half-hour interval spaced 96 pixels apart. Time indicators were written only under the half-hour demarcations, for example 8:30pm, in 12-point font. Demarcations on the half hour measured 83 pixels in length, while demarcations on the hour measured 38 pixels in length. Each was vertically centered on the horizontal line of the timeline.

The statements from part 1 of the event narrative were transformed into six corresponding keyword descriptions (see Table 1). The keyword descriptions were written horizontally above the timeline in black 14-point font. The time in each was written in bold, while the words were not. A 1-point weight black line underlined each keyword description. A second 1-point weight black line that ran perpendicular the timeline and keyword descriptions was used to physically connect the underlined description to the timeline relative to the time they occurred. To prevent the keyword descriptions from overlapping, each of these connecting lines varied in length (M = 211 pixels).

Timeline 2 was a modified version of the timeline 1 used to present part two of the event narrative. Timeline 2 occupied the same physical length as Timeline 1, except that it only depicted the time between 10:30pm to 12:30am, rather than 8:30pm to 1:30am. Keywords (1a) and (1b) were removed, as they did not fall within the specified two-hour window. To adjust for this change in depicted time, the demarcations and
keywords were relocated so that they were proportionately accurate, with a 241-pixel gap between demarcations.

The second timeline had a large, solid, red rectangle covering the timeline between keywords (1e) and (1f). The rectangle measured 592 pixels wide by 244 pixels high. It was vertically centered across the timeline, such that if the timeline were sitting in front of the rectangle, the timeline would have bisected the rectangle horizontally. Within this red rectangle, three keyword descriptions created to were written. Keyword 2a was written in 40-point white font to clearly state the length of time between events (F) and (G). Keywords 2b and 2c were written as cause-and-effect statements to clearly show the relationships discussed in statements M and N. Both were written in 20-point white font. The three key-word descriptions were vertically justified and horizontally centered within the red rectangle.

Timeline 1 and timeline two were presented in the horizontal orientation as described above (see Figure 1), and were also varied on their axis to created two additional orientations. One oriented vertically and one oriented diagonally. The vertical orientation showed the earliest time at the top of the screen, and the latest time at the bottom of the screen. The key-word descriptions of the events were written to the right of the timeline, and the red rectangle was oriented vertically rather than horizontally (see Figure 2). The diagonal orientation showed the earliest time at the top-left of the screen, and the latest time at the bottom-right of the screen. The keyword descriptions were depicted on the right side of the timeline, and in this case, the red rectangle was changed to a red parallelogram so that its borders remained parallel to the body of the timeline (see Figure 3). Regardless of orientation, all time indications and keyword descriptions
Figure 1. Horizontal Timeline 1 after all elements have been revealed.

were written horizontally to avoid any detriment to readability. Each figure shows timeline 1 just before transition to timeline 2, with all elements on timeline one displayed.

Due to screen size and aspect ratio restrictions, dimensions of the timelines varied in the following areas, apart from their axis: overall timeline length, distance between demarcations, distance between key-word description and timeline, and the area of the red rectangle/parallelogram. The exact dimensions of each orientation and its elements can be seen in Table 2.

Each timeline was presented sequentially. In timeline 1, the bare structure of timeline 1 was shown first, accompanied auditorily by statement (A) of the event narrative. Then, keywords (1a – 1f) were presented, each accompanied by the corresponding auditory recording of statements. The keywords were presented in the following increments: (1a) appeared 18.6 seconds after the timeline was introduced, (1b) appeared 7.8 seconds later, (1c) appeared 5.9 seconds later, (1d) appeared 8.8 seconds later, (1e) appeared 5.1 seconds later, and finally (1f) appeared 10.6 seconds after (1e).
One minute and six seconds after timeline 1 appeared, statement (H) was presented auditorily as a transition from timeline 1 to timeline 2.

After statement (H), timeline 1 was removed from the screen and timeline 2 was shown. Then, statements (I) through (K) were progressively stated, without any visual changes to timeline 2. Thirty-two seconds after timeline 2 appeared, the solid red rectangle/parallelogram and keyword (2a) appeared accompanied by statement (L). Twenty-eight seconds later, keyword (2b) was presented accompanied by statement (M), followed 56 seconds later by the presentation of (2c), which was accompanied by
statement N. Timeline two was on-screen for a total of two minutes and nineteen seconds. The transcript of the event narrative, their corresponding keyword descriptions, and the visual changes to both timeline 1 and timeline 2 can be seen in Table 1.

Timelines 1 and 2 were presented in two different modalities, (animated, static-sequential). In the animated timelines, the bare timeline and keyword statements were presented with a 500ms “fade-in” animation. When a keyword description was no longer the focus of the narrative, such as when the following keyword statement appeared, the keywords changed from their original black color to a dark gray over the course of 500ms, but remained visible. It should be noted that this did not occur for keywords (2a), (2b), and (2c), as they were never faded after their first presentation.

Figure 3. Diagonal Timeline 1 after all elements have been revealed.
Table 2

*Dimension, in Pixels, of All Timelines*

<table>
<thead>
<tr>
<th>Timeline</th>
<th>Length</th>
<th>Dimensions of Red Shape</th>
<th>Length of line between timeline and event description</th>
<th>Distance between demarcations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal – 1</td>
<td>990</td>
<td>--</td>
<td>$M = 211$</td>
<td>96</td>
</tr>
<tr>
<td>Horizontal – 2</td>
<td>Unchanged</td>
<td>592 wide x 244 high, area = 144,448 pixels</td>
<td>Unchanged</td>
<td>241</td>
</tr>
<tr>
<td>Vertical – 1</td>
<td>767</td>
<td>--</td>
<td>87</td>
<td>75</td>
</tr>
<tr>
<td>Vertical – 2</td>
<td>Unchanged</td>
<td>300 wide by 477 high, area = 143,100</td>
<td>Unchanged</td>
<td>187</td>
</tr>
<tr>
<td>Diagonal – 1</td>
<td>963</td>
<td>--</td>
<td>87</td>
<td>96</td>
</tr>
<tr>
<td>Diagonal – 2</td>
<td>Unchanged</td>
<td>318 wide x 460 high, area = 146,916</td>
<td>Unchanged</td>
<td>213</td>
</tr>
</tbody>
</table>

To transition between timeline 1 and timeline 2, keywords (1a) and (1b), and all demarcations and time indicators outside of 10:30pm and 12:30am were completely faded out over 500ms, and were no longer visible. Then, the remaining demarcations, time indicators and keyword statements smoothly “slid” to their correct locations for timeline 2. In effect, this smooth animated transition between timeline 1 and timeline 2 gave the illusion that timeline 2 was physically “zoomed in” from timeline 1, when they are actually separate graphics.

The red shape on timeline 2 was introduced with a “wiping” animation. The wiping animation revealed the red box in a smooth motion from one end to the other; similar to what the pain may look like if a paintbrush was wiped from one side to the other. The wiping began beginning at keyword 1e and progressed towards keyword 1f.

In the static-sequential modality, all of the same information was presented, but there was no visible fading of demarcations, keyword statements, or wiping transitions. The horizontal orientation of timeline 2 as it was shown at the very end of its
duration can be seen in Figure 4, as well the vertical and diagonal timelines at the same moment in duration in Figures 5 and 6, respectively.

Figure 4. Horizontal Timeline 2 after all elements have been revealed.

Recall of Events

A measure of recall of timeline events comprised of one essay question was developed. The essay question asked for everything that could be remembered from the presentation, including the case background, expository texts, and timeline, as well as any personal thoughts or feelings about any of the content presented.

Comprehension Measures

A comprehension measure comprised of nine true/false questions was developed as an index of the participants understanding of the two expository texts. Four of the questions were directed at the Medical Negligence text, and five were directed at the vacuum extractor text. The questions required participants to read a statement and choose whether or not it was part of a specified expository text. Participants were scored on a correct / incorrect basis, receiving one point for a correct answer, and zero points for an incorrect answer, with a maximum score of nine.
Figure 5. Vertical Timeline 2 after all elements have been revealed.

**Judgment Scales**

A perceptual rating scale was developed and comprised of three items, two of which estimated judgments, and one item estimating judgment. All items consisted of a statement that required the participant to select a number on a 1 – 9 Likert scale. The two judgment items were designed to measure participants’: (a) judgment in whether or not the hospital staff performed their duties above or below a level of care that could be expected at a common medical facility (1 = far below expectation, 9 = far above expectation), and (b) judgment if the use of the vacuum extractor was appropriate in the birth (1 = very appropriate, 9 = very inappropriate). The judgment item was designed to
Figure 6. Diagonal Timeline 2 after all elements have been revealed.

measure the degree to which participants’ judged the hospital staff as innocent or guilty of medical negligence (1 = certainly innocent, 9 = certainly guilty).

Confidence Rating Scale

On both the comprehension measures and the perceptual rating scales, participants were asked to indicate their confidence in their given answer on a 9-point Likert scale, with 1 = Not at all confident and 9 = Very confident.

Procedure

Participants entered a campus computer lab and were guided through an experimental Power Point presentation that was used as the platform of presentation. The experimental PowerPoint presentation consisted of: an informed consent, the legal case background; the vacuum extractor guidelines text; the medical negligence text; and one
of the six experimental graphics accompanied by the legal narrative. Finally, the presentation included link to the demographics questionnaire, comprehension measures, and perceptual rating scales.

Participants were read the Informed Consent and given instructions, then were guided through the presentation. Participants read each text silently, and upon completion were sent to a wait page. In this way, the entire group moved through the presentation together. Prior to presentation of the experimental graphic, participants were informed that the next slides would progress automatically, and also that there was an audio narration. The experimental graphics and accompanying narrative were then presented on their own page. Participants viewed the timed presentation, and were sent to a wait page for instructions on the questionnaire to follow. After instruction, participants filled out a demographic questionnaire. Participants were then allotted 13 minutes to write an essay containing as much information as they could remember, including any thoughts, feelings or reactions to the presentation. Finally, participants were given all the time they needed to fill out the comprehension and perceptual rating scales.

Participants returned one week later and were allotted 13 minutes to write another essay containing as much information as they could remember, including any thoughts, feelings or reactions to the presentation they saw one week prior. Then, participants were allowed all the time they needed to fill out the same comprehension and perceptual measures. Finally, participants were thanked for their participation and excused.
CHAPTER IV

RESULTS

Data Source

Judgments, Confidence, and Comprehension

Measures of participant judgments, confidence in those judgments, and comprehension of the guidelines and laws were entered for statistical analysis into the basic experimental design. The judgment and confidence ratings were entered as whole numbers from the Likert scales. Comprehension was entered as an index of comprehension, derived by adding the number of correct answers given by learners on the comprehension questions. There were nine true/false questions measuring two concepts: five of the questions assessed understanding of the vacuum extractor guidelines, and four assessed understanding of the California medical negligence laws. Learners could earn a total score of nine points on the comprehension index. All tests were accepted as statistically significant if the alpha level exceeded .05.

Timeline and Narrative Recall

Participants’ essays were scored for content units. A content unit was defined as a clause, phrase, or sentence that conveys a complete idea. Content units in each of the essays were scored for the total number events from the timeline and narrative that were recalled. These units were designated as correctly recalled events. Learners could also insert from mind events that were not present in the original narrative or timeline. These
units were designated as incorrectly recalled events. Learners received one point for each correctly or incorrectly recalled event. Participants could receive six possible points for correct events, with no maximum points for incorrect answers to account for events that participants inserted that were not present in the original material. A score for events from the timeline or narrative that was not mentioned by the participant was calculated by subtracting the total number of mentioned events from the maximum correct score of six, excluding those events that participants created on their own.

Essays were also scored for correct sequence of events, with each correctly or incorrectly sequenced event earning one point for a maximum combined score of six. If a mentioned event was scored as correct, and it was mentioned in the same sequence as presented in the timeline relative to other events, it was scored as being in the correct sequence. If a mentioned event was scored as correct, but was not mentioned in the correct sequence relative to other events, it would be given a sequence score of incorrect. If an incorrect event was mentioned, it was not given a sequence score.

Each essay was also scored for the number of times a correctly recalled event was matched with the correct time that the event occurred on the timeline. Time-Event matches were scored using conditional probabilities, with a time only being eligible to be scored as correct if the event to which it was matched was also correct. Due to the temporal proximity of the events, times could only deviate from what was shown on the timeline by eight minutes to be scored as correct. Words that modified given times, such as “about” or “around” were ignored, and only the actual time given was scored. The conditional probabilities were then transformed into arc-sine scores for analysis.
Essays were also scored for the number of times the 72-minute critical period was mentioned. Each mention of the 72-minute gap was scored as one point. Additionally, the mention of the critical period was scored for accuracy. If the critical period was mentioned, the difference between the mentioned time and the actual time present in the timeline was recorded in minutes.

Finally, essays were scored for frequencies of each time a statement in support of the plaintiff, prosecution, or mother was mentioned, and for statements made in support of the defense, hospital, or hospital staff. Each mention was scored as one point, with one score comprised of support statements for the prosecution, and another score comprised of support statements for the defense. All tests were accepted as statistically significant if the alpha level exceeded .05. Inter-rather reliability yielded an Intraclass correlation (ICC) value of $r (35) = 0.874, p < 0.001$.

Immediate Testing

No reliable results from any of the analysis conducted at the immediate time of testing were revealed.

Delay Testing

Understanding of California Medical Negligence Law and Vacuum Extractor Use Guidelines

A 3 x 2 x 2 ANOVA was conducted to determine the influence of orientation, presentation modality, and time of testing on total comprehension scores. The analysis revealed a reliable influence only for time of testing, $F (1,84) = 60.61, MS_{error} = 41.49, p < .001$, Cohen’s $d = .077$, with learners comprehension scores declining significantly
from time 1 ($M = 7.84, SD = 1.14$) to time 2 ($M = 6.87, SD = 1.36$). These results indicate that learners understood 87.56% of the concepts from the vacuum extractor guidelines and medical negligence laws at time one, and 76.33% of the laws and guidelines at time 2, regardless of presentation modality or orientation. Thus, while comprehension dropped by 11.23% from time 1 to time 2, learners’ comprehension of the guidelines and laws was relatively high and remained so across a full week. Comprehension scores failed to show reliable influence from presentation modality and orientation, or the combination of the two.

**Orientation, Presentation Modality, and Time of Testing Influence on Sequence Scores**

A 3 x 2 x 2 ANOVA was conducted to determine the influence of orientation, presentation modality, and time of testing on the sequence scores. The analysis revealed a reliable influence only for time of testing, $F(1,84) = 12.76, MS_{error} = 1.33$, $p = .001$, Cohen’s $d = 0.35$. Specifically, during their retelling of the narrative, learners put significantly more events in the correct order immediately after exposure ($M = 3.57, SD = 1.73$) than they did after a one-week delay ($M = 2.96, SD = 1.71$). The analysis failed to reveal any other reliable main effects or interactions.

**Orientation, Presentation Modality, and Time of Testing Influence on Time-Event Matching**

Time-event matching scores were entered into the experimental design. The analysis revealed a reliable influence only for time of testing, $F(1,84) = 5.45, MS_{error} = 0.068$, $p = .022$, Cohen’s $d = 0.34$. Specifically, during their retelling of the narrative, learners matched significantly more correct times with corresponding events immediately
after exposure ($M = 0.14, SD = 0.27$) than after a one-week delay ($M = 0.06, SD = .19$).

The analysis failed to reveal any other reliable main effects or interactions.

**Orientation, Presentation Modality, and Time of Testing Influence on the Judgment Scales**

A 3 x 2 x 2 ANOVA was conducted to determine the influence of orientation, presentation modality, and time of testing on each of the three perceptual ratings—guilt, appropriate use of the vacuum extractor, and hospital staff performance. For guilt, the analysis revealed a reliable influence only for presentation modality, $F (1, 84) = 5.127, MS_{error} = 5.62, p = .026$, Cohen’s $d = 0.43$. Specifically, learners assigned a significantly higher judgment of guilt to hospital staff after having viewed the timeline in an animated format ($M = 6.73; SD = 1.71$) than when the timeline was static-sequential ($M = 5.93, SD = 1.99$). The analysis failed to reveal any other reliable main effects or interactions. As for participants’ confidence in their judgments of guilt, the analysis revealed a reliable influence only for time of testing, $F (1, 84) = 4.72, MS_{error} = 1.12, p = .033$, Cohen’s $d = 0.19$. Specifically, learners’ confidence in their judgments of guilt declined significantly from time 1 ($M = 7.21, SD = 1.69$) to time 2 ($M = 6.88, SD = 1.85$). The analysis failed to reveal any other reliable main effects or interactions for guilt confidence.

Again, the same 3 x 2 x 2 ANOVA was conducted – this time on learners’ judgment of the appropriate use of the vacuum extractor. The analysis revealed a reliable influence only for presentation modality, $F (1, 84) = 5.902, MS_{error} = 3.486, p = .017$, Cohen’s $d = 0.33$. Specifically, learners judged the use of the vacuum extractor as more inappropriate after having viewed the timeline in an animated format ($M = 6.26, SD = $...
1.96) than when the timeline was static-sequential ($M = 5.58$, $SD = 2.10$). The analysis failed to reveal any other reliable main effects or interactions on the vacuum extractor judgments. As for participants’ confidence in their judgments of the appropriate use of the vacuum extractor, the analysis revealed a reliable influence, again, only for time of testing, $F (1,84) = 8.74$, $MS_{error} = 1.02$, $p = .004$, Cohen’s $d = 0.25$, with learners’ confidence in their judgments of vacuum extractor use declining significantly from time 1 ($M = 7.29$, $SD = 1.79$) to time 2 ($M = 6.84$, $SD = 1.86$).

**Stepwise Regression**

In order to determine the degree to which judgments of guilt after a one-week delay could be predicted from the other five judgment ratings, a stepwise multiple regression analysis was conducted separately for each of the between-subjects conditions. The analysis revealed that different judgments were significant predictors for each condition.

For the horizontal, static-sequential condition, the prediction model was significant $F (1,14) = 145.11$, $p = .000$. Specifically, judgment of appropriate use of the vacuum extractor taken at time 2 was the only significant predictor of guilt at time 2, ($t = 12.05$, $p = .000$; beta $.955$), explaining 90.6% of the variance.

For the horizontal, animated condition the prediction model was significant, $F (2, 13) = 22.60$, $p = .000$. Specifically, judgment of guilt at time 1 ($t = 6.47$, $p = .000$; beta $.865$) and judgment of appropriate use of the vacuum extractor at time 1 ($t = -2.39$, $p = .036$; beta $-.320$), significantly predicted guilt at time 2, explaining 80.4% of the variance.
For the vertical, animated condition, the prediction model was significant $F(1, 14) = 37.84, p = .000$. In this case, judgment of hospital staff performance taken at time 2 was the only significant predictor of guilt at time 2, $(t = -.615, p = .000, \beta = -.863)$, explaining 74.4% of the variance.

For the diagonal, static-sequential condition, the prediction model was significant $F(3, 13) = 16.55, p = .000$. Judgment of guilt at time 1 $(t = 2.62, p = .000; \beta = 1.008)$, judgment of hospital staff performance at time 1 $(t = 5.04, p = .001; \beta = 0.809)$ and judgment of appropriate use of the vacuum extractor at time 1 $(t = 3.28, p = .008; \beta = .453)$ significantly predicted guilt at time 2, explaining 83.2% of the variance.

Finally, for the diagonal, animated condition, the prediction model was significant $F(1, 14) = 14.17, p = .002$. Judgment of guilt at time 1 was the only significant predictor of guilt at time 2, $(t = 3.76, p = .002; \beta = .709)$, explaining 50.3% of the variance.
CHAPTER V

DISCUSSION

In the present investigation, we asked learners to view a PowerPoint presentation about a medical malpractice case regarding the alleged mishandling of a specific childbirth. Participants were shown one of three different orientations of the same two timelines—one vertical, one horizontal, and one diagonal. The timelines were presented in either a static-sequential or animated modality. Each timeline was accompanied by a concurrent audio narration with a more in-depth description of the events on the timeline than what was shown on screen. To measure mental model construction and memory for the presented content, we asked participants to write a reflective essay containing everything they remembered, in addition to any personal thoughts or feelings participants may have had regarding the content they were shown. Next, to measure comprehension of core concepts, we asked participants to answer a series of questions pertaining to the legal foundations of the case. Finally, to assess judgments of guilt, we asked participants to evaluate the presented content and assign a guilt rating to the defendants in the case. Participants performed all tasks both immediately following viewing of the experimental materials, and after a one-week delay.

The results of this investigation were mixed, indicating that presentation modality can significantly affect the degree to which guilt is assigned to a defendant after
a one-week delay, regardless of the accuracy with which mental models were formed or recall of event sequence. Results also revealed a somewhat predictable decay effect on comprehension of core concepts across groups. Finally, judgment of guilt after a one-week delay was found to have several different predictors that varied based on on presentation modality, as well as timeline orientation.

Influence of Timeline Orientation

Our hypothesis that the top/left/past-bottom/right/future diagonally oriented timeline would lead to better mental model construction, a more coherently constructed story, and therefore higher ratings of guilt, and confidence in those ratings, was not confirmed by the analysis. That is to say, all orientations across presentation modalities performed equally well across mental model construction metrics. One cause for this result might be that, while the timeline described content that was unfamiliar participants, the fact that much of the information was repeated twice may have reduced any effect that could have been seen between groups. For example, while six events were presented in timeline one, timeline two reduced the number of events to four, and then briefly restated those four events.

Further, the case material may not have been challenging for participants to understand. Only six total events presented on the timeline, in addition to the critical period of time between the last two events. Also, the narration was designed to be very easy for participants to understand, and most of the content was described rather simply. Given that the events were repeated, the fact that was a relatively low number of events in general, and that the low number of events was split into two different timelines, it
may be the case that participants’ working memory was not challenged. Thus, these factors may have mitigated any effect orientation may have had on recall of events or mental model construction.

Influence of Presentation Modality

Our hypothesis that the animated presentation modality would lead to better mental model construction, a more coherently constructed story, and therefore higher judgments of guilt, and confidence in those judgments, was partially supported by the analysis. Specifically, while participants who viewed the animated timelines rated the hospital and its staff as significantly more guilty than those participants who saw the static-sequential timelines, and rated the use of the vacuum extractor as significantly more inappropriate than participants that viewed the static-sequential timelines, no reliable differences were found on any of the mental model construction or event sequence metrics between groups. These results may have largely the same causes as the influences discussed regarding timeline orientation. That is to say, the events may not have been complex enough or detailed enough, or may have been presented in such an oversimplified manner such that differences between groups could not be seen.

With regards to the differences revealed between presentation modalities in judgments of guilt and of appropriate use of the vacuum extractor, it may be useful to discuss the largest differences between presentation modalities. Specifically, the transition between timeline one and two, as well as the introduction of the critical period between the last two events, may have influenced the participants in the animated condition more than those in the static-sequential group through cueing. For example, in
the static-sequential condition, the entire red rectangle that represented the critical period appeared instantaneously. In contrast, in the animated condition, the red rectangle representing the critical period was unveiled in a sweeping motion from left-to-right. As mentioned, the rectangle was a vibrant red in both conditions, and was also the only element of the timeline shown in color. The red rectangle was also the only element of the presentation that covered the body of the timeline. It may be that the unveiling of the red rectangle with the aid of this sweeping movement cue could have made the critical period more salient to participants in the animated condition, versus the rectangle appearing instantaneously in the static-sequential condition.

Previous investigations (e.g., de Koning et al., 2010a; Kriz & Hegarty, 2007; Lowe & Bouchiex, 2011) have shown that cues have the ability to guide attention, but may not necessarily increase comprehension. Also, this attention guiding effect has been shown to have the strongest influence on the first viewing of an animation, decreasing in efficacy on subsequent viewings (e.g., de Koning et al., 2010a; Lowe & Bouchiex, 2011). As participants in the present investigation only viewed the timeline presentation one time, there may have been an attention guiding effect in the animated modality that was not present in the static-sequential modality due to the cueing afforded by the animation. Further, previous investigations (e.g., de Koning et al., 2010a; Lowe & Bouchiex, 2011) had some form of comprehension measure, but did not have any judgment measures. So, while neither this investigation nor the previously mentioned investigations showed any gains on comprehension or mental model construction metrics due to cueing, it may be the case that the animated presentation had more perceptual impact on the viewer than in the static-sequential presentation. If so, this could have caused the viewer to attend to the
critical period more in the animated presentation, resulting in differing judgments after a one-week delay, regardless of comprehension or mental model construction.

It should be noted that ratings of hospital staff performance were not significantly different between groups at either the immediate time of testing or after a one-week delay. This may be due to confusion with the question or the phrasing of the question. Logically, if a participant judged the hospital staff as guilty, and also judged the use of the vacuum extractor as inappropriate, it stands to reason that that the same participant would also rate the hospital staff’s performance as inadequate. If confusion with the question is not the case, then the definition of a “reasonable standard of care” may not have been clearly understood by participants. It could also be the case that the participants in this investigation may not expect every hospital visit to go perfectly every time, and thus equated the events described in the timeline and narrative as unfortunate, but unavoidable, just as stated by the defense. A similar effect could be expected in a court of law; that is, many jurors are likely prone to misunderstanding of legal terminology, or the specifics of the laws underlying the judgments they are asked to make in a case.

Influences on Confidence of Judgment

Participants’ judgments of guilt and of the appropriate use of the vacuum extractor significantly differed between modalities after a one-week delay, while confidence scores declined uniformly from immediate to delay testing. As such, participants’ judgment ratings did not vary in parallel with their confidence in those judgments. These findings would seem to go against Pennington and Hastie’s (1992)
theory that the more coherently a learner’s story is constructed, the more confidence the learner will have in their judgment, as analysis did not reveal any differences between groups in accuracy of story construction. Similar results have been shown in other investigations (e.g., Park & Feigenson, 2013).

However, as comprehension of the expository texts also declined from immediate to delay testing, and the fact that Pennington and Hastie’s (1992) story model includes the technical aspects of the laws surrounding a case as part of the model, the comprehension reduction could have, contributed to the drop in judgment confidence scores. If so, then it may be that participants’ in the animated condition were compelled to judge the defendants as more guilty, and the use of the vacuum extractor as more inappropriate, than those in the static-sequential condition for the reasons mentioned above, regardless of their level of confidence in accuracy of their decision.

Influences on Predictors of Guilt

Analysis revealed that there were five different significant predictors of judgments of guilt after a one-week delay across five different conditions within this investigation. Of those five predictors, only immediate judgments of guilt and judgments of appropriate use of the vacuum extractor after a one-week delay appeared multiple times; immediate judgments of guilt appeared three times, and immediate judgments of the appropriate use of the vacuum extractor appeared twice. The diagonal, static-sequential condition was the only condition in which all three of the immediate judgments significantly predicted guilt after a one-week delay. Further, only the vertical,
static-sequential condition did not produce any significant predictors of guilt after a one-week delay.

These results show that neither modality nor orientation inspired common predictors of judgments of guilt after a one-week delay. Additionally, static and animated modalities each inspired four different predictors of judgments of guilt after a one-week delay, regardless of timeline orientation. These results may suggest that judgments of guilt are not necessarily only based on only the legal factors of the case, such as the appropriate use of the vacuum extractor, or whether the hospital provided a reasonable standard of care. That is to say, perhaps participants’ own personal experiences with hospitals or related subject matter could have influenced them to judge the hospital staff as guilty after a one-week delay.

Influences on Comprehension

The results revealed that, across all conditions, learners’ comprehension scores of both expository texts dropped statistically significantly from immediate testing to testing after a one-week delay. Reduction in comprehension is not surprising as learners’ had only a short exposure to the materials, and also the fact that the expository texts were not emphasized nearly as much as the content in the timeline and narrative. However, it should be noted that participants’ had fairly high comprehension at both immediate testing and delay testing, with only an 11.23% drop from immediate testing to delay testing.
Implications for Animation in Litigation

Animation could be used in the courtroom in a similar manner as in the classroom, such as to show how a plane crash may have occurred, or to show the diver’s point of view in a car accident. Regarding court cases in which the distribution of events across time, or a sequence of events, is important, the way time itself is visualized may affect how jurors perceive evidence. As has been shown in this investigation, using animation may not necessarily impact mental model construction or comprehension of the laws surrounding the case. However, what the present investigation does show is that using animation and cueing when presenting a series of events on a timeline can significantly influence judgments of guilt versus a static-sequential presentation of the same timeline.

While analysis of the present investigation did not reveal a significant effect of orientation or modality on mental model formation or comprehension, there was still an effect on judgments of responsibility. It should be noted that this result is difficult to corroborate with other investigations of multimedia and litigation, as measures of comprehension of case materials are not often taken (e.g., Dunn et al., 2006; Kassin & Dunn, 1997, Roese et al., 2006). However, Park, and Feigenson (2013) took comprehension measures in two studies, indicating that, in general, participants had higher comprehension of statistical materials when presented by attorneys that used PowerPoint versus attorneys that did not use PowerPoint. Further, results indicated that participants generally judged the side that the attorney that used PowerPoint was representing as less responsible than the side that did not use PowerPoint (Park & Feigenson, 2013).
The present investigation may also provide insight into how participants conceptualize case materials. For example, results indicated that participants were generally inaccurate in matching the time an event occurred with the corresponding event. Although the time each event occurred was not central to the argument presented, each time was presented on screen at the same instant as the corresponding event, and also mentioned in the narrative when the corresponding event were mentioned. However, it should be noted that, not only were participants generally inaccurate in matching times and events, many participants simply did not include times in their essays at all. Instead, participants only described the events in relation to one another, without discussing exact times. This could mean that, at least for this specific set of case materials, and under these different presentation conditions, the exact time that each event occurred was not important to participants’ judgments. It is clear that, given the variability of results in the present investigation, and in past investigations, more research needs to be conducted before clear recommendations can be made regarding which medium can be used to most effectively present information to a jury in a given case.

Limitations and Directions for Future Research

Although this investigation shows some ways animation and orientation may or may not influence judgment formation, there are areas it could have been improved. First, we did not include a no-graphic or text only conditions. A text only condition was not included on the basis of external validity, given that an attorney will likely always present materials similar to those in this investigation to a jury. A no-graphic condition was not used given that timelines are often used in court (e.g., Bloom & Powdermaker,
2006), and would assumedly be used for a series of events similar to those presented here. Further, the events described in the timeline were lifted from over 600 pages of documents, so it is unlikely a jury would read a text record of the events without some sort of consolidation or interpretation by an attorney or witness. However, depending on the circumstances of future investigations, it may be pertinent to include a no-graphic or text only condition.

Another limitation is participant sample size, as well as demographic. As evidenced by the varied results of the regression analysis, a larger participant pool may have more clearly exposed patterns, or significant influences of modality and orientation, on predictors of guilt. Further, an insignificant number of participants had ever served on a jury. Also, an insignificant number of participants had children. A future investigation with significant numbers of participants from either group may better show how the demographics of a jury member can affect the impact of timeline orientation or presentation modality on mental model construction or judgment determination.

The dependent measure used to measure recall events, and in turn evaluate mental model construction, was developed so that participants could relay the sequence of events, and their personal thoughts and feelings related to the case material, in the most naturalistic way possible. By giving participants the task to write in essay form, it provided an opportunity for participants to retell the events of the timeline and narrative in a natural story format. However, the general distribution of events over time was most important to this investigation, rather than the exact time at which the sequence of events occurred. If the exact time events occur is important is important in future investigations,
it may be more effective to require participants to sequence events, and match times, rather than relying on a free recall measure.

Further, while color was present in the form of the red box encompassing the critical period on the second timeline, its effect cannot be fully understood as it was not manipulated. It may prove fruitful to conduct a similar experiment without color to truly show the effect of animation and cues in isolation. Lastly, while we designed this study to fit within recently established taxonomies (e.g., de Koning et al., 2009; Ploetzner & Lowe, 2012), it was designed with a very specific purpose in the litigation domain, and results cannot necessarily be generalized to other domains or investigations.
REFERENCES
REFERENCES


