Changes in Attentional Focus During Suspenseful Film Viewing

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Abstract of the Dissertation

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An engaging film captures attention and at times may cause viewers to lose focus on the world beyond the screen. One way in which filmmakers command viewers' attention is by generating narrative suspense, which arises when potential negative outcomes become salient. In this series of experiments, I tested the theory that "hot spots," moments that make negative outcomes salient, will narrow the viewer's attentional focus compared to "cold spots," moments that do not emphasize negative outcomes. I measured attentional tuning through latencies in response time (RT) to audio probes as participants viewed suspenseful film excerpts. I also administered post-viewing recognition memory tests for still images taken from hot and cold spots. In Experiment 1a, I compared response times to probes at hot and cold spots and later tested recognition memory for the mirror orientation of stills taken from these spots. As predicted, participants demonstrated slower RT and missed more probes at hot spots than at cold spots, and they correctly recognized the orientation of more hot spot images than cold spot images. In

Experiment 1b, I recorded the same measurements but used randomized still images rather than videos. In this scrambled context, as predicted, RT effects disappeared. Unexpectedly, orientation recognition effects remained. In my next experiment, I investigated if the attentional tuning effect extended beyond the immediate processing of the hot spots themselves. In Experiment 2a, I compared RT to probes during the camera shots immediately following the hot and cold spots and administered an old/new recognition memory test for still images from hot and cold spots. A control experiment (2b) with still images found no difference in RT, but better recognition for hot over cold spot images. In Experiment 3, I manipulated the temporal locations of the hot and cold spots between versions of the film excerpts and again measured response times to probes during the shots immediately following the hot and cold spots. I again found the predicted effects in RT to probes following hot and cold spots. These findings provide new evidence of changes in attentional tuning during the experience of film narratives.

Table of Contents

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Changes in Attentional Focus During Suspenseful Film Viewing

For generations of film viewers, movies have provided highly-engaging experiences. Narratives can at times cause viewers to devote their attention to the world of the film. This attentional absorption can be accompanied by a feeling in viewers that they have lost awareness of their surroundings. The purpose of this thesis is to assess the reality of viewers' sense of the effect of films on their focus of attention. Past research on attention during film viewing has used self-report measures, assessed after the completion of narrative viewing and subject to the biases of introspection. I use a behavioral paradigm to measure of the scope of viewers' attention as the experience actually unfolds.

With this thesis, I test for attentional narrowing effects during the viewing of narrative films. I specifically examine suspenseful scenes as one type of narrative that causes attentional tuning at predictable moments. I argue that moments at which negative outcomes become salient to viewers, which I call hot spots, will cause momentary narrowing of attention, as indexed by longer reaction times to respond to audio probes. I also test the possibility that the visual content of these hot spots is more deeply encoded into memory, causing them to be better recognized by participants when compared to other moments in suspenseful scenes. Finally, I compare reaction time data with the transportation scale, a self-report measure of a viewer's engagement, and the need-for-affect scale, a self-report personality measure of an individual's tendency to approach or avoid emotional situations.

1. The Nature of Narrative Suspense

The element of suspense is a basic ingredient in the construction of narratives. In their influential structural-affect theory, Brewer and Lichtenstein (1982) described suspense as one of the narrative genres that contains distinct types of events. Specifically, a suspenseful narrative must contain an *Initiating Event* (IE) and an *Outcome Event (OE)*. It is best to think of these "events" as moments in a narrative when new information is revealed to the viewer. The IE is any point at which the viewer becomes conscious of a potential negative outcome. Since the negative outcome is not certain, there are at least two possible outcomes that could occur. The term "negative outcome" refers to the viewer's least preferred outcome. Narrative situations with uncertain positive outcomes, such as winning a sporting event or finding romance have implied negative outcomes through the individual preferences of the viewer (losing the game or being rejected). In this way, suspense also arises with respect to potential positive outcomes. The OE occurs when the negative outcome is either realized or averted. Suspense is generated at the moment of the IE and is resolved at the OE.

Although filmmakers can encourage suspense by the careful structuring of a narrative, the actual experience of suspense is generated by an actively engaged viewer. Bordwell (1985) applies Sternberg's (1978) analysis of the way that viewers pose and test a series of hypotheses when experiencing a narrative. According to Sternberg, suspense hypotheses refer to any predictions about upcoming narrative events. Curiosity hypotheses are guesses about past narrative events, such as the identity of a murderer in a classic whodunit. Bordwell stresses that viewers generate and test many hypotheses over the course of a narrative on both a small and grand scale. The content of these hypotheses is constrained both by viewers' individual experiences and by the way in which filmmakers structure narratives. Carroll (1988) uses the term “erotetic” to describe the core structure of linear film narratives. By this term, he meant that the scenes and events of a narrative are connected through the raising of questions and the answering of questions raised by previous scenes and events.

The subjective likelihood of potential outcomes also influences the experience of suspense. Increasing the likelihood of a negative outcome, short of absolute certainty, causes participants to give higher ratings of suspense (Comisky & Bryant, 1982). In sports spectatorship, maximal suspense occurs when the difference in score between two teams is minimized (Gan et al. 1997; Knobloch-Westerwick et al., 2006). This illustrates a key difference between fictional narratives and real-life events. In a fictional narrative with an extremely likely negative outcome, the viewer may nevertheless maintain hope that the unlikely positive outcome will occur. This is due to the viewer possessing many instances in memory of experiencing fictional narratives with similarly dire situations that ended favorably for the protagonists. In a real-life sporting event, the rules of the game make it exceedingly unlikely that a team that is far behind will be able to turn the tide. Here viewers likely have many instances in memory of teams that are behind in points going on to lose the match. This divide between fictional narratives and real experiences makes it difficult to assess viewers’ actual beliefs about the likelihood of outcomes in fictional narratives.

Another factor that affects the intensity of suspense is the viewer’s perception of the time remaining to avert the negative outcome. As the remaining time dwindles, suspense ratings increase (Vorderer, Knobloch, & Schramm, 2001). It also seems that reducing the number of potential avenues of escape for a protagonist facing a negative outcome can increase suspense. Gerrig and Bernardo (1994) asked participants to read an experimental text based on an excerpt from a James Bond novel. In the excerpt, James Bond was being held captive by the villainous

Le Chiffre. The researchers manipulated the perceived number of means of escape for Bond. In one version, Bond attempts to conceal a pen in his pocket before Le Chiffre discovers it and removes it. Another version made no mention of the pen. When participants read the version where a means of escape was removed, they reported experiencing more suspense, suggesting that readers were considering problem-solving aspects of the situation.

Theorists have disagreed as to the emotional valence of suspense, though it is important to consider when generating theoretical predictions about the effect of suspense on attentional narrowing. Many theorists portray the experience of suspense as aversive. For example, Zillmann (1996) uses the terms “torturous” and “noxious” to describe individuals in the throes of suspense, and Madrigal et al. (2011) classify suspense as a thoroughly unpleasant experience. Zillmann (1996) and Madrigal et al. (2011) argue that it is the extreme positive affect of relief activated by the resolution of suspense that redeems the entire experience. Ortony, Clore and Collins (1988) characterized the emotional signature of suspense as a blend of hope for the positive outcome mixed with fear for the negative outcome and Tan and Diteweg (1996) argue that this glimmer of hope is what makes suspense pleasurable for viewers. Mikos (1996) uses the metaphor of an amusement park roller coaster to describe the experience of suspense. In both thrilling situations, high physiological arousal is induced without posing actual danger to the safety of the experiencer. Despite these disagreements on the precise emotional signature, suspense is seen as inducing strong emotions. In the next section, I will discuss how researchers have studied the way that narratives engage attention.

2. Attention and Narratives

The study of the cinema audience's engagement while watching a film dates back to Münsterberg's (1916) psychological observations of the then new medium of silent films: "We feel that our body adjusts itself to the perception. Our head enters into the movement of listening for sound, our eyes are fixating on the point in the outer world. Our ideas and feelings and impulses group themselves around the attended object. It becomes the starting point for our actions while all the other objects in the sphere of our senses lose their grip on one another (pp. 36-37)."

Given the limitations of silent film projectors and unsynchronized sound in 1916, we can only imagine how Münsterberg would react to today's massive Imax screens and Dolby surround sound. Unfortunately, Münsterberg's observations did not capture the attention of the research community, and so the study of psychological processes during film viewing remained dormant for much of the twentieth century.

In the psychological study of engagement in narratives, there is a rich body of research concerning the experience of text narratives. Though there are many differences between the reception of text and film narratives, the common features warrant a discussion of transportation in reading before a discussion of film viewing. Gerrig (1993) invoked the analogy of a traveler to describe the way that readers process narratives: "The traveler goes some distance from his/her world of origin, which makes some aspects of the world of origin inaccessible. The traveler returns to the world of origin, somewhat changed by the journey (pp. 10-11)."
Each element of this analogy implies a psychological consequence for transported readers. The "travelling" to a narrative world entails both cognitive and emotional engagement by the reader. That is, readers will generate thoughts about the narrative events, such as questions about the

motives of characters' actions or predictions about what will happen next, as well as emotional responses, such as fear for the safety of characters or elation after a tragedy is averted.

This cognitive and emotional engagement in the narrative world of a story may result in some loss of access to elements of the real world. On a perceptual level, readers may lose awareness of their immediate physical surroundings, oblivious to sensory input from the real world. On a cognitive level, readers may not access certain real-world knowledge from long-term memory that would contradict the unfolding world of the narrative.

In the final part of the analogy, travelers return to their native lands, having changed as a result of the experience. Gerrig (1993) claimed that readers can experience real-world belief change after reading a narrative. Empirical research has supported this notion, providing many instances of readers incorporating narrative-specific "facts" into their representations of real world knowledge (e.g., Gerrig & Prentice, 1991; Marsh, Meade, & Roediger, 2003; Prentice, Gerrig, & Bailis, 1997; Strange & Leung, 1999;).

The phenomenon of transportation bears a resemblance to several related topics across different areas of study. For example, Csikszentmihalyi (1990) described *flow* as a euphoric state that arises as a result from being completely engaged in an activity. He posited that reading narratives is one of the activities that can induce a flow state of complete engagement. Along similar lines, Tellegen and Atkinson (1974) used the term *absorption* to describe a personality trait characterized by a heightened ability to experience alternate states of reality, such as hypnosis. Finally, in the field of virtual reality, the term *presence* is used to designate immersion in a virtual environment with an accompanying loss of awareness of the physical environment (Aardema et al., 2010).

3. Measuring Transportation

Based on the components of Gerrig's (1993) analysis of narrative transportation, Green and Brock (2000) created a scale to measure readers' level of transportation. The transportation scale consists of 15 items that probe a reader's cognitive and emotional involvement (e.g., "I was mentally involved in the narrative while reading it", "The narrative affected me emotionally"), loss of awareness to the real-world environment (e.g., "While I was reading the narrative, activity going on in the room around me was on my mind"), and generation of mental imagery of characters and situations (e.g., "While reading the narrative I had a vivid image of [character's name]"). In the typical application of the scale, participants read a text and then rated their personal agreement with each item by circling a number from one to seven.

Green and Brock's transportation scale has uncovered individual differences in the occurrence of transportation and the corresponding effects of a high transportation score. One of these effects is that high levels of transportation are associated with real-world agreement with statements supported by narratives. Green and Brock (2000) presented participants with a gruesome text in which a mental patient kills a young girl at a shopping mall. Participants who scored higher on the transportation scale also exhibited higher agreement with story-consistent beliefs, such as that the world is unjust. Individuals who score highly on transportation after reading a narrative also tended to describe the narrative as more realistic than individuals with low transportation scores (Green, 2004). Higher transportation scores were also correlated with higher ratings of enjoyment of narratives (Green, Brock, & Kaufman, 2004; Tal-Or & Cohen, 2010).

Although researchers have mostly studied the effects of transportation in terms of persuasion, it is not necessarily the only consequence of becoming transported. Another potential effect of transportation could be enhanced memory for narratives. The level at which people process information affects the level at which the information can later be retrieved from memory (Craik & Lockhart, 1972). Deeper levels of processing cause improved memory performance. In addition, some researchers have reported that presenting information in a narrative-style text leads to better recall than presenting the same information in an expository text (e.g., Janit, Hammock, & Richardson, 2011; Wolfe, 2005). Based on these effects, it is possible that the deep processing induced by the experience of transportation would lead to better memory performance than moments of lesser transportation. I will test this claim in the experiments of this thesis by comparing recognition memory performance for moments more or less likely to cause the attentional narrowing effects of transportation.

Though engaging narratives may have a powerful effect on transportation and memory, reports of individual differences in transportation suggest that not all viewers can be transported to the same level. If individual differences exist in people's transportability, what factors help explain these differences? To the extent that transportation is an emotional experience, it is likely that a predilection or aversion to experience emotions could affect people's openness to transportation. Maio and Esses (2001) created the need for affect scale to measure an individual's general tendency to approach or avoid emotion-inducing situations. For example, an individual with a high need for affect may enjoy watching emotionally-charged dramatic film and television programs, whereas an individual with a low need for affect may find these types of programs aversive. Given the emotional nature of the transportation experience, it is likely that individuals with a low need for affect may also resist becoming transported. Appel and Richter (2010) reported that need-for-affect had a positive effect on transportation, and that both need for affect and transportation mediated a narrative's ability to persuade the reader.

In addition to studies of individual differences in transportation, researchers have attempted to manipulate transportation with a single text by changing the story context or instructions given to participants. These manipulations have met with little success. For example, Green and Brock (2000) were unable to find differences in transportation scores based on the labeling of the same narrative text as fictional, non-fictional, or the retelling of a dream. There is also little empirical support for the claim that participants with different reading goals show different levels of transportation. For example, Green and Brock (2000) asked some participants to read a text while focusing on surface characteristics, specifically, judging whether the words in it are appropriate for a fourth-grader. The researchers instructed other participants to read the text as they would read for pleasure. They reported that the pleasure readers did show higher transportation than surface readers, but only when reading a moderately compelling text. That is, with a highly compelling text, even participants instructed to focus on surface aspects of the text became transported.

Though researchers have made many interesting findings using the transportation scale, the all-or-none aspect of the scale makes it unable to detect variations in aspects of transportation over the course of narrative viewing. In the next section, I will discuss the secondary task reaction time paradigm. This behavioral measure will be useful in observing differences in the attentional focus aspect of transportation at specific moments of viewing a narrative.

4. Secondary Task Reaction Times

A long-standing area of study in psychology is the effect of performing multiple simultaneous tasks (Bahrick, Noble, & Fitts, 1954; Welch, 1898). These studies typically observe impairment on one task or the other (Posner, 1966). In the secondary task reaction time (STRT) paradigm, participants engage in a primary task, such as reading a story or watching a film. At the same time, participants complete a secondary task in response to a probe, such as pressing a button when hearing the sound of a tone. Researchers measure the reaction time between the presentation of the probe and the participant's response. As the probes for the secondary task occur outside the focus of the primary task, latencies on STRT can be interpreted as greater attentional tuning to the primary task.

Researchers studying secondary task reaction times during the primary task of reading were surprised to report that making a text more challenging did not always slow down participants' reaction time to the secondary task. Britton and Tesser (1982) reported that participants were actually slower to respond to the secondary task when they were reading texts concerning topics about which they had background knowledge. Britton and colleagues also reported that participants reading a simple text had slower reaction times to the secondary task than participants reading a complex text (Britton et al., 1979). These findings were unexpected because the researchers theorized that the ease of processing simple, familiar texts, would provide little interference with completing the secondary task.

However, Britton et al. (1979) used a manipulation of complexity that created very different reading experiences. Both simple and complex texts consisted of a list of cryptic clues about a topic. For example, one text included the sentences, "A newspaper is better than a magazine. A seashore is a better place than the street." The difference in complexity was that the simple texts began with a title making it clear that the passage was about flying a kite, whereas the complex versions made no mention of the underlying topic. Thus, in terms of generating meaning from a text, the simple versions could be processed as coherent information about a topic, while the complex versions remained a confusing puzzle of unconnected sentences.

Communication researchers have studied secondary task reaction times with audiovisual stimuli. Studies in this domain have typically used brief "media messages" such as television advertisements and scenes with durations of about 30 to 60 seconds (Lang et al., 2006). As in the text studies by Britton and colleagues, some audiovisual studies have found evidence of slower reaction times to the secondary task with simple compared to complex stimuli (Lang et al., 2004; Reeves, Thorson, & Schleuder, 1986). Here however, complexity was not defined by the absence of a unifying topic, but by the rate of changes of camera angle during a message.

Further, different types of camera changes have elicited different patterns of secondary task reaction time responding rates. Lang et al. (2006) classified media messages according to their rates of cuts and edits. A *cut* is a camera change to an entirely new visual scene. An *edit* is a camera change to a different angle within the same visual scene, such as between close-ups of two characters engaged in a conversation. The researchers reported that increasing the rate of cuts shortened response times to the secondary task, while increasing the rate of edits lengthened response times. Though the researchers did not interpret their results as such, these findings can be interpreted with respect to transportation. Increasing the rate of cuts to different visual scenes may have hindered participants' engagement with the messages, resulting in faster reaction times to the secondary task.

5. The Present Study

With these experiments, I examine the way attentional tuning changes during the course of suspenseful film scenes. My main theoretical claim is that, at moments when viewers are made aware of potential negative outcomes, attentional focus will temporarily narrow. These moments display looming threats to characters and should transport participants, providing a strong motivation to mentally interact in the narrative. The present study measured changes in attentional focus during the viewing of film scenes.

As I have discussed, suspense is a basic component of narratives across all genres (Bordwell, 1985). However, for these experiments, I limited my stimuli to films from the "thriller" genre. I chose to focus on this genre of film because it represents the archetypal conceptualization of suspense. Also, the stakes in thriller films are often life-or-death for the characters, and viewers typically possess a high degree of agreement on what is the less-preferred negative outcome. For these reasons, I expected that excerpts from thriller films would provide the greatest chance of detecting an effect of suspense on attentional tuning.

In each of the film excerpts I chose, I compared what I call "hot spots," moments at which negative outcomes are made to seem salient, likely and imminent, to "cold spots," moments that do not emphasize a potential negative outcome. For example, in an excerpt from *Munich* (Spielberg, 2005), Israeli agents plant a bomb in the phone of a suspected terrorist to be activated with the turn of a pin in a remote detonator. However, when the agents call the suspect to detonate the bomb, it is not the suspect who answers the phone but his innocent daughter. The agents then frantically attempt to save the life of the innocent child by canceling the attack before the detonator is activated. In this excerpt, the hot spots depicted the agent calling the explosivewired phone and the pin being inserted into the remote detonator. The cold spots depicted the girl climbing the stairs and the suspect sitting at his desk.

I used latencies in completing button presses in response to audio probes as an index of the narrowing of attentional focus. These cues were peripheral in both semantic and spatial senses. Semantically, they were irrelevant to the narrative content of the scenes. Spatially, they originated from an internal computer speaker located to the left of participants. I predicted that the hot spots would narrow the scope of participants' attention, causing longer response times to the peripheral audio probes as compared to the cold spots.

Following each film excerpt, I administered the transportation scale (Green & Brock, 2000), modified for use with audiovisual narratives (Tal-Or & Cohen, 2010). Although the transportation scale is insensitive to moment-by-moment changes over the course of the narrative, I was interested to see if high transportation scores would be linked to stronger attentional effects on the secondary task reaction time task. By treating transportation as an individual differences measure, I was hoping to capture "transportability," consistent with other studies that have used the scale in this manner (Green & Brock, 2000; Green, Brock, & Kaufman, 2004). I also administered the Need-for-affect scale (Maio & Esses, 2001). By including this measure I was testing a connection between participants' tendency to approach emotional situations and the transportation and RT data, consistent with similar findings reported by Appel and Richter (2010).

I also conducted memory tests after participants had completed the need-for-affect scale. These tests were designed to measure the depth of encoding of the hot spots compared to the cold spots. Participants had to recognize the mirror orientation of stills from the film excerpts (Experiments 1a and 1b) or distinguish "old" stills from the excerpts from "new" stills not previously seen (Experiments 2a, 2b, 3). I predicted that after viewing the suspenseful film excerpts, participants would demonstrate better recognition memory for the hot spots than the cold spots.

6. Experiment 1a

With Experiment 1a, I investigated attentional tuning using suspenseful film excerpts taken from commercial films. I identified hot spots, moments at which negative outcomes were salient, as well as cold spots, moments at which negative outcomes were not salient. I predicted that participants would show attentional narrowing at hot spots compared to cold spots, as measured by secondary reaction time latencies. I also predicted that participants would show improved memory for the mirror orientations of the visual content of hot spots compared to cold spots. I also collected self-reported transportation for each excerpt and need-for-affect scores to compare to the reaction time data.

Method

Participants

Twenty-seven undergraduates at Stony Brook University (22 female, 5 male) participated for course credit. One participant was excluded from analyses for pressing the same numerical response to all questions. The final sample size for Experiment 1a was 26 participants. All participants were native English speakers.

Materials

I selected 10 film excerpts from English-language commercial films filmed in color (see Appendix for a list of the films). Each excerpt consisted of a suspenseful situation: A negative event seemed highly likely, but not certain, to occur over the course of the excerpt. I edited the film excerpts minimally using iMovie HD to create contained excerpts of similar durations. The excerpts ranged from 2.63 to 3.46 minutes, with an average duration of 3.16 minutes. I captured still images of the main characters in each excerpt and labeled these with characters' names. I presented these images before each excerpt to introduce participants to the main characters. I also wrote a paragraph introduction for each excerpt to provide additional narrative context (see Appendix). I wrote two yes/no comprehension questions (one yes, one no) for each film excerpt. I used an excerpt from the film *Julia* (Faivre, Marquis, & Zonca, 2008) as practice to familiarize participants with the procedure.

In each film excerpt, I identified two moments of high suspense ("hot" spots) and two moments of low suspense ("cold" spots). The hot spots were moments at which visual information presented onscreen made a negative outcome seem likely to occur. By contrast, the visual content of the cold spots did not emphasize the negative outcome.

I placed audio probes in nine locations during each film excerpt. Each audio probe was a 1000 Hz tone played for 200 ms through an internal computer speaker. Four of the probes occurred concurrently with the camera shots of the hot and cold spots. For example, for one of the *Munich* hot spots, participants would hear a beep as they watched the pin inserted into the bomb detonator. I chose locations for the remaining five probes for each excerpt using the following rules. No probe occurred in the first 10 s of each excerpt, within 500 ms before or after a change of camera angle, or within 8 s of another probe. In addition, the interval between any probe and the probe following it was never the same duration as the interval between the probe and the probe preceding it. By varying each interval, participants were unable to anticipate when upcoming probes would occur. I also placed nine probes in the practice excerpt, to familiarize participants with the procedure. However, these probes were not timed to coincide with any particular narrative information in the practice excerpt.

I also created a mirror orientation recognition task. I captured a still image from the same camera shot as each hot and cold spot in each film excerpt. Each still was taken 200 ms before the moment at which the audio probe occurred. I did this to test memory for the same content as the hot and cold spots, but before participants may have been distracted by completing the button-pressing task. These still did not contain left-right mirror symmetry nor orientation cues such as text or characters driving cars. With two hot and two cold spots in each excerpt, this resulted in a total of forty images. For each film excerpt I randomly selected one hot spot and one cold spot to be inverted about the vertical axis to create a mirror image. I created a second version of the set of forty images in which the opposite half of the images were mirror-reversed for a total of two versions of the mirror orientation recognition task.

Procedure

After obtaining consent, an experimenter led participants to a small room with a computer. The procedure ran on Medialab software presented on a Dell Optiplex 755 personal computer with a 19-inch flat-screen monitor and stereo speakers located on either side of the monitor. Written instructions informed participants that they would see a series of film scenes, with the primary task of watching the scenes for narrative comprehension. They were instructed that in addition to this primary task, whenever they heard a beep from the computer they should immediately press the space bar. They were informed that their memory for the film excerpts would be tested, but were given no information as to the form of the memory test. They were also instructed to keep a hand on the space bar at all times during the scenes.

Participants first viewed the practice excerpt to gain familiarity with the procedure. Then participants viewed the 10 film excerpts in an order randomized for each participant. Before each excerpt, the names and pictures of the main characters as well as the introductory paragraph appeared on the screen. Participants pressed the space bar to proceed through this information and to initiate the start of each excerpt. During each excerpt, participants responded to the audio probes by pressing the space bar and their response times were recorded by the program. If participants failed to respond within 3000 ms after each probe, the probe was counted as missed. After the presentation of each excerpt, participants completed a version of the transportation scale (Green & Brock, 2000) modified for use with video stimuli (Tal-Or & Cohen, 2010). They then answered the comprehension questions, ordered randomly. Following the presentation of all film excerpts, participants completed the need-for-affect questionnaire (Maio & Esses, 2001). Finally, I randomly assigned each participant to complete one of the two versions of the mirror orientation recognition task. Text instructions asked participants to press a button labeled "yes" if they were shown an image in the same orientation as shown in the film excerpts and to press a button labeled "no" if shown an image that had been reversed from its original orientation. An experimenter then asked each participant if they had previously seen any of the films used in the experiment and debriefed them.

Results

For each participant, I excluded data from films that they indicated they had previously viewed, resulting in a loss of 8.85% of the data. Participants viewed a practice film excerpt to become familiar with the button-pressing task. Even so, the response times to the first audio probe of each excerpt showed a high degree of variability. For this reason, I excluded the response times for the first audio probes. For three of the ten excerpts, the first probe location had been designated as a cold spot. Before analyzing the remaining reaction time data, I selected replacement probes to serve as cold spots. I chose from among the remaining five probe locations the location at which the negative outcome seemed least salient for each of these three excerpts. The analyses reported here were conducted including the response times from these three replacement probes. All response time effects reported as significant here remained significant ($p < .05$) when analyzing just the seven film excerpts with no replacement cold spots.

I removed outliers from the response time data. For each of the hot and cold spots, I excluded from analysis response times that were more than three standard deviations above the mean. This caused a loss of 2.60% of the data.

With respect to audio probe response times, I predicted that participants would be slower to respond to probes during hot spots than during cold spots. Indeed, participants were significantly slower to respond to probes at hot spots (M = 402 ms, SD = 130 ms) than at cold spots (M = 307 ms, SD = 138 ms) ($t(25) = 6.82$, $p < .001$). I had also hypothesized that participants would miss more probes at hot spots than at cold spots. The data supported this prediction. Participants missed significantly more of the hot spot probes (M = 8.36%, SD = 9.11%) than the cold spot probes (M = 1.01%, SD = 2.12) ($t(25) = 4.48$, $p < .001$).

For the mirror recognition task, I predicted that participants would correctly recognize the orientations of the stills from the hot spots more than those from the cold spots. This hypothesis was supported by the data. Participants gave more correct responses to images of hot spots (M = 73.14%, SD = 19.14%) than to images of cold spots (M = 68.85%, SD = 15.57%), ($t(25) = 2.22$, $p < .05$).

The transportation scale is meant to measure viewers' attention engagement during a narrative. To the extent that it is accurate in this regard, one might expect to find a statistical relationship between transportation scores and difference scores between RT for hot and cold spots. I tested this possibility using a technique recommended by Lorch and Myers (1990). For each participant, I computed a regression equation, regressing each excerpt's average RT effect size on its transportation score. I then performed a single-group t-test on the regression coefficients to test for a significant pattern. This analysis did not yield a significant relationship ($t(25) = -.451$, $p = .66$). I tested for correlations between each participant's scores on need-for-affect approach and avoidance sub-scales and each participant's average RT effect size, but these correlations were not significant (all *p*'s > .50).

In summary, Experiment 1a revealed significant attentional tuning effects at hot spots as revealed by a greater number of missed audio probes and longer RT to those probes. Participants also demonstrated significantly better recognition memory for the orientations of hot spot images compared to cold spot images. Self-reported transportation and need-for-affect did not correlate with RT performance.

7. Experiment 1b

Experiment 1b served as a control for Experiment 1a. My interpretation of the results of Experiment 1a was that the RT and memory effects were due to the salience of negative outcomes at hot spots within the overall narrative context. In Experiment 1b, I tested to see if the same pattern of results would emerge when using still images presented in a randomized order rather than coherent videos. Significant RT or memory effects in Experiment 1b would challenge the conclusions of Experiment 1a.

Method

Participants

Twenty-nine undergraduates at Stony Brook University (12 female, 17 male) participated for course credit. Three participants were excluded from analyses for not following the instructions of the button-pressing task. The final sample size for Experiment 1b was 26 participants. Participants were all native English speakers.

Materials

To convert the film excerpts from Experiment 1a to sets of still images, I captured 36 still images from each excerpt. Together with the two cold and two hot spots, there were a total of 40 images for each excerpt.

Procedure

The procedure used the same apparatus as Experiment 1a. Participants were instructed that they would view a series of images and that they should pay attention because their memory for the images would be tested. They were also told that during the images they would hear a series of beeps and they should press the space bar immediately upon hearing each beep. They were instructed to keep a hand on the space bar at all times during the viewing of the images.

Participants first viewed a practice set of 40 images taken from the practice film excerpt in Experiment 1a. These images were presented for 5 s each in a randomized order. During the practice images there were nine audio probes.

Participants then viewed the ten image sets in an order randomized for each participant. Each image was displayed for 5 s. The hot and cold spot images appeared in approximately the same temporal locations as in the intact excerpts of Experiment 1a. The order of the other 36 images per image set was shuffled randomly for each participant. There were also nine audio probes during each image set. Probes occurred during the hot and cold spot images as well as during five other randomly chosen still images, at approximately the same temporal locations as in Experiment 1a. Each of the test probes randomly occurred 500 to 2000 ms after image onset. After viewing all image sets, participants completed the need-for-affect questionnaire. Then participants completed the same mirror orientation recognition task as in Experiment 1a, randomly assigned to one of the two test versions. After the task, an experimenter read a list of the films used in the experiment and participants indicated if they had previously viewed any. Finally, the experimenter debriefed the participants.

Results

I excluded data for each participant for any films that they had previously seen. This caused a loss of 9.62% of the data. For each hot or cold spot, I excluded response times more than three standard deviations above the mean as outliers, resulting in a loss of 1.44% of the total data.

I analyzed the data for significant differences between the hot and cold spot images for the percentage of missed probes or for average response time. Participants missed very few probes (a total of two hot spots and one cold spot), providing no evidence of a difference between participants' detection of probes during hot versus cold spots. Also, as predicted, there was no evidence of a difference in response time between hot spots (M = 304 ms, SD = 112 ms) and cold spots (M = 305 ms, SD = 121 ms), ($t(25) = 0.15$, $p = .88$).

For the mirror orientation recognition task, I compared participants' accuracy for recognizing the orientations of hot and cold spot images. Unexpectedly, participants correctly identified the orientations of hot spots (M = 70.9%, SD = 15.18%) better than cold spots (M = 62.4%, SD = 15.64%), ($t(25) = 2.65$, $p < .05$). This effect replicated the data of the mirror orientation recognition task in Experiment 1a, despite the use of silent still images in a shuffled order. Comparing performance by item between Experiment 1a and Experiment 1b revealed a significant correlation ($r = .45$, $p < .01$) between the percentage of correct identifications for each item in Experiment 1a and Experiment 1b.

Overall, the results of Experiment 1b were mixed. The absence of any significant difference between RT for hot and cold spot images provides no challenge to my interpretation of the RT effect from Experiment 1a. However, the significant recognition memory advantage for hot spot images suggests that the memory effect in Experiment 1a may not have been due to negative outcome salience in a narrative context. In the following experiments, I replaced the mirror orientation recognition task with an old/new recognition memory task, to test recognition memory more directly rather than recognition memory of image orientations.

8. Experiment 2a

In the first experiment, I found evidence that during suspenseful film viewing, viewers' attention narrows at hot spots. With the second experiment, I sought evidence that attentional narrowing continues during the camera shot immediately following the hot spot. Finding a significant difference between reaction times for shots following hot and cold spots would provide further evidence that the attentional tuning effect is not due solely to the immediate processing of low-level details of the hot spots. I also included an old/new recognition memory task, as well as the transportation and need-for-affect measures.

Method

Participants

Thirty undergraduates at Stony Brook University (19 female, 11 male) participated for course credit. One participant was excluded from analyses for having previously seen more than 80% of the films and another was excluded for not following the instructions of the button-pressing task. The final sample size for Experiment 2 was 28 participants. Participants were all native English speakers.

Materials

The film excerpts used for Experiment 2 were identical to those used in Experiment 1a. I moved the positions of the audio probes during the hot and cold spots. The new locations of these probes were 500 ms after the camera change to the shot following each hot or cold spot. The locations of the remaining probes were not adjusted unless they needed to be moved to maintain 8 s between all probes.

I created new sets of images for the recognition memory test. The two hot and two cold spot images from previous experiments were kept to serve as "old" items in the recognition test.

For each excerpt, I captured four new images from the original films. These new images were culled from camera shots that I had edited out of the excerpts. This resulted in a set of 80 test images, with each film excerpt yielding two "old" cold spots, two "old" hot spots, and four "new" spots not shown in the videos presented to participants. The eight images for each film excerpt were presented together, but the order of excerpts in the recognition test was randomized for each participant. Within each excerpt, the order of the eight images was also randomized for each participant. In summary, there were eighty images in the recognition memory test for Experiment 2, grouped by film excerpt and randomized in order of presentation.

Procedure

The procedure was the same as the procedure in Experiment 1a, except for the memory test. Participants viewed the ten film excerpts while completing the button-pressing secondary task. After each excerpt, participants completed the transportation scale and answered two yes/no comprehension questions. Following all the excerpts, participants completed the need-for-affect questionnaire. Participants then completed the recognition memory test. They were instructed to press a key labeled "yes" when presented with an image they had seen before. They were instructed to press a key labeled "no" when shown a new image. The instructions stressed that participants should be as quick and accurate as possible in making their judgments. After completing the recognition task, participants indicated any prior viewing of any of the films and were debriefed.

Results

For each participant, I excluded the data from films they had previously viewed. This resulted in a loss of 10.36% of the data. For each hot and cold spot, I also excluded response times more than three standard deviations above the mean response time, eliminating 1.79% of the total data.

I performed an analysis of the film excerpt stimuli to see if there were systematic differences in the durations of shots at hot and cold spots. Differences here could mean that effects could be due to the passage of time rather than differences in the content of the hot and cold spots. I measured the duration from the moment when each probe occurred in Experiment 1a to the moment when each probe occurred in Experiment 2a. The average duration by movie for hot spots was 4835 ms and for cold spots was 3700 ms., although this difference was not significant ($t(9) = .53$, $p = .61$). In Experiment 3, I used hot and cold spots of equal duration to eliminate any effects of shot duration.

I predicted that participants would miss more probes at hot spots than at cold spots. The data supported this prediction. Participants missed significantly more probes at hot spots (M = 7.12%, SD = 7.94%) than at cold spots (M = 2.11%, SD = 3.90%), ($t(27) = 4.89$, $p < .001$). I also predicted that participants would be slower to respond to probes at hot spots than at cold spots. Participants were significantly slower to respond to probes at hot spots (M = 432 ms, SD = 150 ms) than at cold spots (M = 318 ms, SD = 127 ms), ($t(27) = 6.34$, $p < .001$).

For the recognition memory test, I predicted that participants would correctly recognize more still images from the hot spots than from the cold spots. Indeed, participants correctly recognized significantly more hot spots (M = 93.45%, SD = 15.76%) than cold spots (M = 87.83%, SD = 15.48%), ($t(27) = 3.60$, $p < .01$).

I used the same method reported in Experiment 1a to test for a relationship between transportation ratings and the size of the RT effect. The regression coefficients were significantly different from zero, but in a negative direction ($t(27) = -2.59$, $p < .05$). This suggests that surprisingly, participants generally showed larger RT effects during excerpts to which they gave lower transportation ratings. There were no significant correlations between the size of the RT effect and either the approach or avoidance sub-scales of the need-for-affect scale (both *p*'s > .50).

In Experiment 2a, I found that placing probes during the camera shots immediately following hot and cold spots produced similar effects in RT as with probes placed directly at hot and cold spots. This suggests that the attentional tuning effects are not limited to the precise moments of hot spots, but rather extend at least into the following camera shot (as I showed, an average of about three to five seconds). I also reported a significant effect of better recognition memory for hot spots than cold spots. I next performed a similar control experiment to the control for the first experiment.

9. Experiment 2b

In Experiment 2b, I tested for the same effects in Experiment 2a, using randomized still images rather than videos. Finding a significant difference between RT for images taken from the shots following hot and cold spots would challenge the interpretation that the RT effect in 2a is due to negative outcome salience in a narrative context. Similarly, a significant difference in recognition memory performance for still images would challenge the interpretation of the memory effect in 2a.

Method

Participants

30 Stony Brook University students (21 female, 9 male) participated for either course credit or $8. Of this sample, two were excluded due to a technical error in the program failing to record reaction times, leaving a final sample of 28 participants. Participants were all native English speakers.

Materials and Procedure

The image sets used in Experiment 2b were similar to those used in the control experiment 1b. The only difference was that audio probes occurred during images taken from the shots immediately following the hot and cold spots and five other randomly selected images for each excerpt. Audio probes did not occur during the hot and cold spot images. The procedure was identical to Experiment 1b except that following completion of the need-for-affect scale, participants performed the old/new recognition memory task from Experiment 2a rather than the mirror orientation recognition task.

Results

For each participant, I excluded the data from films they had previously viewed. This resulted in a loss of 8.93% of the data. For each hot and cold spot, I also excluded response times more than three standard deviations above the mean response time, eliminating 2.23% of the total data.

I compared RT for the images of shots following hot and cold spots using a paired-samples t-test. There was no significant difference between RT for the shots following hot (*M* = 303 ms, *SD* = 111 ms) and cold spots (*M* = 305 ms, *SD* = 104), ($t(27) = .34$, $p = .74$). Participants missed very few probes, and these did not differ significantly by whether they were from images following hot or cold spots ($p > .50$).

Comparing recognition memory for hot spot to cold spot images revealed an unexpected significant effect. Participants correctly recognized more hot spots (*M* = 81.17%, *SD* = 11.56%) than cold spots (*M* = 74.66%, *SD* = 15.71%), ($t(27) = 2.42$, $p < .05$), similar to the effect observed in Experiment 2a. This finding challenges the interpretation that the memory difference in Experiment 2a is due to attentional tuning. In summary, Experiment 2b tested for RT and recognition memory effects for still images taken from shots following hot and cold spots. There was no evidence of an RT effect with still images, in contrast to the RT effects reported in during the viewing of the film excerpts in Experiment 2a. However, I did report a significant recognition memory effect with still images, suggesting that the memory effect in Experiment 2a may be due to visual features at the hot spots and cold spots rather than narrative context.

Experiment 3

With this experiment, I directly manipulated the timing of the hot and cold spots to search for an attentional narrowing effect when all other elements were held constant. To accomplish this, I selected a hot and cold spot for each film and edited them to equal durations of 1 s each. In the example from *Munich*, the hot spot depicted the key being inserted into the detonator. The cold spot was the suspect sitting down at his desk. I created two versions of each excerpt, inserting the hot and cold spots at different temporal locations in one version, and switching their locations in the other version. I then measured RT to the same shots following either the hot or cold spots, counterbalanced between conditions. Because the shots during which I placed the audio probes were held constant, any difference in RT should be due to the preceding hot and cold shots. I also administered an old/new recognition memory test for both the hot and cold spot images and images from the following shots where the probes were placed.

Method

Participants

59 Stony Brook University students (35 female, 24 male) participated for either course credit or $8. Of this sample, 7 participants were excluded from analyses. One was excluded for a technical error with the computer program, four were excluded for missing over 80% of the probes, and two participants was excluded for manually raising the audio volume of the film excerpts and thereby lowering the relative volume of the audio probes. The final sample totaled 52 participants, with 26 randomly assigned to condition 1 and 26 randomly assigned to condition 2. Participants were all native English speakers.

Materials

The film excerpts from Experiments 1a and 2 were re-edited for Experiment 3. Due to the constraints of Experiment 3, three film excerpts needed to be replaced. Specifically, the changing narrative circumstances rendered them inflexible with respect to moving the locations of the hot spots. I chose three new excerpts, as shown in the Appendix. For each film excerpt, I created a hot and a cold spot, each a single camera shot edited to exactly 1 s in duration with the sound removed. I inserted the hot and cold spots into the film excerpts at temporal locations different from where they had occurred in the original excerpt. The audio from the original excerpt at these moments was preserved. I created two versions of each film excerpt. In one version, the cold spot occurred first and the hot spot occurred shortly before the outcome. In the other version, the temporal locations of these spots were switched, so that the hot spot occurred first and the cold spot occurred shortly before the outcome. The audio soundtrack was identical for both versions of each film excerpt.

Nine audio probes were placed in each film excerpt. The two key probes for each excerpt were placed 500 ms after the onset of the camera shot immediately following the hot and the cold spot. I set the locations of the remaining probes according to the same placement rules as in Experiment 1a. The timing of the probes was identical for both versions of each film excerpt.

I created two conditions of the set of ten film excerpts. In one condition, I randomly selected half of the excerpts to be of one version and the other half of the excerpts were of the other version. The other condition contained the opposite versions of each film excerpt.

For the recognition memory task, the "old" images were screen captures from the hot spot, the cold spot, and the shots following each of those in which the key audio probes were placed. I selected four "new" images in the same manner as in Experiment 2. The eight images for each film excerpt were presented together, but in a randomized order for each participant. The order of the film excerpts was also randomized for each participant.

Procedure

The procedure for Experiment 3 was identical to the procedure for Experiment 2, except that participants were randomly assigned to view one of the two sets of film excerpts. Participants viewed all film excerpts in an order randomized for each participant. They completed the transportation questionnaire and comprehension questions after each excerpt. Then they completed the need-for-affect questionnaire and the recognition memory task as described above. Finally, they indicated any prior viewing of any of the films and were debriefed.

Results

I excluded data for any films that participants indicated they had previously viewed. This resulted in a loss of 4.42% of the data. For each key probe (following a hot or cold camera shot) in each condition, I excluded any response times more than three standard deviations above the mean. This caused a loss of 1.54% of the total data.

I predicted that participants would miss more probes that occurred during camera shots that immediately followed hot spots than those that occurred following cold spots. I found that participants did miss more probes immediately following the hot spots (M = 11.21%, SD = 14.61%) than following the cold spots (M = 8.52%, SD = 12.83%), ($t(51) = 2.13$, $p < .05$). I also predicted that for the key probes to which participants did respond, participants would be slower in responding to probes during camera shots immediately following hot spots than following cold spots. Consistent with this hypothesis, participants were slower to respond to probes immediately following hot spots (*M* = 398 ms, *SD* = 165 ms) than following cold spots (*M* = 346 ms, *SD* = 116 ms), ($t(51) = 2.94$, $p < .01$).

I predicted that participants would demonstrate better recognition memory for hot spot images than cold spot images as well as for images from shots following hot spots than following cold spots. However, participants did not demonstrate significantly better recognition for hot spots (*M* = 88.60%, *SD* = 8.92%) than cold spots (*M* = 85.23%, *SD* = 13.15%), ($t(51) = 1.59$, $p = .12$), and there was no significant difference in observed recognition performance for images taken from the shots following hot spots (*M* = 92.49%, *SD* = 8.34%) compared to cold spots (*M* = 93.17%, *SD* = 8.35%), ($t(51) = .42$, $p = .68$). The lack of significant memory effects is perhaps due to having half the number of test items compared to earlier experiments.

I tested for a relationship between transportation scores and the size of the RT effect using the same method as in Experiments 1a and 2a. This analysis revealed a significant positive, relationship between transportation scores and the size of the RT effect ($t(51) = 2.174$, $p < .05$). This means that for Experiment 3, higher transportation scores were associated with larger RT effect sizes. This result is in contrast with the negative relationship I reported in Experiment 2a. There were no significant correlations between the average size of the RT effect averaged by participant and approach and avoidance scores on the need-for-affect scale (all *p*'s > .20).

Experiment 3 yielded significant RT effects for hot spots compared to cold spots, even when the key probes occurred on the shots following the hot and cold spots with all other details held constant. This provides strong evidence of attentional tuning as a result of negative outcome salience. The recognition memory data did not yield significant effects of hot spots compared to cold spots. The self-reported transportation and need-for-affect scores did not correlate with RT effect size. Given the robust attentional tuning effect found by measuring RT, the lack of correlations on these ancillary measures suggests that they are failing to fully capture viewers' attentional experience of the excerpts.

11. General Discussion

The aim of this dissertation was to provide behavioral evidence for one of the central claims of transportation theory: that experiencing a narrative may at times include a loss of awareness of the outside world. Previous research on this topic has not made specific claims about attentional tuning effects at specific time points during narrative experiences. Focusing specifically on suspenseful film excerpts, I tested the hypothesis that hot spots, moments at which negative outcomes are salient, would cause attentional narrowing compared to cold spots, moments at which negative outcomes are not salient. I also assessed a potential downstream consequence of attentional narrowing by testing recognition memory for hot spots and cold spots.

The response time data from these experiments supported the hypothesis that hot spots would narrow attentional focus. On average, participants demonstrated slower RT at hot spots than cold spots (Experiment 1a), as well as for the camera shots following hot spots compared to the shots following cold spots (Experiment 2a). I found this difference even when those following shots were held constant and counterbalanced between conditions (Experiment 3). However, I did not find differences in RT to still images of hot and cold spots (Experiment 1b) when presented among randomly-ordered still images. I also did not find RT differences to still images taken from the shots following hot and cold spots (Experiment 2b). Significant effects in these control experiments would have suggested that the observed RT effects might have been due to basic visual features of the hot and cold spots. As the effects were null, the control data do not challenge the interpretation that the attentional narrowing effects in Experiments 1a, 2b, and 3 were due to transportation in a narrative context.

The recognition memory data did not lead to a clear interpretation in support of my hypotheses. I had predicted that participants would show better memory for hot spots than cold spots, but only after viewing intact suspenseful film excerpts. Post-viewing, participants did demonstrate better recognition memory performance for the mirror orientations of hot spot images over cold spot images (Experiment 2a) and better recognition for the images themselves (Experiment 1a). However, the same effects occurred for participants who viewed randomized still images (Experiments 1b and 2b) rather than narratives. This suggests that the memory effects in Experiments 1a and 2a might be due to visual features that could be gleaned from still images with no larger narrative context. I had hoped to find that with counterbalanced temporal locations of hot and cold spots, participants would show better recognition memory for the hot spots (Experiment 3), but this did not produce statistically significant differences.

The persistent recognition memory effects in the control experiments limit the claims I can make about the effect of hot spots on memory.   Because I used realistic stimuli from commercial films, I had limited control over the specific content depicted in the hot spots. The still images were not normed for memorability, and it seems that surface features of the hot spots may have driven the memory effects. With access to filmmaking technology, one could create film excerpts in which the same camera shot would denote a hot spot or a cold spot depending on the context preceding it. This would control for any differences in memorability and provide clearer evidence of an effect due specifically to negative outcome salience. A classic cinematic example along these lines would be the opening sequence of Orson Welles' *Touch of Evil* (Zugsmith & Welles, 1958), in which a ticking time bomb is placed in the trunk of a senator near a U.S.-Mexico border crossing. During a continuous tracking shot that lasts over three minutes, the car enters and exits the frame several times as the camera weaves between buildings and follows two of the film's stars Charlton Heston and Janet Leigh. Moments at which the car appears near the pair would count as hot spots because the bomb becomes especially salient at these moments. However, without the knowledge of the bomb in the trunk, these same frames would signal no threat. A difference in memory performance for these specific moments between participants aware and participants unaware of the bomb would provide stronger evidence of higher-order memory effects.

It is also quite possible that, when viewing the randomized still images of the control experiments, participants attempted to form semantic links between the images. Even without the coherence granted by viewing the images in the proper order, participants may have generated proto-narratives to make some sense of the stream of images. Through this process they may have assigned similar importance to the hot spots from the original excerpts, causing the memory effect.

One of the goals of this thesis was to compare my behavioral RT measure of attentional tuning with self-report measures of transportation and need-for-affect. To the extent that these self-report measures capture accurate readings about attentional engagement during the excerpts, one would expect to find correlations between them and the RT effect size. The results across my experiments were inconsistent. I did find a significant positive relationship between transportation and RT effect size in Experiment 3, but the relationship was negative in Experiment 2a, and no effect was present in Experiment 1a. This puzzling inconsistency defies simple explanation. Though the differences were significant in Experiments 2a and 3, the magnitude of the average regression coefficient was small (M = -.17 and M = .12 respectively). These results suggest that the secondary task RT measure may be providing new information not captured in the self-report transportation scores.

A central tenet of transportation theory is that after the experience of transportation, the viewer is somehow changed as a result of transportation (Gerrig, 1993). I was unable to conclude that attentional narrowing was linked to improved memory for hot spots. Still, I am interested to see in future research if other measures can capture downstream consequences of transportation. Researchers have found that higher transportation scores tend to be associated with greater agreement with story-consistent attitudes (e.g., Green, 2004; Green & Brock, 2000; Williams, Green, Houston, & Allison, 2011). Transportation is also linked to greater enjoyment of narratives (Green, Brock, & Kaufman, 2004). Based on these findings, it would be interesting to investigate if individuals who demonstrate stronger attentional narrowing effects in RT also show higher agreement with story-consistent beliefs and higher enjoyment.

Despite the difficulty in interpreting the memory data, the RT data provide strong evidence of attentional tuning at hot spots. This effect extends at least into the camera shot immediately following hot spots as well. Generating predictions about attentional focus at specific points in time during film viewing marks a finer-grained level of inquiry than that provided by the transportation scale (Green & Brock, 2000). Even so, a promising direction for future research will be to assess attentional focus at even more points over the course of narrative viewing. One method to accomplish this would be to use audio probes placed randomly over the entire course of an excerpt, rather than just at fixed points. This technique could reveal durations of attentional narrowing after hot spots as well as uncover any other patterns in attentional narrowing. Still, there are two practical concerns with this method. One is that using randomized probe locations would require a much larger sample size of participants. The other is that participants show individual variation in how quickly they perform the button-pressing task, making it difficult to compare response times to probes at different moments between participants. In light of this issue, response times for participants could be normalized to their individual baselines before comparing between participants.

Another strategy to gain a more complete picture of attentional focus over the course of a narrative would be to use a continuous measure. One such technique is the affect rating dial, a tool that emotion researchers use to obtain continuous self-ratings of affective experience (Ruef & Levenson, 2007). In this paradigm, participants turn a dial to indicate their current level of subjective affect on a particular dimension. However, extending this research paradigm to assessments of attentional focus would pose a conceptual problem due to interference between tasks. If attention is narrowed, participants should become less responsive on the dial task. Because of the ambiguity in interpreting these ratings, the affect rating dial paradigm would not be ideal for measuring attentional focus.

Continuous response measures that do not demand conscious control may be more fruitful in measuring attention. Researchers have made discoveries about viewer attention during film viewing by recording participants' eye movements using eye trackers. When viewing static, two-dimensional scenes, participants tend to make fixations on the same informative regions. However, the order in which participants fixate on these regions varies greatly between participants (Henderson, 2003) and between repeated viewings by the same participant (Mannan, Ruddock, & Wooding, 1997). In contrast to the attentional variability in static scene viewing, when viewing dynamic scenes, participants show a high degree of *attentional synchrony* (Smith, 2006). That is, they tend to fixate on similar regions of the screen at similar points in time. In comparing eye movement patterns across videos from a wide variety of sources, Mital et al. (2011) found that motion was the strongest predictor of where participants' gaze would cluster, surpassing the predictive value of static features such as luminance and orientation. The authors noted that in filmed narratives, objects in motion are often semantically important as well. As such, they were unable to conclude if the effect was due solely to the feature of motion or the influence of higher-level cognition.

Hasson and colleagues used functional magnetic resonance imaging (fMRI) to measure attentional synchronization in terms of neural activity (Hasson, Nir, Levy, Fuhrmann, & Malach, 2004). The researchers asked participants to view the first 30 minutes of the film *The Good, the Bad, and the Ugly* (Grimaldi & Leone, 1966) while recording changes in blood oxygenation using fMRI. Participants were instructed to view the film freely without further instructions. Like the attentional synchrony revealed by tracking eye gaze, participants showed a high degree of inter-subject correlations in their brain activity. The research team examined reverse correlations of which moments in the film caused the highest degree of inter-subject correlations in the brain scans between participants. The logic of this analysis is that low correlations indicate that participants are focusing their attention on different targets and high correlations indicate some form of synchronized attention. These correlations are informative even though they do not allow researchers to pinpoint precisely what cognitive functions participants are performing in synchrony. Hasson et al. found that the moments that caused the highest degree of inter-subject overlap coincided with emotionally intense or surprising narrative developments. For example, these included gunshots, explosions, and plot twists. Although Hasson et al. made these discoveries post hoc, there are reasons why one could predict these moments would capture attention. Gunshots and explosions combine salient auditory and visual components, and on a narrative level, threaten to end the lives of characters.

The findings of this study are limited by the use of thirty minutes of video from a single Western film, but remain provocative. With further analysis of more types of films, it will be interesting to see differences in inter-subject correlations and what elements give rise to these differences. Hasson et al. (2008) conducted an exploratory comparison of inter-subject correlations during the viewing of four videos from radically different genres: the same excerpt from *The Good, the Bad, and the Ugly*, an episode of *Alfred Hitchcock Presents* directed by Hitchcock himself, an episode of the comedy program *Curb Your Enthusiasm*, and an unstructured video of pedestrians in Washington Square Park. They found the highest inter-subject correlations during the Hitchcock program, and the lowest during the unstructured park footage. We should exercise caution in drawing broad conclusions from this extremely limited range of stimuli, but these initial results suggest the potential for stronger findings following the use of a much larger corpus of films. I am interested in using techniques such as eye tracking and fMRI in conjunction with secondary task RT to investigate whether multiple measures provide converging evidence of moments at which attentional narrowing occurs.

My experiments provided behavioral evidence of the attentional component of transportation at precise moments during narrative viewing. Similar work could be performed regarding the emotional component of transportation. I am interested in recording physiological measures such as heart rate, skin conductance, and electromyographic recordings of the movements of corrugator and zygomatic facial muscles as markers of emotional reactions (Lang, Greenwald, Bradley, & Hamm, 1993). Combining these continuous measures with the secondary task reaction time measure could potentially provide converging evidence linking attentional and emotional effects of hot spots in suspenseful narratives.

Another way to extend research in this area would be to examine narrative experiences of greater durations. The present study used brief suspenseful excerpts from thriller films. Future studies could use films in their entirety. This would better represent the format in which viewers typically consume film narratives. Thompson (1999) argued that most Hollywood films tend to consist of four acts, each approximately a half-hour in duration. Measuring secondary task reaction time over the course of an entire film could reveal patterns in attentional focus near act boundaries. It is also possible that over the course of viewing a film in its entirety, viewers would develop stronger allegiances with characters (Smith, 1995). These allegiances might heighten the attentional effects of suspense, because viewers would be more deeply invested in the well being of the characters.

Further research should also explore other narrative genres. As suspense is a basic feature of narratives, future studies could test for similar attentional narrowing effects in excerpts from drama, romance, or comedy films. I would predict similar patterns of results when participants feel suspense concerning potential outcomes that do not place characters' lives at risk, though this claim requires empirical testing. There may also be individual differences in which genres of narratives participants find most engaging. I do not make the claim that suspense is the only narrative element that causes attentional tuning. Future research should explore whether other elements, such as surprising moments, also cause a narrowing of attention.

For researchers of narrative experiences, these findings support the claims of the attentional aspect of transportation theory. They also extend the theory by providing an outline of the time course with which attention fluctuates during suspenseful scenes. My findings demonstrate that attentional tuning occurs at hot spots, when negative outcomes are salient.

As suspense is in part an emotional experience, research on the effects of emotion on attention is relevant for discussion. This field traces back to a classic article by Easterbrook (1959), which presented the hypothesis that individuals in heightened negative emotional states, show decreased processing of peripheral cues in the environment. More recently, researchers have made refinements to Easterbrook's hypothesis using the findings of perceptual experiments.

In her broaden-and-build model of positive emotions, Fredrickson (1998) theorized that positive emotions, such as amusement and contentment, broaden an individual's attentional scope whereas negative emotions, such as anxiety and anger, narrow attentional scope. Fredrickson and Branigan (2005) tested this theory using a global-local processing task. They found that after viewing an amusing penguin video or a serene nature video, participants showed a greater bias for reporting the global shapes over the local shapes.

Other researchers have found effects of negative emotions on attentional focus. Derryberry and Reed (1998) found that anxious individuals show an increased local attention focus using the Navon (1977) letters task. In this paradigm, researchers present participants with images of a large letter composed of many smaller figures of a different letter. For example, participants could see an F comprised of tiny B's. During the viewing of these figures, participants are asked to press a button whenever they see certain letters (e.g. B and L), and researchers measure response time. Researchers interpret faster response times to the large letters as indicative of a global attentional focus and faster response times to the smaller letters as indicative of a local focus.

Researchers have also used the Stroop task to measure conceptual attentional focus. In the Stroop task, participants are presented with the names of colors, but the words themselves are written in different colors. For example, a participant may see the word "blue" written in red ink, among other similar examples. When asked to ignore the words and say aloud the font color, participants demonstrate some degree of degraded performance when the font color and words do not match. Chajut and Algom (2003) reported that participants experiencing the negative emotional stress demonstrated improved selective attention, as measured by greater resistance to Stroop effects compared to baseline. However, research studies on the induction of sad moods in participants have reported null effects on attentional focus using Stroop tasks (Chepenik, Cornew, & Farah, 2007) and flanker tasks (Rowe, Hirsh, & Anderson, 2007). In the flanker task, experimenters instruct participants to respond to a central response cue while ignoring cues that flank the central cue on either side. The extent to which participants are able to ignore distracting flanker cues, as measured by differences in reaction time, has been interpreted as indicative of attentional tuning.

In a review of a large number of attentional tuning studies, Friedman and Förster (2010) argued that implicit affective cues influence attentional scope. By their analysis, benign cues broaden the focus of attention, and threatening cues narrow the focus of attention. They synthesize many studies that found subtle environmental cues of threats causing a narrowing of attention on both perceptual and conceptual tasks.

In provocative recent work, Gable and Harmon-Jones (2008; 2010) suggest that the key dimension of emotions affecting attentional focus is not valence but motivational intensity. In their view, high-motivation emotional states such as desire, anger, and fear would narrow the scope of attention, while low-motivation emotional states such as sadness and amusement would broaden attentional focus. A series of studies using mood induction and the Navon letters task provide tentative support for aspects of this theory (Harmon-Jones & Gable, 2008, Gable & Harmon-Jones, 2010). However, due to several methodological concerns and the novelty of these findings (see Friedman & Förster, 2011), more research is needed to determine the tenability of the motivation hypothesis.

In terms of suspense, recent work by Finucane (2011) has demonstrated attentional tuning in response to film-induced fear. She induced fear in participants by subjecting them to an intense excerpt from the film *The Silence of the Lambs* (Saxon, Utt, Bozman, & Demme, 1991). In this scene, a serial killer wearing night vision goggles stalks FBI agent Clarice Starling (Jodie Foster) in a darkened basement. Following the fear induction, participants completed a flanker task. In other blocks of this repeated measures study, participants viewed anger-inducing and neutral film excerpts. During the "fear" block, participants showed heightened attentional tuning compared to the "neutral" block. Here attentional tuning was indexed by smaller differences between reaction times during incongruent and congruent trials of the flanker task. This finding suggests that film-induced fear can narrow the scope of attention. As suspense induces fear of negative outcomes (Ortony, Clore, and Collins,1988), I would expect to find similar results if these types of spatial attentional focus tasks were administered at hot spots in suspenseful scenes. If this experiment were conducted, participants might find it difficult to "re-engage" with the film after stopping to complete the attention task. A benefit of my secondary task reaction time procedure is that it does not interrupt the flow of film viewing. My audio probes were conceptually peripheral to the action of the narrative. Future research could use visual probes to ascertain if similar effects occur for spatially peripheral stimuli.

The results of my dissertation research program also hold practical implications for the art and commerce of filmmaking. For filmmakers, my findings show that audience engagement varies at different time points during film viewing, and that these time points can be predicted and manipulated in suspenseful film sequences. Filmmakers could use this technique to craft more engaging films by strategically choosing when to call viewers' attention to salient negative outcomes. From a commercial standpoint, knowing the most engaging moments in a film has its own benefits. Editors of film advertisements could measure the most engaging scenes in a film, and use these to create trailers that stand out amid competing bids for viewers' attention. Marketers interested in maximizing the efficacy of product placement could use these findings as well. Placing brands at hot spots rather than cold spots may be more effective, due to viewers' increased attention at these moments. This would be consistent with qualitative studies of consumers that have suggested a viewer's involvement with a narrative is one of the factors that mediates the effectiveness of product placement (DeLorme & Reid, 1999).

In conclusion, these experiments support the notion that engaging films can, at times, narrow the scope of viewers' attention. One such narrative element that can perform this function is suspense, which can constrict attention by making potential negative outcomes salient to viewers. Through future research using converging psychological paradigms, we can more fully understand what film elements narrow attention, as well as the time course with which this process unfolds. This line of research could provide insights to psychologists and film theorists and psychologists about the cognitive processes that function both in the cinema and in the real world.

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Appendix
Film List and Introductory Paragraphs

Films marked with "*" were used in Experiments 1a, 1b, and 2. Films marked with "**" were used in Experiment 3. All other films were used in all experiments. Directors, countries of origin, and years of release are provided in parentheses. The introductory paragraphs were often, but not always, accurate descriptions of the plots of the original films from which they were selected.

Alien (Ridley Scott, United States/United Kingdom, 1979) Brett is an astronaut on a massive spaceship that travels between galaxies on commercial missions. Recently, his ship picked up an alien life form that turned out to be aggressive. It has killed several crewmembers and hidden somewhere deep in the ship. Brett was on another part of the spacecraft when the attack occurred. His cat Jones ran away and now Brett is searching through the ship to find his pet. He is unaware of the threat of the alien hiding in the shadows of the mechanical equipment.

Blood Simple (Joel Coen, United States, 1984) Abby has been trapped in a loveless marriage for 10 years. Though her husband is abusive toward her, Abby is afraid to try to get a divorce. Recently, Abby began having an affair with Ray, who gives her the attention that her husband does not. Abby and Ray have plans to run off together and start a new life. Abby's husband became enraged when he figured out that they were having an affair. He knows they are going to meet up so he plans to kill them both with a rifle.

Cliffhanger (Renny Harlin, United States/France/Italy, 1993) Gabe is an expert mountain climber who lends his free time to rescuing stranded climbers in the Rocky Mountains. He has discovered his friend Sarah has been stranded at the top of a mountain with her boyfriend. A rescue helicopter has also arrived to transport them safely to the bottom of the mountain. Gabe is helping Sarah to cross to the helicopter on a cable. However, he doesn't know that Sarah's equipment is worn down and may not support her on the cable.

****The Day of the Jackal (Fred Zinnemann, United Kingdom/France, 1973)** Jack is a professional assassin who has been hired to kill the president of France at a national ceremony. He has rented out a hotel room overlooking the event so he will have a clear shot with his sniper rifle. Meanwhile, French authorities have received word that an attack is likely and they are ramping up security to try to foil the killer.

****Dog Day Afternoon (Sidney Lumet, United States, 1975)** Sonny has just robbed a bank to pay for an operation for his lover. His friend Sal is his accomplice. After a long hostage situation, they are being transported in a van to the airport, where the police have promised a private jet will take them out of the country. However, the police plan to kill Sonny and Sal before they can reach the jet.

****Julia (Erick Zonca, France, 2008)** Julia is a dangerous criminal on the loose. Her plan to rob a bank became complicated when the police arrived. She shot and killed two police officers, fleeing with a duffel bag of money stashed in the trunk of her car. Now she is hiding out in the woods as she plans her next move. By now, her picture has no doubt appeared on the evening news. In the same forest, an Australian man named Marcus is camping with his young son. Julia didn't realize there would be other people in the forest. She will kill to remove any witnesses who could tie her to the bank robbery.

***Léon: The Professional (Luc Besson, France, 1994)** Leon is an experienced hit man for the mob who is considered the best in the business. An orphaned girl named Jade has shown potential in the mob, so Leon is showing her the ins and outs of being a professional killer. Today's lesson is the proper way to kill someone with a sniper rifle. From his apartment in midtown Manhattan, Leon has a hidden view of unsuspecting joggers in Central Park. Jade is excited for her first chance to pull the trigger. She is going to learn on Leon's custom-made sniper rifle.

***License to Kill (John Glen, United Kingdom, 1989)** Bond is an international super-spy who travels the world, foiling the schemes of criminal masterminds. He has learned that a crime lord named Sanchez has been making counterfeit US dollars in massive quantities. Bond has infiltrated the island retreat of Sanchez where the counterfeit money is produced. Sanchez has learned that Bond is diving in the waters around his island. He has dispatched his henchmen in diving suits to kill Bond and protect his counterfeit money.

The Man Who Knew Too Much (Alfred Hitchcock, United States, 1956) Ben and Jo are an American couple vacationing in London. They were excited to see an orchestral concert in the Royal Albert Hall. However, Jo overheard an assassin mention that he was going to shoot a foreign dignitary sitting in the mezzanine. The assassin said that he would fire during the moment of the concert when the cymbal player crashes the cymbals, masking the sound of the gunshot. As Ben arrives, Jo tells him about the assassination plot that she overheard.

Marnie (Alfred Hitchcock, United States, 1964) Marnie suspects that her company has been dumping chemicals in a nearby river, causing many people to get sick. She knows that her boss keeps important documents in the safe in his office. She plans to break into the safe on a Friday night an hour after the office closes. She knows that all of her coworkers will be gone for the weekend, leaving the office empty. Little does she know that Rita, the janitor, comes in late every Friday night to clean when the office is empty. Rita has been working at the office for years and is very loyal to the company.

***Misery (Rob Reiner, United States, 1990)** Paul is a famous author of thrilling novels. His legs become injured in a car accident in a remote part of Colorado. Annie, a woman who claims to be Paul's biggest fan, rescues him from the wreck and offers to nurse him back to health. However, Paul soon discovers that Annie is mentally unstable and is keeping him locked in a room. Worse, she has begun withholding the pills that Paul takes to relieve pain. One day Paul sends Annie to a store to buy writing paper for him. Then Paul sneaks out of his room to try to escape.

Munich (Steven Spielberg, United States, 2005) A bomb went off in Jerusalem outside of a large temple during an important holiday, killing and wounding many people. The Israeli government spent months tracking down people who were involved in planning the attack.

One of their prime suspects is Mahmoud Hamshari, who is living in France with his family. They have dispatched a team of agents to assassinate him. The agents are going to break into his apartment and plant a bomb in his phone. Their plan is to call him and detonate the bomb when he picks up.

North By Northwest (Alfred Hitchcock, United States, 1959) Roger was a successful advertising executive on Madison Avenue. Due to a case of mistaken identity, a gang of international criminals believes he is a spy and has been chasing him across the country. To try to elude his followers, Roger has taken a bus to an empty cornfield in Iowa. He plans to transfer to a different bus that will take him to South Dakota. He is concerned that the criminals are still trying to kill him. He has noticed that a crop dusting airplane is flying over fields with no crops.