NEURAL EVIDENCE THAT SUSPENSE NARROWS ATTENTIONAL FOCUS

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Abstract—The scope of visual attention changes dynamically over time. Although previous research has reported conditions that suppress peripheral visual processing, no prior work has investigated how attention changes in response to the variable emotional content of audiovisual narratives. We used fMRI to test for the suppression of spatially peripheral stimuli and enhancement of narrative-relevant central stimuli at moments when suspense increased in narrative film excerpts. Participants viewed films presented at fixation, while flashing checkerboards appeared in the periphery. Analyses revealed that increasing narrative suspense caused reduced activity in peripheral visual processing regions in the anterior calcarine sulcus and in default mode network nodes. Concurrently, activity increased in central visual processing regions and in frontal and parietal regions recruited for attention and dynamic visual processing. These results provide evidence, using naturalistic stimuli, of dynamic spatial tuning of attention in early visual processing areas due to narrative context. © 2015 IBRO. Published by Elsevier Ltd. All rights reserved.

Key words: attention, emotions, cognitive neuroscience, narrative transportation, suspense.

INTRODUCTION

In real-world situations, attention is dynamic, varying in scope over time as exogenous and endogenous factors influence an organism's state. Audiovisual narratives are useful for studying the dynamic time course of attention. They offer a continuous stream of realistic auditory and visual stimuli. These features permit analysis on a dynamic scale and mimic real-world settings (Smith et al., 2012). Indeed, films have been used to study simple to complex cognitive behaviors such as event

cognition (Zacks et al., 2010), memory (Hasson et al., 2008) and consciousness (Naci et al., 2014). Our research exploits natural changes in emotional aspects of audiovisual narratives to document dynamic changes in attention.

According to the theory of narrative transportation (Gerrig, 1993; Green and Brock, 2000), engaging narratives can at times suppress a reader's or viewer's processing of the world beyond the page or screen. Using a self-report scale, researchers have found that, when readers experience greater transportation, they perceive texts as more realistic (Green, 2004) and they demonstrate greater acceptance of narrative-consistent beliefs and attitudes (Green and Brock, 2000). Suspense is one of the factors linked to increased transportation (Tal-Or and Cohen, 2010; Krakowiak and Oliver, 2012). Suspense arises when potential threats to characters become salient and is characterized as a mixture of fear for a negative outcome and hope for a positive outcome (Ortony et al., 1990). Research on human emotion has shown that stimuli with negative valence (Easterbrook, 1959), particularly with high motivational intensity (Gable and Harmon-Jones, 2010), may narrow the scope of attention (Mathews and Mackintosh, 2004). Threat-related stimuli can evoke increased activation in relevant sensory brain areas (Pourtois et al., 2013), and electrophysiological studies report a link between processing negative emotional stimuli and a local attentional focus (Hartikainen et al., 2010; Gable and Harmon-Jones, 2012). These results support the hypothesis that suspenseful moments will generally cause viewers' attention to be directed more narrowly into a narrative world. Once the threat becomes diluted—as the narrative resolves the suspense—viewers' attention should expand to include more information from the real world, beyond the narrative. Thus, the focus of attention should parallel dynamic changes in suspense over the course of a narrative, narrowing and broadening as new content appears.

Although films are often used as a reliable method to induce emotions (Schaefer et al., 2010), effects are typically measured post-viewing rather than over the course of a narrative. For example, Finucane (2011) demonstrated that inducing fear with a scene from *The Silence of the Lambs* (Demme et al., 1991) increased participants' inhibition of peripheral incongruent flankers on a behavioral task. Although the effect of narrative-induced fear is clear, this paradigm leaves the dynamic aspects of narrative experiences a mystery.

We have found behavioral effects that suggest attention is modulated by the emotional flow of a narrative as it unfolds over time (Bezdek, 2012).

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Specifically, moments of increasing suspense in a narrative are associated with greater interference on a secondary task: When participants respond to audio tones with button presses while viewing suspenseful film excerpts, they demonstrate slower reaction time and miss a greater number of probes at suspenseful peaks. This interference suggests that, when suspense causes viewers to allocate attention to the narrative, attention to the surrounding world decreases. In the present study, we use functional magnetic resonance imaging (fMRI) to test the hypothesis that the attentional interference manifests spatially, i.e., that viewers suppress processing of the visual periphery at moments of greater transportation.

Other neuroimaging research has studied circumstances that cause suppression of peripheral visual processing. According to Lavie's (2005) perceptual load theory, centrally presented stimuli with a high perceptual load can suppress the processing of peripherally presented distractors. Schwartz and colleagues (2005) provided evidence for this theory using fMRI. Participants performed either a simple or more difficult classification task of colored crosses presented at fixation, while flickering checkerboards appeared in the visual periphery. Functional MRI data comparing the challenging to the simpler version of the task revealed decreased blood-oxygen-level dependent (BOLD) response in peripheral-processing regions when the task involved a higher perceptual load. While Schwartz et al. (2005) found peripheral suppression as a function of the perceptual load of the stimuli, it has not yet been established whether high-level attributes of a stimulus, such as narrative context, can produce similar attentional suppression. In the present experiment, we provide evidence that moment-by-moment changes in the salience of threats to characters (i.e., suspense) can also suppress peripheral attention.

In the current study, we tested the hypothesis that, in moments when suspense increases, narrative transportation will produce a changing pattern of activity in brain regions involved in early visual processing. Participants viewed a series of film excerpts in which characters faced potential negative outcomes while fMRI data were recorded. The film excerpts were presented in the center of the screen while continuous flashing checkerboards appeared in the periphery. Using the time course of increases and decreases in suspense for each excerpt drawn from moment-by-moment suspense ratings, we identified brain regions showing corresponding activation changes in response to those changes in suspense.

Participants also completed a surprise memory test to assess their memory for the colors of objects present at moments of high or low suspense. A level of processing approach (Craik and Lockhart, 1972) predicts that participants should show better memory for the items from high suspense moments because the emotions induced by narratives may lead to deeper processing (Tan, 2013). Alternatively, participants' focus on the goals of the characters may prevent deep encoding of surface features of objects (Levin and Simons, 1997), and therefore memory for objects may not improve with transportation. Together, the neuroimaging and behavioral measures of this experiment probed for attention and memory effects as a function of narrative context, using realistic stimuli with complex, dynamic visual features.

EXPERIMENTAL PROCEDURES

Participants

Nineteen participants (six female, mean age = 20.3 years), recruited from an undergraduate participant pool, comprised the sample. All participants were right-handed and neurologically intact, with normal or corrected-to-normal vision. Of this sample, one female participant was excluded from fMRI analyses due to an interruption in the scanning session. All participants provided informed consent and were compensated with either course credit or money ($10 per h). The protocol was approved by the Institutional Review Board of the Georgia Institute of Technology and carried out in accordance with the provisions of the World Medical Association Declaration of Helsinki.

Materials and methods

Ten suspenseful excerpts were used from a previous study that found behavioral attention effects (Bezdek, 2012). All excerpts were in color, from English-language films, and each featured a character facing a potential negative outcome (see Table 1). Due to the timing of narrative information, the emphasis on suspenseful threats rose and fell over the course of the excerpts, rather than steadily increased (see Section 2.5, and Fig. 1B for an example). All stimuli were presented using custom software programed with the PsychToolbox set of functions for Matlab.

Procedure

After granting consent, participants began the session in the MRI scanner. Participants lay supine and viewed all stimuli projected onto a screen (approximately 14.33 by 11.33 degrees of visual angle) above participants' heads and reflected on a mirror attached to the head coil directly above participants' faces. First, a detailed anatomical scan was taken. Then, participants performed a localizer task to identify brain regions selectively recruited for processing the center and peripheral visual field, using custom software similar to established techniques (Sereno et al., 1995; Engel et al., 1997). Participants maintained fixation on a cross presented in the center of the screen as five 60 s cycles of flashing checkerboards (20 s fixation, 20 s inner checkerboards, 20 s outer checkerboards) appeared onscreen. The inner checkerboards had a radius of about 3.29 degrees of visual angle and the outer checkerboards extended from a radius of about 4.29 degrees of visual angle to the edge of the projection screen. All checkerboards flickered at a rate of 8 Hz. To ensure fixation task compliance, participants were instructed to count the number of times that a white fixation cross changed color. The cross turned green for 1 s, five times during the course of the localizer task.

Table 1. Description of film stimuli

Film (director, year)	Duration of excerpt	Plot description
Alien (Ridley Scott, 1979)	3:13	Brett searches for his pet cat, unaware that an alien lurks in the shadows
Blood Simple (Joel Coen, 1984)	2:38	Abby meets up with her lover Ray, as across the street, a killer takes aim
Cliffhanger (Renny Harlin, 1993)	3:07	During an attempted rescue atop a mountain, Sarah's harness snaps
Léon: The Professional (Luc Besson, 1994)	3:13	Léon trains Mathilda on how to fire a sniper rifle, at an unsuspecting jogger
License to Kill (John Glen, 1989)	3:21	James Bond dodges Sanchez's henchmen, in the sea and air
The Man Who Knew Too Much (Alfred Hitchcock, 1956)	3:24	Ben and Jo race to stop an assassination attempt at a concert
Marnie (Alfred Hitchcock, 1964)	3:04	Marnie stays after hours in her office to rob the safe of her boss
Misery (Rob Reiner, 1990)	3:28	Paul attempts to escape from an obsessed fan holding him hostage
Munich (Steven Spielberg, 2005)	2:50	An innocent girl answers a terror suspect's explosive-wired phone
North by Northwest (Alfred Hitchcock, 1959)	3:19	Roger faces the attack of a crop duster in an isolated cornfield

Next, participants viewed the ten film excerpts, in an order randomized for each participant. To provide context for each film excerpt, a paragraph of text appeared on the screen before each film. An experimenter read this text aloud. The films were presented at the center of the screen (about 4.29 by 3.21 degrees of visual angle), with continuous flashing checkerboards presented in the periphery, with the same dimensions as in the localizer task (see Fig. 1A). The peripheral checkerboards were also presented for 20 s before and after each film excerpt, to prevent effects of changes in peripheral luminance at the onsets and offsets of the excerpts. Participants were instructed to keep their eyes fixated on the center of the screen during presentation of the excerpts, and a 50 percent translucent fixation cross was superimposed over the center of the excerpts to aid this fixation. Otherwise, participants were instructed to pay attention as they would normally when watching a film. Although participants' eye movements were not measured, during debriefing all participants affirmed that they were able to comply with the instructions.

Following the scanning session, participants performed a surprise recognition memory test outside the scanner. Each test item was a two-option forced choice, probing the color of an object in one of the film excerpts. Items were evenly split between objects that

first appeared at moments of high- and low-rated suspense. Items were grouped by the excerpt they were taken from, but randomized within excerpt. The order of excerpts was also randomized. Following completion of the memory test, participants were debriefed and compensated for participation.

Image acquisition

Images were acquired by a 3T Siemens Magnetom Trio scanner. First, a T1-weighted 3D magnetization-prepared rapid gradient-echo (MP-RAGE) structural sequence was captured (1.0 mm isotropic voxels, TR = 2250 ms, TE = 3.98 ms). Then, a T2*-weighted echo-planar imaging sequence was used for all functional runs (TR = 2000 ms, TE = 30 ms, flip angle = 90°, 37 slices, 17% gap, 3.0 mm isotropic voxels, field of view = 204 mm). Functional volumes were recorded in separate runs for each film excerpt. At the start of each run, two dummy scans were discarded to account for magnetic equilibration effects.

Functional MRI analyses

Functional MRI data were analyzed using a combination of Analysis of Functional Neuroimages software (AFNI; http://afni.nimh.nih.gov/afni) and the FMRIB Software Library (FSL; http://www.fmrib.ox.ac.uk). Functional data were preprocessed to correct slice timing and head movement with six parameters. All volumes were
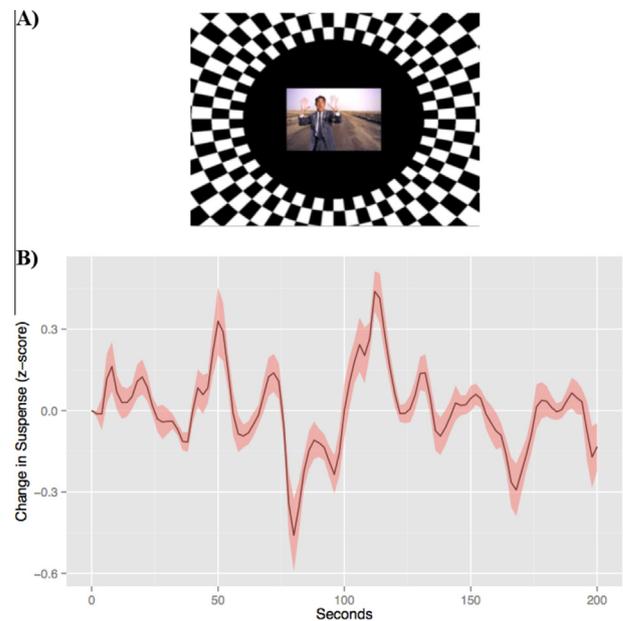
Fig. 1. (A) While lying in the MRI scanner, participants viewed suspenseful film excerpts presented in the center of the screen, while continuous flashing checkerboards appeared in the periphery. (B) Representative average time course of suspense joystick ratings from one excerpt, used for functional MRI analyses. The z-score of the first derivative is depicted, showing moments of increasing and decreasing suspense over the course of the excerpt. The time series has been convolved with a hemodynamic response function and downsampled to the rate of functional MRI acquisition.

spatially smoothed with a 6-mm full width at half maximum (FWHM) Gaussian kernel and transformed to standardized space using the template of the Montreal Neurological Institute (MNI).

Slider ratings of suspense, averaged across 23 participants, were used for analyses (Bezdek, 2012). Specifically, this separate set of participants viewed the same film excerpts while seated at a computer. As they viewed the excerpts, they moved a joystick slider to indicate how strongly the current narrative content emphasized threats to characters and slider position was recorded every 100 ms. Participants were instructed to begin each excerpt with the slider at its lowest position, signifying no threat. They were told that the highest position signified a maximum level of threat to a character and were told to move the slider up and down as the perceived threat level changed. Because participants did not have references for intermediate slider positions as they viewed the excerpts, we found that changes in slider positions were more informative than raw intensity values. Therefore, to capture times at which perceived suspense increased or decreased, we took the first derivative of the slider ratings, on a 1-s time scale (see Fig. 1B). In addition, several low-level stimulus features of the film excerpts were included in the model. The hue, saturation and luminance value of each pixel was calculated and averaged across the frame. The percentage of each frame consisting of edges was calculated with a Sobel edge detector. Finally, an estimate of the amount of motion from frame to frame was calculated using Farnebäck's (2003) dense optical flow algorithm, implemented with OpenCV software (http://opencv.org). The two-dimensional vector length of each pixel from one frame to the next was averaged for the frame. The suspense change functions and low-level visual functions were individually convolved with the canonical hemodynamic response function, downsampled to the acquisition timescale (2000 ms), and included as regressors in a general linear model (GLM) analysis for each participant. Six head movement parameters for each participant were also included in the GLM as part of the baseline model. To summarize, the GLM design matrix included changes in suspense as a regressor of interest, with low-level visual features (hue, saturation, luminance, edges, and optical flow), six head movement parameters, and constant, linear, and quadratic trends as nuisance regressors. Thus, the activation patterns shown below reflect changes in brain activity with changes in perceived suspense, correcting for low-level stimulus properties. In addition, values for each of the low-level features were compared for the top and bottom ten percent of time points for the suspense time course, using independent sample t-tests. None of these comparisons reached statistical significance ($\alpha = .05$), as shown in Table 2. The β-maps obtained for each participant were submitted to a one-sample t-test to determine group effects. Family-wise error was corrected using Monte Carlo simulations created by the program 3dClustSim (http://afni.nimh.nih.gov/afni). Error was corrected to level of $\alpha = .05$ on a whole-brain level, starting from an uncorrected level of .005, resulting in a minimum cluster size of 45 vox.

Table 2. Mean (standard deviation) values for low-level visual features at the 10 percent highest and lowest suspense time points

	High suspense	Low suspense	Statistics
Hue	.68 (.27)	.68 (.28)	$t(186) = .02$, $p = .99$
Saturation	.73 (.20)	.69 (.27)	$t(186) = .99$, $p = .32$
Luminance	.63 (.24)	.67 (.27)	$t(186) = 1.15$, $p = .25$
Edges	.93 (.10)	.90 (.18)	$t(186) = 1.36$, $p = .18$
Optical flow	.35 (.29)	.29 (.20)	$t(186) = 1.17$, $p = .09$

RESULTS

fMRI evidence of attentional tuning

Whole-brain analysis revealed several areas where activity increased or decreased when suspense increased. Of primary interest was the region along the calcarine sulcus. This area is retinotopically organized such that central vision activates posterior calcarine and peripheral vision activates anterior regions of calcarine sulcus (Tootell et al., 1998). Consistent with our hypothesis that narrative transportation leads to a narrowing of attention, we found activity increased in posterior and decreased in anterior calcarine sulcus when suspense increased. This region overlapped with the visual processing regions identified in our visual localizer task (see Fig. 2).

The whole-brain analysis also identified other brain regions where activity changed with increased suspense, as shown in Table 3. Specifically, we found significant decreases in brain activity in nodes of the default mode network (Buckner et al., 2008), including the posterior cingulate cortex and inferior parietal lobule. On the other hand, increased activation was found in large bilateral regions of the occipitotemporal cortex. There were also significant clusters of increased activation in the right inferior frontal gyrus and right supramarginal gyrus.

To further compare the effect of suspense on central and peripheral visual processing, we drew regions of interest (ROI) from contrasting central and peripheral stimulation in the visual localizer task. Significant group-level clusters of activation were identified bilaterally in calcarine sulcus for both the center and periphery. The periphery ROI was further masked with the calcarine region of the AAL atlas (Tzourio-Mazoyer et al., 2002), and these ROIs were used to calculate the percent signal change related to suspense for each participant in the aforementioned GLM. As shown in Fig. 2B, this analysis revealed that increases in suspense caused a significant decrease in signal in the peripheral ROI ($M = -.07$, 95% CI [$-.12$, $-.03$], $t(17) = -3.28$, $p < .01$, Cohen's $d = .77$) and a significant increase in signal in the center ROI ($M = .07$, 95% CI [.01, .12], $t(17) = 2.56$, $p < .05$, Cohen's $d = .60$). These results show that narrative
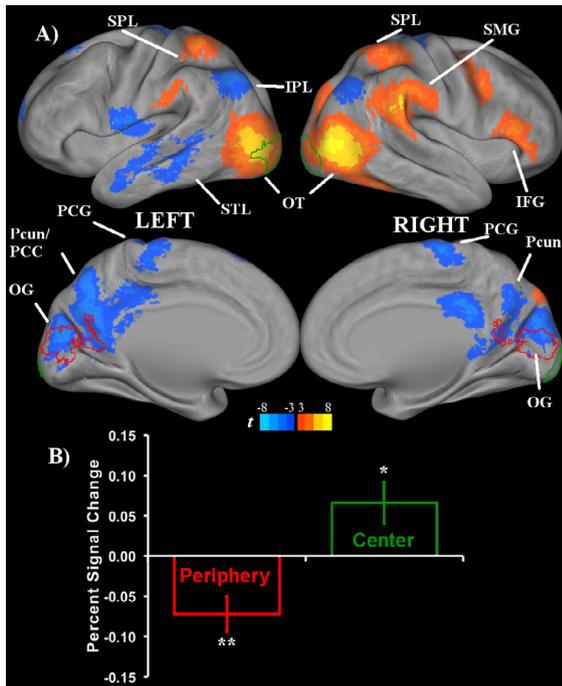
Fig. 2. (A) Lateral (top) and medial (bottom) views of brain areas that show increased (warm colors) or decreased (cool colors) activity as the level of suspense increased in film excerpts ($p_{(FWE)}$ = .05). The red outline shows areas of calcarine sulcus more active during peripheral than central stimulation in the localizer task and the green outline shows areas more active for central than peripheral stimulation ($p_{(FWE)}$ = .05). (B) ROI analyses confirmed that increases in suspense were associated with decreased activity in visual regions that process the periphery ($^{**}p < .01$) and increased activity in visual regions that process the center of fixation ($^{*}p < .05$). Error bars represent the standard error of the mean. SPL = superior parietal lobule; IPL = inferior parietal lobule; SMG = supramarginal gyrus; OT = lateral occipitotemporal cortex; IFG = inferior frontal gyrus; STL = superior temporal lobe; PCG = precentral gyrus; Pcun = precuneus; PCC = posterior cingulate cortex; OG = occipital gyrus.

suspense is associated with increased central processing and decreased peripheral processing.

Recognition memory results

We compared participants' recognition accuracy for the colors of objects shown at moments of high or low suspense. Although on average, participants correctly recognized more objects from the high suspense moments (M = 65.39%; 95% CI [61.07, 69.72]) than the low suspense moments (M = 62.15%; 95% CI [58.42, 65.87]) this difference was not statistically significant ($t(18)$ = 2.10, p = .16; Cohen's d = .34). Therefore, we found no evidence that suspenseful moments enhance the encoding of the colors of depicted objects.

DISCUSSION

The scope of attention changes dynamically over time. We found neural evidence that changes in narrative suspense can suppress attention to the visual periphery. We targeted our hypotheses on early visual processing regions, which show retinotopic organization (Tootell

et al., 1998), with neighboring locations in the visual field processed by neighboring populations of neurons in the cortex. We found that moments of increasing narrative suspense produced a decrease in brain activity in peripheral visual processing areas along the calcarine sulcus and an increase in brain activity for central visual processing areas. These effects of narrative attention mirror a finding of decreased activation in the calcarine sulcus when comparing tasks of high vs. low perceptual load at fixation (Schwartz et al., 2005). They suggest that attention to and processing of central stimuli are enhanced and attention to and processing of peripheral stimuli are suppressed during moments of increased narrative suspense.

In the present experiment, it is unlikely that attended stimulus features drove this effect. The low-level visual features of hue, saturation, luminance, edges, and optical flow did not differ significantly between the peaks of rising and falling suspense. Additionally, these features were included as nuisance variables in the fMRI analysis to further account for their sub-threshold effects on activity. Instead, we believe the effect was driven by the salience of potential threats to characters. This finding suggests that momentary increases in threat perception (i.e., suspense) present another means of attentional capture and suppression of peripheral processing.

This finding is consistent with theorized effects of narrative transportation (Gerrig, 1993; Green and Brock, 2000). Attentional suppression of extra-narrative stimulation has been measured with self-report scales (Green and Brock, 2000; Busselle and Bilandzic, 2009; Tal-Or and Cohen, 2010) and behavioral reaction time measures (Bezdek, 2012). The present results provide the first neural evidence for attentional modulation of visual stimuli as a function of narrative content. Further, we measured the time course of attentional suppression as it waxed and waned during the suspenseful film-viewing experience and found that people dynamically adjust this stimulus processing as the demands of the narrative content change.

Consistent with this interpretation is the right-lateralized increased activation in inferior frontal and parietal areas. These regions form the ventral attention network, which may be recruited for reorienting attention to salient (viz., suspenseful) stimuli (Corbetta and Shulman, 2002). Previous research has found that the processing of negative emotional stimuli may have a right-lateralized bias (Canli et al., 1998), and may reduce right-lateralized event-related potential signals of the detection of global stimuli (Hartikainen et al., 2010). Additionally, the increased activity in the lateral occipitotemporal cortex may represent higher order visual processing, given this region's role in processing aspects of vision such as dynamic motion (Kolster et al., 2010). Evidence suggests that the modulation of visual input due to spatial attention first occurs in the extrastriate cortex (Martinez et al., 1999).

Additionally, we found a pattern of deactivation in nodes of the default mode network with increased suspense. This network has been shown to decrease in

Table 3. Suspense related changes in BOLD signal

Laterality	Region	Brodmann area	t-Value at peak voxel	Size (voxels)	MNI coordinates of peak voxel		
					x	y	z
Increases							
Left	Middle occipital gyrus	18/19	8.68	820	−45	−72	6
	Inferior occipital gyrus						
Right	Middle occipital gyrus	18/19/37	9.43	757	45	−75	3
	Middle temporal gyrus						
	Inferior occipital gyrus						
Right	Inferior parietal lobule	40	8.36	412	69	−33	27
	Supramarginal gyrus						
	Superior temporal gyrus						
Right	Inferior parietal lobule	7	5.70	161	27	−36	42
	Superior parietal lobule						
Right	Inferior frontal gyrus	46/45	5.60	149	48	27	15
Left	Inferior parietal lobule	7	5.81	121	−24	−48	51
Right	Middle frontal gyrus	6	4.85	105	33	0	42
Right	Cuneus	19	4.94	85	27	−78	30
Left	Inferior parietal lobule	40	4.76	62	−66	−36	36
Decreases							
Bilateral	Calcarine gyrus	17/18/7	−5.75	591	−3	−72	48
	Cuneus						
	Precuneus						
Right	Precentral gyrus	4	−5.31	454	30	−24	75
Left	Inferior parietal lobule	39	−5.34	244	−45	−66	57
	Angular Gyrus						
Left	Middle temporal gyrus	21	−5.33	213	−45	−45	0
Bilateral	Cerebellum		−5.18	86	3	−45	−24
Right	Angular gyrus	39	−4.88	86	45	−63	39
Left	Middle temporal gyrus	21	−4.76	78	−60	3	−27
Right	Posterior cingulate cortex	31	−4.24	67	12	−42	6
Left	Superior frontal gyrus	9	−4.39	55	−21	57	27
Left	Insula	13	−5.62	52	−42	−18	15
Left	Superior frontal gyrus	6	−4.71	45	−27	27	60

activity when participants engage in goal-directed behavior, as compared to when participants rest passively in the scanner (Raichle et al., 2001). Increased default mode activity is often observed during periods of mind-wandering (Smallwood and Schooler, 2006; Christoff et al., 2009) or internally directed thought (Raichle et al., 2001). The decrease in default mode activity that we observed is consistent with the idea that participants may engage in fewer internally directed thoughts at moments of increased suspense. Based on previous research using think-aloud protocols during film viewing (Bezdek et al., 2013), we speculate that the perception of threats to characters may in fact cause more active mental participation in processing narrative events.

We tested if participants would show more accurate recognition memory for the colors of objects at high suspense moments or low suspense moments. We did not find significant differences in either direction, which may mean that film viewers do not process surface details like the color of objects more deeply at moments of high vs. low suspense. This raises the question of whether the increased central visual activity that we observed has downstream consequences or is merely epiphenomenal. Although this question extends beyond the findings of the present study, we have reason to believe that the increased central visual processing at moments of high suspense does produce downstream consequences. In general, viewers are primarily concerned with information relevant to the goals of the characters (Suh and Trabasso, 1993) and viewers may mentally participate on behalf of characters (Bezdek et al., 2013). Viewers do not typically approach films with a focus on low-level visual features. Indeed, participants often fail to detect changes in visual details, such as the colors of objects, when these changes occur across film cuts (Levin and Simons, 1997). For these reasons, we suggest that the increased central processing reflects attention and encoding of narrative events, abstracted above the level of visual features. Consistent with this view, we have found stronger memory benefits during high suspense moments using a test of narrative content rather than surface details (Bezdek et al., 2014).

Our neural findings extend research demonstrating behavioral evidence of attentional interference at moments of increasing suspense in film excerpts

(Bezdek, 2012). Together, this evidence suggests that extra-narrative attention is attenuated both conceptually (i.e., across behavioral tasks) and spatially (i.e., in suppression of peripheral early visual processing). These results illuminate the time course of the scope of attentional processing when emotional threats are presented, using realistic stimuli. They also add to work on narrative processing by further elucidating the mechanisms that comprise the phenomenon of narrative transportation. These results suggest that, when we focus on looming potential threats, we decrease our focus on the world around us – and this attentional suppression affects neural visual processing.

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APPENDIX A. SUPPLEMENTARY DATA

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.neuroscience.2015.06.055.