Brain Imaging and Behavior (2013) 7:77–84
DOI 10.1007/s11682-012-9195-y

ORIGINAL RESEARCH

Neural correlates of emotional regulation while viewing films

Arthur P. Shimamura · Diane E. Marian · Andrew L. Haskins

Abstract Negative and arousal-inducing film clips were used to assess the neural correlates of emotional expression and suppression. Compared to viewing neutral clips, both negative (disgusting) and arousal (action) clips activated primarily posterior regions in the parietal and occipital cortex when participants were instructed to express their emotions. When instructed to suppress their emotions while viewing negative clips, a broad frontoparietal network was activated that included lateral, medial, and orbital regions in the prefrontal cortex as well as lateral and medial regions of the posterior parietal cortex. The suppression of arousal clips also activated prefrontal and parietal regions, though not to the same extent as the suppression of negative clips. The findings demonstrate the potency of using movies to engage emotional processes and highlight a broad frontoparietal network that is engaged during the suppression of negative film clips.

Keywords fMRI · Neuroimaging · Emotion · Emotional regulation · Suppression · Films

Introduction

Movies offer an incredibly powerful means of driving mental processes as they unfold in time (see Shimamura in press). As scientific tools, they can capture experiences dynamically in a more naturalistic manner than typical stimuli used in neurobehavioral research (e.g., pictures and words). Indeed, the identification of social signals (e.g., a smile or frown) is enhanced when viewed as a dynamic expression (LaBar et al. 2003). To date, few studies have investigated the neural underpinnings of affective processing using moving pictures, and even fewer studies have used such stimuli to address disorders of emotional expression and regulation (but see Gyurak et al. 2012).

An essential feature of affect processing is the manner in which we regulate our emotions. In social settings, it is rarely the case that we express our emotions fully without some degree of suppression or regulation. Indeed, there may be dire consequences in overtly expressing our feelings, such as directing intense anger toward a boss or colleague. In such instances, it is necessary to suppress or inhibit one's feelings. Extensive neurocognitive research has shown that emotional regulation is mediated by regions in the prefrontal cortex (PFC), including the lateral PFC (both dorsal and ventral regions), medial PFC (including anterior cingulate gyrus), and lateral orbitofrontal cortex (OFC). These regions are particularly involved when emotions are suppressed, diverted, or reappraised (for review, see Denny et al. 2010; Gross et al. 2011). It is thought that the PFC initiates top-down or executive control of brain regions, such as the amygdala and insula, which are thought to be involved in the generation or expression of emotion (Kober et al. 2008: Ochsner et al. 2002, 2004; Urrey et al. 2006).

In studies of neurological patients with affective disorders, impairment in emotional regulation has been particularly associated with OFC damage. Indeed, since the classic case of Phineas Gage (see Macmillan 2000), problems in emotional inhibitory control have been associated with this brain region. In a study of startle responses to abrupt noises, patients with frontotemporal lobar degeneration could not down-regulate responses when warned of the abrupt noise Goodkind et al. (2010). Rule et al. (2002) assessed event-related EEG potentials following abrupt noises and mild shocks and found that patients with circumscribed OFC lesions exhibited disinhibition of early sensory signals in posterior cortical regions. This finding suggests that the OFC has the capacity to modulate (i.e., suppress) incoming sensory signals.

In neuroimaging studies, the neural correlates of emotional regulation have been assessed by manipulating task demands while viewing emotional stimuli. In one study

A. P. Shimamura (✉) · D. E. Marian · A. L. Haskins
Department of Psychology (MC1650), University of California, Berkeley,
Berkeley, CA 94720-1650, USA
e-mail: aps@berkeley.edu

(Ochsner et al. 2004), participants were shown photographs of negative scenes (e.g., a sick person in a hospital bed) and asked to increase or decrease their emotion by interpreting the scene with respect to a *self-focus* or *situation-focus* strategy. For the self-focus strategy, participants were asked to place themselves or a loved one in the scene (increase emotion) or to distance themselves away from it (decrease emotion). For the situation-focus strategy, they were asked to imagine the situation depicted getting worse (increase emotion) or better (decrease emotion). Activations associated with increasing emotion were observed in the left polar regions of the medial PFC (BA 9/10) and posterior cingulate gyrus. Strategies intended to decrease emotion led to heightened activations in dorsal PFC and lateral OFC as well as reduced activation in the right amygdala and bilateral insular cortex. With respect to decreasing emotions, self-focus (distancing oneself from the event) activated medial PFC, whereas situation-focus (considering the situation as getting better) activated dorsal PFC.

Goldin et al. (2008) presented 15-sec film clips that depicted either disgusting (e.g., animal slaughter) or neutral scenes. Participants watched the clips passively or were asked to down-regulate their emotion by reappraisal (viewing the film from the perspective of a medical professional) or by suppression (keeping their facial expressions still). The reappraisal strategy was associated with increased activity in lateral PFC, medial PFC, lateral OFC as well as increased activity in a number of posterior regions, including superior temporal gyrus, precuneus, and angular gyrus. Suppression was associated with increased activity in dorsal PFC (both superior and inferior regions), middle temporal gyrus, inferior parietal lobule, and precuneus. In direct comparisons between reappraisal and suppression, reappraisal was more effective than suppression at reducing emotion-related responses in limbic regions. Also, neural responses to reappraisal was initiated faster than those initiated by suppression.

Other studies have attempted to divert emotional engagement by having participants engage in a secondary task unrelated to the emotional stimuli. McRae et al. (2009) presented photographs depicting negative events and asked participants to 1) attend to the stimuli, 2) reappraise the events through situation-focus (i.e., imagining a good outcome), or 3) maintain six random letters in mind during presentation (distraction condition). Compared to the attend condition, both reappraisal and distraction resulted in reduced activity in amygdala and insula and both strategies were associated with increased activity in lateral (inferior) and medial PFC. Distraction reduced amygdala activity even more so than reappraisal and also evoked greater activation in inferolateral PFC and superior parietal cortex. Relative to distraction, reappraisal elicited greater activation in more superior regions within the medial PFC and temporal cortex. Consistent with the role of executive control in emotional regulation, Gyurak et al. (2012) found that in patients with neurodegenerative disorder (e.g., frontotemporal lobar degeneration) the ability to suppress emotions while viewing disgusting or amusing films was correlated with performance on a test of executive control (verbal fluency). These findings suggest that the ability to divert attention via task switching–a prominent dorsal PFC function (Baldo et al. 2001)–is important in regulating emotional states.

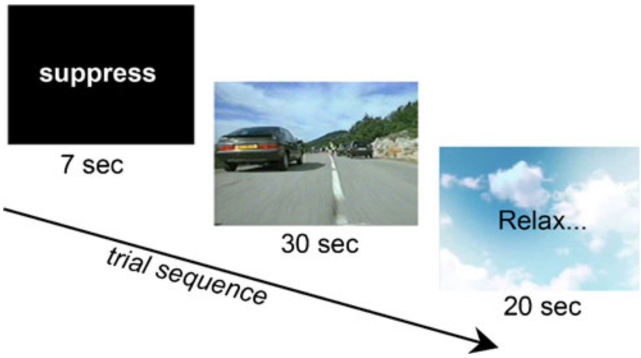

Fig. 1 A trial consisted of an instructional cue ("suppress" or "express") followed by a 30-sec film clip (*negative*, *arousal* or *neutral* clip), and 20-sec inter-trial interval. Shown here is an example of a *suppress-arousal* trial in which a car chase scene is depicted

The present study assessed the neural correlates of emotional regulation by having individuals suppress their

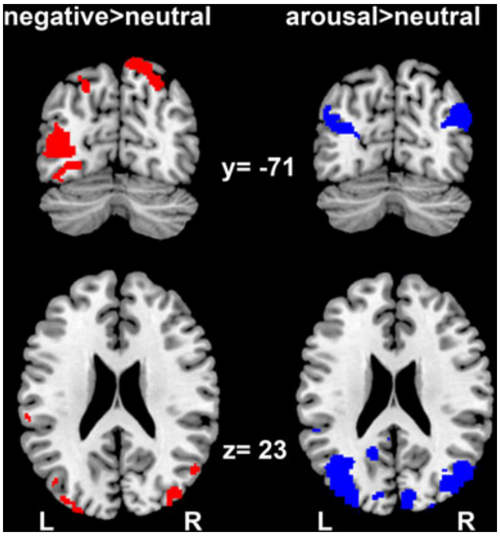

Fig. 2 Regional activations during express trials while viewing *negative* clips (left) and *arousal* clips (right) each compared to *neutral* express trials. A preponderance of posterior activation (bilaterally) was found in lateral posterior parietal and occipital regions as shown in coronal (top panels, MNI y coordinate=−71) and axial sections (bottom panels, MNI z coordinate=23)

emotions while viewing emotionally laden film clips. Compared to cognitive appraisal, suppression has been less well studied, though such attempts at inhibitory control may be quite common during emotional duress. Three types of films were used: 1) negative (e.g., arm amputation), 2) arousal (e.g., car chase), and 3) neutral (e.g., cooking instructions) clips. The arousal clips offered a new and different emotional stimuli compared to those used in previous studies, as they are rated high in arousal but are not negatively valenced. When cued with the word *express* prior to presenting a film clip, participants were instructed to involve themselves within the film (i.e., increased self-focus). When cued to *suppress*, participants were instructed to inhibit their emotions. To our knowledge, this study represents the first to assess the neural correlates of emotional regulation using both negative and arousal-inducing (i.e., action) movies.

Methods

Participants

Twenty healthy, neurologically intact right-handed volunteers participated in the experiment (7 males, 13 females; age range=18–33 years; mean age=21.1 years; mean years of education=14.6). Participants gave their informed consent and were paid for participation.

Stimuli

Stimuli were 30-sec clips excerpted from six different films. Two of the films included negative scenes, one which showed an arm amputation operation and the other depicting a self-mutilation ritual in which a man bloodies his legs with sharp rocks. Two films depicted arousing scenes: a high-

Table 1 Expression emotion vs neutral-express clips

Region	Hemisphere	X (mm)	Y (mm)	Z (mm)	t-score
Negative Express> Neutral Express					
Frontal pole	R	9	69	16	4.24
Frontal orbital cortex	R	26	39	15	4.02
Superior parietal lobule	L	−22	−74	50	4.18
	R	20	−66	57	4.49
Inferior parietal cortex	L	−60	−23	34	3.61
	R	27	−46	52	5.51
Superior temporal cortex	L	−61	−32	23	3.46
Middle temporal cortex	R	53	−67	23	3.98
Inferior temporal cortex	L	−44	−36	25	3.42
Fusiform gyrus	L	−42	−65	12	5.13
Middle occipital cortex	L	−43	−71	9	6.70
	R	39	−88	1	3.67
Inferior occipital cortex	R	30	−85	12	4.10
Arousal Express> Neutral Express					
Inferior frontal cortex	L	−57	36	6	5.50
Supplementary motor area	R	15	22	52	4.16
Superior parietal cortex	R	13	−61	72	4.89
Middle cingulate gyrus	R	13	−18	48	4.51
Temporal pole	L	−23	10	−38	4.90
Inferior temporal cortex	L	−53	−22	25	6.38
Lingual gyrus	R	17	−42	−8	3.48
Parahippocampal gyrus	L	−19	−22	−16	3.94
Hippocampus	R	39	22	−1	3.77
Fusiform gyrus	L	−35	−67	13	3.58
Middle occipital cortex	L	−38	−71	18	4.02
	R	43	−71	26	5.87
Posteriori cingulate gyrus	L	−5	−46	25	3.82
Precuneus	L	−14	−55	18	5.39
Cuneus	L	−10	−86	26	5.74
	R	12	−85	26	5.96

speed car chase through city and rural roads and skiers successfully racing down a slope. Neutral clips were excerpted from an instructional cooking film and an instructional fly fishing film. We obtained four 30-sec clips from each of the six films. These 24 clips were used to elicit *negative*, *arousal*, and *neutral* emotions (eight clips for each condition). In a previous study in which these films were used (Anderson and Shimamura 2005), ratings of both arousal and pleasantness were obtained (1=low, 5=high). Arousal ratings for *negative*, *arousal*, and *neutral* clips were 3.86, 3.29, and 1.52, and pleasantness ratings were 1.29, 3.64, and 3.24, respectively. Thus, both *negative* and *arousal* clips elicited higher arousal ratings compared to the *neutral* clips, with the *negative* clips eliciting somewhat higher ratings of arousal than the *arousal* clips ($p<.05$). The *negative* clips, of course, were rated as much less pleasant than either the *neural* or *arousal* clips.

Procedure

Scanning was conducted at the UC Berkeley Brain Imaging Center with a 4 T Varian INOVA scanner (Varian Inc., Palo Alto, CA). Stimulus presentation involved back-projection of video displays which participants could view through a mirror attached near the head coil. *Presentation* software (www.neurobs.com) was used to synchronize video presentations with EPI pulses. Four 30-sec clips were presented in each of six runs. Each run lasted 4 min, 30 s and began with 4 dummy RF scans to allow time for steady state tissue magnetization and to minimize the effects of head movements that may occur at the onset of the scanner noise.

Participants were instructed to watch the clips with respect to one of two cues: “suppress” or “express.” When cued to “suppress” they were told to pay attention to the action but to conceal their feelings and minimize in any way they could their emotional response. When asked to “express” they were told to increase their emotional response by fully involving themselves in the film. A trial began with the instruction (*express* or *suppress*) displayed for 7 s, followed by a 2-sec blank screen, then the 30-sec film clip (see Fig. 1). Following each clip, a 20-sec inter-trial rest interval was given in which clouds were presented with the word “relax” superimposed. The order of the clip presentations was randomized across participants with the restriction that a run always included two express and two suppress trials presented in a random order. Thus, each participant watched eight clips from each of the emotion conditions (negative, arousal, neutral) of which half were preceded by an *express* cue and the other half preceded by a *suppress* cue.

MRI analyses

Functional scans were obtained with a one-shot T2*-weighted gradient-echo EPI (TR=1,921 ms, TE=28 ms, 64 × 64 matrix, flip angle=270°; FOV =22.4 cm^2). Forty 3.5 mm thick axial slices with a 0.5 mm slice gap were obtained for each volume during each 30-sec film clip. In addition to these functional scans, we used a gradient-echo multislice (GEMS) sequence with the same 40 slices defined for the EPI scans in order to acquire high-resolution T1-weighted anatomical scans (3.50 × 0.875 × 0.875 mm). Images were normalized to the Montreal Neurological Institute (MNI) atlas by co-registering scans across participants using individual 3D T1-weighted magnetization prepared fast low angle shot (MPFLASH) scans.

These scans were analyzed using SPM2 Software (Wellcome Department of Cognitive Neurology, London, UK). The functional and anatomical images were recalibrated so that the origin of all the images was fixed to the anterior commissure. The functional images were then realigned, using the first functional image acquired as the reference. The images were then smoothed using a 6 mm Gaussian smoothing kernal. A general linear model was run using the six experimental conditions (suppress negative, suppress arousal, suppress neutral, express negative, express arousal, express neutral) as regressors, and the experimental contrasts of interest were identified. Each participant’s anatomical images were coregistered, and the experimental contrast files were normalized onto a standard volume brain. Group statistics (t-tests, $p<.001$, uncorrected) were then performed on the experimental contrasts using a minimum cluster size of 5 mm.

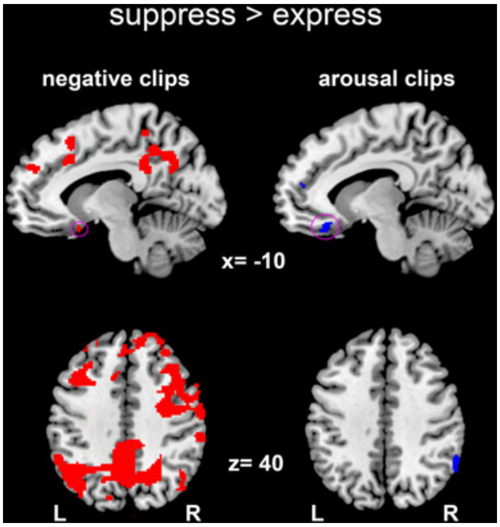

Fig. 3 Contrasts of *suppress>express* trials while viewing *negative* clips (left) and *arousal* clips (right). Top panels show a sagittal section (MNI x coordinate=−10) with an area in the orbitofrontal cortex (purple outline) particularly active during *suppress* trials for both *negative* and *arousal* clips. As shown in the axial section (bottom panels, MNI z coordinate=40), suppression of *negative* clips activated a broad fronto-parietal network not apparent during the suppression of *arousal* clips

Results

We first assessed expressions of emotion to the *negative* and *arousal* clips by comparing activations elicited by express trials while viewing these two clips compared to activations associated with *neutral express* trials. As shown in Fig. 2 (left panel), the *negative* clips (*negative express>neutral express*) activated regions primarily in posterior parietal and occipital cortices (see also Table 1). Other significant clusters occurred in the frontal pole, OFC, and middle and inferior temporal cortices. Expressive responses to the *arousal* clips (*arousal express>neutral express*) also

Table 2 Negative clips (suppress vs express)

Region	Hemisphere	X (mm)	Y (mm)	Z (mm)	t-score
Suppress> Express					
Frontal pole	L	−26	58	6	3.40
Superior frontal cortex	L	−16	58	28	3.59
	L	−12	36	60	4.17
	R	22	2	56	3.80
	R	18	18	54	3.78
Middle frontal cortex	L	−27	33	30	3.47
	L	−28	52	35	3.56
	L	−38	48	2	3.52
	L	−44	24	40	3.55
	R	34	0	40	4.92
	R	26	30	42	4.04
	R	8	50	49	3.81
Supplementary motor area	L	−4	26	54	3.75
	R	12	8	60	3.50
Frontal orbital cortex	L	−28	50	−4	3.42
	L	−10	14	−21	4.00
	R	32	54	−4	3.36
Frontal inferior operculum	R	38	14	30	4.65
Insula	L	−38	10	−8	3.60
Anterior cingulate gyrus	L	−12	26	28	3.34
	L	−11	51	30	5.40
	R	13	38	12	3.77
Middle cingulate gyrus	L	−10	24	36	3.62
Posterior cingulate gyrus	L	−10	38	32	5.22
Angular gyrus	L	−34	−58	44	3.68
	L	−48	−64	52	4.18
	R	52	−54	28	4.92
Inferior parietal cortex	R	36	−54	46	5.01
	R	34	−62	24	3.30
Precuneus	L	−4	−54	42	4.32
	R	6	−56	44	4.48
Temporal pole	L	−48	24	−24	3.49
Superior temporal cortex	R	54	−32	6	3.87
Middle temporal cortex	R	50	−66	4	3.55
Inferior temporal cortex	R	58	−56	−10	3.47
Lingual gyrus	R	13	−90	−12	4.09
Lateral occipital cortex	R	28	−98	−8	3.31
Caudate	R	12	20	66	3.49
Express> Suppress					
Frontal orbital cortex	R	50	40	−8	3.46
Parahippocampal gyrus	R	−10	−4	−18	3.75

activated posterior regions, including superior parietal cortex, middle occipital cortex, lingual gyrus, and parahippocampal gyrus as well as the supplementary motor area and small clusters in the superior and inferior frontal cortices (see Fig. 2, right panel and Table 1). Most notable was the preponderance of activation in the posterior cortex with rather minimal activation in the PFC. We did not observe significant amygdala activation for either negative or arousal clips, which was likely due to poor signal/noise ratios in this region resulting from susceptibility artifacts.

Of primary interest were contrasts of *suppress* vs *express* while viewing the *negative* and *arousal* clips. Importantly, these contrasts control for the actual information portrayed. As shown in Fig. 3 (left panels) and Table 2, extensive activations were observed when participants had to suppress their emotion to the *negative* clips. In particular, suppression of negative affect evoked widespread PFC activity in dorsolateral, ventrolateral, orbitofrontal, and medial (anterior cingulate gyrus) regions. In addition, extensive activation was observed bilaterally in posterior parietal (angular gyrus) and medial regions (posterior cingulate gyrus, precuneus). We also observed increased activation in the insula. The reverse contrast, *negative express>negative suppress* only showed significantly greater activation in the right OFC and right parahippocampal gyrus (see Table 2).

Suppression during the arousal clips (*arousal suppress> arousal express*) activated frontal regions, though not to the same extent as during the negative clips (see Fig. 3, right panels and Table 3). Specifically, regions in the superior frontal and middle gyrus, as well as medial frontal regions (orbital cortex, anterior cingulate gyrus) were activated during suppression of arousing clips. Posterior parietal (right angular gyrus) and middle temporal regions were also activated during suppression as was the right caudate nucleus (see Table 2). As with the reverse contrast during negative clips, the express trials during arousal clips did not activate many regions more than the suppress trials. Specifically, the arousal express> arousal suppress contrast showed significantly greater activation in only three regions: middle temporal gyrus, fusiform gyrus, and lateral occipital cortex (see Table 3).

Table 3 Arousal clips (suppress vs express)

Region	Hemisphere	X (mm)	Y (mm)	Z (mm)	t-score
Suppress> Express					
Superior frontal gyrus	L	−2	32	52	3.42
Middle frontal gyrus	R	35	61	10	3.51
	R	42	50	22	3.34
	R	40	24	34	4.30
Frontal orbital cortex	L	−26	26	−24	3.80
	L	−10	30	−19	4.89
	R	36	56	−4	3.67
Frontal inferior operculum	L	−62	18	24	3.50
	R	32	22	32	3.91
	R	42	16	44	3.33
Anterior cingulate gyrus	L	−10	49	15	3.69
	R	12	46	20	3.82
	R	6	52	14	3.40
Superior parietal lobule	R	44	−62	58	3.87
Angular gyrus	R	46	−58	44	4.24
	R	58	−54	42	4.63
	R	54	−48	36	4.79
Middle temporal gyrus	L	−46	−62	44	3.29
	R	69	−32	2	3.41
Middle temporal pole	L	−46	18	−38	3.78
Caudate	R	18	24	52	3.58
Express> Suppress					
Middle temporal cortex	L	−62	−1	−24	3.91
	L	−62	−46	1	3.42
Fusiform gyrus	R	44	36	23	4.93
Lateral occipital cortex	L	−24	−91	−4	3.87

Discussion

In the present study, negative and arousal-inducing movies were used to assess the neural correlates of emotional regulation (expression vs suppression). The negative clips depicted a surgical arm amputation operation or a brutal self-mutilation ritual. The arousal-inducing clips depicted a car chase or downhill skiers. Across trials, participants were asked to either express their emotions (engage themselves within the movie) or enact suppression (inhibit or mask any feelings). When compared to neutral film clips (cooking show, fishing instructional video), the expression of emotion during negative and arousal clips engaged primarily posterior regions, particularly in the parietal and occipital regions (see Fig. 2). Activations were observed in the PFC regions, such as frontal pole, OFC, and inferior PFC, though these clusters were rather small. Findings of the expressive quality of emotional movies point to brain activations largely being engaged by bottom-up or sensory-driven processes associated with posterior region. These findings are consistent with the potency of movies in guiding and controlling our attention and conceptual processes (Mital et al. 2011; Zacks et al. 2010).

Of primary interest was the neural correlates associated with inhibiting or suppressing emotional responses. When participants were instructed to suppress their emotions while viewing negative film clips, a broad frontoparietal network was activated, which included lateral PFC, medial PFC, and OFC, as well as lateral and medial parietal regions. The extensive pattern of activation engaged during suppression of unpleasant stimuli (see Fig. 3) demonstrated the importance of recruiting many cortical regions in the service of down-regulating or damping negative responses (see also Jackson et al. 2000; McRae et al. 2009). These same brain regions have been implicated in the so-called *default network* (Buckner et al. 2008), which is involved in a variety of internally mediated processes such as theory of mind, episodic retrieval, and prospection. Findings of OFC activation during suppression is consistent with this region being involved in the inhibitory control of affect or arousal (Hornberger et al. 2011; Rule et al. 2002). The present findings clearly point to the importance, and perhaps difficulty, in suppressing emotions from potent negative stimuli, such as disgusting movies (see also, Wright et al. 2004).

A more restricted set of regions was active when participants suppressed arousal-inducing film clips. These clips, typical of action movies, are both arousing and engaging, though are not rated as unpleasant. To our knowledge, such clips have never been used in studies of emotional regulation, though they offer a useful comparison to the our set of negative clips. Specifically, suppression of arousal-inducing clips activated regions in lateral PFC, medial PFC, OFC, and parietal regions, though not as broadly as the pattern of activation observed during the suppression of negative clips (see Fig. 3). These findings map fairly well with a previous study in which regions in the superior prefrontal gyrus and anterior cingulate gyrus mediated emotional suppression while viewing erotic film clips (Beauregard et al. 2001). Our findings, however, suggested an even broader array of PFC and posterior regions active during the regulation (i.e., *suppress>express*) of action scenes compared to erotic scenes.

The present investigation adds to our understanding of the neural correlates of emotional regulation. As relatively few neurocognitive studies have used film clips to induce emotional states, the present findings provided an opportunity to assess emotional regulation during rather highly charged emotional states, at least compared to those evoked by static photographs typically used in such studies. Our findings demonstrated that emotion expression while viewing movies activated primarily posterior regions, whereas emotional suppression, particularly of negative film clips, activated a frontoparietal network. These findings have relevance not only to neurological disorders associated with lesions in the OFC and other prefrontal regions, but also to broader impairments such Alzheimer's disease and psychiatric disorders (e.g., PTSD). Our findings map onto a growing set of investigations that address the various means of emotional regulation, such as suppression, reappraisal, and diversion (for review, see Berkman and Lieberman 2009; Denny et al. 2010; Kolodyazhniy et al. 2011). Moreover, in addition to disgust and arousal, they encourage the application of movies to elicit a broader array of emotions, such as glee, surprise, fear, and amusement.

Acknowledgments Research was supported by NIH Grants DA14110 and NS17778. We thank Ken Iwasaki and Ari Kane for research assistance.

References

Anderson, L., & Shimamura, A. P. (2005). Influences of emotion on context memory while viewing film clips. *The American Journal of Psychology, 118*, 323–337.

Baldo, J. V., Shimamura, A. P., Delis, D. C., Kramer, J., & Kaplan, E. (2001). Verbal and design fluency in patients with frontal lobe lesions. *Journal of the International Neuropsychological Society, 7*, 586–596.

Beauregard, M., Levesque, J., & Bourgouin, P. (2001). Neural correlates of conscious self-regulation of emotion. *Journal of Neuroscience, 21*, 6993–7000.

Berkman, E. T., & Lieberman, M. D. (2009). Using neuroscience to broaden emotion regulation: Theoretical and methodological considerations. *Social and Personality Compass, 3*, 475–493.

Buckner, R. L., Andrews-Hanna, J. R., & Schacter, D. L. (2008). The brain's default network: Anatomy, function, and relevance to disease. *Annals of the New York Academy of Science, 1124*, 1–38.

Denny, B., Silvers, J., & Ochsner, K. N. (2010). How we heal what we don't want to feel: The functional neural architecture of emotion regulation. In A. M. Kring & D. M. Sloan (Eds.), *Emotion* *regulation and psychopathology: A transdiagnostic approach to etiology and treatment* (pp. 59–87). New York: Guilford Press.

Goldin, P. R., McRae, K., Ramel, W., & Gross, J. J. (2008). The neural bases of emotion regulation: Reappraisal and suppression of negative emotion. *Biological Psychiatry, 63*, 577–586.

Goodkind, M. S., Gyurak, A., McCarthy, M., Miller, B. L., & Levenson, R. W. (2010). Emotion regulation deficits in frontotemporal lobar degeneration and alzheimer's disease. *Psychology and Aging, 25*, 30–37.

Gross, J. J., Sheppes, G., & Urrey, H. L. (2011). Emotion generation and emotion regulation: A distinction we should make (carefully). *Cognition and Emotion, 25*, 765–781.

Gyurak, A., Goodkind, M. S., Kramer, J. H., Miller, B. L., & Levenson, R. W. (2012). Executive functions and the down-regulation and up-regulation of emotion. *Cognition & Emotion, 26*, 103–118.

Hornberger, M., Geng, J., & Hodges, J. R. (2011). Convergent grey and white matter evidence of orbitofrontal cortex changes related to disinhibition in behavioural variant frontotemporal dementia. *Brain, 134*, 2502–2512.

Jackson, D. C., Malmstadt, J. R., Larson, C. L., & Davidson, R. J. (2000). Suppression and enhancement of emotional responses to unpleasant pictures. *Psychophysiology, 37*, 515–522.

Kober, H., Barrett, L. F., Joseph, J., Bliss-Moreau, E., Lindquist, K., & Wager, T. D. (2008). Functional grouping and cortical-subcortical interactions in emotion: A meta-analysis of neuroimaging studies. *NeuroImage, 42*, 998–1031.

Kolodyazhniy, V., Kreibig, S. D., Gross, J. J., Roth, W. T., & Wilhelm, F. H. (2011). An affective computing approach to physiological emotion specificity: Toward subject-independent and stimulus-independent classification of film induced emotions. *Psychophysiology, 48*, 908–922.

LaBar, K. S., Crupain, M. J., Voyvodic, J. T., & McCarthy, G. (2003). Dynamic perception of facial affect and identity in the human brain. *Cerebral Cortex, 13*, 1023–1033.

Macmillan, M. (2000). *An Odd kind of fame: Stories of phineas gage*. Cambridge: MIT Press.

McRae, K., Hughes, B., Chopra, S., Gabrieli, J. D. E., Gross, J. J., & Ochsner, K. N. (2009). The neural bases of distraction and reappraisal. *Journal of Cognitive Neuroscience, 22*, 248–262.

Mital, P. K., Smith, T. J., Hill, R. L., & Henderson, J. M. (2011). Clustering of gaze during dynamic scene viewing is predicted by motion. *Cognitive Computation, 3*, 5–24.

Ochsner, K. N., Bunge, S. A., Gross, J. J., & Gabrieli, J. D. E. (2002). Rethinking feelings: An fMRI study of the cognitive regulation of emotion. *Journal of Cognitive Neuroscience, 14*, 1215–1229.

Ochsner, K. N., Ray, R. D., Cooper, J. C., Robertson, E. R., Chopra, S., Gabrieli, J. D. E., & Gross, J. J. (2004). For better or for worse: Neural systems supporting the cognitive down- and up-regulation of negative emotion. *NeuroImage, 23*, 483–499.

Rule, R. R., Shimamura, A. P., & Knight, R. T. (2002). Orbitofrontal cortex and dynamic filtering of emotional stimuli. *Cognitive, Affective, & Behavioral Neuroscience, 2*, 264–270.

Shimamura, A. P. (Editor) (in press). *Psychocinematics: Exploring Cognition at the Movies*. New York: Oxford University Press.

Urrey, H. L., vanReekum, C. M., Johnstone, T., Kalin, N. H., Thurow, M. E., Schaefer, H. S., et al. (2006). Amygdala and ventromedial prefrontal cortex are inversely coupled during regulation of negative affect and predict the diurnal pattern of cortisol secretion among older adults. *Journal of Neuroscience, 26*, 4415–4425.

Wright, P., He, G., Shapira, N. A., Goodman, W. K., & Liu, Y. (2004). Disgust and the insula: fMRI responses to pictures of mutilation and contamination. *NeuroReport, 15*, 2347–2351.

Zacks, J. M., Speer, N. K., Swallow, K. M., & Maley, C. J. (2010). The brain's cutting-room floor: Segmentation of narrative cinema. Frontiers in Human Neuroscience, 4, 1-15.