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Seeing, Thinking, and Feeling:

Emotion-Regulating Effects of Gaze-Directed Cognitive Reappraisal

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Abstract

Cognitive reappraisal (CR) is an emotion-regulatory (ER) process that is theorized to operate via changes in appraisals. CR is distinct from attentional deployment (AD), an ER process that is theorized to operate via changes in attention. However, a recent neuroimaging study suggests that the ER effects of CR might largely be explained by AD. In this study, I manipulated CR while holding visual AD constant across CR conditions. In a randomized within-subjects design, 54 participants used CR to increase and decrease emotion in response to unpleasant pictures. This was compared to simply viewing the pictures. On all trials, gaze was directed to a circumscribed area of the pictures. Even with gaze held constant across conditions, increase reappraisals led to higher ratings of emotional intensity, greater corrugator activity, and greater autonomic arousal. In addition, decrease reappraisals led to lower ratings of emotional intensity and lower corrugator activity, the latter of which held only when gaze was directed to arousing information. Overall, the results suggest that changes in appraisal are the likely mechanism for the emotion-regulatory effects of CR.

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Emotions promote adaptive responses to challenge (Levenson, 2003). However, situations in which it is important to regulate our emotions are ubiquitous in daily life (Gross & Thompson, 2007). As spelled out in the process model of emotion regulation (Gross, 1998; Gross & Thompson, 2007), we have many means of accomplishing our emotion-regulatory goals. According to appraisal theories of emotion, thinking is the precursor to feeling (Roseman & Smith, 2009), thus altering one's thinking should be an effective means of altering one's feelings, an approach to emotion regulation (ER) called *cognitive reappraisal*.

Cognitive reappraisal (CR) refers to the process of modifying the appraised meaning of an emotion-triggering event. Experiments have shown that participant-generated reappraisals are effective in modifying subjective emotional experience and neural activation (Kalisch et al., 2005; McRae et al., 2008; Ochsner et al., 2004; Ochsner et al., 2002; Wager et al., 2008) and expressive behavior (Gross, 1998; Deveney & Pizzagalli, 2008; Jackson et al., 2000) in accordance with one's regulatory goal, but findings are mixed with respect to autonomic physiology (Eippert et al., 2007; Gross, 1998; Kalisch et al., 2005; Sheppes et al., 2009; Urry et al., 2009).

Attentional deployment (AD) is another family of processes by which we can alter our emotions. AD refers to deploying our attention towards or away from certain aspects of emotion-triggering events. Experiments have shown that directing gaze towards emotional relative to neutral areas of unpleasant pictures, a way of manipulating AD, augments the late positive potential, a brain event-related potential that is sensitive to affective arousal (Dunning & Hajcak, 2009; Hajcak et al., 2009). Moreover, MacLeod et al. (2002) found that training attention

towards threat-related stimuli led to increased emotional reactivity in a subsequent task without changing self-reported emotional state.

Importantly, AD is theorized to be distinct from CR with respect to mechanisms for emotion-regulatory effects. Changes in emotion that occur as a function of AD processes should be mediated by changes in attention. Changes in emotion that occur as a function of CR processes should be mediated by changes in appraisal. However, this latter notion was recently called into question. Van Reekum and colleagues (2007) examined the neural correlates of reappraisals that increase and decrease unpleasant emotion evoked using pictures. Participants spent less time looking at emotional information in the pictures when applying reappraisals to decrease their negative emotion. Moreover, the variance in brain activation explained by reappraising was substantially reduced when taking gaze behavior into account. These findings suggest that changes in neural activation may actually have been caused by changes in attentional deployment instead of (or in addition to) changes in appraisals.

The purpose of the present study was to determine whether emotion-regulating effects of CR are observed when AD is held constant across reappraisal conditions. In a randomized within-subjects design, participants used CR to actively increase and decrease emotion in response to unpleasant pictures. This was compared to simply viewing the pictures. On all trials, gaze was directed to a circumscribed area of the pictures, as confirmed with eye tracking. I examined the effects of CR on subjective emotional experience (ratings of intensity), expressive behavior (corrugator muscle activity), and autonomic physiology (heart rate and electrodermal activity).

In recognition of the theoretical distinction between attentional deployment and cognitive change families of ER (Gross & Thompson, 2007), I hypothesized that, even when gaze was held

constant across conditions (thus preventing an AD strategy for ER), increase reappraisals would lead to higher ratings of subjective emotional intensity, greater corrugator activity, and greater autonomic arousal compared to viewing unpleasant pictures. I also hypothesized that decrease reappraisals would lead to lower ratings of subjective emotional intensity and lower corrugator activity compared to viewing unpleasant pictures. I did not expect that decrease reappraisals would necessarily impact autonomic physiology given previous mixed findings.

Method

Participants

Fifty-four undergraduates participated in exchange for course credit. Of the 50 participants for whom demographic data were available, 26 were women (52%) and 38 were White (76%). Ages ranged from 17 to 22 years ($M = 18.8$, $SD = 1.04$). All procedures were approved by the Institutional Review Board at Tufts University. Participants provided written informed consent prior to participating.

Materials and Procedures

Stimuli. Participants viewed a set of digital color pictures (800 x 600 pixels) selected from the International Affective Picture System (IAPS; Lang et al., 2008). Twenty-seven unpleasant pictures were selected on the basis of normative data across men and women, so as to be highly arousing, $M = 5.93$, $SD = .28$ on a 1 to 9 scale where 9 signifies completely aroused, and unpleasant, $M = 2.10$, $SD = .31$ on a 1 to 9 scale where 9 signifies completely happy.¹ Twelve neutral pictures were selected so as to be low in arousal, $M = 3.06$, $SD = 1.09$, and neither pleasant nor unpleasant, $M = 4.99$, $SD = .05$.

Cognitive Reappraisal. Participants were trained to follow one of three pre-recorded auditory CR instructions during each of 78 picture trials. The instruction to *increase* served as a

cue to actively try to feel more emotion. For example, in response to a picture of a girl curled up on the floor with eyes closed, participants were told they could imagine that the girl's mother had just died. Conversely, the instruction to *decrease* signified the cue to actively try to feel less emotion. For example, participants were told they could imagine that the girl in the picture was tired and had fallen asleep. Alternatively, on *view* trials, participants were instructed to view the picture without trying to change the way they feel.

Immediately prior to completing the reappraisal task, participants were trained to reappraise using a standardized set of instructions in which example reappraisals were provided for the increase and decrease instructions in response to sample pictures. Participants then practiced generating their own reappraisals of new sample pictures. Afterwards, the experimenter asked about the strategies participants had used with the new sample pictures, and coached as needed. Participants uniformly demonstrated the ability to generate reappraisals that conformed to the instructions they received.

The reappraisal task was presented using E-Prime (Psychology Software Tools, Pittsburgh, PA) in three blocks of 26 trials of unpleasant and neutral pictures. The unpleasant pictures were paired with increase, decrease, and view instructions (one instruction per trial) whereas neutral pictures were only paired with the view instruction (since there was no emotion to be regulated). Each picture was presented in two trials, once with gaze directed to an arousing area, and once to a non-arousing area as described below. The trial structure is presented in Figure 1.

Gaze Direction. During the reappraisal task, gaze was directed to a specific area of interest (AOI) in each picture half way through the trial. This was accomplished by fading out all but one square (250 x 250 pixels) of the image (see Figure 1). For unpleasant pictures, the

saturated square illuminated one area of the picture judged to be emotionally arousing (arousing focus) or one area judged to be neutral (non-arousing focus). For neutral pictures, the saturated square illuminated one area of the picture judged to include a central feature (arousing focus), or one area judged to be peripheral (non-arousing focus). Participants were instructed to keep their gaze focused within the AOI as they implemented the reappraisal instruction. Looking time data (reported below) validate the selection of these AOI as well as task compliance.

There were 9 unpleasant pictures for each of 6 cells in this fully within-subjects design, described by the cross between reappraisal goal (increase, view, decrease) and gaze direction (arousing focus, non-arousing focus). There were 12 neutral pictures for an additional 2 cells (arousing, non-arousing focus; both paired with the view instruction). More neutral than unpleasant pictures were presented to somewhat offset the preponderance of unpleasant images in each block of trials. Conditions were presented in random order for each participant. Pictures were randomly assigned to each trial.

Ratings of Emotional Intensity

Subjective ratings of emotional intensity were provided on a scale from 1 (“Mildly intense”) to 4 (“Very intense”) at the end of each trial.

Peripheral Physiology

Peripheral data were collected using an MP150 system (Biopac, Goleta, CA) and processed using ANSLAB (Wilhelm & Peyk, 2005).

Corrugator Electromyography (EMG). Corrugator EMG was selected as an index of facial expressive behavior, even that which is not overtly observable. It is sensitive to stimulus valence, exhibiting greater activity in response to unpleasant stimuli, and lower activity in response to pleasant stimuli (Bradley & Lang, 2007). Two 4-mm Ag/AgCl electrodes placed in

bipolar configuration over the left eye per Fridlund and Cacioppo (1986). One ground electrode for all physiological channels was placed on the forehead. Corrugator EMG was sampled at 2000 Hz and bandpass filtered online (5 Hz to 3 kHz; 60-Hz notch filter on). Offline, data were resampled to 400 Hz, rectified and smoothed with a 16 Hz low-pass filter, decimated to 4 Hz, and smoothed with a 1-s prior moving average filter.

Electrocardiography (ECG). ECG was used to measure heart rate (HR), which is dually innervated by the sympathetic and parasympathetic branches of the ANS. In event-related paradigms involving passive viewing of unpleasant pictures, HR exhibits an initial, parasympathetically-mediated deceleration (Bradley & Lang, 2007). Two disposable Ag/AgCl electrodes pre-gelled with 7% chloride gel (1 cm circular contact area) were placed under the left and right collar bones on the chest after swabbing with an alcohol prep pad and then gently abrading using an electrode prep pad. ECG was acquired continuously at 1000 Hz.

Offline, the ECG signal was downsampled to 400 Hz and bandpass-filtered from .5 to 40 Hz. Interbeat interval (IBI) series were created by identifying R-spikes using automated ANSLAB algorithms. R-spikes that were not detected automatically, thus leading to an erroneously long period between successive R-spikes, were marked for inclusion by hand. Similarly, R-spikes that were identified incorrectly, thus leading to an erroneously short period between successive R-spikes, were removed by hand. Following such artifact correction, the IBI series was converted to heart rate in beats per minute. Heart rate data were decimated to 10 Hz and then smoothed with a 1-s prior moving average filter.

Electrodermal activity (EDA). EDA was selected as a pure measure of sympathetic activation of the PNS. Two disposable Ag/AgCl electrodes pre-gelled with 0.5% chloride isotonic gel (1 cm circular contact area) were attached to the distal phalanges of the index and

middle fingers on the left hand. EDA level was recorded with DC coupling and constant voltage electrode excitation at 31.25 Hz (sensitivity = .7 nS). Offline, EDA was smoothed with a 1 Hz low-pass filter, decimated to 10 Hz, and linearly detrended on a trial-by-trial basis.²

Eye Tracking

Bilateral eye tracking data were unobtrusively collected using a Tobii T120 Eye Tracker (sampled at 60 Hz). Fixations were identified when gaze fell within a radius of 30 pixels for at least 100 ms, averaged across both eyes. Looking time within the prescribed square area was expressed as a proportion of the 5-s viewing time.

Data Reduction and Analysis

Emotion Elicitation Manipulation Check. A premise of this work was that the unpleasant pictures would elicit unpleasant emotional responses that could be regulated by cognitive reappraisal. Finding increased corrugator, increased electrodermal activity, and/or deceleration in heart rate during the 4-second time period after picture onset (but before delivery of the reappraisal instruction) would be taken as evidence of this premise. For this question, trials were baseline corrected for the 100-ms (EDA, HR) or 250-ms (EMG) time bin immediately preceding picture onset. Following baseline correction, the data for this 4-second window of interest were averaged across time bins, trials, and conditions separately for unpleasant and neutral pictures for each participant. The mean was then submitted to paired t-tests comparing responses to unpleasant versus neutral pictures.

Effects of Reappraisal Goal and Gaze Direction. Reappraisal-related change was captured by subtracting baseline signal recorded during the 100-ms (EDA, HR) or 250-ms (EMG) time bin just prior to instruction delivery from all subsequent time bins within a 6-second window immediately following this baseline period. To account for delay in EDA response, only

time bins occurring 2 seconds after instruction delivery were included. Following baseline correction, the data were then averaged across time bins and trials within each cell (described by reappraisal goal and gaze direction) for each participant. The mean estimate was then tested with a multivariate General Linear Model (GLM) to assess the effects of reappraisal goal (increase, maintain, decrease) and gaze direction (arousing, non-arousing).

Data Retention. To prevent leveraging of condition estimates by outlying values, only trials falling less than 4 SD from the within-subjects mean were retained on a measure-by-measure basis for each participant. This criterion led to very little data loss. Across conditions, 100% of trials were retained for ratings of emotional intensity, corrugator activity, heart rate, and EDA; 99% of trials were retained for looking time.

To prevent leveraging of groupwise differences between conditions, analyses were completed with and without multivariate outliers (i.e., participants for whom the estimate of Mahalanobis Distance across variables within each measure was too large [$p < .001$]; see Fidell & Tabachnick, 2003). Two participants' EDA data were excluded on this basis thus $n = 52$.

Emotional intensity ratings were unavailable for 3 participants (key presses were not recorded) thus $n = 51$. Corrugator data were available for all participants thus $n = 54$. HR data for 1 participant were excluded due to poor signal quality thus $n = 53$. Eye tracking data were unavailable for 2 participants (equipment failure) and were unusable for 3 participants (problems with the data files), thus $n = 49$ for looking time.

Results

Responses to unpleasant and neutral pictures were used to document the success of emotion elicitation. Responses to unpleasant pictures alone were used to validate the subjectively-defined areas of interest and the gaze direction manipulation, and to test the *a priori*

predictions about the emotion-regulating effects of cognitive reappraisal. Across all analyses, results were considered statistically significant at $\alpha = .05$ (two-tailed). Multivariate F statistics are reported for the repeated measures GLMs. Estimates of within-subjects effect size (Cohen's d_z , which is calculated as the mean difference divided by the standard deviation of the mean difference) are reported for paired effects.

Preliminary Analyses

Have We Effectively Elicited Negative Emotion? Averaged across conditions within the 4-second period following picture onset, a paired t-test indicated that participants experienced the unpleasant pictures, $M = 2.71$, $SD = .35$, as more intense than the neutral pictures, $M = 1.18$, $SD = .16$, $t(50) = 31.26$, $p < .001$, $d_z = 4.38$. Unpleasant pictures also led to greater corrugator activity, $M = .49$, $SD = 1.06$, compared to neutral pictures, $M = -.11$, $SD = .96$, $t(53) = 4.09$, $p < .001$, $d_z = .56$. Finally, unpleasant pictures produced a significant deceleration in HR, $M = -1.06$, $SD = 1.09$, compared to neutral pictures, $M = -.45$, $SD = 1.22$, $t(52) = -3.02$, $p = .004$, $d_z = .41$. There was no difference in EDA between unpleasant, $M = .037$, $SD = .063$, and neutral, $M = .035$, $SD = .073$, pictures, $t(51) = .17$, $p = .866$, $d_z = .02$. Overall these results confirm that the intended unpleasant emotional state was elicited.

Validating the Areas of Interest and the Gaze Direction Manipulation. A repeated measures GLM with two factors, gaze direction (arousing, non-arousing) and time (pre-gaze direction, post-gaze direction) revealed a significant interaction for unpleasant picture trials across reappraisal conditions, $F(1,48) = 235.00$, $p < .001$. As shown in Figure 2, participants looked more in the arousing than in the non-arousing areas of interest. Follow-up analyses (Fisher's Least Significant Difference [LSD]) indicated that this difference was larger during the pre-gaze direction period, $p < .001$, $d_z = 3.32$, than during the post-gaze direction period, $p <$

.001, $d_z = 1.22$ (because so little time was spent looking at the non-arousing area during this period when gaze was free to vary naturally). This validates the subjectively-defined arousing and non-arousing areas of interest. Moreover, looking time significantly increased from before to after gaze direction, a difference that was larger for the non-arousing area, $p < .001$, $d_z = 3.37$, than for the arousing area, $p < .001$, $d_z = 2.38$. This suggests that participants were compliant with the gaze direction manipulation.

Did Participants Look in the Prescribed Area Equally Across CR Conditions? As suggested by mean looking time during the post-gaze direction period of unpleasant picture trials in Table 1, a repeated measures GLM with two factors, reappraisal goal (increase, view, decrease) and gaze direction (arousing, non-arousing) indicated that there was no main effect of reappraisal goal, $F(2,47) = .29$, $p = .752$, nor an interaction between reappraisal goal and gaze direction, $F(2,47) = .89$, $p = .418$.³ This suggests that gaze direction was not confounded with CR in explaining emotion-regulating effects on other measures. As above, participants looked longer in the arousing than in the non-arousing areas, as indicated by the main effect of gaze direction, $F(1,48) = 70.96$, $p < .001$.

Hypothesis Testing

Means (SD) for all measures and F statistics for the CR main effect are presented in Table 1. Figures 3 and 4 present the time course for change in the physiological measures over the entire picture-viewing period when gaze was directed to arousing (Figure 3) and non-arousing (Figure 4) information. The data in these two figures were baseline-corrected using the time bin immediately prior to picture onset.

Data Analysis Strategy. For each of four dependent measures (ratings of emotional intensity, corrugator muscle activity, heart rate, and EDA), hypothesis testing was accomplished

using a repeated measures GLM testing the independent and interactive effects of two factors, reappraisal goal (increase, view, decrease) and gaze direction (arousing, non-arousing). Significant main effects of reappraisal goal were followed up with two planned comparisons (Fisher's LSD for increase versus view and decrease versus view). Significant interaction effects were followed up with the same two planned comparisons within each of the two gaze direction conditions. Estimates of effect size (Cohen's d_z) for each of the two planned comparisons (increase versus view and decrease versus view) across and within gaze directions are reported in Table 2.

Does CR Have Emotion-Regulating Effects Across Gaze Direction Conditions? As shown in Table 1, there were main effects of CR on subjective emotional intensity, corrugator activity, heart rate, and EDA. Increase reappraisals of unpleasant pictures led to higher ratings of subjective emotional intensity, greater corrugator activity, and greater EDA and HR compared to viewing unpleasant pictures. In addition, decrease reappraisals of unpleasant pictures led to lower ratings of subjective emotional intensity and lower corrugator activity compared to viewing unpleasant pictures. This pattern confirms that CR has the predicted emotion-regulating effects even though gaze was held constant across reappraisal conditions.⁴

Does the Effect of Reappraisal Depend on Gaze Direction? It was conceivable that CR might interact with gaze direction in influencing emotion. The interactive effect of CR and gaze direction was only (marginally) significant for corrugator muscle activity, $F(2,52) = 2.89$, $p = .064$ (See descriptives in Table 1, and effect sizes in Table 2). Follow-up analyses (Fisher's LSD) indicated that gaze direction had little effect on increase reappraisals, for which higher corrugator activity was evident for increasing compared to viewing when gaze was directed to both the arousing, $p = .043$, and non-arousing areas, $p = .001$. Gaze direction had more of an impact on

decrease reappraisals, for which lower corrugator activity for decreasing compared to viewing was only observed when gaze was directed to the arousing area, $p = .015$, and not when directed to the non-arousing area, $p = .299$. As is evident in Figure 4a, directing gaze to the non-arousing area in the view condition was sufficient on its own to reduce corrugator activity, leaving little room for further declines as a function of reappraisal.

Does Directing Gaze By Itself Influence Emotion Across CR Conditions? In keeping with recent electrophysiological findings (Dunning & Hajcak, 2009; Hajcak et al., 2009), it was conceivable that directing gaze towards and away from emotionally-arousing information might, in and of itself, have emotion-regulating effects. Indeed, a main effect of gaze direction showed that ratings of emotional intensity were higher when gaze was directed to an arousing area, $M = 2.78$, $SE = .05$, compared to a non-arousing area, $M = 2.66$, $SE = .05$, $F(1,50) = 11.78$, $p = .001$, $dz = .48$. Similarly, corrugator activity was higher when gaze was directed to an arousing area, $M = -.03$, $SE = .11$, compared to a non-arousing area, $M = -.26$, $SE = .08$, $F(1,53) = 6.65$, $p = .013$, $dz = .35$.

Discussion

Previous studies of cognitive reappraisal (CR) using visual stimuli have allowed gaze to vary naturally. This makes it possible that the apparent emotion-regulating effects of CR, an ER process falling within the cognitive change family of ER processes, might actually be explained by attentional deployment (AD), a different family of emotion regulatory processes (Gross & Thompson, 2007). This possibility was supported by van Reekum and colleagues (2007), who took an individual-difference approach to show that the effects of reappraising unpleasant pictures on neural activation were substantially reduced when accounting for variation in eye gaze behavior, an index of visual attentional deployment.

In the present study, I determined that cognitive reappraisal impacts subjective experience of emotional intensity and autonomic physiology even when attentional deployment was equivalent across reappraisal conditions. If visual attentional deployment was the causal agent for the impact of reappraisal on these indices of emotion, then constraining gaze would have prevented reappraisal from having any effect. Yet, as predicted and despite equivalent looking times in the prescribed areas, increase reappraisals prompted higher ratings of emotional intensity, greater corrugator activity, and greater autonomic arousal compared to viewing unpleasant pictures. In addition, decrease reappraisals prompted lower ratings of emotional intensity. These results suggest that changes in appraisal are the mechanism by which CR impacts these aspects of the multisystem emotion response. However, although this study rules out changes in visual attention, other mechanisms (e.g., motivation, empathy) aside from changes in appraisal might still be operating in addition to (or instead of) changes in appraisals (Parkinson, 1997). Future studies that either manipulate or hold these factors constant in the context of reappraisal are needed.

By contrast to the measures of subjective emotional intensity and autonomic physiology, the effects of CR on expressive behavior, as measured via activity over the corrugator muscle region, varied as a function of gaze direction. Whereas increase reappraisals led to greater corrugator muscle activity compared to the view condition in *both gaze direction conditions*, decrease reappraisals led to lower corrugator muscle activity compared to the view condition *only when gaze was directed to the arousing area*. When gaze was directed to the non-arousing area, there was no effect of decrease reappraisals relative to the view condition on corrugator activity. This appears to be due at least in part to a floor effect: When otherwise responding naturally (i.e., during the view condition), diverting gaze away from unpleasant visual information was sufficient on its own to down-regulate expressive behavior to its baseline level.

In future studies, it would be important to ensure that the initial response (i.e., the response engendered during the first 4 seconds of picture presentation in this particular paradigm) is sufficiently high to allow for further declines in expressive behavior beyond those that occur by directing gaze to non-arousing information. It is unclear why expressive behavior was more sensitive to this apparent floor effect than subjective emotional intensity (for which the decrease reappraisal effect was present in both gaze direction conditions). Nevertheless, my speculation is that, in a floor effect-free context, decrease reappraisals should exert emotion-regulating effects on expressive behavior over and above AD just like they did for subjective experience, and just like increase reappraisals did for all three measures of the multisystem emotion response (subjective experience, expressive behavior, and autonomic physiology).

Attending to arousing areas of unpleasant pictures led to higher ratings of emotional intensity and corrugator muscle activity compared to attending to non-arousing areas. Attending to emotional versus neutral information has been shown in previous work to influence electrophysiological indices of emotional arousal (Dunning & Hajcak, 2009; Hajcak et al., 2009) and subjective mood states (See et al., 2009; MacLeod et al., 2002). The results of this study thus converge with previous studies in suggesting that AD is effective in regulating some aspects of the multisystem emotion response. Future studies that test the gaze directions studied here and that also allow gaze to vary freely on some trials are warranted. This would allow one to determine if directing gaze to arousing and non-arousing information has emotion-regulatory effects compared to free viewing, or if the differences in subjective ratings of intensity and expressive behavior observed here are carried by one or the other.

Conclusion

In sum, CR (thinking) impacted subjective emotion experience and autonomic physiology (feeling) despite equivalence of visual AD (seeing). These findings dovetail nicely with the process model of emotion regulation (Gross, 1998; Gross & Thompson, 2007), which

suggests that there are five, theoretically-distinct families of processes by which we can alter our emotions, two of which are 1) deploying our attention towards or away from certain aspects of situations, and 2) modifying our appraisals of the situations we face. The present study provides empirical evidence for the distinctiveness of the attentional deployment and cognitive change families, thus moving forward our understanding of the processes underlying regulation of emotion, an important pursuit since ER processes are tightly linked to well-being (John & Gross, 2004).

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Footnotes

¹ The following pictures from the IAPS 2006 set, listed by catalog number, were used:
unpleasant 2683, 2703, 2717, 3016, 3051, 3063, 3100, 3225, 3261, 6021, 6312, 6570, 6821,
 7380, 9040, 9253, 9254, 9405, 9420, 9423, 9433, 9560, 9571, 9800, 9901, 9910, and 9911, and
neutral 2038, 2214, 2749, 6150, 7009, 7010, 7020, 7035, 7185, 7235, 7640, 7950.

² Repeating all EDA analyses with no linear detrending reveals the same results.

³ Green dot detection accuracy (see the Figure 1 legend) confirms a similar lack of a reappraisal goal main effect or an interaction between reappraisal goal and gaze direction.

⁴ In a separate set of GLMs, looking times in the prescribed area for each of 6 conditions (3 reappraisal goals x 2 gaze directions) were entered as covariates. Table 2 provides Cohen's d_z effect size for the increase versus view and decrease versus view comparisons for the original data and then again with these looking time covariates. Note that the effect sizes changed very little when looking time covariates were included.

Table 1

Means (SD) for the dependent measures as a function of reappraisal goal and gaze direction.

	<i>F statistics for main effect of reappraisal goal</i>	<i>across gaze directions</i>			<i>arousing</i>			<i>non-arousing</i>		
		<i>increase</i>	<i>view</i>	<i>decrease</i>	<i>increase</i>	<i>view</i>	<i>decrease</i>	<i>increase</i>	<i>view</i>	<i>decrease</i>
<i>proportional looking time</i>	$F(2,47) = .29,$ $p = .752$	0.71 (0.15)	0.7 (0.16)	0.7 (0.15)	0.76 (0.16)	0.75 (0.17)	0.74 (0.15)	0.66 (0.16)	0.66 (0.17)	0.66 (0.16)
<i>ratings of emotional intensity</i>	$F(2,49) = 31.06,$ $p < .001$	2.92 ^a (0.33)	2.67 ^{a,b} (0.42)	2.55 ^b (0.42)	2.99 (0.35)	2.71 (0.5)	2.6 (0.49)	2.84 (0.38)	2.62 (0.45)	2.51 (0.44)
<i>corrugator activity</i>	$F(2,52) = 6.34,$ $p = .003$	0.28 ^a (1.33)	-0.24 ^{a,b} (0.48)	-0.48 ^b (0.93)	0.48 ^a (1.99)	-0.1 ^{a,b} (0.48)	-0.46 ^b (0.99)	0.08 ^a (0.84)	-0.37 ^a (0.68)	-0.51 (1)
<i>heart rate</i>	$F(2,51) = 21.94,$ $p < .001$	0.83 ^a (1.73)	-0.4 ^a (1.6)	-0.35 (1.42)	0.76 (2.1)	-0.29 (1.8)	-0.32 (1.82)	0.91 (1.91)	-0.51 (1.8)	-0.39 (1.78)
<i>electrodermal activity</i>	$F(2,50) = 4.96,$ $p = .011$	0.03 ^a (0.05)	0.01 ^a (0.04)	0.01 (0.05)	0.029 (0.051)	0.002 (0.054)	0.011 (0.071)	0.03 (0.068)	0.009 (0.056)	0.002 (0.059)

Notes. Arousing = gaze directed to an emotionally relevant area of the picture, Non-arousing = gaze directed away from the emotionally relevant areas of the picture. For the two planned comparisons of interest (increase versus view, decrease versus view), means sharing the same letter superscript within a row differ at $p < .05$ according to Fisher's LSD across gaze directions. Given the marginally significant interaction between reappraisal goal and gaze direction for corrugator activity, significant differences for that measure are also shown within each gaze direction.

Table 2

Cohen's *d*z effect sizes for the two reappraisal comparisons of interest, increase – view and decrease – view.

	across gaze directions		arousing		non-arousing		
	increase - view	decrease - view	increase - view	decrease - view	increase - view	decrease - view	n
proportional looking time							
original	0.07	0.04	0.12	0.06	0.01	0.00	49
with covariates	--	--	--	--	--	--	--
ratings of emotional intensity							
original	0.82	0.38	0.63	0.27	0.54	0.29	51
with covariates	0.83	0.37	0.63	0.24	0.56	0.33	46
corrugator activity							
original	0.38	0.29	0.28	0.34	0.47	0.14	54
with covariates	0.39	0.29	0.31	0.34	0.44	0.15	49
heart rate							
original	0.90	0.04	0.50	0.01	0.83	0.07	53
with covariates	0.93	0.01	0.52	0.01	0.86	0.03	48
electrodermal activity							
original	0.43	0.03	0.48	0.12	0.27	0.10	52
with covariates	0.41	0.14	0.54	0.25	0.22	0.08	47

Notes. Arousing = gaze directed to an emotionally relevant area of the picture, non-arousing = gaze directed away from the emotionally relevant areas of the picture. The phrase “with covariates” indicates that looking times in the prescribed area for each of 6 conditions (3 reappraisal goals x 2 gaze directions) were included as covariates in estimating the marginal means (and SD) that were used to compute Cohen's *d*z. The word “original” indicates that no covariates were included. The “with covariates” *n* is 5 less than the “original” *n* due to missing observations for looking time data. See *Data Retention* section for details.

Figure Captions

Figure 1. Trials began with a white fixation cross presented in the center of a black screen for 1 second followed by the presentation of a picture for a total of 10 seconds. For the first 5 seconds, the entire picture was visible. For the last 5 seconds, most of the picture was faded out except for one square area to which gaze was directed. The CR instruction was delivered 4 seconds after picture onset. As a way of ensuring that gaze would remain focused in the square, participants were asked to press a button as soon as they saw a 33-ms green dot presented in the square area (data not reported; dot response accuracy mirrors the eye tracking findings). At the end of each trial, participants were prompted to judge picture valence (data not reported) and intensity. Intensity ratings were provided on a scale from 1 (“Mildly intense”) to 4 (“Very intense”). Each rating screen remained present for 3 seconds. Participants then saw a black screen with a central white fixation dot that lasted from 3- 6 seconds. Photo of mourning family by Mikhail Evstafiev retrieved from <http://commons.wikimedia.org/wiki/File:Evstafiev-bosnia-sarajevo-funeral-reaction.jpg> on August 18, 2008.

Figure 2. This figure depicts mean time spent looking at the unpleasant pictures expressed as a proportion of 5 seconds, the total possible viewing time. Means are reported separately for looking time before (pre-gaze direction; left side of the figure) and after (post-gaze direction; right side of the figure) gaze was directed to subjectively-defined areas of interest (AOI). Documenting the validity of the AOI, participants spent more time looking in the arousing (black line) than the non-arousing area (gray line) before gaze was directed (i.e., when gaze was free to vary naturally). Documenting compliance with the gaze direction manipulation, looking time increased from before to after gaze direction for both AOI types, an increase that was bigger for the non-arousing area since so little time was spent in that area to begin with.

Figure 3. Effects of cognitive reappraisal (CR) while gaze was directed to an arousing area. Panels a (corrugator activity), b (heart rate in beats per minute [BPM]), and c (electrodermal activity) depict change in activity over the entire 10-second picture presentation period. The CR instruction was presented 4 seconds after picture onset (marked with the vertical solid black line). Gaze was directed 5 seconds after picture onset (marked with the vertical dotted black line). Solid black lines represent unpleasant trials in which participants received the CR instruction to increase. Solid gray lines represent unpleasant trials in which participants received the CR instruction to view. Black lines with short hash marks represent unpleasant trials in which participants received the CR instruction to decrease. Black lines with long hash marks represent neutral trials for which participants received the CR instruction to view.

Figure 4. Effects of cognitive reappraisal (CR) while gaze was directed to a non-arousing area. Panels a (corrugator activity), b (heart rate in beats per minute [BPM]), and c (electrodermal activity) depict change in activity over the entire 10-second picture presentation period. The CR instruction was presented 4 seconds after picture onset (marked with the vertical solid black line). Gaze was directed 5 seconds after picture onset (marked with the vertical dotted black line). Solid black lines represent unpleasant trials in which participants received the CR instruction to increase. Solid gray lines represent unpleasant trials in which participants received the CR instruction to view. Black lines with short hash marks represent unpleasant trials in which participants received the CR instruction to decrease. Black lines with long hash marks represent neutral trials for which participants received the CR instruction to view.