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Using Reappraisal To Regulate Unpleasant Emotional Episodes: Goals and Timing Matter

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The hypothesis that cognitive reappraisal will have different effects on emotion as a function of regulatory goal and the timing with which reappraisals are enacted within an emotion episode was tested. Forty-one participants reappraised situations depicted in unpleasant pictures by imagining those situations getting worse (increase), staying the same (maintain), or getting better (decrease). Reappraisal instructions were delivered 2 s before (anticipatory) or 4 s after (online) picture onset. Measures of rated unpleasantness, expressive behavior (corrugator muscle activity), heart rate (HR), and electrodermal activity (EDA) were collected. Increase reappraisals produced higher rated unpleasantness, corrugator muscle activity, HR, and EDA relative to maintain reappraisals. For corrugator muscle activity and EDA, the effect of increase reappraisals was only apparent when enacted online. Decrease reappraisals produced lower rated unpleasantness relative to maintain reappraisals but had no effect on expressive behavior or autonomic physiology. The effect of decrease reappraisals did not depend on when reappraisal was enacted. These data underscore the importance of regulatory goals and the impact of regulatory timing as a moderator of emotion regulatory success within an emotion episode.

Keywords: cognitive reappraisal, timing, emotion regulation

Imagine you are sitting on a dais about to deliver an oral presentation to an audience. You're feeling jittery, your eyes are wide, your brow is furrowed, your heart is racing, and you're considering the relative probability that tomatoes will be thrown and where the closest exit is. In a nutshell, you're anxious. At some level of intensity and duration, this is a natural response to a situation of social evaluative threat, but if the anxiety runs rampant, your ability to give a good presentation will be compromised. It may, therefore, be advantageous to find a way to quell the anxiety. How might you do that? There are many avenues to meeting this emotion regulatory goal. You might, for example, count to 10 or think about the items you need to buy at the store later. You might remind yourself that the people in the audience are interested in the ideas you're about to share and that the consequences of saying something foolish are much less severe than you're imagining. You might take deep slow breaths to encourage your heart to stop beating so frantically. You might try to adopt a calm, confident facade in the hopes that the old adage to "fake it 'til you make it" does you some good. If you could turn back the clock, you could instead choose to avoid this anxiety-provoking situation and decline to give that presentation in the first place. Examples such as these highlight the many tools that we as people have at our disposal for regulating emotional responses to situations that beset us, an ability that serves as an important means of achieving and/or maintaining psychological well being (John & Gross, 2004).

Emotion and Its Regulation

The process model of emotion regulation (ER; Gross, 1998; Gross & Thompson, 2007) has provided an influential and useful framework for understanding emotion and its regulation. At its core is a modal model of emotion, which views emotion as "a person–situation transaction that compels attention, has particular meaning to an individual, and gives rise to a coordinated yet flexible multisystem response to the ongoing person–situation transaction" (Gross & Thompson, 2007, p. 5). This person–situation transaction, or emotion-generative cycle, can be depicted graphically, as shown in Figure 1. Notice that the emotion-generative cycle affords a number of different targets for regulation. That is, a person who wants to alter their emotional response has many entrées into the emotion-generative cycle to do so. A broad distinction can be drawn between ER processes that operate on early events that give rise to the multisystem response (situation, attention, and appraisal)—termed the *antecedents*—and the multisystem response itself (Gross, 1998; Gross & Thompson, 2007).

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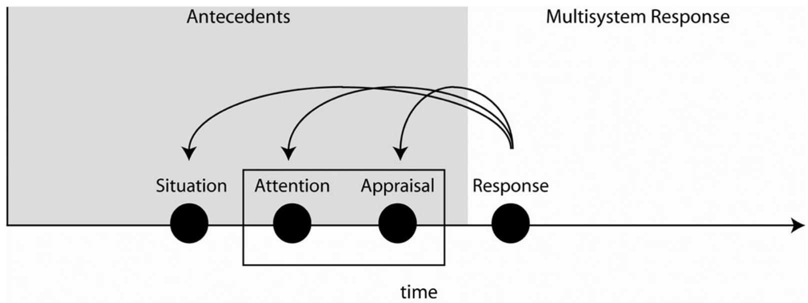

Figure 1. The emotion-generative cycle. Antecedents (i.e., processes that give rise to a multisystem emotional response) are shown in the shaded gray area, and the response is shown in the unshaded area. Feedback arrows from the response to the antecedents emphasize the iterative nature of emotion episodes. From "Emotion Regulation: Conceptual Foundations" (pp. 3–24), by J. J. Gross and R. A. Thompson, in *Handbook of Emotion Regulation*, 2007, New York: Guilford Press. Copyright 2007 by Guilford Press. Adapted with permission.

ER processes that operate on emotion antecedents as targets of regulation would be considered antecedent-focused (AF) ER processes. An example of an AF ER process is cognitive reappraisal, a form of cognitive change that targets the appraisal stage of the emotion-generative cycle. Cognitive reappraisal has received quite a bit of recent attention in the empirical literature (e.g., Eippert, Veit, Weiskopf, Erb, Birbaumer, & Anders, 2007; Goldin, McRae, Ramel, & Gross, 2008; Gross, 1998; Johnstone, van Reekum, Urry, Kalin, & Davidson, 2007; Kalisch et al., 2005; McRae, Ochsner, Mauss, Gabrieli, & Gross, 2008; Ochsner, Bunge, Gross, & Gabrieli, 2002, Ochsner et al., 2004; Urry et al., 2006; van Reekum et al., 2007). Cognitive reappraisal refers to the process of modifying the appraised meaning of an emotion-triggering event (ETE). For example, an impending oral presentation might be appraised as a chance to fail and suffer criticism by one's peers but could instead be reappraised as an opportunity to receive feedback that will improve the work.

In contrast to AF ER processes, response-focused (RF) ER processes are those for which the targets of regulation are the experiential, expressive, and/or physiological responses themselves. An example of an RF ER process that has received a good deal of empirical attention is expressive suppression, which refers to keeping outward emotional reactions in check so that others may not perceive one's internal emotional experience (Demaree, Robinson, Pu, & Allen, 2006; Demaree, Schmeichel, Robinson, & Everhart, 2004; Demaree, Schmeichel, Robinson, et al., 2004; Demaree, Schmeichel, Robinson, Pu, et al., 2006; Gross, 1998; Gross & Levenson, 1993, 1997). For example, if you are walking down the street and see some stranger trip and fall without hurting themselves, you might find their flailing comical, but you would very likely hide your feelings of amusement (i.e., you would stifle your laughter) so as not to come across as insensitive.

Effects of Cognitive Reappraisal on the Multisystem Emotion Response

When engaging in ER processes, the ultimate goal is to change ongoing emotion, but does it? This question has been the focus of numerous ER studies in which emotions were elicited while components of the multisystem emotion response (experience, expression, physiology) were measured. If ER processes are successfully invoked, then they should modulate components of the multisystem response. I focus here on the evidence pertaining specifically to cognitive reappraisal, which has a sizable literature on which to draw and forms the backbone of some forms of psychotherapy.

The early studies examined the effect of reappraisals that were provided by the experimenters rather than generated by the participants themselves. Speisman, Lazarus, Mordkoff, and Davison (1964) found that participants exhibited lower heart rates (HRs) and skin conductance levels in response to a disgusting film clip when exposed to intellectualization and denial appraisals compared with traumatic appraisals. Similar effects were observed by Lazarus and Alfert (1964), who showed that skin conductance, HR, and rated emotional intensity were lower when the disgusting film clip was preceded by a verbal introduction indicating that the procedure they were about to see was neither painful nor dangerous and that the adolescents viewed it favorably as a sign of manhood.

In the context of everyday emotion in adults, although others do at times provide reappraisals to support our emotion regulatory efforts, the ability to generate reappraisals oneself is an important skill. There is good evidence that participant-generated reappraisals are effective in modifying subjective emotional experience as measured by self-report (Kalisch et al., 2005; McRae et al., 2008; Ochsner et al., 2002, Ochsner et al., 2004; Wager, Davidson, Hughes, Lindquist, & Ochsner, 2008). Fewer studies have examined expressive behavior, but those that have indicate that reappraisal instructions indeed modulate expressive behavior as measured with observational coding (Gross, 1998) or facial muscle activity (Deveney & Pizzagalli, 2008; Jackson, Malmstadt, Larson, & Davidson, 2000) in ways that are consistent with the regulatory goal.

The findings are mixed with respect to the effects of reappraisal on autonomic physiology. Reappraisals focused on increasing negative emotion seem to potentiate activation of the autonomic nervous system (ANS), as evidenced by increases in electrodermal activity (EDA; Eippert et al., 2007) and pupil diameter (Johnstone et al., 2007; Urry et al., 2006; van Reekum et al., 2007). Reappraisals focused on decreasing negative emotion have been shown to have no effect on (Gross, 1998; Kalisch et al., 2005), increase (Sheppes, Catran, & Meiran, in press), or decrease (Urry, van

Reekum, Johnstone, & Davidson, 2009) EDA and to increase pupil diameter (Johnstone et al., 2007; Urry et al., 2006; van Reekum et al., 2007). Decrease reappraisals have also been shown to reduce (Kalisch et al., 2005) or increase (Urry et al., 2009) accelerative aspects of HR.

As reviewed earlier, the evidence of the effects of reappraisal on ongoing emotion, particularly autonomic physiology, is mixed. It is important to note that the mixed nature of these findings cannot be explained by differences in the target of regulation since target of regulation; in this case, the appraisal event within the emotion-generative cycle, was held constant. The inconsistencies may, however, reflect differences in *when* reappraisals were enacted relative to the emotion-triggering event. The instruction to reappraise was delivered before the ETE (e.g., film, picture) in some studies (Gross, 1998; Kalisch et al., 2005; Kim & Hamann, 2007; Ochsner et al., 2004; Phan, Fitzgerald, Nathan, Moore, Uhde, & Tancer, 2005) and during the ETE in other studies (Deveney & Pizzagalli, 2008; Eippert et al., 2007; Jackson et al., 2000; Johnstone et al., 2007; Ochsner et al., 2002; Sheppes, Catran, & Meiran, 2009; Urry et al., 2006; van Reekum et al., 2007).

The effect of such differences in the timing with which reappraisals are enacted in an emotion episode has been examined only once (Sheppes & Meiran, 2007). These authors found that reappraisal instructions delivered in advance of and early in a sad film clip were more effective in reducing reported negative emotion than when delivered late and that later reappraisal led to recalling fewer happy autobiographical memories relative to early reappraisal. Their clever experiments confirm that the timing with which reappraisal begins within an emotion episode affects emotional experience and memory processes. Why might this be?

The Role of Timing in Successful ER

As described previously, the process model of ER emphasizes the idea that the target of regulation determines the level of response activation that occurs within an emotion-generative cycle. Because expressive suppression targets the response, which occurs late in each emotion-generative cycle once level of response activation is high, it is costlier to the organism than down-regulating reappraisals, which target the appraisal antecedent within each emotion-generative cycle (and thus could prevent or minimize a response in the first place). Over the past 15 years, many laboratory and individual difference studies have been conducted to evaluate the social, physiological, and cognitive consequences of reappraisal and expressive suppression—canonical examples of AF and RF ER, respectively. The bulk of the evidence supports the notion that they have divergent consequences, with the profile being generally more positive for reappraisal than for suppression (for a review, see John & Gross, 2004).

It is important to note that the process model highlights the importance of timing at a microlevel (i.e., within the emotion-generative cycle). However, according to Gross and Thompson (2007), a given emotion episode may comprise many emotion-generative cycles. This is depicted in Figure 2, which demonstrates one hypothetical emotion episode that involves three emotion-generative cycles. Level of emotional activation is shown in the nonlinear trajectory of the black line, which starts off at a low level, rises to a high-level peak that is sustained for some period of time, and then returns to its initial low level. When one graphs an emotion episode in this manner, it becomes apparent that, at a macrolevel, one might draw a distinction between ER processes

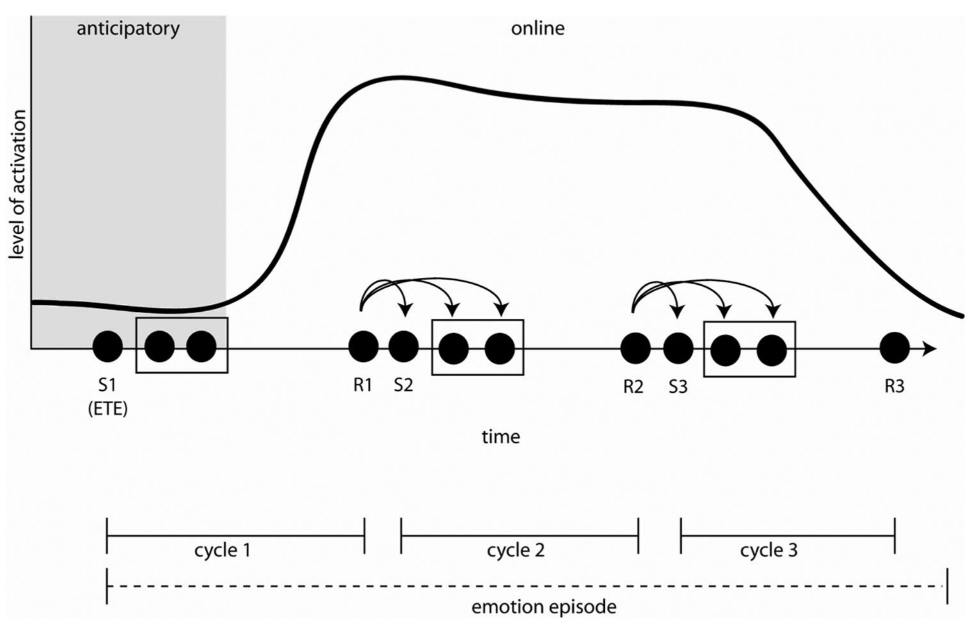

Figure 2. The nonlinear unfolding of emotional activation during a hypothetical emotion episode. Whereas this represents just one emotion episode, there are three emotion-generative cycles in this example. Each cycle comprises a situation (S) and a response (R). The boxes on the X axis, sandwiched in between the S and the R in each cycle, contain the attentional and appraisal processes that contribute to the R. Arrows run from the R to the antecedents of the subsequent emotion-generative cycle, reflecting the iterative nature of emotion episodes. Regulatory processes invoked during the time period depicted in the shaded gray area would be anticipatory, whereas those invoked during the time period depicted in the unshaded area would be online.

that occur early in the emotion episode, when level of emotional activation is low—anticipatory regulation, shown in gray shading in Figure 2—and those that occur later in the emotion episode, when level of emotional activation is high—online regulation.

To illustrate this hypothetical emotion episode, imagine that the ETE that starts the episode (Situation 1, or S1) is hearing the sound of breaking glass in another room late at night. In response to S1, attentional and appraisal processes, represented as the two black circles within the first little box on the X axis, produce Response 1, or R1 (in this case fear), which is depicted by an uptick in activation. After this initial R1, a new emotion generative cycle begins with S2, in which you grab a bat, hurry to the next room, and cautiously peek around the corner. Seeing nothing unusual, attentional and appraisal processes produce fear response R2, in which level of activation is maintained at the level reached in R1. A new emotion-generative cycle begins then with S3, in which, having moved into the kitchen, you see a glass bottle fallen on the floor and your cat sitting on the counter above, looking guilty. Attentional and appraisal processes then produce R3, a large diminution in activation with the evaluation that you are not in danger. At each point in this episode, the process iterates so that the multisystem response (e.g., R1) affects the antecedents of the subsequent emotion-generative cycle (e.g., S2, and Attention 2 and Appraisal 2, which are not labeled), which is demonstrated with the arrows in this figure.

Why might enacting regulatory processes with anticipatory versus online timing in the emotion episode affect regulatory success? ER processes enacted later in the emotion episode might be expected to be differentially effective compared with ER processes enacted earlier in the emotion episode because of the generally higher level of emotional activation. This is consistent with a similar logic described by Gross and his colleagues for the microlevel timing of the emotion-generative cycle, which is now being applied to the macrolevel timing of an emotion episode. This is also consistent with the viewpoint offered by Sheppes and Meiran (2007), who suggested that reappraisal may be less effective in down-regulating unpleasant emotion later in the course of an ETE because the high level of emotional activation would overwhelm one's ability to override the affect-laden train of thoughts that naturally unfold in response to an ETE while trying to establish a new train of thoughts that would reduce unpleasant emotion.

Here I propose that the impact of anticipatory versus online regulatory timing depends on one's regulatory goal, which defines a desired level of emotional activation. Anticipatory regulation may be most effective when focused on the goal of decreasing the emotional response, as the level of activation that is already present (low) is consistent with the regulatory goal (a desired low level of response activation). Using a roller coaster ride as an example, when you are waiting in the inevitable amusement park line, trying to reduce your fear by thinking of the ride as no big deal or perfectly safe might be more effective compared with when you are flying through the air with your heart pounding and a scream emerging from your mouth. By contrast, online regulation may be most effective when focused on the goal of increasing the emotional response because the level of response activation that is already present (in this case, high) is consistent with the regulatory goal (a desired high level of response activation). Again with the roller coaster ride, when you are flying through the air, trying to amplify your fear by thinking about the possibility that the coaster rails might break or your seatbelt might fail should be more effective compared with when you are waiting in line.

Overall, an assumption of the reasoning here is that, in the absence of new information (i.e., with no perceived change in the situation), the level of response activation in one emotion-generative cycle (say, cycle 1 in Figure 2) will promote antecedents that engender a similar level of response activation in the next emotion-generative cycle within the emotion episode (cycle 2). It is important to note that, although I have referred to "response" in the aforementioned example as if it were one monolithic entity, each response component will exhibit a unique trajectory of moment-to-moment emotional activation within the episode, despite moderate temporal coherence between experience, expression, and physiology (for an empirical test of the response coherence postulate, see Mauss, Levenson, McCarter, Wilhelm, & Gross, 2005). As a result, a regulatory process invoked at one time point is likely to have different effects on each component.

The Present Study

The purpose of the present study was to determine whether one's regulatory goal governs emotion regulatory success and whether success is moderated by macrolevel regulatory timing within an emotion episode. Timing of regulation was held constant at the microlevel because cognitive reappraisal, which always operates on an appraisal antecedent in each emotion-generative cycle, was the sole ER process of interest. Sheppes and Meiran's (2007) clever experiments confirmed that the timing with which reappraisal begins within an emotion episode affects emotional experience and memory processes. What remains to be determined is whether reappraisals enacted with anticipatory versus online timing in an emotion episode differ with regard to their expressive and physiological consequences. Moreover, because these authors used a 4-min film clip to induce the unpleasant emotional states to be regulated, it is unclear how their findings relate to emotion episodes of shorter duration, such as those examined in reappraisal studies using pictures. Finally, the focus of Sheppes and Meiran's (2007) study was on regulatory processes for which the goal was to reduce the emotional response. As described earlier, there is reason to believe that different findings would emerge when the emotion regulatory goal was instead focused on amplifying an unpleasant emotional response.

In the present study, participants were asked to voluntarily regulate their response to unpleasant pictures using reappraisal. Participants reappraised situations depicted in unpleasant pictures by imagining those situations getting worse (increase), staying the same (maintain), or getting better (decrease). Reappraisal instructions were delivered 2 s before (anticipatory timing) or 4 s after (online timing) picture onset. Thus, in the anticipatory condition, participants were given the instruction to reappraise before any emotion had been generated. In the online condition, on the other hand, the emotional response had already "come online" by the time the instruction to reappraise was given. Measures of emotion experience (ratings of subjective unpleasantness), expressive behavior (corrugator muscle activity), and autonomic physiology (HR and EDA) were collected.

On the basis of previous studies assessing different reappraisal goals, I expected that increase reappraisals would lead to increased reports of negative emotion, increased corrugator activity, and increased autonomic arousal compared with the maintain condition, a pattern signifying success in meeting the regulatory goal to increase negative emotion. I further expected that decrease reappraisals would lead to decreased reports of negative emotion and decreased corrugator activity, a pattern signifying success in meeting the regulatory goal to decrease negative emotion. Given previous reports, I was noncommittal as to whether decrease reappraisals would affect autonomic physiology. Finally, on the basis of the macrolevel timing considerations described herein, I expected that increase reappraisals (relative to maintain reappraisals) would be more successful when initiated with online as opposed to anticipatory reappraisal timing and that decrease reappraisals (relative to maintain reappraisals) would be more successful when initiated with anticipatory as opposed to online reappraisal timing.

Method

Participants

After providing informed consent, 41 undergraduates (26 female, ages 18–24) participated in exchange for course credit. Of the 38 participants for whom demographic data were available, the following nonexclusive racial categories were endorsed: 2 Black or African American (5.3%), 6 Asian (15.8%), 3 American Indian or Alaska Native (7.9%), 1 Native Hawaiian or other Pacific Islander (2.6%), and 26 White (68.4%). Three (7.9%) individuals selected more than one category, 3 declined to provide ethnic or racial information, and 4 (10.5%) endorsed being of Hispanic or Latino ethnic origin. All procedures were approved by the Social, Behavioral, and Educational Research Institutional Review Board on the Medford campus of Tufts University.

Materials and Procedure

Overview of Tasks

During their laboratory session, participants viewed a set of 108 digital color photographs selected from the International Affective Picture System (IAPS; Lang, Bradley, & Cooper, 2005). These pictures were designed to elicit either neutral (54 pictures) or unpleasant (54 pictures) emotional states. Participants first viewed these pictures under passive viewing conditions (data not reported given the focus on reappraisal in this article). The unpleasant pictures were then presented a second time in an ER task in which participants were asked to regulate their affective response using reappraisal. Unpleasant pictures were selected on the basis of IAPS normative data across men and women so as to be highly arousing ($M = 6.05$, $SD = 0.77$), on a scale ranging from 1 (*completely unaroused*) to 9 (*completely aroused*), and unpleasant ($M = 2.13$, $SD = 0.47$), on a scale ranging from 1 (*completely unhappy*) to 9 (*completely happy*).[1]

Reappraisal Task

Using a variant of the paradigm validated in previous published work (Jackson et al., 2000), participants were trained to follow one of three auditory instructions during each picture trial: increase, decrease, or maintain. The instruction to increase (participants heard the word "enhance"), presented through desktop speakers, served as a cue to imagine the depicted situation getting worse. For example, in response to a picture of a ferocious dog, a participant might imagine that the dog's leash broke and therefore the dog is about to bite them. Conversely, the instruction to decrease (participants heard the word "suppress") signified the cue to imagine the situation improving. For example, participants might imagine that victims of a car accident survived and healed well. Alternatively, on maintain trials, participants were instructed to imagine the situation staying the same and to view the picture carefully without trying to change the way they think about it. Note that all three of these instructions involve effortful regulatory processing. The active nature of the maintain control condition means that differences between it and the increase and decrease conditions reflect a change in emotional valence or arousal rather than effort.

Participants were instructed to keep their thoughts focused on the content of the pictures and not to think of something else, which would be more like distraction than reappraisal. In addition, participants were instructed not to think of the picture as unreal because such an approach would unlikely be used as a real-world emotion-regulatory strategy. Furthermore, they were told to view each picture the entire time it was on the screen without closing their eyes or looking away. Training was provided by way of 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. Afterward, the experimenter asked about the strategies that participants had used with the new sample pictures. Participants uniformly demonstrated the ability to generate reappraisals that conformed to the instructions they received.

Presentation of regulation conditions was pseudorandomized so that all three conditions followed one another with equal frequency. Three different condition orders were generated, one for each block of trials. Blocks were counterbalanced across participants, and pictures were randomly assigned to trials for each participant; thus, the picture order was unique for each participant.

The regulation trials were presented in three blocks of 18 trials, each using an event-related design. As depicted in Figure 3, each trial began with a white fixation cross presented in the center of a black screen for 3 s. The fixation cross was followed by the presentation of a picture for 12 s. The regulation instruction (increase, maintain, or decrease) was delivered either 2 s before picture onset in the anticipatory condition or 4 s after picture onset in the online condition. These specific timings were selected to be representative of past reports in which pictures were used to study the emotion regulatory effects of cognitive reappraisal on a trial-by-trial basis (e.g., Jackson et al., 2000; Johnstone et al., 2007; Ochsner et al., 2002, Ochsner et al., 2004; Urry et al., 2006; van Reekum et al., 2007). Participants were instructed to continue

[1] The following unpleasant pictures from the IAPS 2005 set, listed by catalog number, were used: 2053, 2205, 2800, 2900, 3000, 3030, 3051, 3053, 3060, 3061, 3062, 3064, 3080, 3100, 3102, 3130, 3150, 3160, 3168, 3170, 3181, 3220, 3230, 3261, 3266, 3300, 3301, 3350, 3400, 3530, 6200, 6213, 6230, 6300, 6313, 6350, 6560, 6570, 7380, 8230, 9040, 9180, 9253, 9300, 9320, 9405, 9421, 9561, 9611, 9630, 9800, 9810, 9910, and 9921.

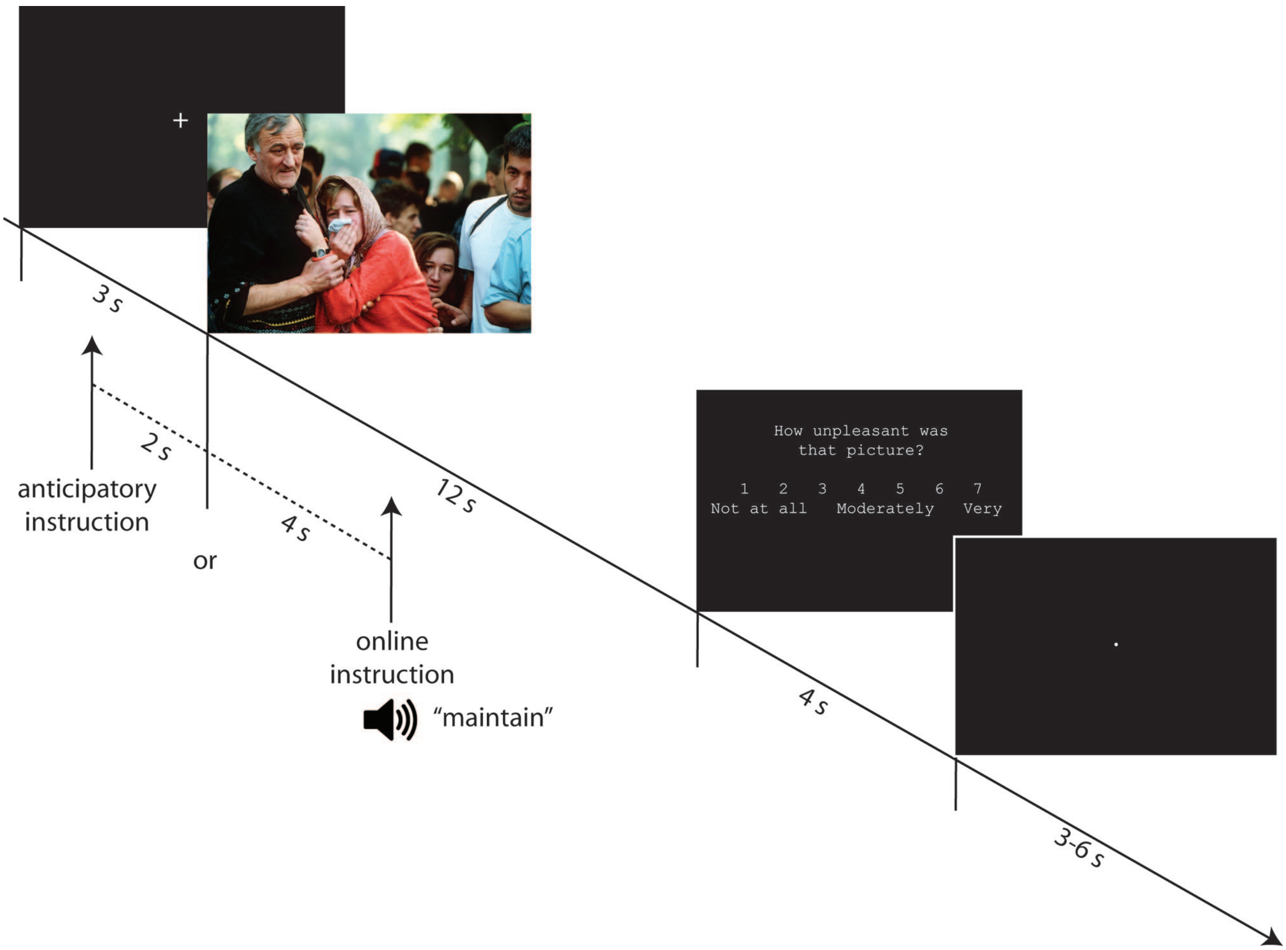

Figure 3. Trial structure. Photo of mourning family by Mikhail Evstafiev retrieved from http://commons.wikimedia.org/wiki/File:Evstafiev-bosnia-sarajevo-funeral-reaction.jpg on August 18, 2008. It has been reproduced with permission.

following the task instruction until the picture was removed from the screen. Participants were then asked to rate the unpleasantness of the picture with an on-screen question reading, "How unpleasant was that picture?" Responses were provided on a scale ranging from 1 (*not at all unpleasant*) to 7 (*very unpleasant*). They were instructed, "Please quickly select the number that best describes how you actually feel, and not how you think you should feel." The rating screen remained on screen for 4 s and was then replaced by a black screen with a central white fixation dot that lasted 3, 4, 5, or 6 s. Trials ranged in duration from 22 to 25 s (23.5 s on average).

After the reappraisal task had been completed, participants described what they thought the experiment was about and what strategies they used when instructed to increase, maintain, and decrease. Participants then completed a mood and anxiety symptoms questionnaire (data not reported). These postexperiment data were collected through Web-based questionnaires (www.SurveyMonkey.com) presented on the computer screen in front of them. Participants registered their answers using keyboard and mouse-click responses.

Peripheral Nervous System (PNS) Activity

PNS data were collected continuously with an MP150 data acquisition system (Biopac Systems, Inc., Goleta, CA) as participants completed the reappraisal task. All PNS measures were processed with ANSLAB, a suite of open source Matlab routines developed by Wilhelm and Peyk (2005), which is freely available in the software repository of the Society for Psychophysiological Research (http://www.sprweb.org).

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 pairs of 4-mm Ag/AgCl electrodes were placed in bipolar configuration over the left eye (corrugator) and left cheek (zygomatic; data not reported) according to guidelines described by Fridlund and Cacioppo (1986). One ground electrode was placed on the forehead. Before electrode placement, sites were swabbed with an alcohol prep pad and then gently debraded using an electrode prep pad. Corrugator activity was acquired continuously at 2000 Hz (bandpass-filtered online from 0.5 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 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, Miccoli, Escrig, & Lang, 2008). Two disposable Ag/AgCl electrodes pregelled with 7% chloride gel (1-cm circular contact area) were placed under the left and right collarbones on the chest after swabbing with an alcohol prep pad and then gently debrading 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 0.5 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. After such artifact correction, the IBI series was converted to HR in beats per minute. HR data were decimated to 10 Hz and then smoothed with a 1-s prior moving average filter.

EDA. EDA was selected as a pure measure of sympathetic activation of the PNS. In paradigms involving passive viewing of pictures, pleasant and unpleasant stimuli produce larger EDA compared with neutral pictures (Bradley et al., 2008). Two disposable Ag/AgCl electrodes pregelled 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 = 0.7 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. Trials with visible artifact were eliminated.

Data Reduction and Analysis

Online Reappraisal Manipulation Check

A premise of the online reappraisal timing manipulation was that regulatory processes were being engaged once emotional activation was present. Finding increased corrugator and EDA and deceleration in HR during the 4-s time period after picture onset but before delivery of the reappraisal instruction would be taken as evidence of this premise. Online reappraisal trials were aggregated over the first 4 s of picture onset, baseline corrected for the 100-ms (EDA, HR) or 250-ms (EMG) time bin immediately before picture onset. After baseline correction, the data for this 4-s window of interest were aggregated across trials within each cell (described by reappraisal goal) for each participant. The summary statistic (mean for corrugator EMG and HR, maximum for EDA) was averaged across reappraisal conditions, and an independent sample *t* test was performed to test whether the summary statistic was significantly different from zero. A significant nonzero difference would indicate that emotional activation was present during online reappraisal timing trials. Also, the effect of reappraisal goal (increase, maintain, decrease) was tested with a multivariate general linear model (GLM). Because the reappraisal instruction had not yet been delivered, no differences were expected to emerge in this analysis. These analyses were limited to the online (as opposed to anticipatory) condition, as these were the only trials for which the first 4 s of picture viewing was unencumbered by an explicit reappraisal instruction.

Effects of Reappraisal Goal and Timing

Because anticipatory and online reappraisals were enacted before and after emotion had been elicited, respectively, the physiological data were baseline corrected so that the comparisons of interest between reappraisal goals (increase vs. maintain, decrease vs. maintain) reflect changes in emotion that take into account different levels of activation at the starting point. Reappraisal-related change was thus captured by subtracting the baseline signal recorded during the 100-ms (EDA, HR) or 250-ms (EMG) time bin just before instruction delivery from all time points within an 8-s window immediately after this baseline period. During anticipatory trials the instruction was delivered 2 s before picture onset, and during online trials the instruction was delivered 4 s after picture onset. After baseline correction, the 8-s reappraisal window of interest was subdivided into early (first 4 s) and late (last 4 s) periods to enable detection of changes in the effect of reappraisal goal over time. The data were then aggregated across trials within each cell (described by reappraisal goal, timing, and period) for each participant. The summary statistic (mean for corrugator EMG and HR, maximum for EDA) was then tested with a multivariate GLM to assess the effects of reappraisal timing (anticipatory vs. online), reappraisal goal (increase, maintain, decrease), and time period (early, late).

Data Retention and Statistics

HR data for 1 participant were excluded because of poor signals. To prevent leveraging of findings by outlying values in the remaining participants, I eliminated trials falling more than 4 *SD* from the within-subjects mean on a measure-by-measure basis for each participant. Furthermore, multivariate outliers across participants were also eliminated (Mahalanobis distance, $p < .001$). Very little data were lost.

For each of four dependent measures, hypothesis testing was accomplished with a repeated measures GLM testing the independent and interactive effects of reappraisal goal (increase, maintain, decrease), and timing (anticipatory, online). For the physiological measures, time period within the trial (early, late) was a third within-subjects factor. Multivariate *F* statistics are reported. Significant main effects involving more than 1 degree of freedom were followed up with two planned comparisons (increase vs. maintain, decrease vs. maintain) using Fisher's least significant difference. Significant interaction effects were followed up with two planned contrasts, described later. Results were considered statistically significant at $\alpha = 0.05$. In addition, estimates of effect magnitude, partial eta-squared (η_P^2), are reported for each multivariate effect. Results were considered practically significant if $\eta_P^2 > .10$.

Results

Overview

The results are structured in three sections. In the first section, I report descriptive information about the strategies participants reported using when reappraising. In the second section, I present the results of the online reappraisal manipulation check. In the third section, I report the results of hypothesis testing, in which I examine the effects of reappraisal goal (increase vs. maintain, decrease vs. maintain) and how the effects of reappraisal goal depend on macrolevel reappraisal timing.

Did Participants Follow the Prescribed Instructions?

Participants were instructed to use specific strategies to meet the reappraisal goals of increasing, maintaining, and decreasing their negative emotions. The strategies that participants reported were therefore inspected to determine to what extent they actually followed those instructions. Strategy data were available for 38 participants.

When increasing, participants were instructed to imagine the situation getting worse. Of 38 participants, 34 reported using this strategy. A number of them ($n = 17$) also (or instead) reported using self-focused strategies that amplified the self-relevance of the events depicted. When maintaining, participants were instructed to imagine the situation staying the same and to view the picture carefully without trying to change how they think about it. All participants reported doing so. Some also reported concentrating on the details ($n = 4$), trying to empty their mind ($n = 1$), or trying to ignore the picture ($n = 1$). When decreasing, participants were instructed to imagine the situation getting better. Of 38 participants, 36 reported using this strategy. A few of them ($n = 3$) also reported using self-focused strategies that minimized the self-relevance of the events depicted. A number of them ($n = 6$) also reported sometimes viewing what they were seeing as fake or unreal.

Overall, the reported strategies indicated that participants followed the instructions given to them with respect to increasing, maintaining, and decreasing their emotional response to the pictures. Note that participants were also asked what they thought the experiment was about. Of 38 participants, 14 reported believing the experiment had something to do with the ability to alter emotional responses.

Has Emotion Been Effectively Activated for Online Reappraisal?

Emotional activation to unpleasant pictures was expected to include increased corrugator activity, increased EDA, and decreased HR over the 4-s period of interest during online reappraisal trials. As expected, means across what would become increase, maintain, and decrease trials when the instruction was eventually delivered revealed significant increases in both corrugator activity, $M = 1.25$, $SD = 1.05$, $t(37) = 7.33$, $p < .001$; and EDA, $M = 0.11$, $SD = 0.14$, $t(38) = 5.01$, $p < .001$; and a significant decrease in HR, $M = -0.61$, $SD = 1.19$, $t(39) = -3.32$, $p = .002$, within 4 s after picture onset. As the reappraisal instruction had not yet been delivered, it was expected that there would be no differences in activity as a function of the reappraisal goal. This was true for corrugator activity and HR, both ps $> .10$ and η^2_P s $< .10$. For EDA, the effect of reappraisal goal was nearly significant, $F(2, 37) = 3.24$, $p = .051$, $\eta^2_P = .15$, an effect driven by the fact that EDA was higher when increasing, $M = 0.13$, $SE = 0.03$, than when maintaining, $M = .09$, $SE = .02$, before delivery of the instruction, $p = .015$.

Overall, these results confirm the notion that online reappraisals were, in fact, delivered when emotion was present. In addition, they more generally suggest that the intended unpleasant emotional state was elicited by these pictures. This conclusion is bolstered by the fact that, in the preceding task in which participants passively viewed unpleasant and neutral pictures, the unpleasant pictures produced greater corrugator activity and greater deceleration in HR compared with the neutral pictures (data not shown).

Hypothesis Testing

Figure 4 presents the means for self-reported negative emotion. Figures 5, 6, and 7 present the time course for baseline-corrected change in corrugator activity, HR, and EDA, respectively, for the

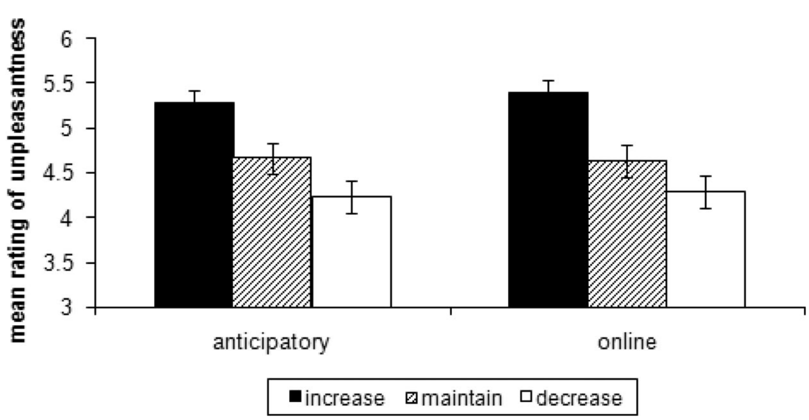

Figure 4. Mean ratings of unpleasantness as a function of reappraisal goal and timing. Solid black bars indicate increase reappraisals, white bars with black hash marks indicate maintain reappraisals, and solid white bars indicate decrease reappraisals. Instructions were delivered with anticipatory timing (i.e., 2 s before picture onset) for bars on the left side of the figure and with online timing, (i.e., 4 s after picture onset) for bars on the right side of the figure. Error bars represent ±1 standard error.

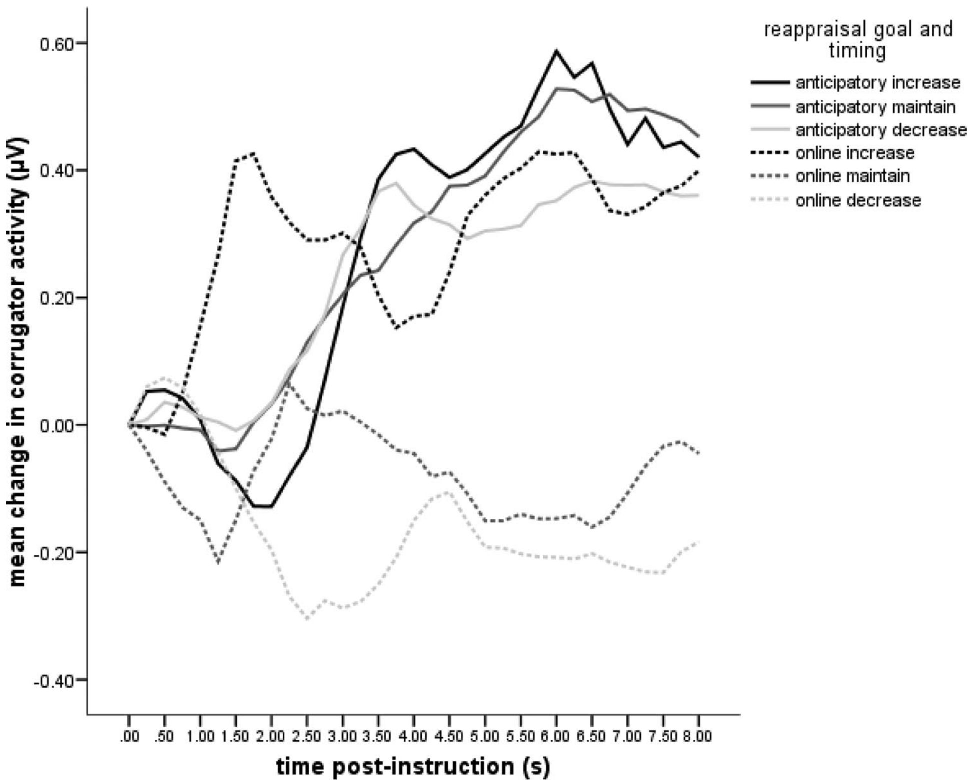

Figure 5. Change in mean corrugator activity in microvolts as a function of reappraisal goal and timing. Black lines indicate increase reappraisals, dark gray lines indicate maintain reappraisals, and light gray lines indicate decrease reappraisals. Instructions were delivered with anticipatory (solid lines) or online timing (dotted lines).

8 s after delivery of the reappraisal instruction. In addition, means and standard deviations for all measures are presented in Table 1. Table 2 provides a simple summary of the results of hypothesis testing. Note that time period within the trial did not interact with reappraisal goal, nor were there any three-way interactions between time period, reappraisal goal, and timing. Time period within the trial is thus not considered further.

Does Cognitive Reappraisal Affect the Multisystem Emotion Response?

I expected that increase reappraisals would lead to increased reports of negative emotion, increased corrugator activity, and increased autonomic arousal compared to the maintain condition, a pattern signifying success in meeting the regulatory goal to increase negative emotion. I further expected that decrease reappraisals would lead to decreased reports of negative emotion and decreased corrugator activity, a pattern signifying success in meeting the regulatory goal to decrease negative emotion. Consistent with these hypotheses, ratings of unpleasant emotion, $F(2, 39) = 37.67$, $p < .001$, $\eta_P^2 = .66$, were higher when increasing ($M = 5.34$, $SE = 0.14$) compared with maintaining ($M = 4.65$, $SE = 0.16$), $p < .001$, and lower when decreasing ($M = 4.26$, $SE = 0.17$) compared with maintaining, $p < .001$. Similarly, corrugator muscle activity, $F(2, 38) = 3.62$, $p = .037$, $\eta_P^2 = .16$, was higher when increasing ($M = 0.30$, $SE = 0.09$) compared with maintaining ($M = 0.05$, $SE = 0.05$), $p = .012$; but there was no difference in corrugator activity for decreasing ($M = 0.09$, $SE = 0.04$) compared to maintaining, $p = .420$.

With respect to autonomic arousal, there was a main effect of reappraisal goal on HR, $F(2, 38) = 4.05$, $p = .026$, $\eta_P^2 = .18$; indicating that HR was higher when increasing ($M = 0.31$, $SE = 0.21$) compared with maintaining ($M = -0.26$, $SE = 0.19$), but this difference was only a trend with the two-tailed test, $p = .088$. Given previous reports, I did not expect that decrease reappraisals would necessarily affect autonomic physiology. Indeed, there was no difference in HR for decreasing, $M = -0.46$, $SE = 0.25$, compared with maintaining, $p = .548$. The main effect of reappraisal goal was not significant for EDA, $F(2, 39) = 1.12$, $p = .337$, $\eta_P^2 = .06$, which suggests that reappraisal had no affect on this aspect of autonomic physiology across reappraisal timings.

Does the Impact of Reappraisal Goal Depend on Reappraisal Timing?

I expected that increase reappraisals (relative to maintain reappraisals) would be more successful when initiated with online as opposed to anticipatory reappraisal timing and that decrease reappraisals (relative to maintain reappraisals) would be more successful when initiated with anticipatory, as opposed to online, reappraisal timing. This hypothesis was tested by examining the interaction between reappraisal goal and reappraisal timing. The

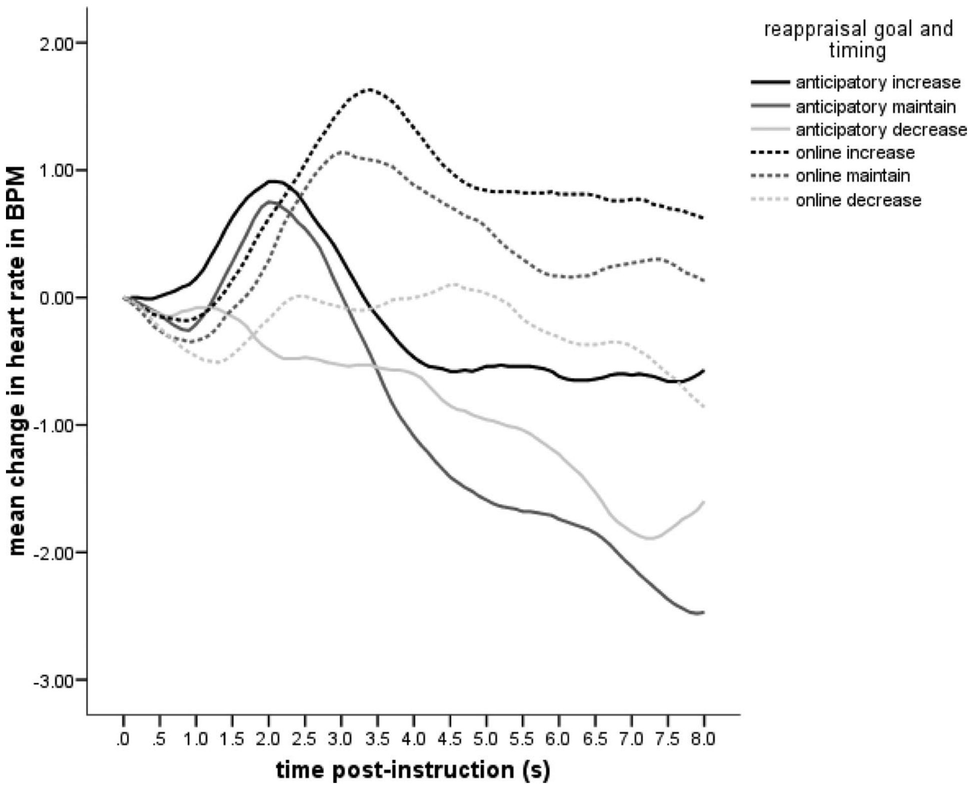

Figure 6. Change in mean heart rate in beats per minute as a function of reappraisal goal and timing. Black lines indicate increase reappraisals, dark gray lines indicate maintain reappraisals, and light gray lines indicate decrease reappraisals. Instructions were delivered with anticipatory (solid lines) or online timing (dotted lines).

interaction was statistically significant for EDA, $F(2, 39) = 3.92$, $p = .028$, $\eta_P^2 = .17$. For corrugator muscle activity, although the interaction was not statistically significant, $F(2, 38) = 2.36$, $p = .109$, $\eta_P^2 = .11$, the effect magnitude suggested a practically significant effect that merited follow-up (i.e., because $\eta_P^2 > .10$).[2]

To follow up on these effects, I computed planned contrast scores (or *L* scores) for each participant using the method described by Rosenthal, Rosnow, and Rubin (2000). To capture an effect in which increase reappraisals exact greater response than maintain reappraisals in the online condition relative to the anticipatory condition, I computed the following contrast score for each participant separately for EDA and corrugator activity: (online increase value—online maintain value) − (anticipatory increase value—anticipatory maintain value). This score was then tested in a one-sample *t* test (test value = 0) for each of the two measures (one-tailed, only positive *t* values were of interest). The predicted effect was obtained for both EDA, $t(38) = 1.93$, $p = .031$; and corrugator activity, $t(39) = 1.67$, $p = .052$.

To capture an effect in which decrease reappraisals exact lower response than maintain reappraisals in the anticipatory condition than in the online condition, the following contrast score was computed for each participant separately for EDA and corrugator activity: (anticipatory maintain value—anticipatory decrease value) – (online maintain value—online decrease value). This score was then tested in a one-sample *t* test (test value = 0) for each of the two measures. Neither analysis revealed the predicted effect, EDA $t(38) = -0.46$, $p = .652$; and corrugator activity $t(39) = 0.103$, $p = .918$.

The interaction between reappraisal goal and reappraisal timing was not statistically significant for ratings of negative emotion, $F(2, 39) = 0.60$, $p = .556$, $\eta_P^2 = .03$; or HR, $F(2, 38) = 0.69$, $p = .509$, $\eta_P^2 = .04$. Moreover, in neither case did the η_P^2 exceed the .10 criterion for practical significance. Thus, there was no support for the importance of macrolevel timing with regard to the effects of reappraisal goal on these two measures.

What is the Effect of Reappraisal Timing on the Multisystem Emotion Response?

Although no predictions were made concerning the main effects of reappraisal timing, the pertinent results from the aforementioned analyses are reported here for the sake of completeness. A significant main effect of reappraisal timing emerged for corrugator muscle activity, $F(1, 39) = 13.18$, $p = .001$, $\eta_P^2 = .253$; HR, $F(1, 39) = 9.10$, $p = .004$, $\eta_P^2 = .19$; and EDA, $F(1, 40) = 4.60$, $p = .038$, $\eta_P^2 = .103$. In all cases, greater emotional activation was evident with anticipatory compared with online timing, all *p*s $< .05$. Specifically, corrugator activity and EDA were higher for anticipatory timing ($M = 2.65$,

[2] Controlling for preexisting levels of EDA and corrugator activity before delivery of the online reappraisal instruction has no effect on these results.

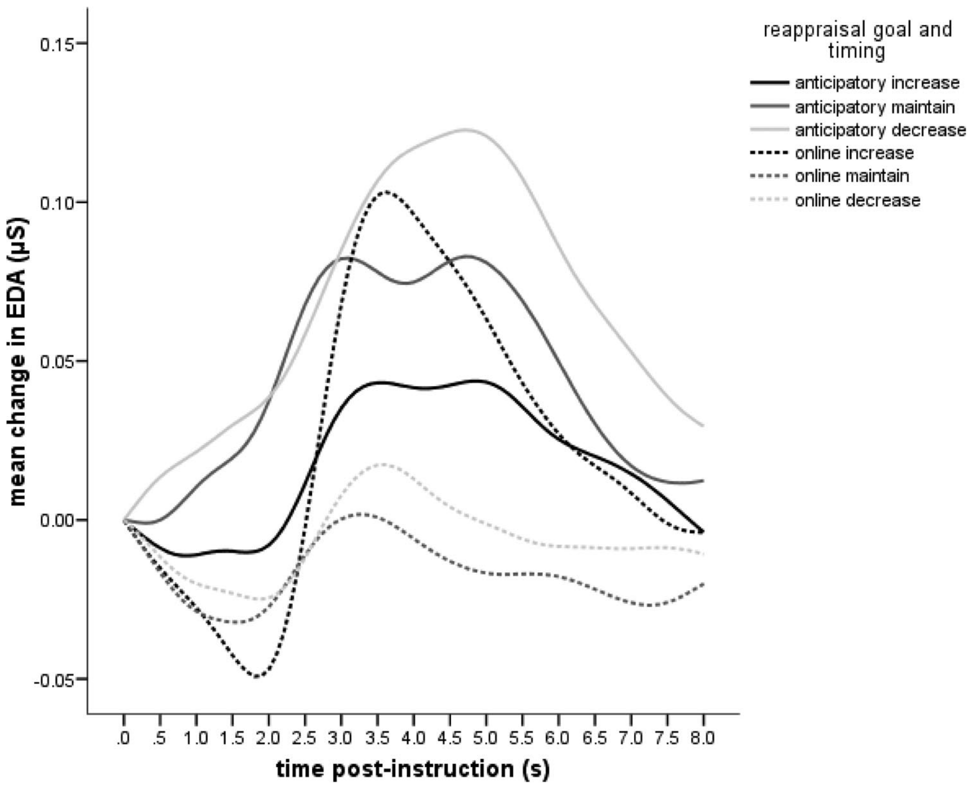

Figure 7. Change in mean electrodermal activity (EDA) in microSiemens as a function of reappraisal goal and timing. Black lines indicate increase reappraisals, dark gray lines indicate maintain reappraisals, and light gray lines indicate decrease reappraisals. Instructions were delivered with anticipatory (solid lines) or online timing (dotted lines).

$SE = 0.072$ and $M = 0.16$, $SE = 0.028$, respectively) than for online timing ($M = 0.026$, $SE = 0.038$ and $M = 0.11$, $SE = 0.025$, respectively), whereas HR was lower for anticipatory timing ($M = -0.58$, $SE = 0.18$) than for online timing ($M = 0.31$, $SE = 0.20$). There was no main effect of reappraisal timing on ratings of unpleasant emotion, $F(1, 40) = 0.43$, $p = .518$, $\eta^2_P = .011$.

Discussion

Summary of the Effects of Reappraisal Goal and Timing

The most novel finding of importance in this study is that the timing with which situation-focused reappraisals were imple-

Table 1
Means (and Standard Deviations) for the Dependent Measures as a Function of Reappraisal Goal and Timing (Columns), and Time Period (Rows)

	Anticipatory timing			Online timing		
Measure	Increase	Maintain	Decrease	Increase	Maintain	Decrease
Ratings of unpleasantness	5.28 (0.95)	4.67 (1.11)	4.24 (1.13)	5.4 (0.95)	4.63 (1.12)	4.29 (1.15)
Corrugator activity						
Early	0.18 (0.55)	0.09 (0.35)	0.15 (0.4)	0.16 (0.56)	−0.13 (0.51)	−0.1 (0.25)
Late	0.53 (1.03)	0.31 (0.47)	0.33 (0.76)	0.32 (0.65)	−0.08 (0.5)	−0.02 (0.3)
Heart rate						
Early	0.27 (1.53)	0.07 (1.59)	−0.32 (1.59)	0.66 (1.38)	0.39 (1.2)	−0.18 (2.2)
Late	−0.52 (2.22)	−1.74 (2.63)	−1.24 (2.58)	0.83 (2.52)	0.26 (2.38)	−0.1 (2.79)
Electrodermal activity						
Early	0.14 (0.15)	0.2 (0.28)	0.2 (0.23)	0.17 (0.26)	0.08 (0.09)	0.09 (0.11)
Late	0.12 (0.19)	0.13 (0.22)	0.16 (0.22)	0.17 (0.33)	0.09 (0.16)	0.09 (0.15)

Note. For anticipatory timing, instruction was provided 2 s before picture onset; for online timing, instruction was provided 4 s after picture onset. Early = first half (first 4 s) of the reappraisal period; Late = second half (last 4 s) of the reappraisal period.

Table 2
Simple Summary of Experimental Findings Across Measures

<table>
<tr><th>Reappraisal</th><th>Ratings</th><th>Corrugator</th><th>Heart rate</th><th>Electrodermal activity</th></tr>
<tr><td>Increase–maintain</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Anticipatory</td><td rowspan="2">⬆</td><td>○</td><td rowspan="2">⬆</td><td>○</td></tr>
<tr><td>Online</td><td>↑</td><td>↑</td></tr>
<tr><td>Decrease–maintain</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Anticipatory</td><td rowspan="2">⬇</td><td>○</td><td rowspan="2">◯</td><td>○</td></tr>
<tr><td>Online</td><td>○</td><td>○</td></tr>
</table>

Note. An upward-pointing arrow indicates that the effect was positive (i.e., increase > maintain), and a downward-pointing arrow indicates that the effect was negative (i.e., decrease < maintain). An open circle indicates the effect was not significant. When the shapes in a column overlap both the anticipatory and online cells, this indicates that the main effect of regulatory goal did not interact with reappraisal timing.

mented within an emotion episode was an important determinant of goal-consistent regulatory success, at least when the regulatory goal was to increase one's ongoing level of response activation to unpleasant stimuli. Specifically, increase reappraisals were more effective in potentiating expressive behavior (as indexed by activity over the corrugator muscle region) and autonomic physiology (as indexed by EDA) when they were engaged online (i.e., during the ETE) compared with when they were engaged in an anticipatory fashion. Reappraisal timing did not moderate the effect of increase reappraisals on self-reported negative emotion or on changes in HR. Surprisingly, reappraisal timing also did not moderate the effect of decrease reappraisals on any index of unpleasant emotion. In fact, decrease reappraisals affected neither expressive nor physiological measures of emotional responding, regardless of reappraisal timing. I discuss these results later, a simple summary of which is provided in Table 2.

Reappraisal Timing Moderates the Effect of Increase Reappraisals

When reappraisal instructions were provided with online timing, increase reappraisals produced greater EDA and corrugator activity compared with maintain reappraisals, but this was not true when the same instructions were provided with anticipatory timing. When it came to HR and subjective emotion experience, however, timing did not matter: Regardless of reappraisal timing, increase reappraisals led to faster HR and higher ratings of negative emotion than maintain reappraisals. This pattern provides support for the notion that the ability to increase emotion expressive behavior and sympathetically mediated autonomic arousal is potentiated when the emotional reaction is already online, as predicted by the macrolevel timing considerations proposed earlier. By contrast, the low level of activation that was present during anticipatory reappraisal timing may have hampered the success of increase reappraisals.

It has been suggested by Sheppes and Meiran (2007) that reappraisal would be very difficult if engaged online during the course of an ETE. Their discussion focused, however, on the use of reappraisal to reduce or minimize sad emotion. What these results underscore is the importance of considering reappraisal goal: We can modify our emotions to be less *or more* intense by virtue of the meanings that we attach to the situations that we face. These data call attention to the idea that reappraisals with a goal of ramping up unpleasant emotion have a bigger impact when one waits to reappraise until level of emotional activation is already high. This moderating effect of reappraisal timing on the impact of increase reappraisals on autonomic physiology was only significant for EDA and not for HR. This indicates that the moderating effect was sympathetically mediated.

Implications for the Process Model of ER

The process model of emotion regulation (Gross, 1998; Gross & Thompson, 2007) proposes that emotion regulatory processes have divergent consequences as a function of whether they target emotion antecedents or the multisystem response, which vary as a function of time at a microlevel in each emotion-generative cycle. Those that target the response are predicted to be more costly than those that target the antecedents, because one is attempting to act on responses that have been partially or fully activated. I have suggested that it may be useful to also consider a similar logic about the effect of timing at a macrolevel, specifically at the level of emotion episodes, which are made up of many emotion-generative cycles. In a test of this notion, reappraisals were instructed either in anticipation of an ETE (in this case, pictures) or once emotion was online.

I argue that the macrolevel timing effects in this study emerged because of differences in the level of emotional activation at the time that regulatory processes were invoked and not as a function of macrolevel timing per se (i.e., absolute time relative to the onset of an ETE). If true, this leads to the prediction that differences between regulatory goals (e.g., increase > maintain reappraisals) should track online level of emotional activation in the continued presence of the ETE. For example, referring to Figure 2, engaging an increase reappraisal during the second emotion-generative cycle (when emotional activation is high) would be expected to be more effective compared with engaging an increase reappraisal during the tail end of the third emotion-generative cycle (when emotional activation is low), even though the third cycle occurs later in the emotion-generative episode.

If, on the other hand, the effect observed here really is about timing per se, then differences between regulatory goals enacted with online timing should be obtained regardless of level of activation, which would mean either no difference in effectiveness of increase reappraisals during the second and third cycles, or an even more pronounced effect for the third cycle. This latter effect would be consistent with the position taken by Sheppes and Meiran (2007), who proposed that there is a "point of no return," at which point emotional activation swamps one's ability to use reappraisal to good effect. Only one online reappraisal timing was studied here, selected to fall at a point in time when emotional activation was at or near its peak; thus, these predictions must be tested in suitably designed follow-up studies. Moreover, only one ER process, cognitive reappraisal, was studied. Cognitive reappraisal always targets the appraisal event within each emotion-generative cycle. In subsequent work, it would be worthwhile to examine two or more ER processes that operate on different targets and also to manipulate the level of emotional activation and macrolevel regulatory timing in the same study. This would allow one to examine their independent effects and whether they interact in important ways as well.

Why Doesn't Timing Moderate the Effects of Reappraisals on Subjective Emotion Experience?

Increase and decrease reappraisals were effective in modulating subjective emotion experience in accordance with the regulatory goal, which might suggest that reappraisals focused on imagining different outcomes of the scenes depicted were highly effective in modulating the experience of unpleasant emotion. An alternative account of this pattern is that demand characteristics were operating as participants were explicitly asked to think about the situations in the pictures getting worse or better. However, after excluding the 14 participants who reported knowing that the study involved an interest in the ability to alter emotional responses (data not reported), the results for ratings of emotion experience were exactly the same, with no decrement in variance explained. Moreover, previous studies have, in fact, demonstrated differences in expressive behavior and physiology (Deveney & Pizzagalli, 2008; Gross, 1998; Jackson et al., 2000). It thus seems unlikely that the effects on self-reported emotion are fully driven by demand characteristics.

If the self-report ratings are accepted as valid indicators of subjective emotion experience, an important question remains: Why was the effect of reappraisal goals on subjective emotional experience independent of reappraisal timing? One possibility is simply that the timing with which one generates reappraisals of unpleasant visual stimuli within a larger emotion episode makes no difference in determining the phenomenological output of the reappraisal process. The phenomenological output of the reappraisal process may be insensitive to subtle differences, particularly when measured retrospectively at the end of each trial. Those differences may be better captured in the continuous measures of expressive and electrodermal output, which perhaps explains why the timing effect is evident for increase reappraisals for those measures. Had there been a continuous measure of emotional experience, perhaps timing effects would have emerged.

However, this conclusion is inconsistent with the Sheppes and Meiran (2007) study in which participants reported greater reductions in negative affect when reappraisal occurred in advance of or early in the sad film period compared with late, even without continuous measurement of emotional experience. It is noteworthy that, with protections against demand characteristics in place in their third experiment, Sheppes and Meiran did not observe a difference in experienced negative affect as a function of reappraisal timing, supporting the possibility that demand characteristics contributed to the late versus early reappraisal effects on ratings of negative emotion in the two previous experiments.

Given that reappraisal timing did not moderate the effects of reappraisal goal on subjective emotional experience in the present study and the fact that reducing demand characteristics mitigated the reappraisal timing effect in Sheppes and Meiran (2007), one might want to conclude that reappraisal timing at the level of the emotion episode does not affect the phenomenological output of the reappraisal process. Such a conclusion is, however, premature because it is based on only two studies. Moreover, careful inspection of the pattern of means for subjective emotion experience presented in Figure 4 indicates exactly the predicted pattern. The increase > maintain effect was larger with online than anticipatory timing (Cohen's dz = .17), and the maintain > decrease effect was larger with anticipatory than online timing (Cohen's dz = .09). However, these are very small effects, which were not statistically significant (small enough to be of questionable practical importance, too). Nevertheless, they are consistent with the macrolevel timing considerations of primary concern in this report and thus argue against concluding at this point that reappraisal timing has no effect on subjective emotional experience.

What Explains the Relative Lack of Decrease Reappraisal Effects?

As noted earlier, regardless of whether the instructions were delivered with anticipatory or online timing, there were strong effects of the decrease reappraisal goal on subjective emotional experience: Decrease reappraisals prompted lower ratings of unpleasantness compared with maintain reappraisals. However, in no case did decrease reappraisals yield significantly different expressive behavior or autonomic physiology (HR, EDA) compared with maintain reappraisals. Moreover, in no case did the effect of decrease reappraisals depend on whether they were engaged with anticipatory or online reappraisal timing. Several factors may have contributed to these null results.

First, the lack of decrease reappraisal effects may be a function of previous exposure to the unpleasant images. At the time they completed the reappraisal task, participants had already seen the unpleasant pictures (along with a set of neutral pictures) in a previous task. The purpose of the previous exposure was to provide a means for assessing natural emotion reactivity in a way that would not be systematically affected by the reappraisal strategies that participants would later be trained to use. However, I suspect that previous exposure may actually lead to one's initial negative interpretation of the image becoming somewhat "entrenched." Entrenchment of the initial negative interpretation of an emotion-triggering event might hinder the success of decrease reappraisals because the initial negative interpretation is inconsistent with the goal of making the picture less unpleasant. By contrast, entrenchment of the initial negative interpretation might actually encourage the success of increase reappraisals because the initial negative interpretation is consistent with the goal of making the picture more unpleasant.

Second, the lack of decrease reappraisal effects may be the result of high cognitive load in this experimental context. Participants were asked to meet three different regulatory goals on a randomized trial-by-trial basis, which was complicated by the fact that these goals were delivered at varying points in time within a constant stream of unpleasant images. Participants may have simply been unable to devote sufficient resources to generating reappraisals that effectively decrease negative emotion, which has been reported to be more difficult than generating reappraisals that effectively increase negative emotion (see, e.g., Ochsner et al., 2004). Expressive behavior and autonomic physiological response systems may be differentially sensitive to this tax on cognitive resources, which would explain why subjective emotion experience alone confirms that participants were able to meet the reappraisal goal of decreasing negative emotional experience.

Finally, the lack of decrease reappraisal effects in this study might also be due to the nature of the reappraisal instructions that were provided. In the present study, participants were encouraged to use a situation-focused approach (focusing on different possible outcomes) and were explicitly barred from using the self-focused approach of viewing what they were seeing as fake or unreal, a strategy that few actually used in this study but that many people have reported using in past research (Jackson et al., 2000). Within the context of picture-induced emotion, detaching oneself by viewing the images as fake or unreal may be the most effective way of reducing aversive emotion. Subjective emotional experience may be less sensitive to subtle differences in strategy, which would explain why it alone shows any sign that decrease reappraisals actually reduced negative emotional experience.

Limitations and Additional Directions for Future Research

This study presents highly novel and important findings regarding the impact of experimentally manipulated reappraisal goals and timing on unpleasant emotion. In summary, I found that increase reappraisals were more successful in terms of expressive and autonomic effects when engaged with online than anticipatory reappraisal timing, yet there was no reliable evidence for a moderating role of reappraisal timing on the effects of decrease reappraisals. On one hand, this pattern may suggest an interesting asymmetry with respect to competing reappraisal goals; that is, that reappraisal timing matters for increase reappraisals but does not matter for decrease reappraisals. On the other hand, in light of my aforementioned speculations about factors contributing to the absence of decrease reappraisal effects, future research (using novel stimuli, a less complex task, and/or different reappraisal strategies) may yet expose a moderating role of reappraisal timing on decrease reappraisals in line with the predictions described in this report (as hinted by the small effects in the self-report ratings of unpleasantness). This would mean that reappraisal timing matters for *both* increase and decrease reappraisals. This intriguing pair of competing conclusions will need to be adjudicated in future research.

Future research will also be useful in addressing the limitations of this study, four of which are discussed here. First, as operationalized in this study, there were differences between the anticipatory and online reappraisal timing conditions that may have contributed to the pattern of findings. For one, participants were asked to regulate their response to stimuli that ranged from moderately unpleasant images such as sad children to highly disturbing images of bloody mutilated faces. For anticipatory trials, participants could not predict what exactly they were about to see or how unpleasant it would be, but for online trials, the picture had been present for several seconds by the time they were asked to regulate their response. Moreover, for anticipatory trials, the presence of a reappraisal instruction alerted participants that they would soon be seeing an unpleasant picture, but for online trials, there was no such instructional alerting cue. Finally, for anticipatory trials, the 8-s reappraisal window of interest involved processes associated with initial evaluation of and reactions to the image (“what”) as well as processes associated with generation of an appropriate reappraisal (“how”). For online trials, the 8-s reappraisal window of interest would have been dominated more by the “how,” as the “what” would have been dispensed with in the 4 s before the instruction was presented. These differences in anticipatory uncertainty and alerting, and postpicture onset processing together may explain the overall greater emotional activation associated with anticipatory, compared with online, reappraisal timing across reappraisal goals. It may very well be that anticipatory reappraisal of known circumstances (e.g., reappraising an upcoming exam to reduce anxiety) may evoke a different pattern of response.

Second, it has been suggested that providing verbal information before or during emotional provocation does not directly manipulate appraisals. Parkinson (1997) wrote: “The interpretations encouraged by the instructions may have influenced other variables such as involvement, identification, empathy, attentional allocation, cognitive coping, self-distraction, and so on, which in turn had direct effects on emotional reaction” (p. 70). Previous work has suggested, for example, that participants may close their eyes or shift their gaze away from the salient emotional objects to decrease their emotional response (Johnstone et al., 2007; van Reekum et al., 2007; Xing & Isaacowitz, 2006). Thus, it is possible that processes other than reappraisal (e.g., eye gaze) produced the effects reported or that eye gaze shifts represent an important process in reappraising visual stimuli. Studies that independently manipulate cognitive change and, for example, attentional deployment families of ER processes in the same people are needed (see, e.g., Urry, in press; or McRae, Hughes, Chopra, Gabrieli, Gross, & Ochsner, in press).

Third, the design of this study implies a dimensional rather than discrete theory of emotion. The dimensional approach suggests that variations in the emotion landscape are well described by two dimensions, valence (pleasantness) and arousal (activation). Pictures were therefore selected to be both highly unpleasant and highly arousing, but they were not selected with respect to specific emotions (e.g., disgust, anger, sadness), and no pleasant emotional states were evaluated. This means that it cannot be determined here whether specific negative or positive emotions would yield a different set of findings or if the findings reported reflect valence, arousal, or both, as the two are confounded in the set of pictures used.

Finally, all of the participants were college-aged young adults living in a Western culture, and most were White. In addition, although both women and men were studied, gender was not included as a factor in the design. Studies indicate that ER processes in adulthood may vary over the course of the life span (see review by Carstensen, 2006) and for different cultural groups therein (Fung, Isaacowitz, Lu, Wadlinger, Goren, & Wilson, 2008). ER processes may also operate differently in men and women (McRae et al., 2008). Unfortunately, the sample was homogeneous with respect to age and culture, and there was an imbalance in the number of women and men, an imbalance that dampened the utility of including gender as a factor in these analyses. Age, culture, and gender are important factors to consider as researchers further develop our understanding of ER and the factors influencing regulatory success.

Conclusion

This work is predicated on the notion that humans are capable of regulating their emotions. As articulated by Gross and Thompson (2007), the process model of ER suggests that emotional episodes to be regulated are potentially made up of many emotion-generative cycles. These emotion-generative cycles provide targets for emotion regulatory processes that can be subdivided on a microlevel time scale into the antecedents, which occur early, and the multisystem response, which occurs late. It is important to note that RF ER processes are thought to be less effective than AF ER processes because they are brought to bear on response tendencies that have already been activated at the microlevel.

A novel conceptual contribution of the work presented here is the idea that there is a larger macrolevel time scale to consider, (i.e., that which unfolds over the course of the larger emotion episode) and that a similar logic regarding regulatory success can be applied (i.e., that regulatory processes brought to bear late in the emotion episode might be differentially effective compared with those that are brought to bear early because of differences in level of emotional activation). A subset of these ideas was tested by manipulating three reappraisal goals (increase, maintain, decrease) and two reappraisal timings (anticipatory, online) to determine their independent and interactive effects on negative emotion.

Use of multiple measures of emotional responding, including subjective ratings of experience, micromomentary expressive behavior, and autonomic physiology, enabled the important conclusion that the success of reappraisal goals—specifically, the goal to increase unpleasant emotion—depended on reappraisal timing within the emotion episode. Because the target of regulation was held constant across the anticipatory and online timings that were tested, this approach isolated macrolevel timing as a separable factor that governs emotion regulatory success. I speculated that macrolevel regulatory timing effects emerge because of differences in level of emotional activation at different times in the emotional episode, but further studies are needed to test this notion. In conclusion, the distinction between timing at the level of the emotion-generative cycle and timing at the level of the emotion episode may prove to be very important in refining our understanding of ER.

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