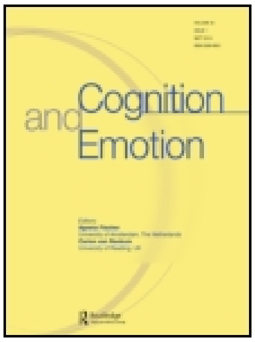

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Unconscious emotion regulation: Nonconscious reappraisal decreases emotion-related physiological reactivity during frustration

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Reappraisal of negative events is known to be useful in decreasing their emotional impact. However, existent evidence for this conclusion mostly relies on conscious, deliberate reappraisal that comes with the cost of cognitive efforts. The aim of the present study was to compare emotion regulation effects of conscious and unconscious reappraisal, which has been shown to be less costly in previous studies. Subjects randomly assigned to an unconscious reappraisal, conscious reappraisal, and control condition performed a frustrating arithmetic task. Subjective emotional experience and heart-rate reactivity were recorded. Participants primed with unconscious reappraisal showed the same decrease in heart-rate reactivity as those explicitly instructed to reappraise. In addition, the unconscious reappraisal group did not show reductions in subjective negative emotion, whereas this was significantly decreased in the conscious reappraisal group. Heart-rate reactivity was positively correlated with negative emotion ratings and negatively correlated with the positive emotion ratings. These results suggest that unconscious reappraisal is only effective in decreasing physiological consequences of frustrating emotion, but not in reducing subjective experience.

Keywords: Unconscious; Emotion regulation; Reappraisal; Frustration; Heart rates.

In daily life, people are surrounded by all kinds of emotional stimuli. Although emotions can be useful, some task-irrelevant, disruptive emotion states need to be regulated to avoid interference with ongoing activities, situational demands or long-term goals. Successful control of emotional impulses is important

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for an individual's well-being, health and social functioning (Davidson, MacGregor, Stuhr, Dixon, & MacLean, 2000; Davidson, Putnam, & Larson, 2000; Gross, 2001; Mayer & Salovey, 1995). Most of prior emotion regulation studies focused on conscious, deliberative and resource-demanding strategies, such as strategic reappraisal (Gross, 2001), effortful distraction (Van Dillen & Koole, 2007) and suppression of emotional responses (Butler et al., 2003).

However, it has been acknowledged that the performance of conscious emotion regulation may result in a number of maladaptive consequences, such as the cost of cognitive resources or the increase of physiological activity (Bonanno, Papa, Lalande, Westphal, & Coifman, 2004; Gross, 1998). Specifically, it has been consistently reported that the conscious suppression of negative emotion enhances sympathetic physiological activations, disrupts social and cognitive dysfunctioning (Butler, Lee, & Gross, 2007) or even impairs physical health. Recent research, however, has found that when implicit (largely unconscious) processes are strongly involved in emotion regulation (Fiori, 2009; Koole, 2009; Mauss, Bunge, & Gross, 2007; Phillips, Ladouceur, & Drevets, 2008), these adverse outcomes were absent (Mauss, Bunge, et al., 2007; Mauss, Cook, & Gross, 2007). For example, previous studies showed that priming unconscious regulation goals decreased experienced anger without maladaptive physiological consequences (Mauss, Cook, et al., 2007), and that automatic attention shifted from negative to positive cues, resulting in enhanced positive affects in older people (Carstensen & Mikels, 2005; Isaacowitz, Wadlinger, Goren, & Wilson, 2006; Mauss, Bunge, et al., 2007).

Based on this evidence, we propose that it may at times be more adaptive to regulate emotions implicitly. Implicit emotion regulation is defined as the process to modify the quality, intensity or duration of emotional responses without the need for conscious supervision and explicit intentions (Koole & Rothermund, 2011). Implicit emotion regulation is often realised by unconscious goal pursuit, using an emotion-evoking task with an unconscious priming procedure. For instance, Mauss, Cook, et al. (2007) found that unobtrusively priming people with emotional control words (e.g., cool, covered) led to less angry experiences in response to a laboratory anger provocation, compared with people primed with words related to emotion expressions (e.g., volatile, boiled). Additionally, Gallo, Keil, McCulloch, Rockstroh, and Gollwitzer (2009) showed that automatizing emotion regulation goals by an implementation practice reduced negative affective reactivity to mutilation images in disgust-sensitive individuals and to fearful images in spider-fearful individuals (Gallo et al., 2009), though reducing negative affect was not explicitly requested. Recently, it was also found that creating an implementation intention alone (e.g., "if I see a dog approaching me, then I will stay calm", Eder, 2011; Eder, Rothermund, & Proctor, 2010), is sufficient to change emotion-relevant behaviours even in the absence of implementation practices (Eder, 2011).

Reappraisal is a cognitive strategy that regulates emotions by changing one's interpretation of the emotional situation, and this strategy has proven useful in reducing negative emotions (Gross, 2001; Ochsner et al., 2004). It was reported that reappraisal was effective in decreasing negative emotion experience, regardless of whether sad, disgusting or distressing contexts were presented (Gross, 2001). Nonetheless, it has been shown that conscious reappraisal is effortful and resource-demanding (Ortner, Zelazo, & Anderson, 2013), and applying reappraisal is associated with activation of dorsal anterior cingulated, dorsal medial prefrontal and lateral prefrontal cortices, as shown by a couple of studies (Lévesque et al., 2003; Phan et al., 2005). Thus, it is important to examine alternative regulation methods that have less cognitive costs. In line with this purpose, Williams, Bargh, Nocera, and Gray (2009) recently found that priming subjects with reappraisal goals, which involved non-conscious reappraisal, reduced cardiovascular reactivity during the anxiety-eliciting task to the same extent as the conscious reappraisal group, suggesting that unconscious reappraisal might be as effective as conscious reappraisal in regulating at least the bodily components of an unpleasant emotion. However, emotional experiences were not directly measured in this study, thus we are unable to determine whether these physiological modulations during unconscious reappraisal also reflected a decrease in negative subjective experience. Therefore, it is important to compare the effects of conscious and unconscious reappraisal at both experiential and physiological levels, and to explore whether a reduction in physiological activity is associated with a reduction in subjective negative experiences.

The present study aimed at comparing the effects of emotion regulation using conscious and unconscious reappraisal strategies on affective responses measured at both experiential (subjective emotion rating) and physiological (heart rate) levels. Heart rate variations were used as the physiological index of emotion regulation, because this index has been verified to be sensitive to frustration (Washington & Adviser-Jones, 2011) and changes in arousal (Williams et al., 2009).

THE PRESENT STUDY

Previous studies suggested that personal relevance is an important component for effective emotional induction, such that emotional stimuli with personal relevance evoked more intense emotional reactivity than those without personal relevance (Grèzes et al., 2013; Phan et al., 2004). In real-life settings, negative emotions often result from negative events that have strong personal relevance, such as experienced frustrations and setbacks after failing in an important exam or losing a sports game. This empirical and anecdotal evidence implies that it is highly necessary to induce emotion in an ecologically valid, self-relevant paradigm. Though many prior studies have assessed the effects of emotion regulation in the context of viewing emotional scenes or film clips (Campbell-Sills, Barlow, Brown, & Hofmann, 2006a, 2006b; Dunn, Billotti, Murphy, & Dalgleish, 2009; Liverant, Brown, Barlow, & Roemer, 2008), these materials were not directly relevant to observers. To date, few studies have used experimental paradigms in which the emotion induction closely resembles that in natural situations, such as negative emotions induced by frustrations and setbacks. Thus, it is practically important to assess the effects of negative emotion regulation in an ecologically valid, frustrating situation. Based on this consideration, the present study manipulated a complex, frustrating arithmetic task to induce negative emotions.

Because priming subjects with control-relevant words, despite lacking overt emotion-control instructions, effectively reduced subjective negative emotions or cardiovascular responding (Mauss, Cook, et al., 2007), we assumed that priming subjects with reappraisal-relevant words is a valid unconscious reappraisal strategy. We predict that unconscious reappraisal will reduce subjects' affective responding at experiential and physiological levels, in the same way as conscious reappraisal. Furthermore, as heart rate has shown to increase with frustration (Jost, 1941; Washington & Adviser-Jones, 2011), we predict that heart-rate measures will be positively correlated with the experienced negative emotion during the frustration task.

METHOD

Participants

Sixty undergraduates (35 men and 25 women; M = 21.6 years, ranging from 18–24 years old) were recruited for the study and were randomly divided into three groups: control group (N = 20, 8F/12M), conscious reappraisal group ((N = 21, 8F/13M), non-conscious reappraisal group (N = 19, 9F/10M). The experimental session lasted approximately 60 minutes. All the subjects reported no history of affective disorder and were free of any psychiatric medication. The subjects were free of anxiety or depression symptoms, indicated by the relatively low scores in the measures of Spielberg State/Trait Anxiety Scale (Spielberger, 1970) and Beck Depression Inventory-II (Beck, Steer, & Brown, 1996). The subjects were right-handed and had normal or corrected to normal vision. The study was approved by the Local Review Board for Human Participant Research and each subject signed an informed consent form before the experiment.

To verify whether our randomization was successful, we tested whether the three groups were similar in emotional states, emotion-related personality traits and gender composite. There were no significant group differences in emotion-related states and personality traits, indicated by similar scores in the Spielberg State Anxiety Scale ($F(2, 57) = .81, p > .40$), the Spielberg Trait Anxiety Scale ($F(2, 57) = 2.18, p > .10$), the Beck Depression Inventory-II ($F(2, 57) = 2.67, p > .07$) and the Rosenberg Self-Esteem Scale (Rosenberg, 1979) ($F(2, 57) = .61, p > .50$) (see Figure 1). In addition, the gender composite was not significantly different across the three groups ($\chi^2(2, 57) = .824, p > .90$). We also checked whether the habitual emotion regulation style was successfully controlled across groups using the Emotion Regulation Questionnaire developed by Gross and John (2003). The results showed no significant differences in the habitual use of cognitive reappraisal ($F(2, 57) = .56, p > .50$) and expressive suppression ($F(2,57) = .45, p > .60$) across the three groups (see Figure 1).

The frustration task

The frustration task contained 20 trials. In each trial, participants were instructed to count the number of triangles in a complex graphic presented on the computer screen. They received feedback of whether their answer was correct or incorrect. Incorrect feedback and correct feedback appeared in a fixed order, and this manipulation was unknown to the subjects. Correct feedback was presented in the second and the seventh trials and incorrect feedback in the other trials. The 20 graphics used for the task were selected out of 38 graphics that were evaluated in a pilot study. A separate group of 40 participants (20 men and 20 women, $M = 22.3$ years, range from 18 to 26) took part in this pilot to evaluate the material. After counting the number of triangles in the complex figure, participants were instructed to rate the complexity of the figure on a scale from 1 (not difficult at all) to 8 (extremely difficult). Their response times during triangle counting were also recorded. On the basis of these results, we selected 18 moderately complex figures, for which the averaged reaction time was 39 seconds.

To ensure that participants could not guess the goal of the experiment, the 18 graphics associated with error feedbacks were moderately difficult and the 2 graphics associated with correct feedbacks were relatively simple.

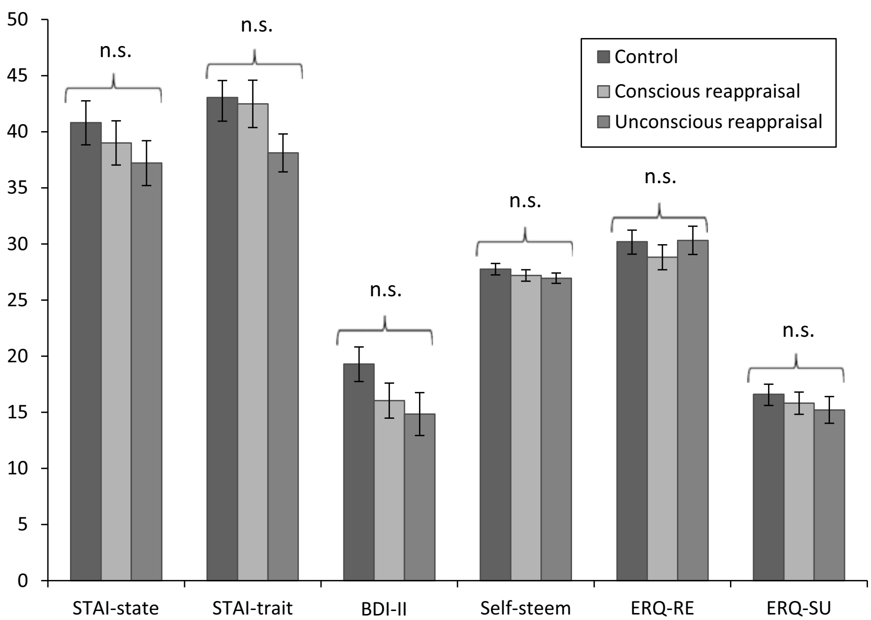

Figure 1. *The scores of three groups in Spielberg State Anxiety Scale, Spielberg Trait Anxiety Scale, Beck Depression Inventory-II Rosenberg Self-Esteem, ERQ-RE(reappraisal) and ERQ-SU(suppression). Error bars represent the standard errors of the mean values.*

Procedure

After arrival at the lab, participants were placed in a separate room containing the psychophysiological recording equipment, where they received information about the triangle-counting task. Participants were then prepared for psychophysiological recordings. We attached the sensor to participants' thumb for continuous heart-rate recording. The experiment consisted of three phases: a baseline phase, a task phase and a recovery phase.

Baseline phase

In the baseline phase, we instructed participants to rest for 3 minutes during which the baseline heart rate reactivity was recorded. After this 3-minute rest time, participants were asked to complete the modified PANAS. This phase was designed to control the potential influence of pre-experiment group differences on the emotion regulation effects.

The task phase and emotion regulation instruction

In the task phase, participants performed two tasks. First, they were required to accomplish a scrambled sentence task, in which they needed to construct a grammatical four-word sentence from five-word jumbles (Srull & Wyer, 1979). Those primed with the reappraisal goal unscrambled five neutral sentences and ten sentences containing words or phrases related to reappraisal (such as reassess, analyse, rethink). Participants in the conscious reappraisal and control groups unscrambled 15 neutral sentences.

After the scrambled sentence task, participants performed the frustrating task for approximately 20 minutes. Prior to the task, participants in the conscious reappraisal condition were provided with the following additional instructions (Gross, 1998):

> The task was a bit difficult, you may experience negative emotions sometimes. Try strategically to reassess the failures and adopt a neutral attitude towards the test. In other words, your performance does not necessarily reflects your ability, try to think about the test objectively, this is just a test. Don't care about the result too much.

Participants in the non-conscious reappraisal and control conditions received no further instructions. After participants completed the frustration task, the conscious reappraisal group needed to rate the extent to which they applied the emotion regulation instructions during the task. Then, subjects were asked to complete the modified PANAS.

Recovery phase

Immediately after completing the frustration task, a 3-minute rest (recovery phase) was implemented, which was designed to help participants recover from the negative mood induced by the frustration task. Participants completed the modified PANAS when the recovery was over. None of the three groups showed significant differences between recovery and baseline phases in the positive emotion measure ($p_s > .20$), the negative emotion measure ($p_s > .40$) and heart rate reactivity ($p_s > .12$), suggesting that all the subjects successfully recovered from negative emotional state at the end of the experiment, and the frustration task did not produce prolonged negative impacts.

Finally, participants were probed for suspicion of experimental purposes and debriefed using the funnelled debriefing method (Bargh & Chartrand, 2000). No participants indicated suspicion of the purposes of the priming and the task procedures.

Measures

Subjective emotion experience

Emotion experience was assessed using Positive and Negative Affect Scales (Watson, Clark, & Tellegen, 1988). PANAS contains 20 emotion descriptors, 10 items measuring positive affect and 10 items measuring negative affect. All the items were rated on 5-point Likert scales, ranging from 1 (none at all) to 5 (extremely). To measure emotion changes of participants more sensitively, all the items were rated on 7-point Likert scales, ranging from 1 (not at all) to 7 (extremely) in our experiment.

Physiological measure

Physiological channels were sampled at 2048 Hz, using Spirit— 10 wireless telemetry channel (bluetooth) 10 biofeedback instrument (Spirit, the

Netherlands). The biotrace software recorded the data simultaneously with experimental progress. Heart rate was used as a measure of physiological activity related to emotional response, consistent with recent investigations of the effect of emotion regulation on cardiovascular reactivity (Mauss, Cook, et al., 2007). During the collection of data, laboratory software computed average values in every phase.

RESULTS

Manipulation check

The first manipulation check was to examine whether our triangle-counting task successfully induced negative emotion. We conducted paired-samples *t*-tests of subjective experience and heart rate measures between baseline and the task phases in the control group, where emotion induction was free of regulatory influences. The positive emotion measure of PANAS was significantly decreased in the task phase ($M = 35.20$, SD = 8.77) relative to the baseline ($M = 42.90$, SD = 8.93; $t(19) = 3.9$, $p < .001$). The negative emotion measure of PANAS was significantly increased in task phase ($M = 26.75$; SD = 8.83) relative to the baseline ($M = 16.85$; SD = 4.72; $t(19) = -5.2$, $p < .001$). The heart rate reactivity was significantly increased in task phase ($M = 86.30$; SD = 9.45) relative to the baseline ($M = 82.0$; SD = 9.72; $t(19) = -5.4$, $p < .001$). These results verified that the triangle-counting task used in this study successfully induced negative emotion.

The second manipulation check aimed to examine whether subjects in the conscious reappraisal condition successfully complied with the reappraisal instruction. Subjects in the conscious reappraisal group were asked to rate the extent to which they reappraised their emotions on a 6-point scale (1: not at all; 6: extremely) immediately after completing the task. The analysis of the instruction confirmation ratings showed that the reappraisal strategy was successfully used in the task ($M = 4.57$; SD = .81). The scores were significantly higher than the midpoint of the rating scale ($t(21) = 8.88$, $p < .001$).

Randomization check

ANOVAs were conducted to examine whether the experimental groups were similar in baseline emotional state. The three groups showed similar levels in positive emotion (PANAS-P; $F(2, 57) = .92$, $p = .40$), negative emotion (PANAS-N; $F(2, 57) = .43$, $p = .65$) and heart rate $F(2, 57) = 1.3$, $p = .26$. Thus, the three groups were highly similar in their pre-experiment emotional state, ruling out the possibility that post-experiment group differences were due to pre-treatment group differences in emotional states.

Emotion regulation effect on subjective experience

To compare the effects of conscious and unconscious reappraisal on negative emotion experience, we conducted univariate ANOVAs with the positive and negative emotional experience ratings during the frustrating task (see Figure 2 and Table 1). To control the possible influence of individual differences in baseline emotion (though non-significant), the negative emotion experience in baseline was entered as a covariate. The ANOVA revealed that three groups were significantly different in negative emotion experience, $F(2, 56) = 4.96$,

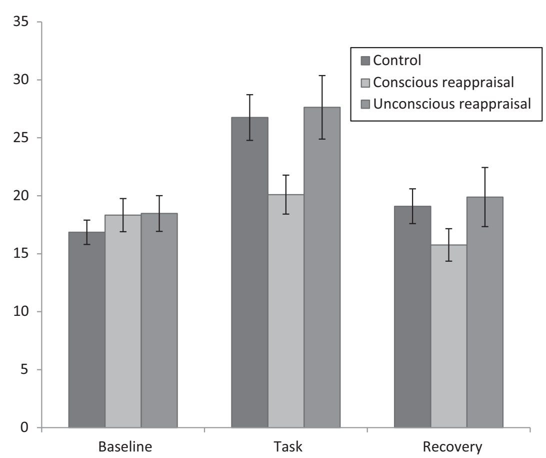

Figure 2. *Mean negative emotion ratings for pre-experiment baseline, task (emotion induction), post-experiment recovery phases in the three groups. Error bars represent the standard errors of the mean values.*

Table 1. *The means and standard deviations of negative emotion ratings for pre-experiment baseline, task (emotion induction), post-experiment recovery phases in the three groups*

Experimental condition	*Baseline phase*	*Task phase*	*Recovery phase*
Control group	16.85 (4.72)	26.75 (8.83)	19.1 (6.70)
Conscious reappraisal group	18.33 (6.54)	20.10 (7.69)	15.76 (6.39)
Non-conscious reappraisal group	18.47 (6.73)	27.63 (11.93)	19.89 (11.13)

p = .01, η^2 = .15. Post hoc comparisons using Bonferroni correction indicated that the conscious reappraisal group had significantly less intense negative experience compared with the control group, $F(1, 38) = 10.39$, $p = .024$, $\eta^2 = .22$) and the unconscious reappraisal group, $F(1, 37) = 6.69$, $p = .021$, $\eta^2 = .15$. The control group and the unconscious reappraisal group showed no significant differences in negative subjective experience $F(1, 36) = .003$, $p = .96$, $\eta^2 = .00$.

To control for the possible influence of individual differences in emotion-related personality traits, the SATI-state, SATI-trait, BDI, Rosenberg Self-Esteem, ERQ-RE, ERQ-SU scores were entered as covariates. The ANCOVA revealed the same pattern of group differences in negative emotion experience, $F(2, 50) = 4.38$, $p = .02$, $\eta^2 = .15$. Thus, conscious reappraisal, but not unconscious reappraisal, effectively reduced the intensity of negative emotions compared with the control group.

Emotion regulation effect on physiological index

For physiological activity, a similar ANOVAs was conducted similarly with the heart-rate activity during the task as dependent measure (see Figure 3 and Table 2). To control for the possible influence of individual differences in baseline heart rate reactivity, the heart rate in baseline was entered as a covariate. The ANOVA revealed that the three groups were significantly different in heart rate reactivity, $F(2, 56) = 4.68$, $p = .01$, $\eta^2 = .14$. Post hoc comparisons using Bonferroni correction indicated that the conscious reappraisal group had significantly less heart rate reactivity compared with the control group, $F(1, 38) = 6.92$, $p = .023$, $\eta^2 = .15$. In addition, the unconscious reappraisal group also had significantly less heart rate reactivity compared with the control group, $F(1, 36) = 6.62$, $p = .045$, $\eta^2 = .16$). The conscious reappraisal group and the unconscious reappraisal group showed no significant differences in heart rate, $F(1, 37) = .09$, $p = .77$, $\eta^2 = .02$.

To test the reliability of these results, other individual difference factors, like the scores of SATI-state, SATI-trait, BDI, Rosenberg Self-Esteem, ERQ-RE and ERQ-SU, were also entered as covariates. Similarly, the ANCOVA also revealed the same pattern of group differences in heart rate measures ($F(2, 50) = 4.05$, $p = .02$, $\eta^2 = .14$). Thus, the non-conscious reappraisal was equally effective as conscious reappraisal in reducing physiological activity (heart-rates) associated with frustrating emotion induction.

Correlations between subjective emotion and heart-rate activity

To examine whether the enhanced heart rate reactivity during the frustrating task is accompanied by the increase of negative subjective experience, we conducted Pearson correlations between these two variables. Subjective emotion was quantified by both PANAS-N and PANAS-P subscales. We found that the negative emotion rating indexed by PANAS-N scores increased significantly with the heart rate reactivity during frustration, $r = .32$, $p < .01$. On the other hand, the positive emotion rating indexed by PANAS-P scores decreased significantly as a function of increasing heart rate reactivity during the frustrating task, $r = -.34$, $p < .01$. The correlation results (see Figure 4) further support the frustrating task successfully induced negative emotion.

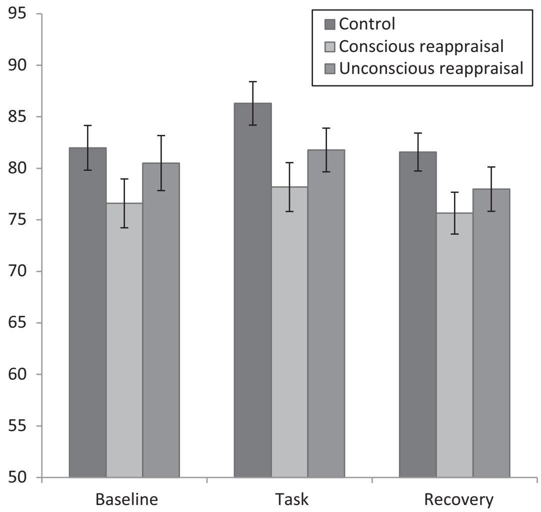

Figure 3. *Mean heart rate for pre-experiment baseline, task (emotion induction) and post-experiment recovery phases in the three groups. Error bars represent the standard errors of the mean values.*

DISCUSSION

The present study used an ecologically valid, frustrating arithmetic task to induce negative emotions and investigate their down-regulation by conscious and unconscious reappraisal. The results showed that first of all that conscious reappraisal resulted in significantly less intense negative subjective experience compared with the control group, whereas unconscious reappraisal resulted in similar levels of subjective experience as in the control group. Second, both conscious and unconscious reappraisal groups showed significantly less heart rate activity during the task compared to the control group. The heart rate levels were similar across the conscious and unconscious reappraisal groups. Third, heart rate reactivity was positively correlated with the negative subscale of the PANAS, and negatively correlated with the positive scale of the PANAS. These results suggest that although unconscious reappraisal is less effective in reducing negative subjective experiences compared to conscious reappraisal, priming unconscious reappraisal goals is as effective as performing conscious reappraisal in decreasing emotion-related physiological activity.

A couple of previous studies have shown that unconscious regulatory processes reduced negative emotional experiences or emotion-related physiological reactivity (Isaacowitz et al., 2006; Mauss, Bunge, et al., 2007; Mauss, Cook, et al., 2007). It is important to assess both the subjective and physiological outcomes of unconscious and conscious reappraisal, because this study has shown that unconscious emotion regulation may decrease physiological consequences, but not subjective experience. This finding was supported by a recent study by Williams et al. (2009), who observed that priming non-conscious reappraisal goals decreased heart rate reactivity to the same extent as the conscious reappraisal condition during a stressful speech-preparing task (Williams et al., 2009). However, this study did not overtly measure subjective emotional experience during the task. In the present study, we measured both subjective emotional experiences and physiological activity (Heart rates), and found that the heart-rate reactivity during the frustrating task was positively related to negative emotion rating and negatively related the positive emotion rating. Our observation of lower heart rate reactivity in unconscious reappraisal versus control groups most likely reflects that priming unconscious reappraisal goals

Table 2. *The means and standard deviations of heart rate for pre-experiment baseline, task (emotion induction), post-experiment recovery phases in the three groups*

Experimental condition	*Baseline phase*	*Task phase*	*Recovery phase*
Control group	81.99 (9.71)	86.30 (9.45)	81.58 (8.23)
Conscious reappraisal group	76.60 (10.88)	78.18 (10.86)	75.65 (9.31)
Non-conscious reappraisal group	80.51 (10.83)	81.78 (9.26)	77.98 (9.18)

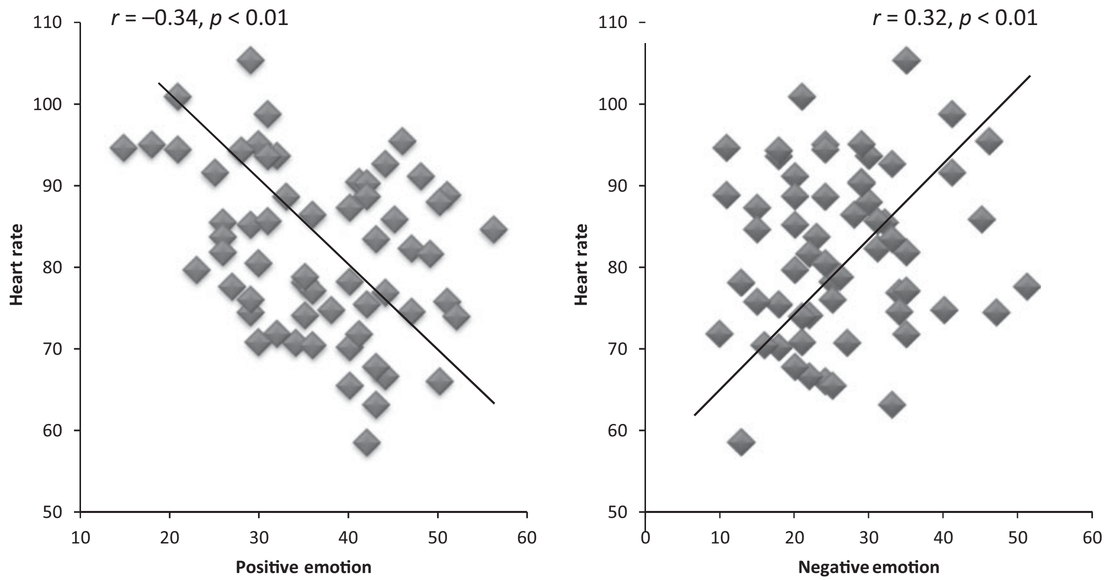

Figure 4. *The scatterplots for the correlation between the emotion experience (left: positive emotion; right: negative emotion) and the heart rate reactivity during the frustrating task. The positive (or negative) emotion experience was quantified by the sum of the scores in positive (or negative) items of the PANAS.*

is useful in reducing emotion-related physiological activity during frustration.

However, unconscious reappraisal priming did not reduce one's subjective negative experiences, which were significantly decreased during conscious reappraisal. It is apparent that, different from conscious reappraisal which decreased both subjective emotion and physiological reactivity, unconscious reappraisal priming did not alter participants' subjective experiences but only decreased emotion-related physiological reactivity to the same extent as the conscious reappraisal in comparison with the control group. It is worth noting that according to the attribution theory of emotion, the subjective emotional experience is a result of the cognitive interpretation of physiological arousal as well as the environmental context (Lewis & Daltroy, 1990; Schachter & Singer, 1962). That is, cognitive factors most likely determine what we subjectively experience. In the current study, the subjects in the unconscious reappraisal condition received no explicit emotion regulation instructions and were unaware of the goal of the priming procedures, as indicated by our post-experiment debriefing results. However, the conscious reappraisal group received explicit reappraisal instruction to decrease potential negative emotions and this may have influenced their subjective reports. Thus, though both conscious and unconscious groups displayed similar reductions in physiological activity during frustration, it may have been easier for the conscious reappraisal group to attribute this physiological effect to the application of the reappraisal strategy. This was impossible for the unconscious reappraisal group. This may explain why the unconscious reappraisal group showed a significant reduction of physiological reactivity but little reduction of negative subjective experience in comparison with the control group. Although heart rate reactivity was significantly correlated with emotion ratings in our experiment, some previous research (De Burgo & Gendolla, 2009; Obrist, 1981; Wright, 1996) showed that heart rate as a cardiovascular parameter was also related to energy mobilisation in addition to emotional arousal. It is worth noting that the completion of the triangle-counting task entails energy mobilisation. Nevertheless, the unconscious reappraisal and the control groups performed the same triangle-counting task, both of whom had no additional task of explicit emotion regulation. Thus, the extent of energy mobilisation should be similar for the two groups, which suggests that the heart rate differences between the two groups are probably specific to unconscious emotion regulation. Though significant correlations between heart-rates and subjective ratings suggest that heart rate reactivity may be a physiological index of emotion regulation, we still need to be cautious with drawing conclusions because energy mobilisation was not directly assessed in the current study. What heart rate reactivity really reflects should be further examined in future studies by manipulating both energy mobilisation and emotion regulation.

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