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Influence of Unconscious Emotional Control Goals Priming on Anticipatory Anxiety and Physiological Activity

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Abstract

Individuals frequently generate emotion during the anticipation process and the anticipatory emotion has an important adaptive significance, especially the negative anticipative emotion. Many researches used conscious emotion regulation strategy and successfully reduced negative anticipatory emotion. However, it is costly for our limited cognition. In the present study, we used sentence unscrambling tasks to prime unconscious emotion control goal and investigated its effect on anticipatory anxiety, including experience and physiological activity. The results showed that 1) relative to anticipating neutral images, participations' anxiety experience and skin conductance level were higher when anticipating negative and unknown images; 2) participants who had a unconscious emotion control goal primed achieved the same decrease in skin conductance as those explicitly instructed to reappraise, compared to a control group; 3) heart rate was not affected by experiment condition and anticipation type. Together, these findings suggest that unconscious emotion regulation may provide an effective mean of regulating negative anticipatory emotion.

1. Introduction

There is no terror in a bang, only in the anticipation of it—Alfred Hitchcock

Our daily life is always filled with a lot of emotionally stimulating information, such

as yesterday's birthday, present homework, and incoming exam; all have the potential to influence people's emotional lives. Anticipatory emotion has been defined as current emotion experience due to the prospect of a desirable or undesirable future event [1]. Researches indicated that anticipatory emotion had influences on our cognitive processes, decision-making, and physical-mental health [2] [3] [4]. Insufficient or excessive anticipatory emotion would lead to mental illness; for instance, there were characteristics of excessive negative anticipatory emotion or lack of positive anticipatory emotion among patients with anxiety disorder, depression disorder, or psychosis [5] [6] [7] [8]. Therefore, people often attempt to regulate distressing anticipatory emotional states, such as anticipatory anxiety. However, most researchers focused on the cognitive processes of anticipation while there was little research paid attention to the anticipatory emotion and its regulation [9] [10] [11].

According to Gross and Thompson's theory [12], emotion regulation strategies include conscious emotion regulation (e.g. cognitive reappraisal, suppression) and unconscious emotion regulation. There were many researches that indicated conscious emotional regulation was effective on reducing negative anticipatory emotion, including subjective experience, physiological activity and brain activity [13] [14] [15]. However, these conscious emotion regulations have significant costs for the individual and have difficulties in many situations, such as anxiety in the stress environment [16]. Ideally, there would be a way for individuals to regulate anticipatory emotion whenever they need and "cost-free". However, is that possible?

Unconscious emotion regulation has been defined as the unintentional, automatic, and relatively effortless control of one's exposure to, processing of, and response to emotionally evocative events [17]. On the one hand, in the past researches, habitual usage of certain emotion regulation was proved effective on reducing negative anticipatory emotion, such as anxiety. For example, Carlson and his colleague found that individuals who score high in dispositional reappraisal could reduce the activity of anterior insula, which could indicate the anxiety even without the instruction of cognitive reappraisal, during aversive anticipation [18]. Abler *et al.* chose 30 individuals who did not show symptoms of clinical depression and scored either relatively high or low suppression on Emotion Regulation Questionnaire, as participants to anticipate images selected from International Affective Picture System [19]. The results showed that individuals with high suppression scores decreased activation of the orbital medial prefrontal cortex (OMFC), which could indicate a lack of antecedent emotion regulation, when expecting negative pictures. With comparing the anticipatory emotion of individuals who score high or low in a certain emotion regulation strategy during the anticipation tasks, these studies provide a possibility to develop unconscious regulation of anticipatory emotion. However, there was no causal relationship between them or direct proof which can prove unconscious regulation could successfully reduce anticipatory emotion. Furthermore, if it is effective for the individuals of habitual usage cognitive reappraisal to regulate anticipatory emotion, what about those who score low in dispositional reappraisal?

On the other hand, some researches discussed this question based on the mechanism of unconscious emotion regulation—unconscious goal pursuit [16] [20] [21]. The goal pursuit theory proposed that goal could be activated by corresponding clues, such as semantic priming, instrument priming and interpersonal priming [22] [23] and further directed to individuals' behavior [24], which has the same effect with conscious goal pursuit [25]. Mauss *et al.* firstly used sentence unscrambling tasks effective priming emotional expression and emotional regulation, then found that relative to priming emotion expression, priming emotion control could reduce negative emotion experience without maladaptive cardiovascular responding [21]. Tamir, Ford, and Ryan found that unconscious collaboration goal priming could reduce individuals' anger experience [26], which was also effective for negative emotion pictures [27] [28]. Since it is feasible for the regulation for negative emotion, is it also effective for anticipatory emotion?

Above all, the most researches focused on the cognitive process of anticipation and neglected anticipatory emotion with it. It was the first aim of this present study. Furthermore, to date, there was few researches had direct investigated the unconscious regulation of anticipatory emotion although habitual cognitive reappraisal was effective on reducing anticipatory emotion. Therefore, we studied unconscious emotion regulation of anticipatory emotion based on unconscious goal pursuit theory and it was the primary aim of this research. On the end, many researchers studied the brain activity of anticipatory emotion, while physiological activity was also important for the discussion of the regulation of anticipatory emotion. So, we used heart rate and skin conductance level as the physiological activity indicators of emotion, which were common and effective to reflect the change of emotion [29] [30] [31] [32].

2. Method

2.1. Participants

Participants included 85 undergraduate students (44 females) at Southwest University. All participants were free of neurological and psychiatric disorders (self-report) and all were right-handed. All participants completed the whole experiment procedure. In order to study the effects of instruction manipulation on dependent variables, eleven participants were excluded in the final analysis, nine due to not execute instruction at all and, two, because they were suspicious about the "imagery ability test". A total of 74 participants (mean age = 21.48 years) were selected and randomly assigned to control condition ($n = 26$), conscious emotion regulation condition ($n = 25$) or unconscious emotion control goal condition ($n = 23$). All participants gave their written informed consent after receiving a detailed explanation of the experiments. After the experiment, they were paid 10 Yuan for their participation. The study protocol was approved by the relevant ethics institution.

2.2. Self-Report Measures

Self-rating Depression Scale (SDS) was used to assess depression symptoms using a

scale covering affective, psychological and somatic symptoms associated with depression on a 4-point Likert scale ranging from 1 (a little of the time) to 4 (most of the time) [33]. The SDS is a 20-item scale and has high internal consistency ($\alpha = 0.87$) [34].

Trait Anxiety Inventory (TAI) was used to assess one's tendency to respond fearfully to anxiety-related symptoms on a 4-point Likert scale ranging from 1 (almost never) to 4 (almost always) [35]. The TAI is a 20-item scale and has high internal consistency ($\alpha = 0.90$) [36].

2.3. Emotional Images

The 24 images of this research were all selected from the pre-study. In the pre-study, 17 participants were asked to rate the arousal and valence of 40 images from the International Affective Picture System (IAPS) [37] by Self-Assessment Manikin Scale (SAM) [38]. On the end, we obtained 12 neutral images (arousal: $M = 4.09$, $SD = 0.50$; valence: $M = 4.88$, $SD = 0.22$) and 12 negative images (arousal: $M = 6.31$, $SD = 0.38$; valence: $M = 2.21$, $SD = 0.28$).

2.4. Priming Stimuli

To manipulate unconscious emotion regulation, we adapted the Sentence Unscrambling Task [27] [28], in which participants have to construct grammatical four-word sentences from five-word jumbles. These sentences included 8 emotion control conditions and 15 neutral conditions.

2.5. Physiological Activity

Two measures of Physiological activity included heart rate and skin conductance level were sampled at 32 Hz using laboratory software.

Heart Rate (HR; beats/Min) was calculated from RR intervals. During each heartbeat, when blood flow through blood vessels, the maximum of the blood flow was called peak. HR was calculated from the interval of the twice peak. Sensor was placed in the fingers of the left hand.

Skin Conductance Level (SCL; V) was measured through the skin conductance sensors which placed in the middle and ring finger of the left hand.

2.6. Procedure

Upon arrival to the laboratory, written consent was obtained from each participant. After signing the consent form, participants were then randomly assigned to one of the three conditions. Participants of the conscious emotion regulation condition were introduced the knowledge and strategy of cognitive reappraisal by a research assistant, who attached a series of physiological sensors to them while the participants of the control condition and unconscious emotion control goal condition were only attached the physiological sensors.

While the participant was waiting, a blank screen which lasted three-minute was shown to establish baseline physiological activation. Once the video was over, the re-

search assistant informed participants that they'd be participating in an "imagery ability test". Between the practice stage and the formal experiment stage, there was a linguistic exam. At this point, practice stage which included 2 trials for each condition was beginning. During the practice stage, a fixation presented first then there was a prompt ("↓", "−", or "?") on the screen. Participants were asked to anticipate the content of the incoming images according to the prompt and pay attention to their current emotion, and the prompt of "↓", "−", and "?" represent negative anticipation, neutral anticipation and unknown anticipation, respectively. In the unknown anticipation, half of the target images are negative, and the others are neutral. Next, participants reported on their anxiety experience using a Likert scale ranging from 1 (none at all) to 6 (extremely). After presenting the target images for 4 seconds, there were 17 seconds to return to neutral mood before next trial (note: In the pre-study, we also investigated the recovery time after the presentation of images. The results indicated that the three trend lines of SCL of negative, positive and neutral anticipation conditions intersected and began to go flat around 17 seconds, while the trend lines of HR were always in fluctuation. Therefore, we set the duration of recovery as 17 seconds). Figure 1 shows the time course for a single trial. At this time, participants were asked to complete sentence unscrambling task. In this stage, participants of unconscious emotion control goal condition completed 8 emotion regulation sentences and 7 neutral sentences while participants of the control condition and conscious emotion regulation condition completed 15 neutral sentences.

After completed the sentence unscrambling task, the formal experiment stage began. Formal experiment stage was presented with 10 trials per condition in a pseudo random sequence. The procedure of formal stage was the same as the procedure of practice stage. Figure 1 showed the time course for a single trial of the practice stage and formal experiment stage.
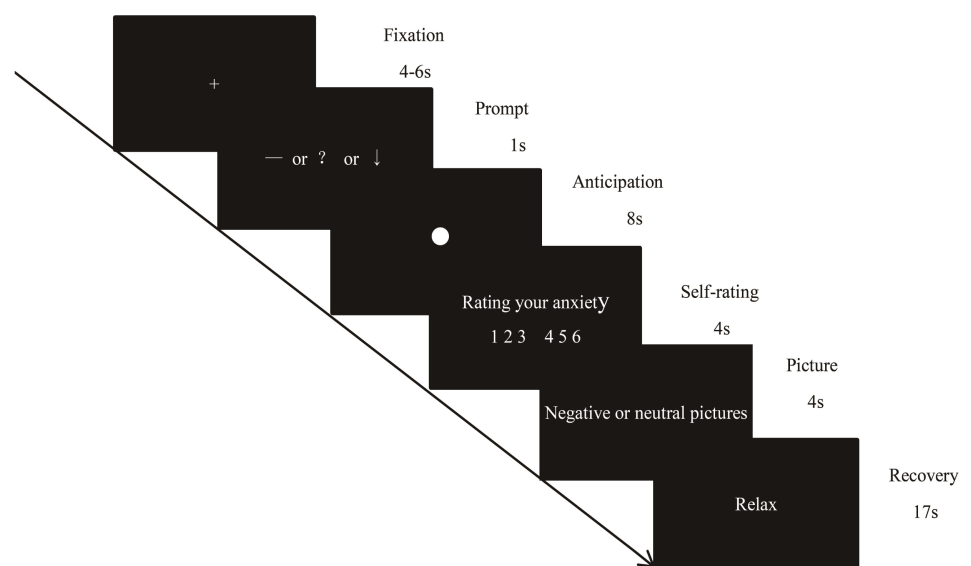

Figure 1. Example of time course for one trial.

Then, sensors were removed and participants completed the Self-rating Depression Scale (SDS) and Trait Anxiety Inventory (TAI). On the end, participants were asked to rate 1 (not at all) to 3 (absolutely) to assess the extent to execute instruction and reported whether they were aware of the true nature of the "imagery ability test".

3. Results

The following data analytic strategy was used. (a) To ascertain that randomization was successful, one-way ANOVAs comparing the three experiment conditions for each DV (Dependent Variable) were performed. (b) To assess the effectiveness of the emotion control goal, we conducted ANCOVAs for process value of physiological activity, with experiment condition (unconscious emotion control goal condition, conscious emotion regulation condition, and control condition) as a group factor and anticipation type (negative anticipation, neutral anticipation, and unknown anticipation) as a repeated-measures factor and baseline responding as the covariate. (c) To assess the changing extent of physiological activity, we conducted omnibus ANOVAs for the change rate of physiological activity, with experiment condition(unconscious emotion control goal condition, conscious emotion regulation condition, control condition) as a group factor, and anticipation type (negative anticipation, neutral anticipation, unknown anticipation) as a repeated-measures factor. The following sections show (a) randomization checks, (b) results of ANCOVAs, (c) results of omnibus ANOVAs.

3.1. Randomization Checks

To ascertain that randomization was successful, one-way ANOVAs were used to compare the three conditions. As Table 1 indicated, none of the effects of condition were significant (all $ps > 0.3$) (see Table 1), indicating that there were no group differences in emotion experience or physiological responding before or during the experiment and in the daily life.

3.2. Effects of Emotion Regulation Goal Priming

To examine whether emotion regulation goal priming led to differences in emotional

Table 1. Descriptive statistics for different conditions on physiological response baseline and other variables (M ± SD).

	Unconscious emotion control goal condition ($n = 23$)	Conscious emotion regulation condition ($n = 25$)	Control condition ($n = 26$)
HR baseline	1.40 ± 0.88	1.35 ± 0.81	1.48 ± 0.85
SCL baseline	75.96 ± 20.96	75.87 ± 35.17	66.64 ± 17.74
Sentence unscrambling task RT	241.74 ± 41.32	225.53 ± 35.94	234.34 ± 44.79
SDS score	35.65 ± 8.60	33.28 ± 6.32	35.96 ± 9.22
TAI score	40.00 ± 6.36	38.16 ± 84.95	40.27 ± 7.42

Note. M = Mean; SD = Standard Deviation; HR = Heart Rate; SCL = Skin Conductance Level; RT = Reaction Time; SDS = Self-rating Depression Scale; TAI = Trait Anxiety Inventory.

responding, we conducted ANCOVAs with experiment condition (unconscious emotion control goal condition, conscious emotion regulation condition, and control condition) as the group factor, anticipation type (negative anticipation, neutral anticipation, and unknown anticipation) as a repeated-measures factor and baseline responding as the covariate.

For heart rate, this test revealed a significantly covariate effect, $F(1, 70) = 13.28$, $p < 0.01$, $\eta^2 = 0.16$, which indicated that heart rate process value was influenced by the baseline when participants were asked to anticipant different images. However, there was not significantly main effect for experiment condition and anticipation type, as well as the interaction of experiment condition by anticipation type (all $ps > 0.30$) (see Table 2).

For skin conductance level, this test revealed a significantly covariate effect, $F(1, 70) = 443.216$, $p < 0.01$, $\eta^2 = 0.86$, which indicated that skin conductance level process value was influenced by the baseline when participants were asked to anticipant different images.

Furthermore, there was a significantly main effect for experiment condition, $F(2, 70) = 3.11$, $p = 0.05$, $\eta^2 = 0.08$, and the post-hoc revealed that the skin conductance level process value of unconscious emotion control goal condition and conscious emotion regulation condition was lower than control condition ($ps < 0.01$) while there was no difference between unconscious emotion control goal condition and conscious emotion regulation condition ($p > 0.05$). There was also a significantly main effect of anticipation type, $F(2, 140) = 4.29$，$p = 0.03$, $\eta^2 = 0.06$, and the post-hoc revealed that the skin conductance level process value of anticipation of negative images and unknown images was higher than anticipation of neutral images ($ps < 0.05$) while there was no difference when participants anticipated negative and unknown images ($p > 0.05$). However, there was no significantly interaction effect of experiment condition by anticipation type ($p > 0.05$) (see Table 2).

3.3. Results of the Omnibus ANOVAs

To further analyze the change rate of physiological activity, we conducted a 3 (experiment condition) × 3 (anticipation type) repeated measures ANOVA with change rate of

Table 2. Mean physiological activity for different anticipation type (M ± SD).

		Unconscious emotion control goal condition ($n = 23$)	Conscious emotion regulation condition ($n = 25$)	Control condition ($n = 26$)
HR process value	Negative anticipation	109.01 ± 39.32	104.33 ± 40.72	95.56 ± 46.65
	Neutral anticipation	108.96 ± 39.33	104.00 ± 41.04	95.92 ± 47.07
	Unknown anticipation	109.32 ± 40.19	103.52 ± 42.23	95.69 ± 46.01
SCL process value	Negative anticipation	1.48 ± 0.86	1.50 ± 0.91	1.81 ± 1.11
	Neutral anticipation	1.43 ± 0.83	1.44 ± 0.86	1.73 ± 1.16
	Unknown anticipation	1.46 ± 0.83	1.50 ± 0.89	1.83 ± 1.11

SCL (change rate of SCL = (process value of SCL-baseline of SCL)/baseline of SCL × 100%) [39] as the dependent variable. The results showed a significantly main effect for experiment condition, $F(2, 71) = 3.30$，$p = 0.04$, $\eta^2 = 0.09$, and the post-hoc revealed that the change rate of SCL of unconscious emotion control goal condition and conscious emotion regulation condition was lower than control condition ($ps < 0.01$) while there was no difference between unconscious emotion control goal condition and conscious emotion regulation condition ($p > 0.05$). There was also a significantly main effect of anticipation type, $F(2, 142) = 21.59$, $p < 0.01$, $\eta^2 = 0.23$, and the post-hoc revealed that the change rate of SCL of anticipation of negative images and unknown images was higher than anticipation of neutral images ($ps < 0.01$) while there was no difference when participants anticipated negative and unknown images ($p > 0.05$). However, there was no significantly interaction effect of experiment condition by anticipation type ($p > 0.05$) (see **Figure 2(a)**).

To analyze participants' anxiety experience, we conducted a 3(experiment condition) × 3 (anticipation type) repeated measures ANOVA with participants' self-rating anxiety as the dependent variable. There was a significantly main effect of anticipant type, $F(2, 142) = 21.13$, $p < 0.00l$, $\eta^2 = 0.23$, and the post-hoc revealed that the anxiety experience of anticipation of negative images and unknown images was higher than anticipation of neutral images ($ps < 0.05$) while there was no difference when participants anticipated
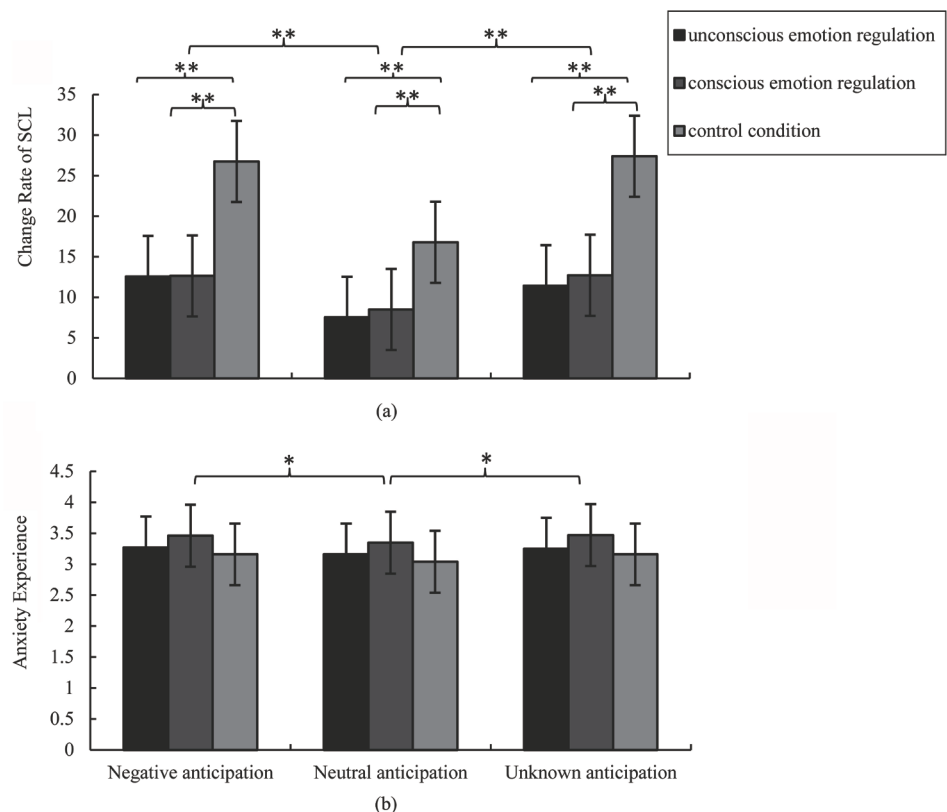

Figure 2. (a) Change rate of SCL; (b) Anxiety experience for the experiment condition and anticipation type.

negative and unknown images ($p > 0.05$). However, there was no significantly main effect for experiment condition, as well as the interaction of experiment condition by anticipation type (all $ps > 0.50$) (see Figure 2(b)).

4. Discussion

Individuals often generated a lot of emotion before the things, especially some negative (e.g. anxiety), which have important effect on life. Therefore, it is necessary to regulate the anticipatory emotion. Some researches indicated that instructed cognitive reappraisal was effective on reducing anticipatory emotion [13] [14] [15], but it is costly and difficult [16]. This presents a question, namely whether there is a method to regulate anticipatory emotion cost-free.

Some researches indicated that habitual using emotion strategies could successfully regulate anticipatory emotion [18] [19], which gives us a hint that unconscious emotion regulation may be the key to this question. However, the prior studies of unconscious emotion regulation have relied principally on correlation designs, which make it difficult to assess this hypothesis based on existing research. The present study was designed to fill this gap by providing an experimental manipulation of unconscious emotion regulation by Sentence Unscrambling Tasks and assess the effect of unconscious emotion regulation relative to instructed cognitive reappraisal and control condition.

Results indicated that 1) relative to neutral anticipation, negative and unknown anticipation led to higher anxiety experience and skin conductance level; 2) unconscious emotion control goal priming and conscious emotion regulation led to lower skin conductance level than control condition, while there was no difference between them; 3) heart rate is not affected by experiment condition.

4.1. The Difference between Different Anticipation

Long-term uncertainty will lead to press and anxiety [40]. The present study support this view due to unknown anticipation led to higher anxiety experience and skin conductance level relative neutral anticipation. However, there was no difference between negative anticipation and unknown anticipation, which is consistent with the prior research [14]. From an evolutionary perspective, we have to prepare ourselves for coping better with a potentially threatening environment. In our present study, anticipating negative and unknown pictures led to higher anxiety experience and skin conductance level relative neutral anticipation means that there was similar anticipatory emotion when anticipating the incoming potential and certain negative events.

4.2. The Effect of Unconscious Emotion Regulation

The auto-motive model proposed that frequently used mental representations will, over time, become active upon the mere presence of relevant information in the person's environment and further assumed that, once activated in unconscious manner, the goal representation would then operate in the same way as when it is consciously activated [23]. Empirical researches showed that emotion control goal priming had effect on re-

ducing physiological activity despite after anger provocation or negative pictures [27] [28] [41]. The present study showed that unconscious emotion control goal priming reduced participants' skin conductance level, consistent with the auto-motive model and prior researches.

However, unconscious emotion control goal priming couldn't reduce anxiety experience, which differs from other studies' findings demonstrating an effect on emotion experience [41]. The discrepancies in findings may arise in part from the fact that the most of the emotion self-rating of the prior researches is the emotion arousal [27] [28] and unconscious emotion goal priming affected only the emotional arousal, but not valence [42] [43].

4.3. The Difference between Heart Rate and Skin Conductance Level

Heart rate and skin conductance are two important physiological indexes in the emotion laboratory study. Emotion change leads to sweat increase, and further influence the skin conductance, which indicated the permeability of the skin and sweat gland activity. Therefore, skin conductance is a kind of sensitive and stable emotional physiological index. In the present study, different anticipation led different skin conductance, and relative to neutral anticipation, negative and unknown anticipation led to higher anxiety experience and skin conductance level. This proved that negative and unknown condition led to strong physiological activity, consistent with the self-rating anxiety experience.

However, the finding that heart rate didn't affect by anticipation conditions and emotion regulation condition is consistent with findings of previous researches [44] [45] and differs from other finding's results [31] [46]. The discrepancies in findings may arise in part from the different anxiety inducing paradigm and emotion regulation goal. Above all, skin conductance is a kind of sensitive and stable emotional physiological index while heart rate only reflects emotion activity in some situation.

4.4. Limitations and Directions

The present study suggests a number of compelling directions for future research. In the following section, we consider three of the most important limitations and future directions.

First, the present study investigated the effect of unconscious emotion regulation on anticipatory by priming emotion regulation goals but didn't distinguish the specific regulation strategies, which may correlated to individuals' emotional regulation habits in the daily life. In future studies, it is necessary to explore the effect of different emotion regulation strategies (including situation selection, situation modification, attention deployment, cognitive reappraisal and response modulation) on anticipatory emotion in the unconscious level and the relationship between the effect and individuals' life experience. What's more, we only investigated anticipatory anxiety through images priming which indicated there should be other emotion and other methods to be investigated about the unconscious emotion regulation on anticipatory emotion in future studies.

Second, in the present study, college students as the research samples led to inadequate ecological validity. So it is important to focus on difference samples and pay more attention to special populations, such as anxiety, depression, bipolar disorder patients and other patients with emotion regulation disorder. The use of regulation theory to intervene and treat emotion regulation disorder, perhaps will greatly enrich the research field of emotion regulation strategies, and has high clinical practice significance.

Third, the present study measured the skin conductance level and heart rate. It will be important to assess additional measures (e.g. Skin temperature, pulse and HRV) to reflect the change of whole body or investigate the change participants' emotion expression by using expression encoding technology. Further, some measures (e.g. fMRI) will permit a clearer understanding of the mechanisms underlying the present effects. These are all the future directions.

5. Conclusion

The control of negative anticipatory emotion is important in many domains, including cognitive process, decision-making, and physical health. However, conscious negative anticipatory emotion control is difficult to achieve, and seems to be often associated with significant costs for the individuals. The present study provides an effective answer to the question. Firstly, anticipatory anxiety is affected by anticipation types. Related to anticipating neutral images, participations' anxiety experience and skin conductance were higher when anticipating negative and unknown images. And participants who had an emotion-control goal primed and operating unconsciously achieved the same decrease in skin conductance as those explicitly instructed to cognitive reappraise, compared to a control group. Together, unconscious emotion regulation may provide an effective way to regulate negative anticipatory emotion.

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