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Research Article

The neurophysiological effects of detached and positive reappraisal during the regulation of self-conscious emotions

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Abstract

Background: While cognitive reappraisal represents a promising emotion regulation strategy in regulating basic emotions, little experimental research has investigated its efficacy in reducing self-conscious emotions such as shame and guilt.

Objective: The present study aimed to investigate the effectiveness of detached reappraisal and positive reappraisal in regulating feelings of shame and guilt, and also compared the effectiveness of these two strategies using behavioral and event-related potentials.

Method: Thirty-nine participants grouped either in positive reappraisal or detached reappraisal condition were informed to advise the decider to perform a dot-estimation task. Participants were also informed that the payment of the decider would be reduced if he/she adopted the wrong advice provided by them.

Result: The behavioral results demonstrated that both regulation strategies reduced shame and guilt when compared to the observation stage. We also observed a phenomenon (absent during the regulation of shame) where regulating guilt resulted in a higher parietal P3 amplitude, a component related to negative experiences, compared to the observation phase in the detached reappraisal group.

Conclusion: The results demonstrated that both regulation strategies were able to regulate self-conscious emotions (shame, guilt) effectively. The findings of this study enhance our understanding of the neurophysiological effects of different regulation strategies on self-conscious emotions.

Keywords: self-conscious emotions; shame; guilt; reappraisal; emotion regulation

Introduction

Shame and guilt are two common negative self-conscious emotions that are influenced by how individuals interpret and assess their successes and failures based on the attribution theory (Sznycer, 2019). These emotions are advanced emotions, which are crucial in shaping moral judgment, social behavior, and subjective well-being (Tangney *et al.*, 2007). Prior research indicates that feelings of shame and guilt have a strong correlation with psychological symptoms, including depression, anxiety, and even self-harm behaviors, and these two self-conscious emotions should be considered possible targets for therapeutic or preventive interventions for adolescents with high levels of depressive symptoms (Bastian *et al.*, 2011; Cândea and Szentagotai-Tătar, 2018; Gambin and Sharp, 2018; Williamson *et al.*, 2020). However, despite the correlation between self-conscious emotions and mental health, these emotions have not received the same level of attention as basic emotions. Therefore, it is imperative to investigate effective strategies for regulating feelings of shame and guilt to enhance individuals' mental well-being and provide clinical support.

Shame is considered a profound self-criticism of the entire self, potentially resulting in severe self-blame, and avoidance of failure and its outcomes, while guilt is seen as a self-criticism of one's specific behavior, promoting individuals to make amends (Leach, 2017). Conceptually, both emotions involve self-processing, self-control, and theory of mind, which means shame and guilt are more intricate than basic emotions (Gilead *et al.*, 2016). Additionally, shame involves a comprehensive evaluation, leading to a more intense and pervasive feeling, whereas guilt relates to a specific part of oneself and results in a temporary, limited feeling associated with a particular action (Orth *et al.*, 2010; Dempsey, 2017). From a neurophysiological perspective, both shame and guilt involve self-referential processing and this process often elicits larger amplitudes in a frontal P2 component (Chen *et al.*, 2011). However, shame provokes a stronger P2 response in the frontal area compared to guilt, as shame is more closely associated with self-referential processing than guilt (Zhu and Wu *et al.*, 2017). In addition, self-referential processing and negative materials are also associated with the P3 component due to their higher social/adaptive significance, and individuals may need to allocate additional cognitive resources to evaluate these materials (Tacikowski and Nowicka, 2010). Previous study demonstrated that shame and guilt elicit a larger P3 response than happiness in individuals, as feelings of shame and guilt may result in

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potential negative consequences such as retaliation and criticism from others (Zhu and Feng *et al.*, 2019).

Several paradigms have been developed to elicit feelings of shame and guilt. Since shame and guilt experiences typically arise in interpersonal interactions, our primary focus is on an interpersonal decision-making task based on a dot estimation task (Zhu and Feng *et al.*, 2019; Zhu and Wu *et al.*, 2017). In this task, participants were required to assist a confederate in correctly identifying the number of white dots that have changed position. Due to having additional time to observe the dots, participants were more likely to provide the correct response than the confederate. They were also informed that the payment of the confederate would be varied according to the correctness rate of the task, while their payment would be constant. As a result, the participants would feel a sense of inadequacy when the confederate rejected their wrong advice, which meant the confederate outperformed them in less time, leading to a shameful experience. Additionally, they would feel guilt if their suggestions resulted in the confederate giving an incorrect response and losing money.

Prior studies have demonstrated that emotion regulation is crucial for maintaining psychological well-being (Aldao *et al.*, 2010). Among well-researched strategies, cognitive reappraisal, which involves reconstructing the emotion-eliciting situation differently (John and Gross, 2004), is considered particularly adaptive and highly effective in regulating negative emotions (Troy *et al.*, 2013). Specifically, cognitive reappraisal can be implemented through several specific strategies that vary in how individuals reinterpret the target situation. Two commonly researched strategies include detached reappraisal and positive reappraisal, both of which have demonstrated effectiveness in down-regulating negative emotions (Kross *et al.*, 2005; Krishnamoorthy *et al.*, 2020). Detached reappraisal refers to detaching or distancing oneself from an emotional event in a non-involved observer perspective (e.g. viewing a negative situation as unrelated to personal matters), while positive reappraisal involves positively reinterpreting an emotional situation such as viewing a negative situation with a positive attitude by focusing on the benefits of the situation (Shiota and Levenson, 2012). In other words, detached reappraisal focuses on decreasing the relevance of the situation to the individual, and positive reappraisal focuses on shifting perspectives to view the situation positively.

Previous studies suggested that detached reappraisal has the effect of globally reducing emotional responding no matter whether negative or positive emotions, while positive reappraisal regulates negative emotions mainly by preserving and augmenting positive emotions (Shiota and Levenson, 2012; McRae *et al.*, 2012). Apart from the difference in how they work, there were researchers found that the regulation effect of detached reappraisal occurred earlier than that of positive reappraisal with no significant differences in effectiveness (Qi *et al.*, 2017). Researchers also discovered that when regulating negative emotions, juveniles (ages 10–15) had a higher success rate with the detached reappraisal technique compared to positive reappraisal, with no significant difference in effectiveness. Conversely, for youths (ages 17–28), positive reappraisal was found to be more effective than detached reappraisal, with no significant difference in success rate between the two strategies (Yu *et al.*, 2021). These results indicate that detached reappraisal may be more readily applied than positive reappraisal. However, it remains inconclusive if there is a discernible difference in their effectiveness.

The previously mentioned findings primarily addressed basic negative emotions, with less emphasis on strategies for regulating feelings of shame and guilt. These two emotions require more complex psychological processes and engage neural substrates associated with self-processing, self-control, and theory of mind, as compared to basic emotions (Gilead *et al.*, 2016; Zhu *et al.*, 2019). Only a few studies explored the effect of cognitive reappraisal on shame and guilt, for example, Krishnamoorthy and his college found that positive reappraisal regulated shame effectively among high shame-prone participants (Krishnamoorthy *et al.*, 2020), while Cândea and her college suggested that detached reappraisal was not as effective in regulating shame as it is in regulating basic emotions (Cândea and Szentagotai-Tătar, 2020). Therefore, the first aim of this study is to investigate whether detached reappraisal and positive reappraisal remain effective when regulating shame and guilt. Considering the differences between detached reappraisal and positive reappraisal mentioned before, we also further examined whether there will be a difference in their effectiveness.

In summary, negative self-conscious emotions such as shame and guilt develop over a person's life and can lead to psychological distress including depression and anxiety (Bastian *et al.*, 2011; Cândea and Szentagotai-Tătar, 2018; Gambin and Sharp, 2018; Williamson *et al.*, 2020). Therefore, understanding how to regulate these emotions is crucial for personal well-being and harmonious social relationships. This study used a decision-making task to elicit shame and guilt during social interactions, which excluded unrelated psychological processes such as imagination and recall. In addition to self-report data, we also utilized event-related potentials (ERPs) to more accurately assess the efficacy of the two strategies due to their notable benefits in examining the temporal dynamics of emotional changes and their objective nature. This study may enhance our understanding of self-conscious emotions and effective strategies for regulating them.

Method

Participants

This study used a mixed design to examine variations in the regulatory effects of various emotion regulation strategies. Repeated measures ANOVA was utilized, with sample size determined using G-power software based on a medium effect size of $f = 0.25$, $\alpha = 0.05$, and power of 0.8, resulting in a sample size of 20 participants per group. In total, 42 healthy college students (7 males and 35 females) participated in the experiment for payment. All participants provided written consent according to the Declaration of Helsinki and reported no history of psychiatric, neurological, or cognitive diseases. Two female participants were excluded because they did not complete the experiment for personal reasons, and one female participant was excluded since artifacts were >30%. The final sample consisted of 39 participants ($M_{age} = 19.38$, SD = 1.48) who were randomly assigned to either the detached reappraisal group or the positive reappraisal group. (The first participant was randomly assigned to one of the two groups, and then the next participant of the same sex/gender was assigned to the other group. The remaining participants were assigned following the same guideline to ensure random allocation to different groups while maintaining a balanced representation of gender between the two groups.) There were 18 individuals in the detached reappraisal group and 21 individuals in the positive reappraisal group. One male and one female student, who were strangers to the participants, were recruited as confederates. The study was approved by the ethical committee of the host university.

Table 1: Affective words following different outcome.

Roles	Conditions	Outcomes		Affective words	Number of trials
		Advice	Decision		
Decider		wrong	wrong	sadness or anger	30
		wrong	right	happiness or pride	
		right	right	happiness or pride	
		right	wrong	sadness or shame	
Advisor	guilt	wrong	wrong	guilt or shame	50
	shame	wrong	right	guilt or shame	50
	happiness	right	right	happiness or pride	50
	uncertainty	right	wrong	happiness or pride	10

Procedure

On arrival, participants met a same-sex confederate and were told that they would play an advice-decision game with the confederate in separate rooms. They were expected to alternate roles in a dot-estimation task, with one individual serving as the advisor providing guidance (who had more time to observe the dots), while the other made the final decisions to determine whether the number of dots presented was above or below 20. It was stated that the compensation for advisors remained consistent regardless of advice accuracy, whereas the decider received 0.5 yuan for correct decisions and was penalized 0.5 yuan for incorrect decisions. Research has shown that participants may experience feelings of shame when their incorrect advice is rejected by a confederate, as it implies that the confederate outperformed them. Conversely, participants may feel guilty when their incorrect advice leads to financial loss for a confederate (Zhu and Feng *et al.*, 2019).

Participants served as decision-makers for 30 trials initially, with the accuracy of their decisions determined by established rules: If they followed the advice of the advisor, their likelihood of making a correct decision was 80%; if not, the likelihood was 20%. This manipulation underscored the role of the advisor and suggested that the advisor's task was not overly challenging, potentially intensifying feelings of guilt and shame for participants when they later assumed the role of the advisor.

Then participants were randomly assigned to a detached reappraisal group or positive reappraisal group and acted as the advisor for 320 trials (160 trials in the observation phase at first and then 160 trials in the regulation phase). During each trial, the advisor received instruction on how to cope with their emotions first. In the observation phase, the instruction was "When your partner's feedback results appear, take a moment to thoughtfully experience the emotions that may arise from the current feedback situation and allow yourself to process them naturally." In the regulation phase, the participants in the detached group received instructions "When your partner's feedback results appear, take a detached and objective approach when reviewing the current feedback and try to minimize the emotional impact it may have on you," while the participants in the positive group received instructions of "When your partner's feedback results appear, take a positive view of the current feedback, envision the beneficial outcomes of this feedback, and try to minimize the emotional impact it may have on you."

Next participants viewed a picture of 20 random dots for 1.5 s (the decider saw the same picture for only 0.75 s), advised whether there were more or fewer than 20 dots within 2 s, and waited for the decider's decision on whether to take the advice within 3 s. Next, participants saw the outcomes of the advice and decision (the decider saw the results at the same time). Finally, two affective words emerged according to the outcome (Table 1) and the participants chose the word that precisely described their emotion at that time and rated the intensity (Fig. 1) or chose neither of the two words if both words failed to match their current emotions. Different conditions were presented in a pseudo-random order, ensuring the trials of the same condition did not appear consecutively more than twice. The left and right positions of affective words were counterbalanced. At the end of each phase, participants were required to indicate their adherence to instructions, the success degree in using strategies (observe, detached reappraisal, or positive reappraisal), and the subjective level of effort exerted in using strategies on a nine-point Likert scale.

Electroencephalographic recording and analysis

EEG signals were obtained from the scalp using an ANT EEG device with 64 standard Ag/AgCI electrodes, of which the ground electrode was GRN and the online reference electrode was CPz (bandpass 0.01–100 Hz, sampling rate 1000 Hz). The impedances were set at $\leq$5 kΩ for all apparatuses. The data from the left (M1) and right (M2) mastoids were also recorded during the experiment. During the offline data processing, the EEG was re-referenced to the average activities of the left and right mastoids.

EEG data were processed offline using EEGLAB2020 (Delorme and Makeig, 2004). EEG data were filtered with a 0.1-Hz high-pass filter and a 40-Hz low-pass filter first. The data were segmented into epochs with a time window from −200 to 3000 ms. Baseline correction was performed by subtracting the mean of the 200 ms before image onset. Trials with a large drift were manually removed, and trials contaminated by eye movement or eyeblinks were corrected using an independent component analysis algorithm.

We analyzed the ERP data during the outcome of the decision stage (marked with a red frame in Fig. 1). The main EEG components of the research are P2 and P3. The average amplitude was used to measure the P2 component (in the time window of 185–235 ms, averaged with electrodes FCz, FC1, FC2, Cz, C1, C2), and the P3 component (in the time window of 260–290 ms, averaged with electrodes Pz, P1, P2, P3, P4, POz, PO3, and PO4). The time windows and electrode sites for these ERP components were chosen based on previous studies (Zhu and Wu *et al.*, 2017; Na *et al.*, 2019; Sánchez-García *et al.*, 2021) and visual inspection of the ERP waveforms.

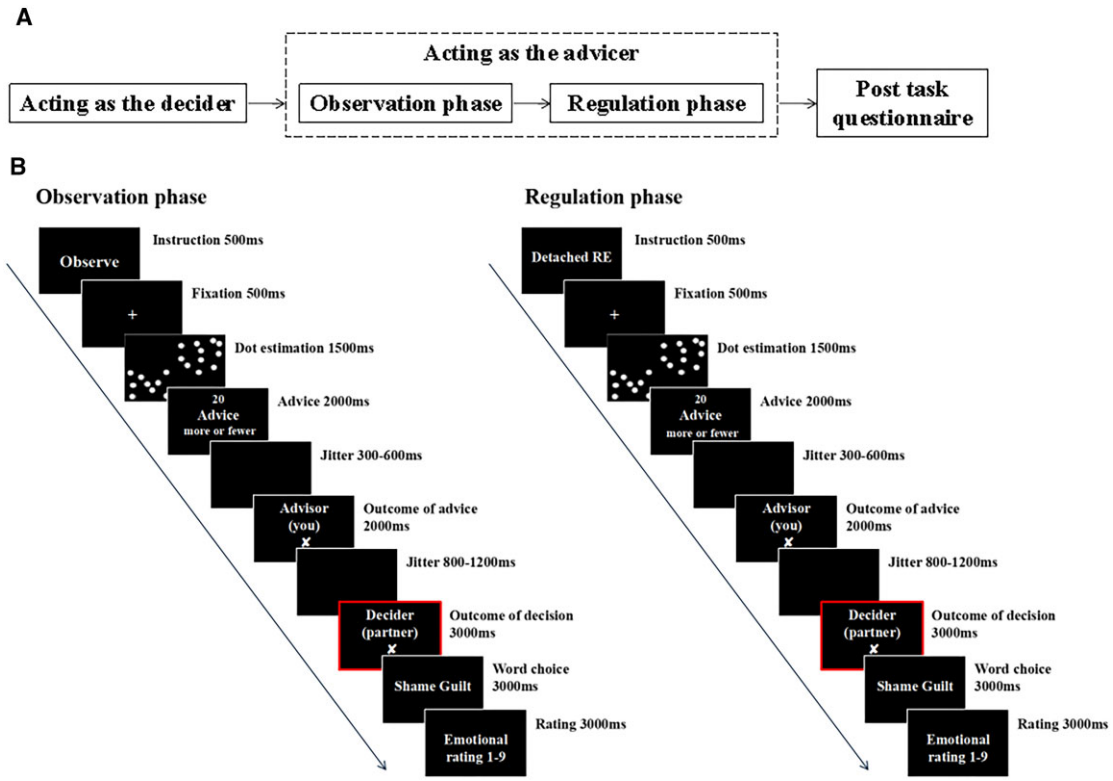

Figure 1: (**A**) The procedure of whole experiment. (**B**) Timeline of the experimental procedure (take the detached group as an example).

Result

Manipulation check

There were no significant differences in gender, age, anxiety, depression, and strategy use tendency among the different groups ($P > 0.05$), as shown in Fig. 2a. We then analyzed the choice of emotional words during the observation stage to test whether the induction of emotion was successful. The findings indicated that, within the shame scenario, participants tended to opt for shame over guilt and no selection ($F_{(2,76)} = 111.275$, $P < 0.001$, $\eta_p^2 = 0.745$), participants tended to choose guilt over shame and no selection in the guilt scenario ($F_{(2,78)} = 132.165$, $P < 0.001$, $\eta_p^2 = 0.777$), and participants tended to choose happy over pride and no selection in the happiness scenario ($F_{(2,76)} = 338.256$, $P < 0.001$, $\eta_p^2 = 0.899$), as shown in Fig. 2b. Thus, the results of the choice of emotional words during the observation stage showed that the emotion induction procedure used in the present study was effective in inducing corresponding shame, guilt, and happiness.

We then examined the self-reported data regarding adherence to instructions, success in strategy implementation, and the level of effort put into implementing strategies among both detached and positive groups. The results indicated that the ratings of the adherence to instructions and the success degree in using strategies were significantly higher than the middle point, which means that all the participants learned and performed strategies as expected ($P < 0.05$). The results indicated that there were not any statistically significant differences across all three dimensions between the two groups ($P > 0.05$).

Self-report emotional ratings

A 2 (group: detached vs positive) × 2 (phase: observation and regulation) × 3 (emotion: shame, guilt, and happiness) repeated measures ANOVA was conducted. There was a significant main effect of phase ($F_{(1,37)} = 72.747$, $P < 0.001$, $\eta_p^2 = 0.663$), and the *post hoc* results showed that the emotional ratings in the observation phase were significantly higher than in the regulation phase ($P < 0.001$). There was a significant main effect of emotion ($F_{(1,37)} = 5.074$, $P = 0.03$, $\eta_p^2 = 0.121$), and the *post hoc* results showed that the emotional ratings of guilt were higher than the ratings of shame ($P = 0.013$).

There was a significant three-way interaction ($F_{(1,37)} = 13.439$, $P = 0.001$, $\eta_p^2 = 0.266$). Simple effect analysis found that there was not a significant difference in the ratings during the observation phase for three emotions between the two groups ($P > 0.05$). We also found that both detached reappraisal and positive reappraisal significantly reduced shame and guilt across phases, which indicated that these two strategies can effectively regulate shame and guilt. By contrast, only detached reappraisal had a significant impact on reducing happiness levels throughout the phases ($P < 0.001$), while the intensity ratings of happiness did not differ significantly in the positive reappraisal group (Fig. 3).

EEG results

P2: A 2 (group: detached vs positive) × 2 (phase: observation and regulation) × 3 (emotion: shame, guilt, and happiness) repeated measures ANOVA revealed no significant main or interaction effects.

P3: A 2 (group: detached vs positive) × 2 (phase: observation and regulation) × 3 (emotion: shame, guilt, and happiness) repeated measures ANOVA revealed that there was a significant three-way interaction ($F_{(1,37)} = 6.409$, $P = 0.016$, $\eta_p^2 = 0.148$). Simple effect analysis found that there was no significant difference in the amplitudes of the P3 component during the observation phase for three emotions between the two groups ($P > 0.05$). Besides, when the emotion was shame, the mean amplitude of P3 was not

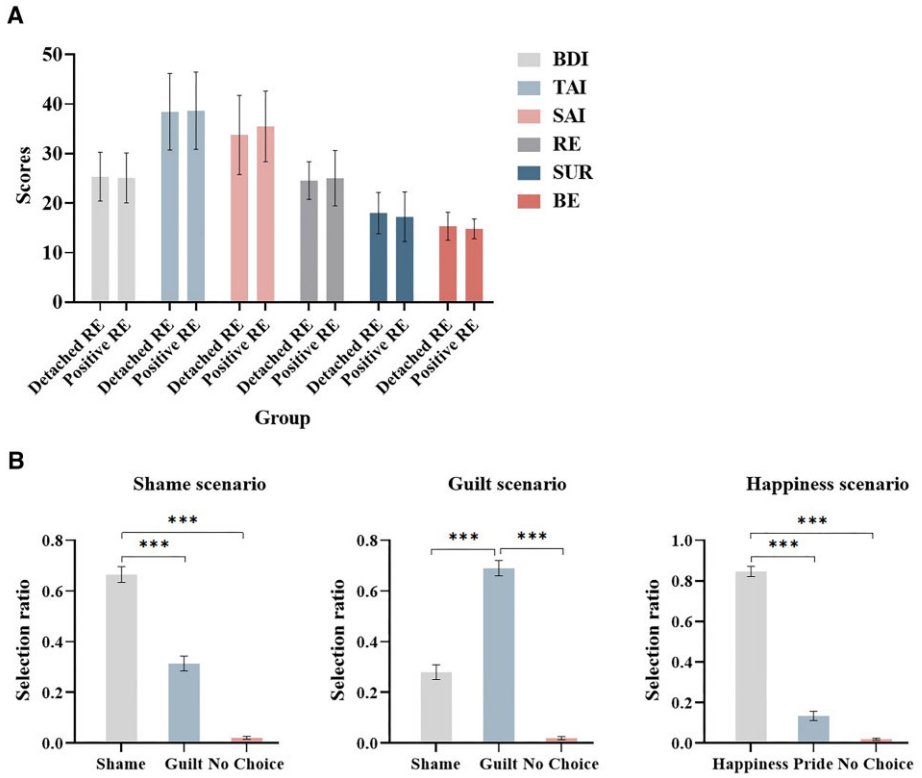

Figure 2: (**A**) Anxiety, depression, and strategy use tendency among the different groups, BDI = Beck's Depression Inventory, TAI = Trait Anxiety Inventory, SAI = State Anxiety Inventory. (**B**) The choice of emotional words during the observation stage, Bar = SE, ***$P < 0.001$

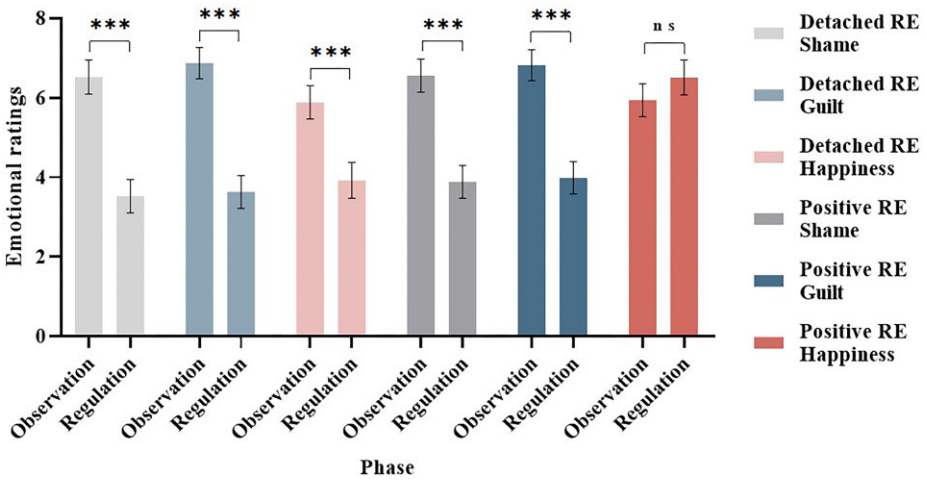

Figure 3: The results of the self-reported emotional intensity of shame, guilt, and happiness in different groups, Bar = SE, ***$P < 0.001$, ns = no significance.

significantly different from the observation phase to the regulation phase in the detached reappraisal group ($P = 0.231$) and in the positive reappraisal group ($P = 0.092$). By contrast, when the emotion was guilt, the mean amplitude of P3 in the observation phase was significantly lower than in the regulation phase in the detached group ($P = 0.034$) but not in the positive reappraisal group ($P = 0.249$). When the emotion was happiness, the mean amplitude of P3 was not significantly different from the observation phase to the regulation phase in the detached reappraisal group ($P = 0.145$) and in the positive reappraisal group ($P = 0.683$), as shown in Fig. 4.

Discussion

Shame and guilt are two crucial self-conscious emotions that may lead to psychological distress including depression and anxiety (Bastian *et al.*, 2011; Cândea and Szentagotai-Tătar, 2018; Gambin and Sharp, 2018; Williamson *et al.*, 2020). Effective strategies for managing these emotions are essential for promoting mental well-being and providing clinical support. However, there has been little experimental research investigating its efficacy in reducing self-conscious emotions such as shame and guilt. The current study examined the impact of detached reappraisal and positive

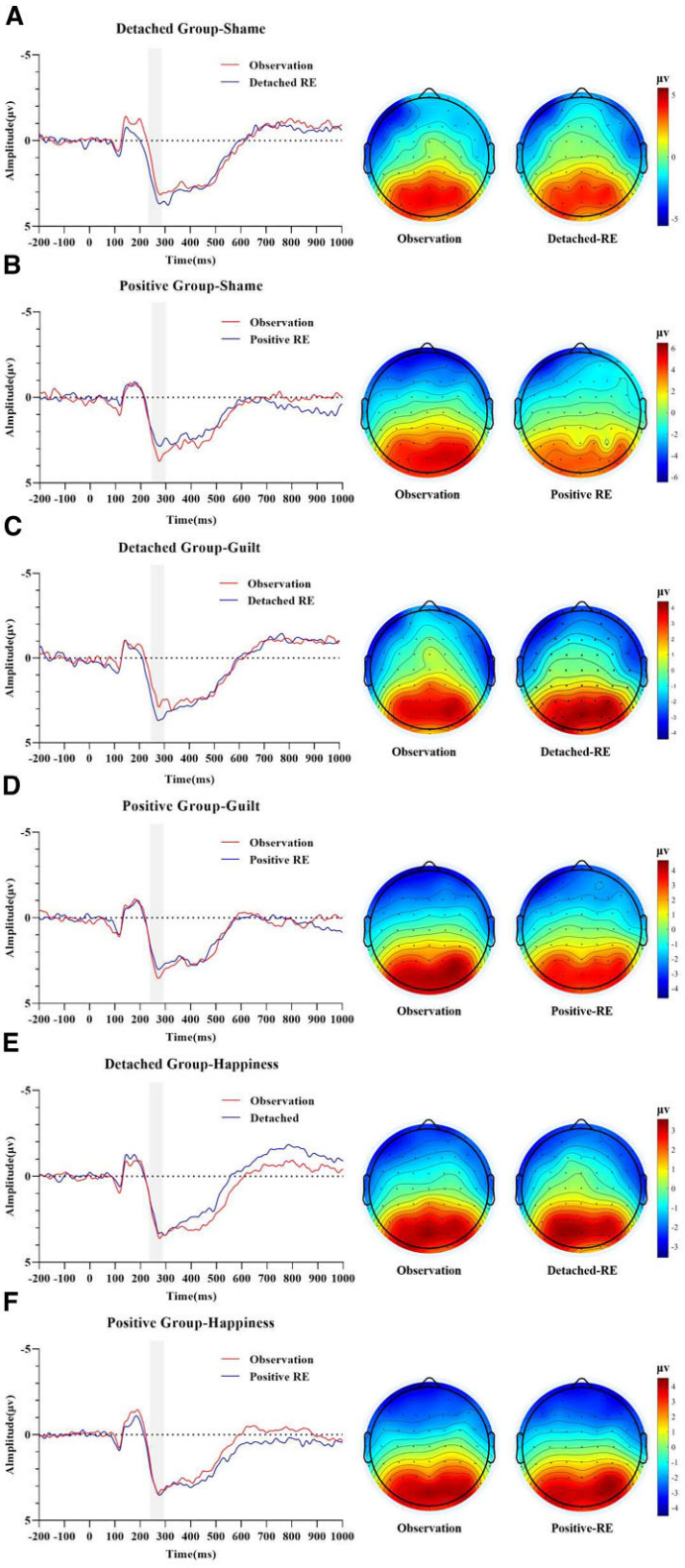

Figure 4: Grand-average P3 and the topographical distribution of wave P3 (Pz, P1, P2, P3, P4, POz, PO3, and PO4) in (**A**) shame in the detached group; (**B**) shame in the detached group; (**C**) guilt in the detached group; (**D**) guilt in the positive group; (**E**) happiness in the detached group; and (**F**) happiness in the positive group.

reappraisal on feelings of shame and guilt within the context of interpersonal interactions. Additionally, it investigated how ERPs can be used to assess cognitive involvement during the regulation of these emotions.

The behavioral results showed that both detached and positive reappraisal could effectively regulate shame and guilt, as suggested by Hypothesis 1. This discovery has confirmed that both detached and positive reappraisal are effective strategies when dealing with self-conscious emotions such as guilt and shame. However, we did not find that detached reappraisal and positive reappraisal techniques had varying effects on different types of emotions. This may be because shame and guilt are commonly found to coexist, as indicated by previous research studies (Michl *et al.*, 2014; Wagner *et al.*, 2011). We observed a distinction between these two strategies specifically in terms of regulating happiness, as detached reappraisal demonstrated a significant capacity for down-regulating happiness while positive reappraisal did not yield a significant effect. This finding was consistent with the previous study, which suggested that the mechanism of detached reappraisal was to reduce emotional arousal while the mechanism of positive reappraisal was to increase emotional pleasure (Qi *et al.*, 2017).

At a neurophysiological level, we discovered that regulating guilt resulted in a higher parietal P3 amplitude in the detached reappraisal group when compared to the observation phase, while we did not find the same pattern in the positive reappraisal group. The increased P3 amplitudes are observed during tasks that require a higher level of attentional resources and when exposed to emotionally negative stimuli (Zhu and Feng *et al.*, 2019; Tacikowski and Nowicka, 2010; Wang *et al.*, 2019). Considering that we observed no significant difference in the effort required to implement detached reappraisal compared to positive reappraisal in the self-report data, this finding may be attributed to negative experiences. Guilt occurs when individuals contribute to negative outcomes for others, prompting them to take steps towards making amends such as confessing and committing to improving future behavior. Shame, by contrast, arises when an individual attributes negative outcomes of their actions to their lack of ability, which is associated with avoidance behaviors such as hiding one's face, and gaze aversion (Dempsey, 2017; Leach, 2017). In other words, guilt is often viewed as a prosocial emotion that demonstrates a concern for moral standards and the welfare of others, while shame is typically linked to a desire to evade criticism and consequences from others, rather than addressing and resolving the issue at hand (Higgs *et al.*, 2020). Detached reappraisal involves reducing the personal significance of a situation and increasing the emotional distance from it. Therefore, detached reappraisal aligns with the action tendency of shame while contradicting the behavioral response of guilt, potentially leading to less favorable outcomes when using detached reappraisal to regulate feelings of guilt.

Regarding the results of the P2 component, a previous study indicated that it could serve as a useful indicator for differentiating between shame and guilt because guilt involves more self-referential processing than shame (Zhu and Feng *et al.*, 2019). However, we did not observe similar outcomes, and we also did not notice significant differences among shame, guilt, and happiness. This may be partly attributed to the fact that participants were informed of their tasks and strategic instructions before the experiment, which led to a more efficient processing of information and potentially reduced involvement. Besides, further exploration is needed to determine whether the P2 component can be reliably used as an indicator for differentiating between feelings of shame and guilt.

Some limitations in this study need to be improved in future studies. First, although the demographic variables were balanced between groups, the male and female participants were unbalanced since previous research has indicated that women are more susceptible to negative stimuli than men (Yuan *et al.*, 2009). It is recommended that future studies explore these findings by including subjects of different genders. Second, it is important to note that our sample was limited to college students, and future studies could benefit from examining these findings in individuals with diverse backgrounds. Third, this study used interpersonal interactions to evoke feelings of shame and guilt. although we ensured the ratings of the target emotion in each condition were significantly higher than any other emotion, it is hard to induce pure shame and guilt. Future research should consider exploring a more adaptive paradigm to elicit these emotions, thereby facilitating a deeper understanding of the processes involved in shame and guilt. Finally, this study only examined the impacts of various strategies on the emotional intensity of self-consciousness. Future experiments could delve deeper into the effects of detached and positive reappraisal on behavioral outcomes associated with feelings of shame and guilt.

Conclusion

This study examined the impact of detached reappraisal and positive reappraisal on self-conscious emotions using ERP techniques. Our findings suggest that both regulation strategies effectively reduced feelings of shame and guilt in comparison to the observation stage. Additionally, we observed that regulating guilt resulted in a higher parietal P3 amplitude when compared to the observation phase only within the detached reappraisal group. These results indicate that both regulatory strategies are successful in managing shame and guilt, although there may be differences in their effectiveness between detached reappraisal and positive reappraisal. The findings of this study deepen our understanding of the neurophysiological effects of different regulation strategies on self-conscious emotions.

Author contributions

Leling Zhu (Formal analysis, Visualization, Writing – original draft), Tingyu Fu (Data curation, Formal analysis, Investigation, Methodology), Xinyu Yan (Writing – review & editing), Jiajin Yuan (Conceptualization, Funding acquisition, Project administration, Resources, Supervision, Writing – review & editing), and Jiemin Yang (Conceptualization, Funding acquisition, Resources, Supervision, Writing – review & editing)

Conflict of interest

None declared.

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