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RESEARCH ARTICLE

The formation of the if–then contingency in implementation intention relieves anticipatory anxiety

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ABSTRACT

Anxiety is characterized by anticipatory emotions as a response to potential threats. Despite knowledge of the effectivity of implementation intention in regulating emotion evoked by aversive stimuli, whether this method is effective in regulating anticipatory anxiety for potential threats remains unknown. To bridge this gap, this study applied a cue–target paradigm to induce anticipatory anxiety toward potential negative pictures among participants. Specifically, emotion feeling (no-regulation), goal intention, goal intention+response and implementation intention were administered to different groups to explore their regulatory effects on anticipatory anxiety. The results demonstrated a unique regulatory effect of implementation intention on anticipatory anxiety, regardless of the type of cue. However, this effect is absent under the goal intention and goal intention+response conditions. These findings suggest that implementation intention is effective in downregulating anticipatory anxiety. In addition, its regulatory effect cannot be attributed to a mere goal setup or the setup of goal and response combination, but should be accounted for by the setup of the situation–response contingency in addition to goal representation.

1 Introduction

Anxiety is a composition of anticipatory affective, cognitive, and behavioral states in response to the potential future threats or challenges [1, 2]. Research on anxiety regulation demonstrated that cognitive reappraisal and acceptance are more effective in regulating physiological arousal than suppression is [3]. Moreover, nonadaptive strategies (e.g., expressive suppression) play a more important role in the occurrence of psychopathology [4] compared with adaptive strategies (e.g., cognitive reappraisal and problem-focusing), which may be due to increased cognitive costs or resource consumption during strategy implementation [5, 6]. However, even for adaptive cognitive strategies (e.g., reappraisal or acceptance), research found that its intentional

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application may also be of cognitive depletion. In other words, it is high in cognitive cost, such as increased frontal late positive potential amplitudes or reduced preference to use it for daily emotion regulation [7, 8]. Alternatively, the uncertainty of future events also entails a heavy consumption of cognitive resources for coping, which engenders the increased necessity to find another form of regulatory method that is not resource-costly.

In line with this objective, previous studies have shifted their attention to implementation intention, which is an efficient means of fulfilling less effortful and even automatic emotion regulation [9, 10]. The intention to achieve a goal includes goal and implementation intentions [11, 12]. Goal intention refers to one's intention to seek a specific goal, such as "I want to do Z." The implementation intention, the socalled "if–then" plan, is based on goal intention and employs a specific implementing method to achieve the goal, which makes individual know when, where, and how to achieve the goal, such as "I will not feel scared. And if I see a spider, then I will remain calm and relaxed" [13, 14]. A rehearsal of the goal and the if–then plan then leads to the formation of contingency between the if-situation and the then-response. In other words, the "then" part of the response will be automatically initiated without deliberate mobilization when the "if" situation is encountered. A recent study using a functional neuroimaging method illustrates that the implementation intention is effective in reducing negative emotions evoked by disgusting stimuli without online mobilization of cognitive control resources, as reflected by reduced functional coupling of neural networks subserving emotional stimulus processing [15]. Therefore, the current study hypothesizes that implementation intention combined with an adaptive cognitive strategy may be efficient in reducing anticipatory anxiety.

Specifically, to investigate the unique effect of implementation intention in regulating anticipatory anxiety, we designate three other strategies as baseline comparison conditions, namely, emotional feeling (no-regulation condition), goal intention, and goal intention+response. We designed a single condition of goal intention to verify whether the goal setup instead of the formation of implementation intention is effective in regulating anticipatory anxiety. Given that implementation intention requires longer instructions than goal intention, we also designed a goal intention+ response condition as an additional baseline group, to control the length of instruction between implementation intention and control. In other words, implementation intention only differs from the goal intention+response condition in the automated association between cue and response.

The cue–target paradigm was used to induce the anticipatory anxiety of the participants. The specific process of the cue–target paradigm is as follows. An experimenter informs participants that negative events may occur afterward, while different cues indicate whether negative events will occur. We expect that participants will feel anxious from the time they see a negative cue to the time the negative event occurs. The subjective anxiety score was used to measure the intensity of anxiety.

2.1 Methods

2.1.1 Participants

The study recruited 121 female undergraduate students (age: M = 19.52, standard deviation (SD) = 0.72) to participate in the experiment, because females are more sensitive to negative pictures. They are right-handed, free of any reported affective disorders, psychotropic drugs, or hormonal drugs, and had normal or corrected to normal vision. Each participant signed an

informed consent form prior to the experiment. They were randomly divided into four groups, namely, control (n = 30), goal intention (n = 30), goal intention+response (n = 30), and implementation intention (n = 31).

Prior to the experiment, participants were required to complete the State Anxiety Scale, Trait Anxiety Scale (STAI-trait) [16], Self-Rating Depression Scale [16], Self-Esteem Scale [16], cognitive reappraisal and expressive suppression tendencies measured by the Emotion Regulation Questionnaire [17], and the Acceptance and Action Questionnaire (AAQ) [18]. ANOVA on the scores of various scales demonstrated no significant differences between groups regardless of scale type (F(3,117) = 0.32–1.83, p = 0.15–0.81). Figure 1 displays the results.

2.1.2 *Stimuli*

The pictures were selected from the international affective picture system [19], the Chinese affective picture system [20], and the Internet, including negative pictures of snakes, spiders, and cockroaches, bloody pictures, and neutral pictures of landscapes. Prior to the experiment, we recruited another sample of 47 female undergraduates, who did not participate in the formal experiment, to rate the valence, arousal, fear, and disgust of all pictures. Using a self-report nine-point rating scale, the participants were required to rate emotion valence (1 = very unpleasant; 9 = very pleasant), arousal (1 = very calm; 9 = very excited), fear (1 = not scared at all; 9 = very scared), and aversion (1 = not disgusted at all to 9 = very disgusted). According to the evaluation results, 62 negative and 62 neutral pictures were screened out for a total of 124 pictures, where four pictures were used for practice, and the remaining were used for the formal experiment. The valence of negative pictures (M = 2.59, SD = 0.88) was significantly lower than that of neutral pictures (M = 5.45, SD = 0.26; t(118) = –24.19, p < 0.001) and significantly lower than the median score (i.e., 5) of the rating scale. (t(59) = −21.23, p < 0.001). The intensity of arousal (M = 6.25, SD = 1.52), fear (M = 5.03, SD = 1.00), and disgust (M = 5.86, SD = 1.36) for negative pictures were significantly higher than those of neutral pictures (M = 2.88/1.70/1.82,

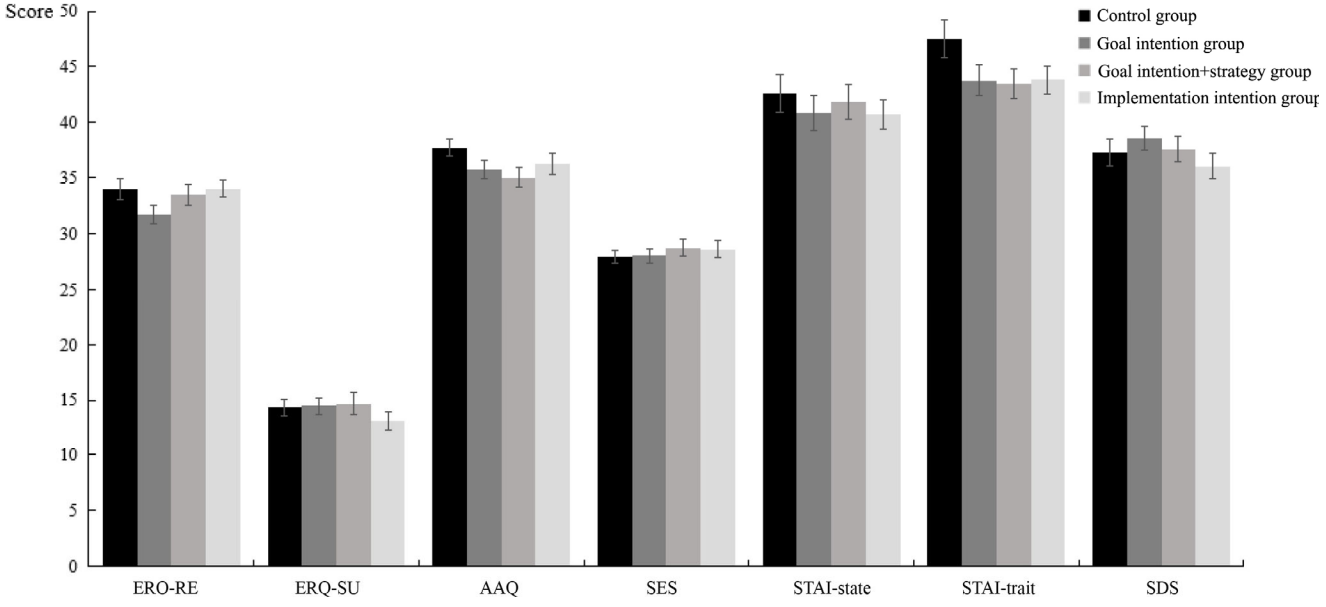

Figure 1 The scores of Cognitive Reappraisal Strategy (ERO-RE), Expression Suppression Strategy (ERQ-SU), Acceptance and Action Questionnaire (AAQ), Self-Esteem Scale (SES), State Anxiety Scale (STAI-state), Trait Anxiety Scale (STAI-trait), and Self-rating Depression Scale (SDS) in 3 groups of subjects, the error line is standard error (SE).

SD = 0.47/0.20/0.22; $t(118) = 16.41–25.36$, $p < 0.001$), whereas the intensity of arousal and aversion of negative pictures were significantly higher than the median score of 5 ($t(59) = 6.37/4.89$, $p < 0.001$).

2.1.3 *Procedure*

Prior to the experiment, the groups were given different instructions to activate corresponding emotion regulation strategies. The following instructions were given: "In the following experiment, I will attend, feel and reveal my emotions naturally" (no-regulation group); "In the following experiment I will not feel anxious" (goal intention group); "In the following experiment, I will not feel anxious, I will remain calm and relaxed" (goal intention+response group, with a specific response to the instruction of goal intention); and "I will not feel anxious. If the cue indicates negative picture, then I will remain calm and relaxed" (implementation intention group).

We employed the cue–target paradigm to induce anticipatory anxiety among the participants. Three types of cues were given, namely, "×" (a negative clue that indicated a negative picture will appear; "○" (a neutral clue, which indicates that a neutral picture will appear; and "?" (an uncertain cue, which indicates that a negative or a neutral picture will appear).

The practice phase consists of four trials: one negative picture for the negative cue; one neutral picture for the neutral cue; and one negative picture and one neutral picture under uncertain cues. To ensure the understanding of the participants regarding the meaning of each cue, they were required to write down the meaning of each cue on paper, and the experiment would continue only when the content was written correctly. The formal experiment consists of two runs, where each run contained 60 trials, including 15 negative pictures after negative cues; 15 neutral pictures after neutral cues; and 15 negative pictures and 15 neutral pictures after uncertain cues.

In formal experiment, the participant initially focused on a cross on the screen for 500 ms; then, a cue would be randomly presented for 4000 ms. After the cue disappeared, the participant was required to rate their anxiety using a nine-point scale (1 = not anxious at all; 9 = "very anxious") and pressed a corresponding key in 2000 ms. Afterward, a picture corresponding to the cue was presented. At the end of the experiment, the participant was required to rate the degree to which they followed the instruction during the experiment (1 = didn't follow at all; 9 = completely followed). The participants were then informed about the purpose of the experiment, and they were given a token for their participation. Figure 2 presents the behavioral procedure for the experiment.

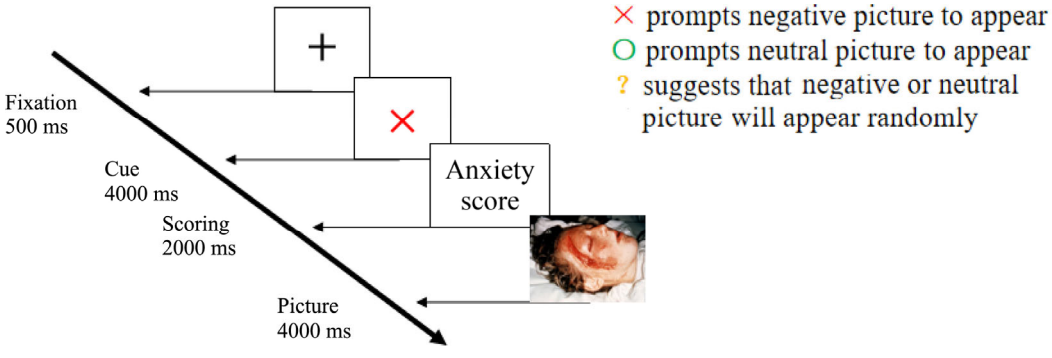

Figure 2 In each trial, 4 visual stimuli appeared successively: a fixation, a cue, anxiety score, and a target picture. The participants were informed of the meaning of each cue and the cue–target association. They were tasked to rate their anxiety level after the cue presentation.

2.2 Results

2.2.1 Effectiveness of data

To ensure that all participants complied with the instructions, data that indicated low levels of compliance (≤ 6) were excluded, such that only data from 102 participants were included for analysis. ANOVA on the remaining compliance scores demonstrated the absence of significant differences in the degree of compliance between strategies ($F(3,101) = 0.17$, $p = 0.92$).

2.2.2 Effectiveness of the experimental program

To verify whether the experimental task successfully induced anticipatory anxiety among participants, we first analyzed the data of the control group. Repeated-measures ANOVA on the anxiety scores of the control group indicated a significant main effect of cue type ($F(2,58) = 80.16$, $p < 0.001$, $\eta_p^2 = 0.73$). Anxiety scores for negative cues ($M = 6.39$, SD = 1.76) were significantly higher than those for uncertain cues ($M = 5.45$, SD = 1.67, $p < 0.001$) and neutral cues ($M = 2.70$, SD = 1.34, $p < 0.001$). Moreover, anxiety scores for uncertain cues were significantly higher than those for neutral cues ($p < 0.001$). In addition, anxiety scores for negative cues were significantly higher than the median of 5 (medium anxiety; $t(29) = 4.32$, $p < 0.001$, Cohen's $d = 1.12$), whereas anxiety scores for neutral cues were significantly lower than the median of 5 ($t(29) = -9.42$, $p < 0.001$, Cohen's $d = 2.43$). Anxiety scores for uncertain cues was non-significantly different from the median value of 5 ($t(29) = 1.46$, $p = 0.15$, Cohen's $d = 0.38$). These results indicated that the experimental task successfully induced anticipatory anxiety among the participants.

2.2.3 Effect of different strategies on anticipatory anxiety

To test the impact of the different regulatory methods on anxiety and whether the impact differed according to cues, repeated-measures ANOVA was performed on anxiety scores, with group type, and cue type as independent variables. The results illustrated that the main effect of group type ($F(3, 98) = 4.77$, $p = 0.002$, $\eta_p^2 = 0.14$) was significant, and the anxiety score of the implementation intention group was significantly lower than those of the control ($p < 0.001$), goal intention ($p = 0.03$), and goal intention+response ($p = 0.01$) groups. Differences between the control, goal intention and goal intention+response conditions were non-significant.

The main effect of cue type ($F(1.20, 117.12) = 212.59$, $p < 0.001$, $\eta_p^2 = 0.68$) was significant, whereas anxiety scores for negative cues were significantly higher than those for uncertain cues ($p < 0.001$), which, in turn, elicited higher anxiety scores compared with those for neutral cues ($p < 0.001$). The interaction effect of strategy × cue type tended to be significant ($F(3.59, 117.12) = 2.32$, $p = 0.07$, $\eta_p^2 = 0.07$).

To illustrate the effect of different regulatory strategies on anticipatory anxiety according to cues, the study conducted subsequent simple effect analyses. The results demonstrated that for negative cues, the anxiety score of the implementation intention group ($M = 4.27$, SD = 2.35) was significantly lower than that of the control ($M = 6.45$, SD = 1.56; $t(54) = 3.75$, $p < 0.001$, Cohen's $d = 1.09$), goal intention ($M = 5.55$, SD = 2.05; $t(47) = 2.00$, $p = 0.05$, Cohen's $d = 0.58$), and goal intention+response ($M = 5.93$, SD = 2.45; $t(49) = 2.47$, $p = 0.02$, Cohen's $d = 0.69$) groups. The study observed no significant differences among goal intention, goal intention+response, and the control group ($p_s > 0.13$). Under neutral cues, the anxiety score of the implementation intention group ($M = 1.92$, SD = 1.19) was significantly lower than that of the control group ($M = 2.65$, SD = 1.31; $t(54) = 2.17$, $p = 0.03$, Cohen's $d = 0.38$) without significant differences among the goal intention, goal intention+response, and control groups ($p_s > 0.12$). Under uncertain cues,

the anxiety score of the implementation intention group (M = 3.55, SD = 1.83) was significantly lower than that of the control (M = 5.49, SD = 1.58; $t(54) = 3.99$, $p < 0.001$, Cohen's $d = 1.13$), goal intention (M = 4.71, SD = 1.98; $t(47) = 2.14$, $p = 0.04$, Cohen's d = 0.61), and goal intention+response (M = 4.82, SD = 2.11; $t(49) = 2.31$, p = 0.03, Cohen's $d = 0.64$) groups. Moreover, no significant difference was noted among the goal intention, goal intention+response, and control groups ($p_s > 0.17$; Fig. 3). These findings indicate that only implementation intention could effectively regulate anticipatory anxiety, whereas neither goal intention nor goal intention+response exerted a similar effect on anxiety.

2.3 Discussion

Using a cue–target paradigm and experiential measures, the current study investigated the components of implementation intention in regulating anticipatory anxiety. Four conditions, namely, emotion feeling (no-regulation), goal intention, goal intention+response, and implementation intention were administered to different groups to explore their regulatory effects, respectively. The results demonstrated a unique regulatory effect of implementation intention on anticipatory anxiety, regardless of the type of cue. However, this effect is absent under the goal intention and goal intention+response conditions. These findings suggest that the if–then contingency, rather than goal setup or strategic representation alone, plays a pivotal role in the successful regulation of implementation intention on anticipatory anxiety.

Emotional anticipation is important for the humans' adaptiveness to the environment. However, this process can lead to the activation of threat-related neural circuits in the brain, and alertness or vigilance toward potential threat signals, which is termed anxiety [21–24]. For instance, the activity of stimulus preceding negativity (SPN, the electrical component of the brain related to alertness and vigilance during the anticipatory process) increased significantly before the fear stimulus of electric shock, which suggests that an individual's anticipation of threat induces anxiety responses [21]. In addition, neuroimaging evidence suggested that anticipation and exposure to aversion pictures activated the same emotion-related brain areas, including dorsal amygdala, anterior insula, anterior cingulate

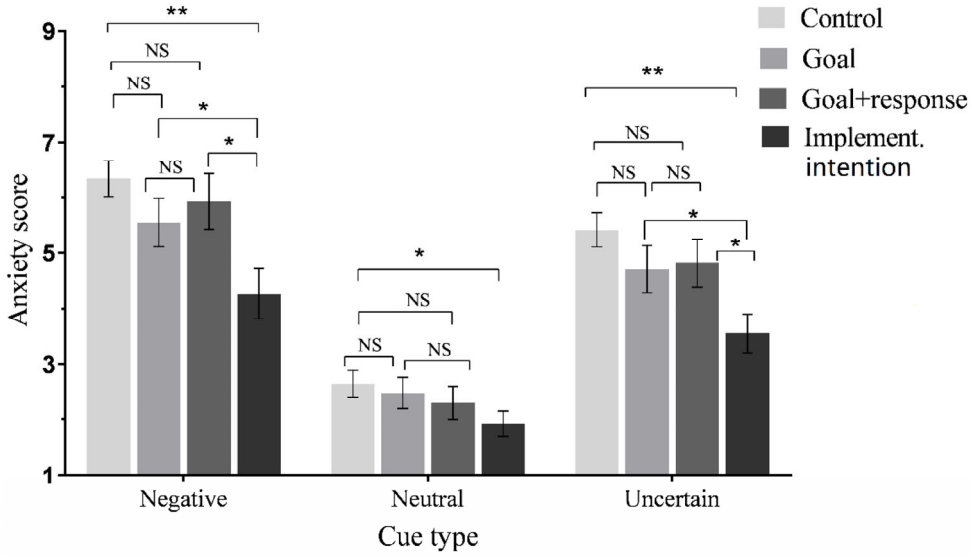

Figure 3 Regulatory effect of different strategies on anticipatory anxiety under different type of cues. NS = not significant; error lines = standard errors; *$p \leq 0.05$, **$p < 0.01$.

cortex, right dorsolateral prefrontal cortex, and the right posterior orbitofrontal cortex, which are implicated in anticipatory anxiety [22, 24]. More relevant to the current study, studies demonstrated that psychological anticipation of negative events could lead to anxiety responses [25, 26], whereas anticipation is an important component of anxiety [1]. Consistent with these evidences, the current study used a cue–target paradigm to show that cues related to threats robustly induced anxious experiences among individuals.

To explore the unique effect of implementation intention on anticipatory anxiety, the study randomly classified participants into the control, goal intention, goal intention+response, or the implementation intention group to receive different regulatory strategies. The results demonstrated that the experiment procedure successfully induced anticipatory anxiety among the participants, in that negative cues induced higher levels of anxiety than did uncertain cues. In turn, the uncertain cues induced higher levels of anxiety than neutral cues. As stated above, the key findings suggested that only implementation intention, compared with the three comparison groups, could effectively regulate the anxiety of participants, and neither the goal intention group nor the goal intention+response group could regulate it. The abovementioned results indicated that implementation intention can effectively regulate the anticipatory anxiety of individuals. As such, this finding should be accounted for by the formation of if–then contingencies in addition to goal setup, as specified by the operations for implementation intention instead of using a mere goal setup or the addition of a strategy into the goal itself. Therefore, if–then contingencies play the most critical role in the interpretation of the effects of emotion regulation through implementation intention, instead of the mere representation of a strategy use or goal setup in advance. One possible explanation is that the formation of the situation (specified by the if component) and strategic response (specified by the then component) combination is the most likely basis to automatically trigger a given emotion-regulatory response upon the presentation of the specified situation, in the absence of mobilizing intentional efforts [27].

However, this conclusion would be more robust if we had designed a mere if–then condition without goal intention. Regarding the current data, the study remains unsure whether if–then contingencies could effectively achieve a desirable emotion-regulatory effect similar to implementation intention, in the absence of goal setup. Thus, future studies should address this limitation. Another limitation is that the current study just recruited female subjects in consideration of a better emotion induction, as females are known for enhanced emotional susceptibility [28]. However, this approach limited the generalization of the current findings to male population. Further study should also investigate potential gender differences concerning the current findings, with two sexes included in the sample. Lastly, the current study only used an experiential report on anxiety score without objective and physiological measures of anxiety response. Future studies should use electrophysical measures, such as EEG, to replicate the current study.

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Declaration of conflicting interests

The authors declare there are no conflicting interests regarding the content of this article.

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