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Emotion regulation by implementation intention is generalizable to unspecified situations: The nature of the underlying goal matters

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ABSTRACT

Implementation intentions (II), which specify how to respond in a given situation based on the goal, is known for its automaticity of regulating emotion to the specified situation. However, it is unknown whether such regulatory effects can be generalized to unspecified situations. For this purpose, we performed four experiments, each consisting of specified (bloody) and unspecified (non-bloody) stimuli with the goal of disgust (Exp.1–2) or unpleasant (Exp.3) regulation. Results showed that II reduced negative feelings for both bloody and non-bloody situations (Exp.1). This generalization effect was absent for goal-unrelated, frightening situations (Exp.2). However, broadening the goal extended the generalization effect to the frightening situation, an effect further amplified when a flexible response was used (Exp.3). Moreover, the II buildup did not disrupt feelings for pleasant situations (Exp.4). These results provide the first evidence that II-based emotion regulation is generalizable to unspecified, goal-related situations and that increasing goal coverage expands the generalization.

1. Introduction

Goals do not guarantee goal-directed behaviors. Self-regulation researchers have suggested that implementation intentions (II) can help bridge the gap between goals and behaviors (Gollwitzer, 1996; Gollwitzer, 1999; Gollwitzer & Brandstätter, 1997; Gollwitzer & Sheeran, 2006; Sheeran, 2002). II is the if-then plan ("If situation X is encountered, then I will initiate response Y!") that spells out when, where, and how to put a goal into action based on the goal intention (GI) ("I intend to reach Z!"). A typical example—"I intend to lose weight; if I have to eat out, then I will only order a fruit salad!"—develops II to realize the goal of dieting. The if-then plan forms an automatic connection between the anticipated situation (if) and the goal-directed behavior (then). When an individual encounters the planned situation X, the mental representation of the predetermined response becomes highly activated and is consequently more accessible, facilitating goal realization without increased conscious involvement (Gallo et al., 2009; Gollwitzer, 1993; Gollwitzer & Sheeran, 2006; Webb et al., 2012).

Automatic emotion regulation (AER) is an important application of II. Cognitive reappraisal is one of the most effective emotional-regulation strategies at the cost of cognitive efforts (Goldin et al., 2008; Ochsner et al., 2002). II combined with reappraisal can help realize the emotional regulation goal without increasing cognitive efforts. Abundant studies have indicated that participants who formed reappraisal-based implementation intention (RII) felt less unpleasant to negative stimuli than those in GI and passive viewing conditions, without increasing regulatory efforts (Gallo et al., 2009; Gallo et al., 2012; Gallo & Gollwitzer, 2007; Gomez et al., 2015; Hallam et al., 2015; Sheeran et al., 2005; Urry, 2009).

However, these studies only examined the regulatory effects of RII in specified situations defined by the "if" component, rarely focusing on unspecified situations. For instance, an RII formed to down-regulate disgust is commonly connected with bloody situations: "I will not get disgusted; if I see blood, then I will take the perspective of a physician!" (Gallo et al., 2012; Gomez et al., 2015). However, negative situations in daily life vary and cannot be specified in advance. Thus, it is important to know whether the emotion regulation effects of RII built on a specified situation can be generalized to other unspecified emotional situations.

Few studies on automatic self-regulation have explored the generalizability of the effects of II. Researchers found that participants who were primed for an achievement goal performed better and more flexibly in the Wisconsin Card Sorting Test (WCST, measures task-

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switching) than did non-primed participants, indicating that automatically pursued goals are not firmly linked to the predetermined situations that limit one's ability to cope with changing circumstances (Ran et al., 2009). In addition, Brewster et al. (2016) found that IIs can change driving behaviors not only in specified situations but also in contextually similar situations (Brewster et al., 2016). A recent study also showed that participants with II tended to categorize similar but unspecified stimuli faster than those with GI, providing preliminary evidence for the generalizability of IIs (Bieleke et al., 2018). These findings suggest that the regulation effects of IIs may be generalizable to unspecified situations. Therefore, we infer that the AER effects of RII specified to a certain scene (e.g. blood) may be generalized to unspecified (e.g., non-blood) negative scenes. However, whether the generalization phenomenon occurs in II-based emotion regulation, to what extent the generalization may be applied and what preconditions support this phenomenon are all unknown, awaiting systematic examination.

To clarify this issue, this study aimed to examine the following three questions. First, can the AER effects of RII specified to a certain situation (e.g. bloody) be generalized to unspecified (e.g. non-bloody) negative scenes? If the answer is yes, the second question is: What preconditions support the generalization phenomenon and how to optimize the generalization effects? Lastly, does the generalization of RII in negative emotion regulation impede one's experience of positive emotions? Specifically, for the first step, we should replicate the AER effects that participants with RII experience less unpleasant feeling to bloody pictures than GI and control conditions without increasing cognitive efforts in Experiment 1. Moreover, given the emotional similarities in bloody and non-bloody stimuli (disgust), we predict that such automatic regulation effects would be generalized to unspecified disgusting situations.

2. Experiment 1

2.1. Methods

2.1.1. Pilot test

In Exp.1, all participants were presented with three types of pictures: bloody (i.e., bleeding wound), non-bloody (i.e., animals that looked disgusting) and neutral (i.e., hat). In order to balance the valence and arousal of bloody and non-bloody pictures, and to confirm whether each type of picture depicts the corresponding situation, 25 independent female students (M_{age} = 22.2) were recruited to participate in a pilot test. In total, 80 pictures—60 (30 bloody, 30 non-bloody) taken from the International Affective Picture System (IAPS) (Lang, 1999) and 20 (10 bloody, 10 non-bloody) from the Internet—were assessed. Participants were asked to rate the valence (happy to unhappy) and arousal (relaxed to excited) for each picture using a 9-point scale. In addition, they were required to rate how bloody, disgusting and fearful they felt for each scene on scales ranging from 1 (not at all) to 5 (very much). Finally, 18 bloody and 18 non-bloody pictures were selected according to the following results: similar valence ($t(34) = 1.47$, $d = 0.49$, $p = 0.15$), arousal ($t(34) = -1.67$, $d = -0.56$, $p = 0.10$), degree of disgust ($t(34) = -0.45$, $d = -0.15$, $p = 0.66$); and a highly significant difference in bloody scene recognition ($t(34) = 14.36$, $d = 4.79$, $p < 0.001$). In addition, all the chosen pictures are dominated by the emotion of disgust, as all the chosen pictures were associated with a higher disgust rating compared to fear rating(main effect: $F(1,34) = 34.27$, $p < 0.001$, $\eta p2 = 0.502$), regardless of the picture type (fear/disgust * blood/non-blood interaction: $p = 0.967$).

2.1.2. Stimuli

The experimental stimuli consisted of 54 pictures, including 18 bloody and 18 non-bloody pictures selected from the pilot test, and 18 neutral pictures taken from the IAPS with medium valence ($M \pm SD = 5.68 \pm 1.74$) and low arousal ($M \pm SD = 4.02 \pm 2.21$).

2.1.3. Participants

We determined the sample size according to GPower (Faul et al., 2007). To detect a large emotion regulation effect (Cohen's $d = 0.8$) with a power of 0.8 at an alpha of 0.05, the power analysis indicated that a sample size of 26 participants per group would be appropriate. In order to achieve greater statistical power, we increased the sample size. Thus, 108 female subjects (aged 18 to 25; $M \pm SD = 20.1 \pm 1.76$) who were not in mense and who had normal or corrected-to-normal vision were invited to participate in the study. Only females were recruited because they have proven more sensitive than males to feelings of disgust (Rozin et al., 1999). Participants signed written informed consent before experiment, and the study was approved by the Human Ethics Committee of Southwest University and Sichuan Normal University (China).

The 108 participants were randomly assigned to three groups (36 each in the RII, GI, and passive watching). To confirm whether the randomization was successful, we assessed participants' emotional state/trait and habitual use of emotion regulation using four questionnaires: the State-Trait Anxiety (S-TAI) Scale (Spielberger et al., 1970), the Beck Depression Inventory (BDI) (Beck et al., 1961), the Emotional Expression Scale (EES) (Kring et al., 1994), and the Emotion Regulation Questionnaire (ERQ) (Gross & John, 2003). Results showed similar scores across the three groups in all these dimensions ($p > 0.05$; $\eta_p^2 = 0.01–0.05$).

2.1.4. Design and procedure

We used a 3 × 3 factorial design with the emotion regulation condition (RII, GI, and control) as the between-subject factor and picture type (bloody, non-bloody, and neutral) as the within-subject factor. The Self-Assessment Manikin scale (SAM) (Bradley & Lang, 1994) was used to assess the valence (1 happy to 9 unhappy) and arousal (1 relaxed to 9 excited) after the picture presentation.

Before the formal experiment, five example trials were first presented to inform participants of the experimental materials. They were given the SAM rating procedure and practiced rating until they were familiar with the meaning of each point. After the practice, participants in RII and GI groups were asked to form the goal intention “I will not get disgusted,” and RII participants were asked to form the if-then plan: “if I see blood, then I will take the perspective of a physician.” Those in the control group were required to observe the pictures carefully without further instructions. The instructions for each condition had to be rehearsed for1 minwith the eyes closed before the experiment started. Each picture (512 × 372 pixels) was presented with E-prime 2.0 on a computer screen at a distance of 60–70 cm from participants' eyes. The visual stimuli were presented in a pseudo-random order, and each picture was displayed for 4 s with a variable inter-stimulus interval of 4–8 s (M = 6 s). Participants were required to rate the valence and arousal immediately after each picture presentation. The flow of the experimental procedure is shown in Fig. 1.

2.1.5. Post-experimental questionnaire

After the picture presentation, the RII and GI groups were asked to complete a questionnaire (Gallo et al., 2009) which measures the goal commitment to the instruction and their cognitive efforts based on three questions: (1) “How committed did you feel to the self-regulation intention/instruction?” (2) “To what extent did you try to control your negative feelings?” (3) “How difficult was it to control your negative feelings?” Participants were required to indicate their responses by providing scores on a scale ranging from 1 (not at all) to 9 (very much).

2.1.6. Data analysis

Repeated-measures analyses of variance (ANOVAs) were performed on the valence and arousal data using SPSS software (version 23.0), with picture type (bloody, non-bloody, and neutral) and emotion

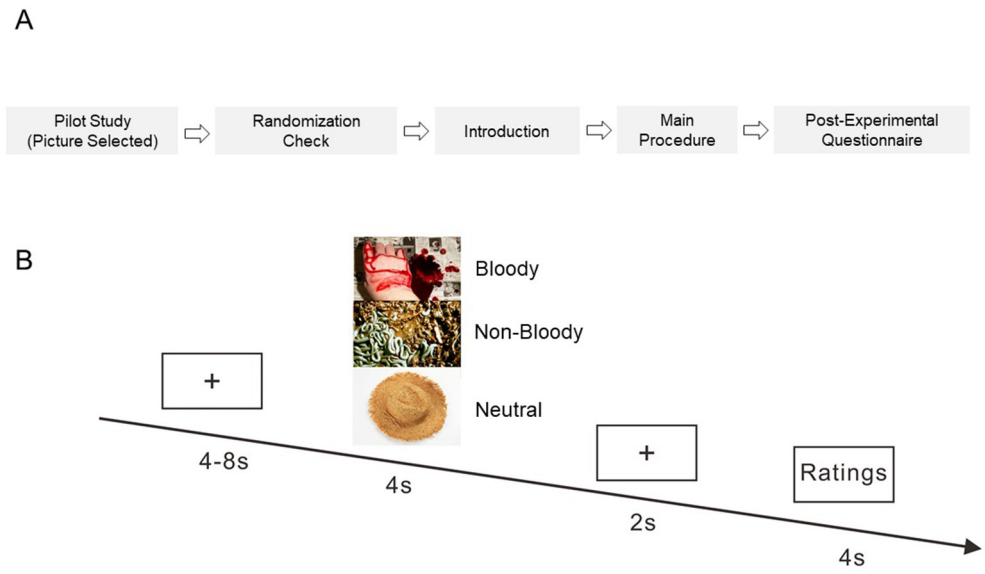

Fig. 1. The flow of the study design (A) and the experimental procedure (main procedure, B).

regulation condition (RII, GI, and control) as repeated and between-subjects factors, respectively. The degrees of freedom of the F-ratio were corrected for violation of spherical assumption according to the Greenhouse-Geisser method. The Bonferroni-Holm method was used for post hoc comparisons if significant main or interaction effects appeared. Partial η-squared (η_p^2) was reported as a measure of effect size for ANOVAs, with 0.05, 0.10, and 0.20 indicating a small, medium, and large effect, respectively. Unbiased Cohen's d was reported as a measure of effect size for *t*-tests.

We also computed Bayes factors using JASP with default prior width (Wagenmakers et al., 2018) and interpreted BF_{10} of < 3 as anecdotal, 3–10 as substantial, and > 10 as strong evidence for accepting H_1; we also interpreted BF_{10} of > 1/3 as anecdotal, 1/3–1/10 as moderate, and < 1/10 as strong evidence for accepting H_0 (Jeffreys, 1998).

2.2. Results

2.2.1. Manipulation check

To ensure that the chosen negative pictures successfully induced participants' unhappiness, paired-sample t-tests were performed among the control group, revealing a significant difference between bloody and neutral stimuli, valence/arousal: t (35) = 25.90/16.53, all p < 0.001, d = 5.30/2.76, all BF_{10} > 100, as well as between non-bloody and neutral stimuli, valence/arousal: t (35) = 27.50/19.19, all p < 0.001, d = 4.59/3.20, all BF_{10} > 100. No significant difference was found between these two kinds of negative pictures in valence and in arousal, t (35) = 0.83/−0.59, p = 0.41/0.56, d = 0.14/0.10, all BF_{10} < 1/3. As expected, specified and unspecified pictures successfully elicited similar emotional experiences.

2.2.2. Primary analyses

Results showed a significant interaction effect between picture type and regulation condition on both valence, F (4,210) = 7.17, p < 0.001, η_p^2 = 0.12, BF_{10} > 100, and arousal ratings, F (4,210) = 6.38, p < 0.001, η_p^2 = 0.11, BF_{10} > 100.

A one-way ANOVA on valence ratings was performed for each stimulus type. The results showed no significant group differences for neutral pictures, valence/arousal: F (2,105) = 2.33/1.96, p = 0.10/0.15, BF_{10} < 1. However, there were significant group differences for bloody and non-bloody pictures in valence, bloody/non-bloody: F (2,105) = 9.62/4.39, p < 0.001/p = 0.015, BF_{10} > 100/BF_{10} > 1, and arousal F (2,105) = 5.51/5.57, all p = 0.005, all BF_{10} > 3. The post hoc analysis showed significantly fewer unpleasant feeling during RII compared to GI and control conditions both for bloody and non-bloody pictures (valence: $t_{RII\text{-}GI}$ (70) = −3.54/−2.48, p = 0.002/0.044, d = −0.80/−0.58, BF_{10} > 100/BF_{10} > 3; $t_{RII\text{-}Control}$ (70) = −4.02/−2.65, p < 0.001/p = 0.028, d = −1.00/−0.60, BF_{10} > 100/BF_{10} > 3; arousal: $t_{RII\text{-}GI}$ (70) = −3.06/−2.73, p = 0.009/p = 0.022, d = −0.73/−0.60, BF_{10} > 10/BF_{10} > 3; $t_{RII\text{-}Control}$ (70) = −2.65/−3.02, p = 0.028/0.009, d = 0.6/0.71, BF_{10} > 3/BF_{10} > 10). The difference between GI and control conditions was not significant for bloody or non-bloody pictures (valence: t = −0.48/−0.17, all p = 1.00, d = −0.11/−0.04, all BF_{10} < 1/3; arousal: t = 0.41/−0.29, all p = 1.00, d = 0.09/0.07, BF_{10} < 1/3) (see Fig. 2).

To directly test whether the RII-related emotion regulation effects were comparable for bloody and non-bloody pictures, we computed the difference in scores between the control and RII conditions as an index of the emotion-regulation effect for the ratings of both valence and arousal for each picture. The results showed no significant differences in emotion regulation effects between bloody and non-bloody scenes (valence/arousal: p = 0.53/0.87, d = 0.15/−0.04, all BF_{10} < 1/3).

2.2.3. Post-experiment questionnaire

To examine whether emotion -regulatory effects during RII were caused by participants' differences in commitment to instruction or by increased cognitive efforts, the RII and GI groups were compared on the three questions mentioned above. The results showed no significant differences between RII and GI conditions in the commitment rating (t = −0.60, p = 0.55, BF_{10} < 1/3). Additionally, the RII group scored similarly to the GI group in the cognitive effort (t = 0.26, p = 0.80, BF_{10} < 1/3) and regulatory difficulty ratings (t = −0.19, p = 0.85, BF_{10} > 1), indicating that participants in RII did not expend more cognitive efforts or face regulatory difficulties compared to those in the GI group.

2.3. Discussion

Exp.1 investigated whether the emotion regulation effects of RII planned on a certain situation can be generalized to unspecified situations. We found that RII participants reported fewer unpleasant feeling and lower emotional arousal than those in GI and control groups in both bloody and non-bloody (disgusting) situations. Such regulatory effects did not come with increased cognitive efforts.

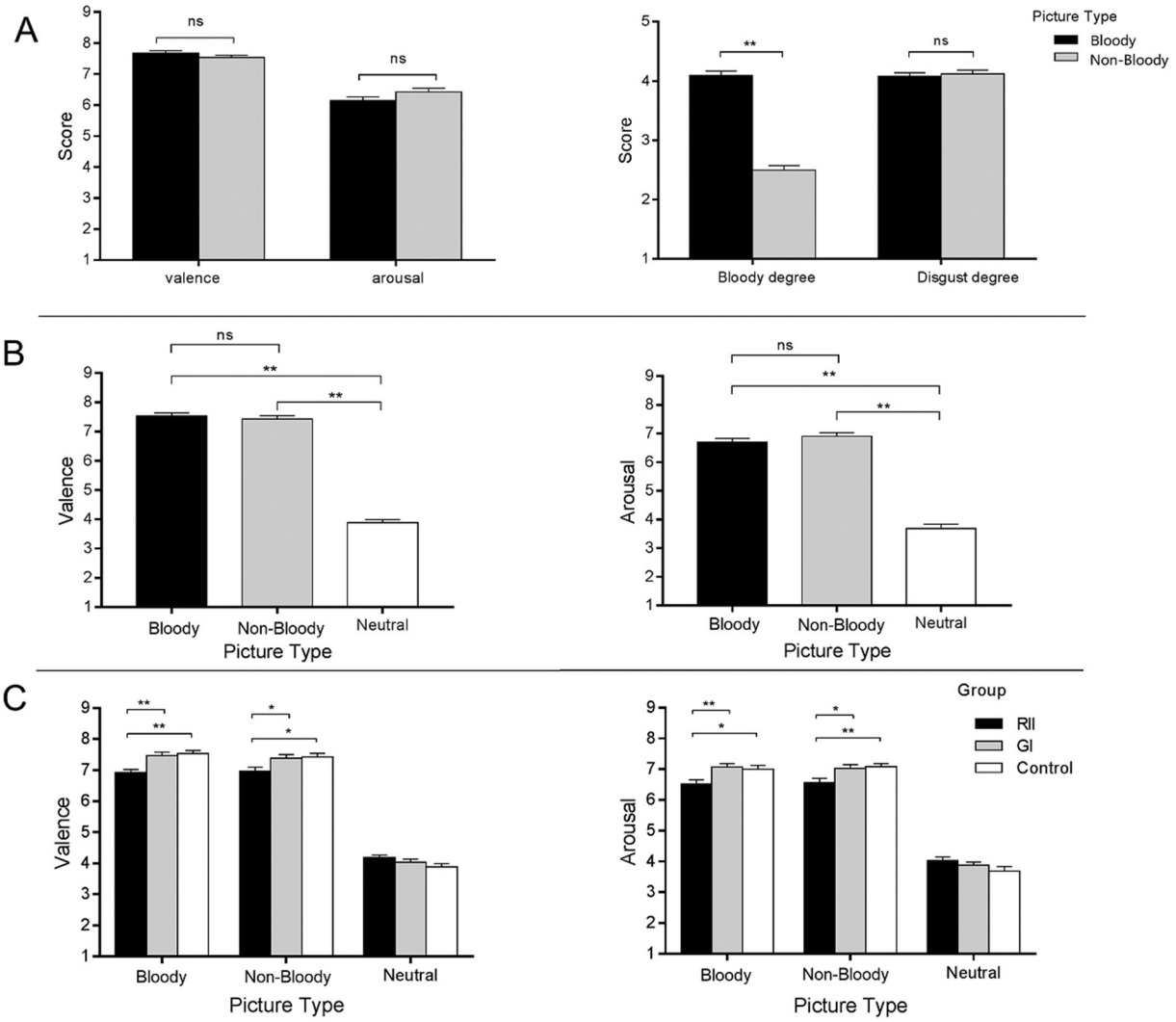

Fig. 2. Experiment 1 (A) The valence, arousal rating, and the perceived bloody, disgust ratings between bloody and non-bloody pictures in the pilot study; (B) Manipulation check for emotion induction in the formal experiment; (C) Valence and arousal ratings for bloody, non-bloody, and neutral pictures for each experimental condition. The error bar denotes the standard error (S.E.) of the mean. The abbreviation "ns" means "not significant"; *p < 0.05, **p < 0.01

Bloody and non-bloody materials were characterized by and matched in disgust; that is, both specified and unspecified situations are goal-related situations (disgusting). Thus, the findings of Exp.1 showed that the emotion-regulatory effects of RII can be generalized to goal-related, unspecified situations. However, it is still unknown whether they can only be generalized to goal-related situations or can also be generalized to more global, goal-unrelated situations. This was examined in Experiment 2 using goal-unrelated, fear-inducing pictures as the unspecified stimuli.

3. Experiment 2

3.1. Methods

3.1.1. Participants and design

In order to control the effects of personal preference on emotional elicitation, candidate participants rated their preference for horror movie and bleeding scenes via two five-point scales, respectively (1, dislike at all, 5 like very much). 90 female subjects (aged 18 to 25; $M \pm SD = 20.63 \pm 1.51$) with no preference to horror films and bleeding scenes (preference score less than 3) were recruited and randomly assigned to three groups (30 each in RII, GI, and control) in Experiment 2. The experimental design was identical to that of Exp.1, that is, the 3 × 3 factorial design with the emotion regulation condition (RII, GI, and control) as the between-subject factor and picture type (bloody, non-bloody, and neutral) as the within-subject factor.

3.1.2. Stimuli and procedure

The stimuli consisted of 54 pictures, including 18 bloody and 18 neutral pictures used in Exp.1, and 18 non-bloody pictures (pictures that were frightening, from horror films, or of a scary doll) selected from Internet to create unspecified situations ($M_{valence/arousal}$ = 7.55/6.27; $SD_{valence/arousal}$ = 0.31/0.34; N = 18). The selected frightening pictures did not differ from the bloody pictures in valence ($t(34) = 1.29$, $p = 0.20$, $d = 0.43$, $BF_{10} < 1$) and arousal ($t(34) = -0.88$, $p = 0.39$, $d = -0.29$, $BF_{10} < 1$), but were significantly less bloody ($t(34) = -19.08$, $p < 0.001$, $d = -6.36$, $BF_{10} > 100$), less disgusting ($t(34) = -10.24$, $p < 0.001$, $d = -3.41$, $BF_{10} > 100$), and more frightening ($t(34) = 3.79$, $p < 0.001$, $d = 1.27$, $BF_{10} > 30$) than the bloody pictures, indicating that the two types of pictures can be distinguished and the selected frightening pictures are valid in inducing fearful emotion. The procedure and instruction in each group were the same as those in Exp.1.

3.2. Results

3.2.1. Manipulation check

Paired-sample *t*-tests in the control group showed a significant difference not only between bloody and neutral stimuli but also between non-bloody and neutral stimuli both in valence and in arousal: valence/arousal; $t_{blood\text{-}neutral}$ (29) = 14.05/11.95, all $p < 0.001$, $d = 2.56/2.18$, all $BF_{10} > 100$, $t_{non\text{-}blood\text{-}neutral}$ (29) = 13.93/12.18, all $p < 0.001$, $d = 2.54/2.22$, $BF_{10} > 100$. No significant difference was found between bloody and non-bloody pictures in valence and in arousal, $t_{blood\text{-}non\text{-}blood}(29) = 1.29/0.03$, $p = 0.21/0.98$, $d = 0.24/0.01$, $BF_{10} < 1/BF_{10} < 1/3$, indicating that specified and unspecified pictures successfully elicited negative feelings to a similar extent.

3.2.2. Primary analyses

A 3 × 3 ANOVA revealed a significant interaction effect between regulation condition and picture type on valence and arousal ratings (valence/arousal: $F(4, 174) = 3.61/2.62$, $p = 0.008/0.037$, $\eta_p^2 = 0.11/0.01$, $BF_{10} > 3/BF_{10} > 1$).

The follow-up one-way ANOVAs showed a significant group difference for bloody pictures (valence/arousal; $F(2, 87) = 8.69/7.26$, $p < 0.001/p = 0.001$, $\eta_p^2 = 0.17/0.14$, $BF_{10} > 30/BF_{10} > 10$). Similar to that in Exp.1, the post hoc analysis showed reduced negative experience and a lower arousal rating during RII compared to GI (valence/arousal; $t_{RII\text{-}GI}$ (58) = −3.29/−3.00, $d = -0.88/d = -0.88$, $p = 0.004/0.01$, all $BF_{10} > 10$) and Control ($t_{RII\text{-}Control}$ (58) = −3.86/−3.54, $d = -1.01/d = -0.86$, $p < 0.001/p = 0.002$, $BF_{10} > 100/BF_{10} > 10$) conditions. By contrast, no significant group differences were found for non-bloody pictures ($F(2, 87) = 0.29/0.51$, $p = 0.75/0.61$, all $\eta_p^2 = 0.01$, all $BF_{10} < 1/3$) or for neutral pictures ($F(2, 87) = 0.56/0.17$, $p = 0.58/0.85$, $\eta_p^2 = 0.01/0.004$, all $BF_{10} < 1/3$) (see Fig. 3).

3.2.3. Post-questionnaire

No significant differences were observed between the RII and GI conditions in task commitment ($t = 0.53$, $p = 0.60$, $d = 0.14$, $BF_{10} < 1/3$), subjective efforts ($t = 0.40$, $p = 0.69$, $d = 0.10$, $BF_{10} < 1/3$), and regulatory difficulty ratings ($t = -0.21$, $p = 0.83$, $d = -0.06$, $BF_{10} < 1/3$).

3.3. Discussion

Exp.2 used frightening pictures to examine whether the emotion regulation effects of RII planned on a bloody situation can be generalized to goal-unrelated, fear-inducing situations. Consistent with Exp.1, RII participants can successfully down-regulate negative feelings during bloody scenes. However, compared to GI and control groups, the RII group did not show effective regulation for non-bloody stimuli. This indicates that RII planned on the bloody situation under the goal of disgust-regulation did not reduce negative feelings evoked by goal-unrelated, frightening situations. On the other hand, a recent study suggests that the suitability of the planned response for the situation plays an important role in the generalization of II (Bieleke et al., 2018). Thus, another plausible interpretation for the lack of generalization in Exp.2 is that the planned response (taking the perspective of a physician) is suitable for disgusting but not for frightening situations.

However, it is important to seek methods that can optimize the generalization effects of AER by RII. Sheeran et al. showed that the effective action control by II is sensitive to the activation and the strength of the underlying goal intentions, indicating that the beneficial effects of forming if-then plans are related to the nature of the underlying goal (Sheeran et al., 2005). Given our findings that generalization only applies to goal-related situations, we infer that increasing the coverage of the goal may optimize the generalization effects to unspecified frightening situations. Additionally, we designed a more flexible response to meet the situational requirement in Experiment 3, to examine whether increasing the goal coverage to include frightening situations and planning a flexible response may optimize the generalization effects to frightening, fearful situations.

4. Experiment 3

4.1. Methods

4.1.1. Participants and stimuli

In Experiment 3 (Exp.3), 72 female students (aged 18 to 25; M ± SD = 19.8 ± 1.65) who had not participated in previous experiments and had no preference to horror films or bleeding scenes were recruited. The stimuli were the same as those in Exp.2, including 18 bloody, 18 neutral pictures, and 18 frightening pictures.

4.1.2. Design and procedure

A 3 × 3 factorial design was used with emotion regulation conditions (GI, RII_A, RII_B) as the between-subject factor and picture type (bloody, non-bloody, and neutral) as the within-subject factor. Before the experiment, subjects in three groups were given different instructions. All the subjects were asked to form the goal "I will not feel unpleasant." Then, the RII-A group were required to form the same if-then plan as in Exp.1 and 2 ("If I see blood, then I will take the perspective of a physician!"). Subjects in the RII_B group were required to form the new if-then plan characterized by a flexible response ("If I see blood, then I will take the perspective of an art designer!"). The experimental procedure was the same as that in Exp.2.

4.2. Results

4.2.1. Primary analyses

The mixed-design ANOVA showed a significant interaction effect between stimulus type and regulation condition both on valence and arousal ratings (valence/arousal: $F(4,138) = 5.73/6.44$, all $p < 0.001$, $\eta_p^2 = 0.14/0.82$, all $BF_{10} > 100$). The post hoc one-way ANOVAs showed a significant group difference for bloody (valence/arousal; $F(2,69) = 8.89/9.62$, all $p < 0.001$, $\eta_p^2 = 0.21/0.22$, $BF_{10} > 30/BF_{10} > 100$), and non-bloody pictures ($F(2, 87) = 7.38/5.87$, $p < 0.001/p = 0.005$, all $\eta_p^2 = 0.13/0.15$, all $BF_{10} > 3$), but not for neutral pictures $F(2,69) = 1.87/0.89$, $p = 1.63/4.16$, $\eta_p^2 = 0.05/0.03$, $BF_{10} < 1/BF_{10} < 1/3$.

Specifically, bloody pictures elicited less negative experience ($t = 3.06/4.04$, $d = 0.93/1.13$, $p = 0.009/p < 0.001$, $BF_{10} > 10/BF_{10} > 30$) and a smaller arousal rating ($t = 3.00/4.27$, $d = 1.02/1.18$, $p = 0.01/p < 0.001$, $BF_{10} > 30/BF_{10} > 100$) in the RII groups compared to the GI group, while the two RII groups showed no significant differences in valence ($t = 1.11$, $d = 0.28$, $p = 0.8$, $BF_{10} < 1$) and arousal ($t = 1.28$, $d = 0.34$, $p = 0.62$, $BF_{10} < 1$). For frightening pictures, the RII_A group reported fewer negative feelings and lower emotional arousal than did the GI group, despite small statistical power (valence/arousal: $t = 2.10/2.25$, $d = 0.61/0.76$, $p = 0.08/0.056$, $BF_{10} > 1$ or $BF_{10} > 3$). Moreover, the RII_B group reported reliably smaller negative feelings ($t = 3.21$, $d = 1.07$, $p = 0.006$, $BF_{10} > 30$) and lower emotional arousal ($t = 3.36$, $d = 0.97$, $p = 0.004$, $BF_{10} > 10$) than did the GI group. A comparison of RII-A and RII-B showed no significant differences in both valence and arousal rating ($p > 0.80$) (see Fig. 4).

4.2.2. Post-questionnaire

No significant differences were observed across the three groups in commitment rating ($F(2,69) = 0.08$, $p = 0.92$, $\eta_p^2 = 0.002$, $BF_{10} < 1/3$), effort rating ($F(2,69) = 1.14$, $p = 0.33$, $\eta_p^2 = 0.03$, $BF_{10} < 1/3$) and regulatory difficulty rating ($F(2,69) = 0.04$, $p = 0.96$, $\eta_p^2 = 0.001$, $BF_{10} < 1/3$).

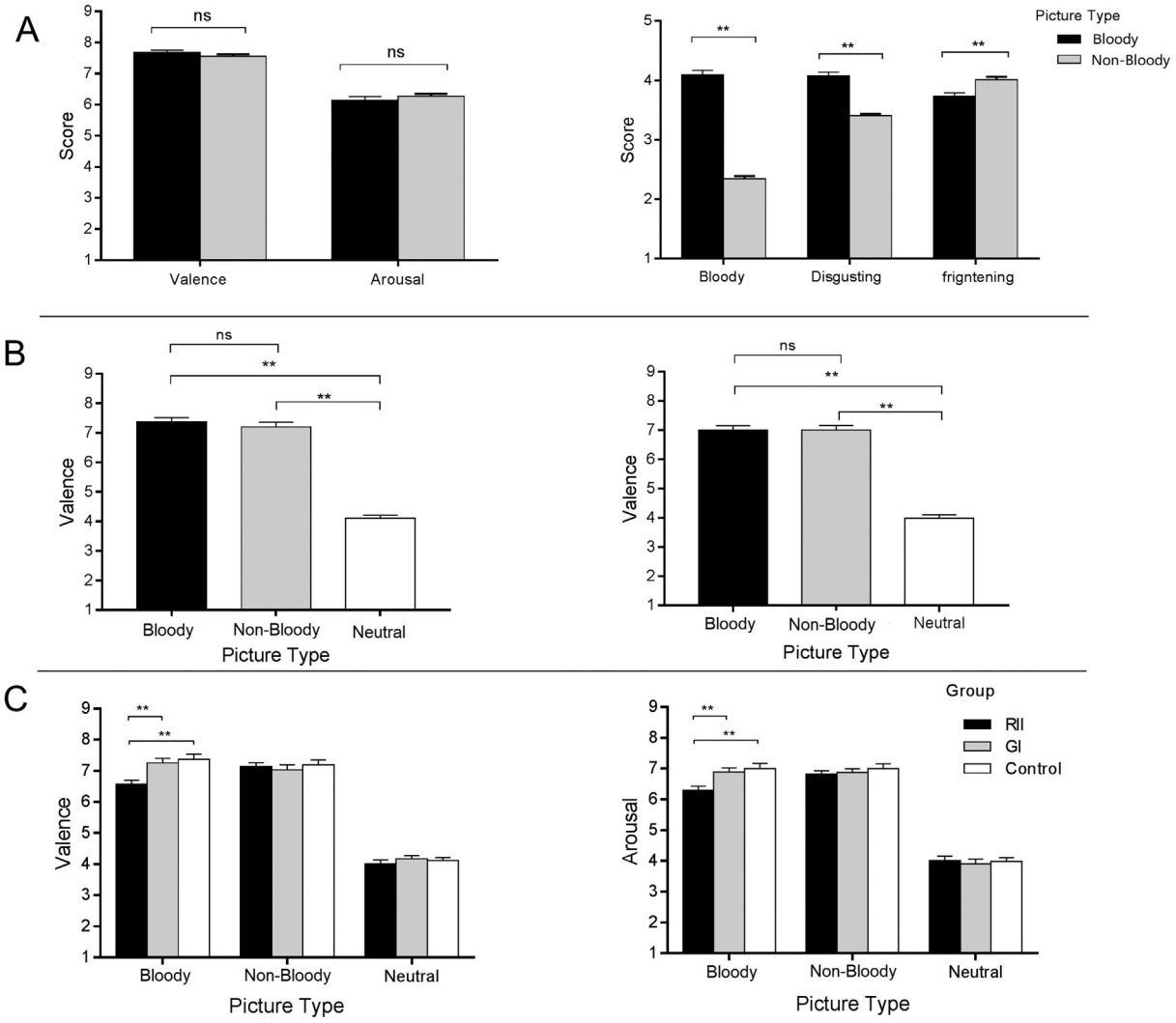

Fig. 3. Experiment 2 (A) The valence, arousal, and the perceived bloody, disgust and frightening ratings in the pilot study; (B) Manipulation check for emotion induction in the formal experiment; (C) Valence and arousal ratings for bloody, non-bloody(frightening), and neutral pictures for each group. The error bar denotes S.E. of the mean. The abbreviation "ns" means "not significant"; *p < 0.05, **p < 0.01

4.3. Discussion

Exp.3 modified the original RII to optimize the generalization effects. Specifically, the original goal-part "I would not be disgusted…" was modified to a broader concept "I will not feel unpleasant," covering both the specified bloody-disgusting situation and unspecified, frightening situation. We designed the RII-B condition whose response in the then-component was defined as "taking the perspective of an art

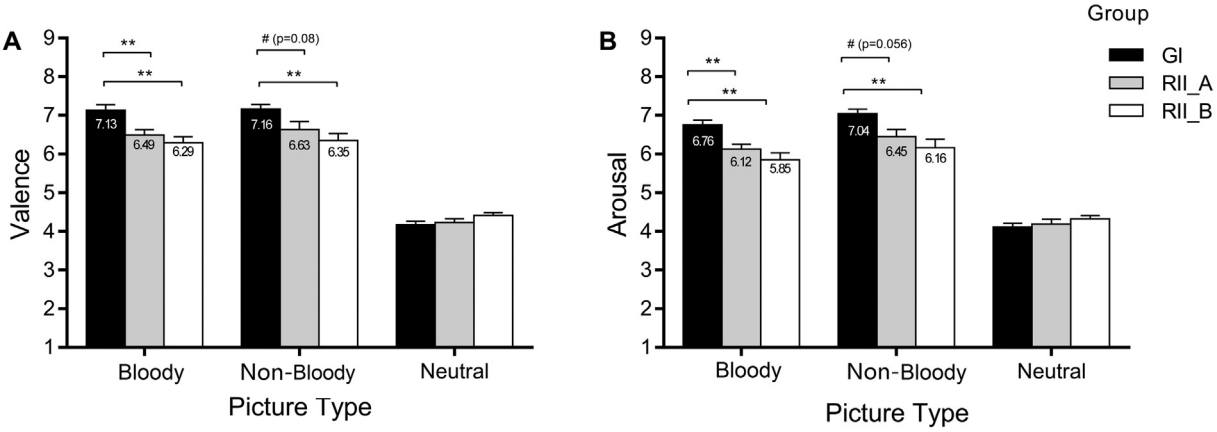

Fig. 4. Experiment 3 Valence (A) and arousal (B) rating for bloody, non-bloody (frightening), and neutral pictures during the RII-A, RII-B, and GI conditions. The error bars denote S.E. of the mean. *p < 0.05, **p < 0.01; $^{\#} \leq 0.08$

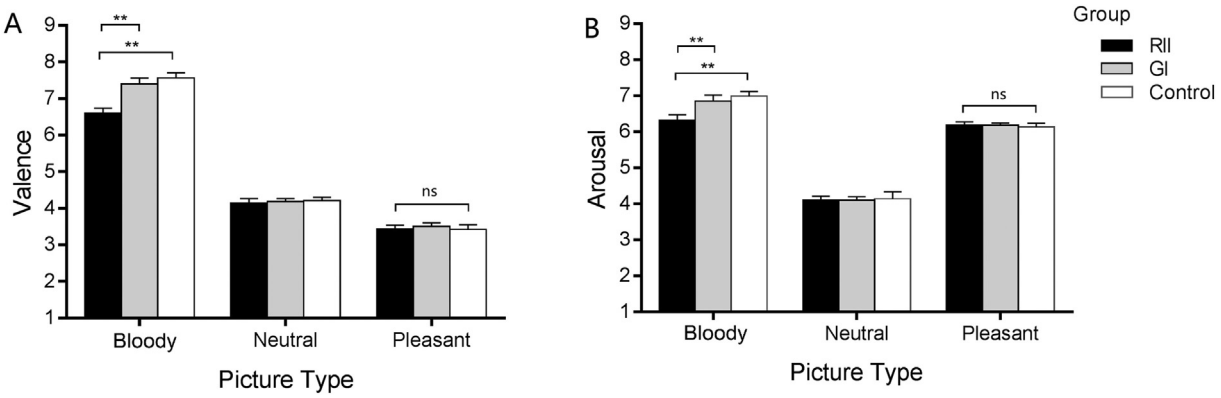

Fig 5. Experiment 4 Valence (A) and arousal (B) rating for bloody, neutral and pleasant pictures during the RII, GI and control conditions. The error bars denote S.E. of the mean; **p < 0.01

designer," to allow specified responses applicable to various adverse situations.

The results showed that increasing goal coverage alone can generalize the regulatory effects to unspecified frightening situations, despite small statistical power. However, RII-B, which expanded goal coverage and used a flexible response simultaneously, exhibited a robust reduction of negative feelings for unspecified situations compared to GI. This suggests that increasing goal coverage combined with a flexible response can optimize the generalization effects of AER by II.

Several studies suggest that the suppression of negative experience may come at the cost of decreasing reactivity to positive materials, leading to maladaptive consequences (Dunn et al., 2009; Liverant et al., 2008). It is unknown whether successful emotion control via RII would also disrupt one's response to pleasant stimuli. Thus, Experiment 4 used high-arousal pleasant pictures as the unspecified situations to explore whether the generalization of RII disrupts one's positive experiences. Given that the evaluative space model suggests that positive and negative emotions are represented by separate dimensions rather than polar opposites (Cacioppo et al., 2011), and as Exp.1–3 have shown that generalization occurs under the goal coverage, it is reasonable to assume that pleasant materials outside of the goal would elicit similar feelings in subjects with and without RII.

5. Experiment 4

5.1. Methods

5.1.1. Participants and design

In Experiment 4 (Exp.4), 90 female students (aged 18 to 25; M ± SD = 20.47 ± 2.36) who had not participated in previous experiments were recruited. They were randomly assigned to three groups of 30 each.

This experiment used the same design as did Exp.1, that is, the 3 × 3 factorial design with emotion regulation condition (RII, GI, and control) as the between-subject factor and picture type (bloody, pleasant, and neutral) as the within-subject factor.

5.1.2. Stimuli and procedure

The stimuli comprised of 54 pictures, including 18 bloody and 18 neutral pictures used in Exp.1, and another 18 pleasant pictures (valence/arousal: M = 2.47/6.17, SD = 0.23/0.21, rated by 16 independent subjects) selected from the Internet. The pleasant and bloody pictures were matched in arousal (t (34) = 0.23, p = 0.82, d = 0.08, BF_{10} < 1). The procedure and instruction were identical to that of Exp.1.

5.2. Results

5.2.1. Manipulation check

Paired-sample *t*-tests were performed in the control group. Results showed significant differences between bloody and neutral pictures both in valence and arousal (t (29) = 18.46/13.85, p < 0.001, d = 3.37/2.53, all BF_{10} > 100) and between pleasant and neutral pictures (t (29) = −6.32/8.52, p < 0.001, d = −1.15/1.56, all BF_{10} > 100). Thus, bloody stimuli successfully induced unpleasant feelings and pleasant stimuli induced pleasant emotions.

5.2.2. Primary analyses

A 3 × 3 ANOVA revealed a significant regulation condition by stimulus type interaction effect both on valence and arousal ratings, F (4, 174) = 5.18/2.65, p = 0.002/0.04, η_p^2 = 0.11/0.06, BF_{10} > 100/BF_{10} > 1, and a significant main effect of picture type on valence and arousal ratings, F (2, 174) = 741.70/358.65, all p < 0.001, η_p^2 = 0.90/0.81, all BF_{10} > 100.

For simple effect analysis, one-way ANOVAs showed a significant group difference for bloody (valence/arousal: F (2, 87) = 12.43/5.44, p < 0.001/p = 0.006, η_p^2 = 0.22/0.11, BF_{10} > 100/BF_{10} > 1), but not for neutral (F (2, 87) = 0.13/0.03, p = 0.88/0.98, η_p^2 = 0.003/0.001, BF_{10} < 1/3) and pleasant (F (2, 87) = 0.21/0.10, p = 0.81/0.90, η_p^2 = 0.005/0.002, BF_{10} < 1/3) pictures. Similar to that in Exp.1, the post hoc analysis showed reduced negative experiences and a lower arousal rating for bloody pictures during RII compared to GI (t (58) = −3.87/−2.51, p < 0.001/p = 0.042, BF_{10} > 30/BF_{10} > 1) and control (t (58) = −4.66/−3.11, p < 0.001/p = 0.008, BF_{10} > 100/BF_{10} > 10) conditions (see Fig. 5).

5.2.3. Post-questionnaire

No significant differences were found between the RII and GI conditions in commitment (t = −0.60, p = 0.55, d = −0.15, BF_{10} < 1/3), effort (t = −0.67, p = 0.51, d = −0.17, BF_{10} < 1), and regulatory difficulty ratings (t = −0.80, p = 0.43, d = −0.51, BF_{10} < 1).

5.3. Discussion

Similarly, this experiment demonstrated that RII participants felt less unpleasant than did those in GI and control groups during the bloody picture condition. However, the three groups showed no significant differences in emotional experiences during the pleasant picture condition. Our findings indicate that the emotional control through RII in negative situations do not spread to positive ones. Additionally, the unspecified pleasant pictures in Exp.4 were irrelevant to the goal (disgust regulation). Thus, this experiment also lends support to the regulatory effects of RII being only generalizable to goal-related

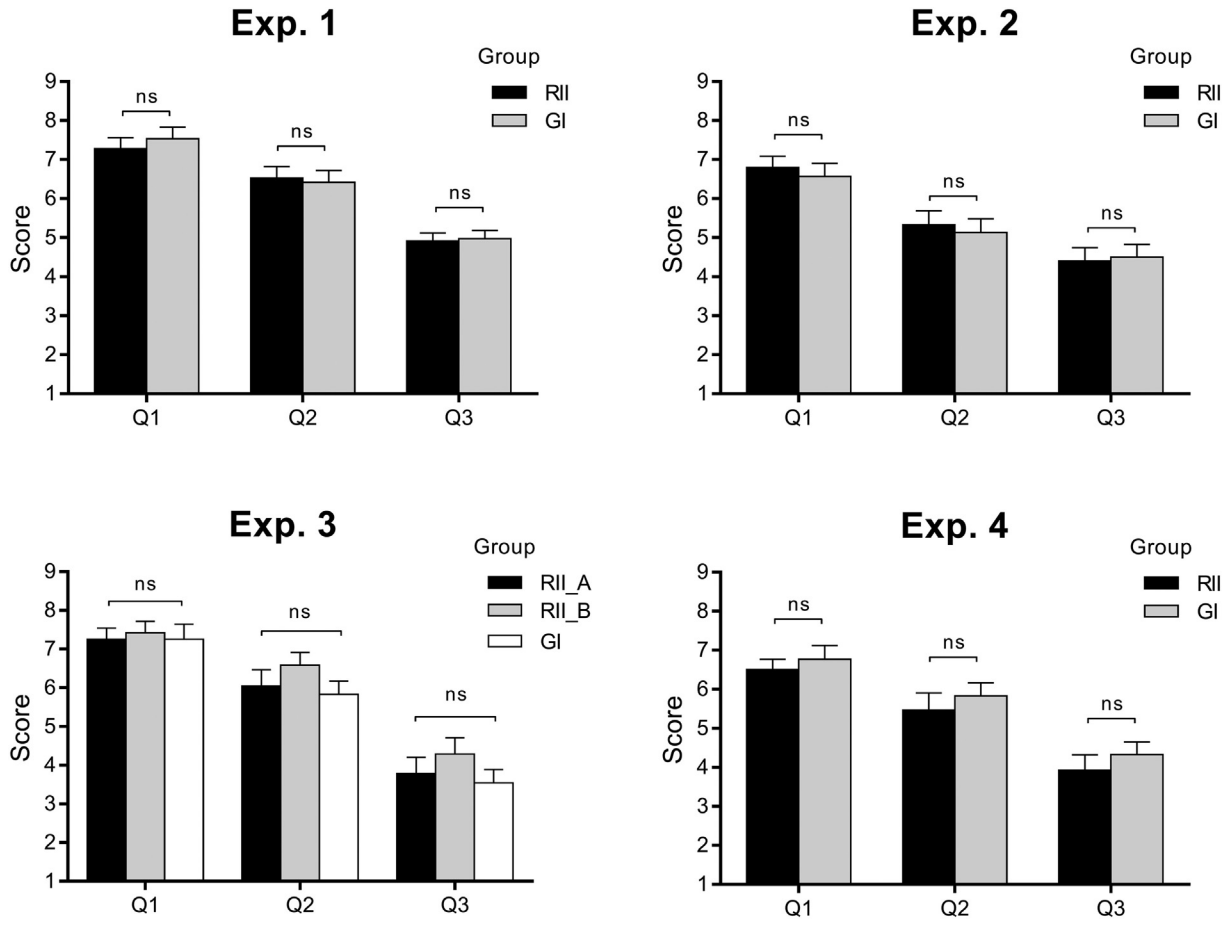

Fig 6. The scores for RII and GI conditions on commitment (Q1), cognitive efforts (Q2), and regulatory difficulty (Q3). Error bars denote S.E. of the mean. The abbreviation "ns" means 'not significant."

unspecified situations.

6. General discussion

This study is the first to investigate the generalization effects of IIs in emotion regulation. Exp.1 used bloody pictures as planned stimuli and non-bloody, disgusting pictures as unplanned stimuli. Our findings suggest that RII specific to blood can down-regulate unpleasant feelings evoked by both bloody and non-bloody pictures compared to GI and control conditions. One possible explanation is that both bloody and non-bloody pictures shared the same goal of disgust regulation. Exp.2 and 3 further suggest that the goal is important in the generalization effects of RII during emotion regulation. Consequently, unspecified situations within the scope of the goal (in Exp.3) exhibited a generalized emotion-regulatory effect while those outside did not (in Exp.2). These results suggest that increasing the goal coverage may broaden generalized emotion regulation effects, which was confirmed by the findings of Exp.3 that II with a general goal (i.e., negative emotion regulation) extends regulatory effects to frightening situations. Moreover, using a more flexible response increased the robustness of the generalization effect in Exp.3, suggesting that constructing a general goal and a situation-independent, flexible response can optimize the generalization effects of automatic emotion regulation via II.

One explanation for the important role of goal in generalization of II is that it depicts the boundary between specified and unspecified situations. Previous studies indicated that the effects of self-regulation training can be near transferred to a task that is similar to the training (Berkman, 2016; Koster et al., 2017; Miles et al., 2016), while far transfers to dissimilar tasks are difficult (Hung, 2013; Richmond et al., 2011). In Exp.1, bloody and non-bloody stimuli—both disgust-inducing—are inherent to the goal representation. In this regard, both types of stimuli share an emotional similarity that is absent between frightening and bloody stimuli in Exp.2, when the goal is disgust regulation. However, the goal of Exp.3 expanded the emotional similarity between bloody and frightening stimuli, in that disgust and fear both belong to the concept of negative emotion as defined by the goal. Therefore, Exp.4 did not observe an impeding effect of RII on emotional experience for unspecified positive situations, which were outside of the goal representation and thus emotionally dissimilar to the specified stimuli. The role of goal-related emotional similarity in RII-based generalization effects needs to be directly examined in future studies.

It is notable that successful emotion regulation during the application of RII was not due to better adherence to instructions, as RII and GI participants reported the same commitment to instructions. RII participants did not report more cognitive efforts than did the GI group (see Fig. 6), implying that our finding of RII-based emotion regulation and the generalization was an automatically self-regulatory effect.

Several limitations should be acknowledged. Although studies indicate that II benefits cognition by automaticity (Bargh & Gollwitzer, 1994; Brandstaetter et al., 2001; Gollwitzer, 1993; Gollwitzer & Sheeran, 2006), research testing this automatic linkage between predetermined emotional situation and specified response is scant. Thus, systematic experimental design and diversified methods are needed to resolve this issue. Moreover, because the observed effects of II in this study are based on self-report measures, it is important for future studies to use other methods, such as functional magnetic resonance imaging, to investigate neural underpinnings of the II-related generalization effects to unspecified situations during emotion regulation.

In summary, in addition to the confirmation that forming IIs facilitates down-regulation of negative emotion evoked by the specified situations, four experiments in the current study demonstrate, for the first time, that the emotion regulation effects of RII can be generalized to goal-related, unspecified situations. Moreover, increasing goal coverage and using situation- independent, flexible responses can optimize the generalization effects. Thus, our findings may contribute to the improvement of emotional regulation performance in people with multiple emotional stressors or under cognitive depletion, and to the updating of psychotherapies for clinical population.

Declaration of conflicting interest

The authors declared no conflicts of interest with respect to the authorship or the publication of this article.

CRediT authorship contribution statement

Xing Huang: Conceptualization, Methodology, Formal analysis, Writing - original draft, Writing - review & editing. **Shengdong Chen:** Methodology, Writing - original draft. **Wei Gao:** Formal analysis. **Jiemin Yang:** Conceptualization, Formal analysis. **Jiajin Yuan:** Conceptualization, Methodology, Writing - original draft, Writing - review & editing, Supervision.

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