Cognitive Mechanisms of Emotion Regulation in Improving Procrastination Behavior: The Mediating Role of Task Aversion

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Abstract

Previous research has demonstrated that greater use of adaptive emotion regulation strategies (particularly cognitive reappraisal) is associated with reduced procrastination behavior. However, the cognitive mechanisms through which emotion regulation influences procrastination remain unclear. The temporal decision model of procrastination posits that the decision to procrastinate depends primarily on the trade-off between task aversion and outcome utility; procrastination occurs when task aversion significantly outweighs outcome utility, whereas immediate execution occurs otherwise. Therefore, emotion regulation may ameliorate procrastination either by reducing task aversion or by enhancing outcome utility. To elucidate this issue, the present study, grounded in Gross's emotion regulation theory and the temporal decision model of procrastination, selected high-procrastination individuals (General Procrastination Scale, GPS $>$ 67.5) as participants and assigned them to either a positive reappraisal group (34 participants) or an ineffective strategy group (34 participants). A longitudinal tracking study employing the experience sampling method was conducted over 7 days (14 assessments total). The findings revealed: (1) The two groups showed no significant difference in implementation intention at pre-test; at post-test, the positive reappraisal group exhibited significantly higher implementation intention than the ineffective strategy group, indicating that positive reappraisal significantly enhances individuals' implementation intention. (2) The two groups showed no significant difference in task aversion at pre-test; at post-test, the positive reappraisal group demonstrated significantly lower task aversion than the ineffective strategy group. The two groups showed no significant difference in outcome utility at pre-test; at post-test, the positive reappraisal group showed significantly higher outcome utility than the ineffective strategy group. (3) Mediation analysis revealed that the reduction in task aversion mediated the effect of emotion regulation on the degree of procrastination improvement (i.e., increase in implementation intention), whereas the

enhancement in outcome utility did not mediate this effect. These results indicate that emotion regulation primarily enhances implementation intention and thereby reduces procrastination behavior by decreasing task aversion, providing a solid theoretical foundation for procrastination intervention from an emotion regulation perspective.

Full Text

The Cognitive Mechanism of Emotion Regulation in Reducing Procrastination: The Mediating Role of Task Aversiveness

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Abstract

Previous research has demonstrated that greater use of adaptive emotion regulation strategies, particularly cognitive reappraisal, is associated with reduced procrastination. However, the cognitive mechanisms through which emotion regulation influences procrastination remain unclear. The temporal decision model of procrastination posits that procrastination is primarily determined by the trade-off between task aversiveness and outcome utility. When task aversiveness significantly exceeds outcome utility, procrastination occurs; conversely, when outcome utility outweighs task aversiveness, immediate action is taken. Therefore, emotion regulation may improve procrastination either by reducing task aversiveness or by enhancing outcome utility.

To address this question, the present study, grounded in Gross's emotion regulation theory and the temporal decision model of procrastination, selected individuals with high procrastination tendencies (General Procrastination Scale, GPS > 67.5) as participants and divided them into a positive reappraisal group (34 participants) and an ineffective strategy group (34 participants). A longitudinal experience sampling method was employed to track both groups over a 7-day period (14 assessments total). The findings revealed: (1) No significant difference in task execution willingness existed between the two groups at pre-test, but the positive reappraisal group showed significantly higher execution willingness at post-test compared to the ineffective strategy group, indicating that positive reappraisal significantly enhanced individuals' task execution willingness. (2) No significant difference in task aversiveness was found between groups at pre-test, but the positive reappraisal group exhibited significantly lower task aversiveness at post-test. Similarly, no significant difference in outcome utility emerged at pre-test, but the positive reappraisal group demonstrated significantly higher outcome utility at post-test. (3) Mediation analysis indicated that the reduction in task aversiveness mediated the effect of emotion regulation on procrastination improvement (i.e., the increase in execution willingness),

whereas the enhancement of outcome utility did not mediate this relationship.

These results suggest that emotion regulation primarily enhances task execution willingness by reducing task aversiveness, thereby decreasing procrastination behavior. This provides robust theoretical support for intervening in procrastination from an emotion regulation perspective.

Keywords: procrastination; task aversiveness; outcome utility; emotion regulation; temporal decision model of procrastination

1. Introduction

Procrastination refers to the voluntary delay of starting or completing a planned behavior despite anticipating negative consequences (Steel, 2007; Zhang & Feng, 2017). Procrastination exhibits cross-temporal stability and cross-situational consistency (Steel, 2007), and this problematic behavior affects individuals across various age groups and cultures (Ferrari & Roster, 2018; Steel & Ferrari, 2013). For instance, research has found that over 70% of students acknowledge experiencing academic procrastination (Janssen, 2015), while 40% of adults report being troubled by procrastination (Hen & Goroshit, 2018), with 15% to 20% experiencing chronic procrastination (Steel, 2007). Numerous studies have shown that procrastination not only impairs academic performance and work achievement (Kim & Seo, 2015; Nguyen et al., 2013) but also generates intense negative emotions such as anxiety, self-blame, and self-denial, consequently harming physical and mental health by exacerbating cardiovascular disease and compromising immune function (Chung et al., 2020; Sirois, 2015; Stead et al., 2010). Therefore, identifying the core mechanisms underlying procrastination and developing effective clinical interventions have garnered widespread attention from researchers both domestically and internationally.

Emotion regulation is the process of increasing adaptive emotional responses, involving the use of strategies to alter emotional intensity, duration, and quality (Gross, 2015). Effective emotion regulation is fundamental to maintaining intact social functioning, promoting physical and mental health by enhancing positive emotional experiences and overall well-being, and fostering healthy interpersonal relationships (Gross & John, 2003). A central question in emotion regulation research concerns how individuals manage and employ various emotion regulation strategies (Gross, 2015). Consequently, this study primarily examines the mechanisms through which emotion regulation influences procrastination based on strategy utilization. When facing negative life events, people often actively employ regulatory strategies to adjust their emotions. The two most commonly used strategies are cognitive reappraisal and expressive suppression (Gross & John, 2003). Cognitive reappraisal involves changing one's perspective, viewpoint, or attitude toward a situation, focusing primarily on modifying cognitive evaluations to alleviate negative emotions (Gross, 1998; Gross & John, 2003). Expressive suppression refers to a response-focused regulation strategy where individuals inhibit the outward expression of internal

emotional experiences (Gross, 1998). Emotion regulation and procrastination are closely interconnected. For example, research has found that individuals who use cognitive reappraisal more frequently exhibit less procrastination (Sirois et al., 2019), and similarly, those who use expressive suppression more often also show reduced procrastination tendencies (Wang et al., 2022). Thus, both emotion regulation strategies can play important roles in improving procrastination. However, studies have indicated that greater use of cognitive reappraisal is associated with enhanced positive emotional experiences and promotes long-term psychological health, whereas greater use of expressive suppression may reduce negative experiences in the short term but increase negative emotional experiences over the long term, thereby decreasing mental health levels (Goldin et al., 2008; Gross & John, 2003). Furthermore, according to Garnefski et al., cognitive reappraisal is considered an adaptive emotion regulation strategy (Garnefski et al., 2001). Therefore, cognitive reappraisal may represent a more adaptive approach to improving procrastination in the long term. In summary, this study proposes **Hypothesis 1:** Emotion regulation may improve procrastination.

Although previous research has established that emotion regulation helps reduce procrastination, the cognitive mechanisms underlying this relationship remain unclear. The temporal decision model of procrastination posits that task aversiveness triggers avoidance motivation, thereby exacerbating procrastination (Zhang, Liu & Feng, 2019). Task aversiveness refers to the anticipated or experienced sense of aversion or unpleasantness toward a task (Blunt & Pychyl, 2000). Task aversiveness can trigger avoidance motivation, where individuals postpone anxiety-inducing and distressing tasks to avoid the negative emotions they elicit, consequently intensifying procrastination (Zhang, Liu & Feng, 2019). Empirical research has also demonstrated that negative experiences during tasks strengthen individuals' procrastination tendencies, and the more negative the task, the more likely it is to be postponed (Sigall et al., 2000). However, such negative emotional experiences may be down-regulated through emotion regulation, subsequently reducing procrastination levels. Specifically, weaker functional connectivity between prefrontal regions (particularly the dorsolateral prefrontal cortex, DLPFC) and limbic systems (such as the insula) is associated with poor performance in negative emotion regulation tasks like cognitive reappraisal (Steward et al., 2016), while transcranial direct current stimulation (tDCS) of the right DLPFC can effectively reduce individuals' negative emotions (Wu et al., 2020). These findings suggest that systematic emotion regulation training may improve procrastination by reducing task aversiveness (avoidance motivation). Additionally, the temporal decision model of procrastination also posits that outcome utility triggers approach motivation, thereby reducing procrastination (Zhang, Liu & Feng, 2019). Outcome utility refers to individuals' subjective valuation of task outcomes (Zhang, Liu & Feng, 2019). Outcome utility can trigger approach motivation—the desire to obtain task outcomes, prompting immediate action (Zhang, Liu & Feng, 2019). Empirical research has also shown that tasks with lower outcome utility are more likely to be postponed (Zhang, Becker et al., 2019), while neuromodulation of the left DLPFC can in-

crease outcome utility and consequently enhance task execution willingness to improve procrastination (Xu et al., 2023). These findings underscore the important role of outcome utility (approach motivation) in reducing procrastination. Therefore, emotion regulation may also influence procrastination by enhancing outcome utility (approach motivation). Previous research has found that cognitive reappraisal not only serves as an adaptive emotion regulation strategy but also affects reward processing. This perspective is supported by task-based studies showing that use of this regulation strategy is associated with activation in reward-processing brain regions, including the ventral striatum and putamen (Fabiansson et al., 2012; Staudinger et al., 2009). In summary, these studies suggest that emotion regulation may modulate individuals' evaluation of task outcome value, thereby improving procrastination. Consequently, this study proposes **Hypothesis 2:** Emotion regulation may improve procrastination by reducing task aversiveness; and **Hypothesis 3:** Emotion regulation may also improve procrastination by enhancing outcome utility.

In summary, the primary objective of this study is to investigate the mechanisms through which emotion regulation influences procrastination. To address this question, based on Gross's emotion regulation theory and the temporal decision model of procrastination, this research employs a 2 (emotion regulation strategy: positive reappraisal vs. ineffective strategy) $\times$ 2 (time point: pretest vs. post-test) mixed experimental design, selecting individuals with high procrastination tendencies (GPS $>$ 67.5) as participants and using experience sampling to longitudinally track task aversiveness, outcome utility, and procrastination behavior over 7 days (14 assessments total). Overall, the innovations of this study include: First, regarding the research question, this study is the first to investigate the mechanisms through which emotion regulation influences procrastination based on the temporal decision model, which holds important theoretical significance for understanding the core mechanisms of procrastination and provides experimental evidence for intervening in procrastination from an emotion regulation perspective. Second, regarding research design, this study employs experience sampling to longitudinally track individuals' real task evaluations and feelings, thereby enhancing ecological validity. Previous research has predominantly used cross-sectional designs and questionnaires to preliminarily explore the impact of emotion regulation on procrastination (Sirois et al., 2019). Currently, researchers consider generalizability of findings as one of psychology's gold standards, and experience sampling, by repeatedly and dynamically capturing people's actual experiences and behaviors in real-world contexts, is more effective than questionnaire methods at reducing retrospective bias and thus improving ecological validity (Duan & Chen, 2012).

2. Method

2.1 Participants

This study used G*Power 3.1 to estimate the required sample size (Faul et al., 2007), which yielded a required sample of N = 66 (effect size f = 0.25; $\alpha = 0.05$, 1

- $\beta = 0.80$, for a 2 × 2 mixed design). The study recruited 68 university students with high procrastination tendencies using Lay's (1986) General Procrastination Scale (GPS > 67.5, exceeding one standard deviation above the mean GPS score of 1,067 university students), randomly assigning them to either the positive reappraisal group or the ineffective strategy group (Lay, 1986). The positive reappraisal group comprised 34 participants (M age = 19.82 years, SD = 1.49), while the ineffective strategy group comprised 34 participants (M age = 20.18 years, SD = 1.45).

2.2 Experimental Objectives

The study had two primary objectives: (1) To investigate whether emotion regulation can improve procrastination in individuals with high procrastination tendencies. (2) Based on the temporal decision model of procrastination, to examine the mechanisms through which emotion regulation reduces procrastination—specifically, whether it operates by reducing task aversiveness or by enhancing outcome utility.

2.3 Experimental Design

This study employed a 2 (emotion regulation strategy: positive reappraisal vs. ineffective strategy) × 2 (time point: pre-test vs. post-test) mixed experimental design, with emotion regulation strategy as a between-subjects variable and time point as a within-subjects variable. Since this study aimed to investigate the cognitive mechanisms through which emotion regulation influences procrastination, the improvement in task execution willingness (calculated as the difference between post-test and pre-test scores) served as the indicator of procrastination improvement (Xu et al., 2023). Previous research has demonstrated that task execution willingness significantly predicts subsequent actual task performance (Xu et al., 2023), suggesting that task execution willingness can serve as an indicator of procrastination behavior. Moreover, prior studies have repeatedly used this indicator to investigate procrastination behavior (Xu et al., 2023; Zhang & Feng, 2020). Additionally, because procrastination represents a trade-off between task aversiveness and outcome utility—occurring when task aversiveness significantly exceeds outcome utility (Zhang, Liu & Feng, 2019)—this study examined the mechanisms of emotion regulation's impact on procrastination by calculating the reduction in task aversiveness (difference between post-test and pre-test) and the enhancement of outcome utility (difference between post-test and pre-test) as process variables. SPSS 25.0 was used for statistical analysis of the collected data.

2.4 Experimental Materials

Participants were required to provide three real tasks that they were currently procrastinating on (i.e., tasks they intended to complete but had not yet started) with deadlines more than 7 days away (i.e., beyond the experimental period) for tracking purposes. Group tasks were excluded as they significantly affect

individual autonomy in task execution. The study conducted a 7-day longitudinal tracking of both the positive reappraisal and ineffective strategy groups using experience sampling. Data were collected twice daily at 9:00 AM and 2:30 PM (totaling 14 assessments) to capture participants' task execution willingness, task aversiveness, and outcome utility. The question assessing task execution willingness was: "How willing are you to start working on this task today? (0–10 rating, where 0 = not at all and 10 = extremely willing)." Task aversiveness was assessed with: "If you needed to start working on this task today, how would you feel? (–8 to 8 rating, where –8 = extremely unpleasant, 0 = completely neutral, and 8 = extremely pleasant)." Outcome utility was measured by: "How much do you desire to achieve the goal through this task? (0–10 rating, where 0 = not at all and 10 = extremely desirable)."

2.5 Experimental Procedure

On the first day of the experiment, the Positive and Negative Affect Schedule (PANAS) was administered to collect participants' baseline emotions (Kuesten et al., 2014; Huang et al., 2003), and the Difficulties in Emotion Regulation Scale (DERS) was reverse-scored to assess emotion regulation ability (ERA) (Gratz & Roemer, 2004; Wang et al., 2007). Subsequently, participants provided three real tasks they were procrastinating on (resulting in 204 tasks total) and completed the first questionnaire, rating each task's aversiveness, outcome utility, and execution willingness (serving as pre-test data). The experimenter then provided the positive reappraisal group with the positive reappraisal emotion regulation strategy and the ineffective strategy group with a strategy ineffective for reducing procrastination.

The positive reappraisal group received an effective emotion regulation strategy for reducing procrastination—positive reappraisal. Survey research has shown that using cognitive reappraisal helps decrease procrastination (Sirois et al., 2019). Based on items from the positive reappraisal subscale of Garnefski et al.'s Cognitive Emotion Regulation Questionnaire (CERQ) (Garnefski et al., 2001), and to prevent expectancy effects (i.e., participants being influenced by the experimenter's expectation to improve procrastination), participants were informed that the provided method was for improving physical and mental health. The instructions for the positive reappraisal group were: "Hello, we have found that forcing oneself to work on aversive tasks is generally detrimental to physical and mental health. Therefore, when facing an aversive task, if you find it difficult to start, you can choose to view your task from a positive perspective by considering the benefits of completing it—'What can I learn from this, and how will what I learn benefit me…', 'What can I gain or avoid', 'How can I improve myself in some way'—which is more conducive to physical and mental health. Please use this method throughout the experiment and report truthfully how many times you used it each day when completing the questionnaire."

The ineffective strategy group received a strategy ineffective for reducing procrastination—"choosing a dedicated workspace"—as an active control

group. Hou's (2021) empirical research found that procrastination levels did not change significantly after using this method, indicating its ineffectiveness in reducing procrastination. The instructions for the ineffective strategy group were: "Hello, we have found that forcing oneself to work on aversive tasks is generally detrimental to physical and mental health. Therefore, when facing an aversive task, if you find it difficult to start, you can choose to go to a library, study room, or similar location to work or study, immersing yourself in a learning environment to fully devote yourself to work and study, which is more conducive to physical and mental health. Please use this method throughout the experiment and report truthfully how many times you used it each day when completing the questionnaire."

On Day 1, after presenting the emotion regulation instructions to both groups, the positive reappraisal group received positive reappraisal strategies tailored to each task (i.e., viewing tasks positively and considering the benefits of completion). Participants in this group were required to use the provided method (positive reappraisal). Since participants' arrival times on Day 1 varied between 9:00 AM and 5:00 PM, to avoid between-subject differences due to varying completion times of the first questionnaire, participants were required to complete the next questionnaire 4 hours after finishing the first one (i.e., the second questionnaire on Day 1).

During Days 2 through 7, participants were required to complete two questionnaires daily: one at 9:00 AM to assess baseline emotions and task ratings, including task aversiveness, outcome utility, and execution willingness. Additionally, to explore spontaneous emotion regulation strategies used by the ineffective strategy group, the questionnaire included an item: "When you experienced negative emotions about the task and didn't want to work on it, what thoughts did you use to regulate?" At 10:30 AM, researchers sent participants a reminder about the emotion regulation instructions to prompt them to use the provided strategy. At 2:30 PM, participants completed the day's second questionnaire for task ratings and to assess task execution, including task aversiveness, outcome utility, execution willingness, actual task execution ("Did you start working on the task today? If so, did you start after completing yesterday's second questionnaire or today?"), regulation frequency ("How many times did you use the provided method today?"), and regulation effectiveness ("How effective do you think using this method was for improving your physical and mental health?" 1–5 rating: 1 = not effective at all; 5 = extremely effective). Regulation frequency was used as a manipulation check variable for statistical analysis. Regulation effectiveness data were not included in statistical analyses to avoid expectancy effects.

3. Results

3.1 Group Homogeneity Test

Chi-square tests were conducted on gender, and independent samples t-tests were performed on age, trait procrastination (GPS), emotion regulation ability, baseline emotions, task deadlines, and pre-test measures (including task aversiveness, outcome utility, and execution willingness) between the positive reappraisal and ineffective strategy groups. Results revealed no significant differences between the two groups in gender ($^2 = 0.16$, $p = 0.690$, $N = 68$), age, trait procrastination, emotion regulation ability, baseline emotions, task deadlines, or pre-test indicators (see Tables 1 and 2), indicating that the two groups were homogeneous on these measures.

3.2 Emotion Regulation Improved Procrastination Behavior

All participants in the positive reappraisal group had average emotion regulation frequencies greater than 0 across all their tasks (102 tasks), indicating successful manipulation of their use of positive reappraisal strategies. Data obtained from the first measurement on Day 1 served as pre-test data, while data from the final measurement before actual task execution served as post-test data.

To investigate the effect of emotion regulation on procrastination, task execution willingness served as the procrastination indicator. A 2 (group: positive reappraisal vs. ineffective strategy) × 2 (time point: pre-test vs. post-test) repeated measures ANOVA was conducted with execution willingness as the dependent variable. Results showed a significant main effect of group ($F(1,202) = 16.54$, $p < 0.001$, partial $^2 = 0.08$), a significant main effect of time point ($F(1,202) = 133.38$, $p < 0.001$, partial $^2 = 0.40$), and a significant group × time point interaction ($F(1,202) = 72.14$, $p < 0.001$, partial $^2 = 0.26$). Simple effects analysis revealed no significant difference between groups at pre-test (M positive reappraisal pre-test = 2.05, SD = 1.67; M ineffective strategy pre-test = 2.42, SD = 2.17; $F(1,202) = 1.88$, $p = 0.172$). However, at post-test, the positive reappraisal group showed significantly higher execution willingness than the ineffective strategy group (M positive reappraisal post-test = 5.26, SD = 1.97; M ineffective strategy post-test = 2.91, SD = 2.44; $F(1,202) = 57.49$, $p < 0.001$, partial $^2 = 0.22$) (see Figure 1a). Therefore, Hypothesis 1 was supported: positive reappraisal emotion regulation improved procrastination behavior.

[Figure 1: see original paper]

3.3 Effects of Emotion Regulation on Process Variables: Reducing Task Aversiveness and Enhancing Outcome Utility

To examine the effects of emotion regulation on the two process variables—task aversiveness and outcome utility—a 2 (group: positive reappraisal vs. ineffective strategy) × 2 (time point: pre-test vs. post-test) repeated measures ANOVA was first conducted with task aversiveness as the dependent variable. Results

revealed a significant main effect of group ($F(1,202) = 21.19$, $p < 0.001$, partial $^2 = 0.10$), a significant main effect of time point ($F(1,202) = 306.73$, $p < 0.001$, partial $^2 = 0.60$), and a significant group × time point interaction ($F(1,202) = 67.95$, $p < 0.001$, partial $^2 = 0.25$). Simple effects analysis showed no significant difference between groups at pre-test (M positive reappraisal pre-test = –5.81, SD = 1.65; M ineffective strategy pre-test = –5.56, SD = 1.88; $F(1,202) = 1.06$, $p = 0.304$). At post-test, however, the positive reappraisal group exhibited significantly lower task aversiveness than the ineffective strategy group (M positive reappraisal post-test = –0.77, SD = 3.19; M ineffective strategy post-test = –3.75, SD = 3.02; $F(1,202) = 46.59$, $p < 0.001$, partial $^2 = 0.19$) (see Figure 2a). These findings indicate that using positive reappraisal strategies effectively reduced task aversiveness.

[Figure 2: see original paper]

Next, a 2 (group: positive reappraisal vs. ineffective strategy) × 2 (time point: pre-test vs. post-test) repeated measures ANOVA was conducted with outcome utility as the dependent variable. Results showed a non-significant main effect of group ($F(1,202) = 3.41$, $p = 0.066$), a significant main effect of time point ($F(1,202) = 4.96$, $p = 0.027$, partial $^2 = 0.02$), and a significant time point × group interaction ($F(1,202) = 10.45$, $p = 0.001$, partial $^2 = 0.05$). Simple effects analysis revealed no significant difference between groups at pre-test (M positive reappraisal pre-test = 6.94, SD = 2.33; M ineffective strategy pre-test = 6.81, SD = 2.62; $F(1,202) = 0.14$, $p = 0.714$). At post-test, the positive reappraisal group demonstrated significantly higher outcome utility than the ineffective strategy group (M positive reappraisal post-test = 7.69, SD = 1.90; M ineffective strategy post-test = 6.68, SD = 2.69; $F(1,202) = 9.58$, $p = 0.002$, partial $^2 = 0.05$) (see Figure 3a). These results indicate that using positive reappraisal strategies effectively enhanced outcome utility.

[Figure 3: see original paper]

3.4 Prediction of Procrastination Improvement by Process Variables

To further investigate the mechanisms through which emotion regulation improves procrastination—specifically, whether it operates through reducing task aversiveness or enhancing outcome utility—a mixed linear model analysis was conducted. The reduction in task aversiveness and enhancement of outcome utility served as predictor variables (fixed factors), while group, participant ID, and task number were included as random factors to control for within-subject differences, with procrastination improvement (i.e., increase in execution willingness) as the dependent variable. Results indicated that both the reduction in task aversiveness and the enhancement of outcome utility significantly predicted procrastination improvement (reduction in task aversiveness: $t(172.75) = 7.71$, $p < 0.001$; enhancement of outcome utility: $t(201.00) = 3.25$, $p = 0.001$) (see Table 3). These findings further support the notion that both task aversiveness and outcome utility play important roles in procrastination.

3.5 Mediating Role of Task Aversiveness Reduction

To further test whether emotion regulation improves procrastination by reducing task aversiveness, emotion regulation was coded as the independent variable (1 = using positive reappraisal strategy, 0 = not using positive reappraisal strategy), with procrastination improvement (increase in execution willingness) as the dependent variable, reduction in task aversiveness (difference between post-test and pre-test) as the mediator variable, and gender, age, task deadline, and outcome utility enhancement as covariates. A bootstrap-based mediation analysis was performed using PROCESS (Hayes & Preacher, 2014) with 5,000 resamples and a 95% confidence interval. The experiment successfully manipulated positive reappraisal use in the positive reappraisal group, so all tasks in this group (102 tasks) were coded as using positive reappraisal. Since participants in the ineffective strategy group spontaneously used positive reappraisal on some tasks (as identified through spontaneous emotion regulation strategy coding), these tasks (47 tasks) were also coded as using positive reappraisal. Results showed that the direct effect of emotion regulation (positive reappraisal) on procrastination improvement was significant, $b = 0.55$, $p < 0.001$, 95% CI = [0.809, 2.136]. The indirect effect through reduction in task aversiveness was also significant, $b = 0.44$, 95% CI = [0.765, 1.561] (note: $0.95 \times 0.46 = 0.44$) (see Figure 4). These results indicate that reduction in task aversiveness mediates the effect of emotion regulation on procrastination improvement. Therefore, Hypothesis 2 was supported.

[Figure 4: see original paper]

Additionally, to determine whether emotion regulation improves procrastination by enhancing outcome utility, emotion regulation was coded as the independent variable (1 = using positive reappraisal strategy, 0 = not using positive reappraisal strategy), with procrastination improvement as the dependent variable, outcome utility enhancement (difference between post-test and pre-test) as the mediator variable, and gender, age, task deadline, and reduction in task aversiveness as covariates. Mediation analysis revealed that while the direct effect of emotion regulation (positive reappraisal) on procrastination improvement remained significant, $b = 0.55$, $p < 0.001$, 95% CI = [0.809, 2.136], the indirect effect through outcome utility enhancement was not significant, $b = 0.06$, 95% CI = [–0.013, 0.367]. These results indicate that outcome utility enhancement does not mediate the relationship between emotion regulation and procrastination improvement. Therefore, Hypothesis 3 was not supported.

In summary, the present findings suggest that the improvement in procrastination through emotion regulation was not caused by enhanced outcome utility, thereby further demonstrating that the improvement was due to reduced task aversiveness.

4. Discussion

The study's findings indicate: (1) No significant difference in execution willingness existed between groups at pre-test, but the positive reappraisal group showed significantly higher execution willingness at post-test, demonstrating that positive reappraisal significantly enhanced individuals' task execution willingness. (2) No significant difference in task aversiveness was found between groups at pre-test, but the positive reappraisal group exhibited significantly lower task aversiveness at post-test. Similarly, no significant difference in outcome utility emerged at pre-test, but the positive reappraisal group demonstrated significantly higher outcome utility at post-test. These results show that positive reappraisal significantly reduced individuals' task aversiveness while significantly enhancing task outcome utility. (3) Mediation analysis revealed that the reduction in task aversiveness mediated the effect of emotion regulation on procrastination improvement (i.e., increased execution willingness), whereas the enhancement of outcome utility did not mediate this relationship.

4.1 Emotion Regulation Effectively Improves Procrastination

Previous research has primarily investigated the relationship between emotion regulation and trait procrastination through survey studies. The innovation of this study lies in its focus on task-specific procrastination and its use of experience sampling to explore the relationship between emotion regulation and procrastination. The findings demonstrate that emotion regulation can improve procrastination by enhancing task execution willingness. This aligns with previous survey research showing that greater use of cognitive reappraisal is associated with less procrastination (Emadi Chashmi et al., 2023; Sirois et al., 2019) and that greater use of expressive suppression is also associated with reduced procrastination (Wang et al., 2022). Additionally, empirical studies have shown that emotion regulation training can reduce procrastination (Eckert et al., 2016). These studies collectively confirm that emotion regulation plays an important role in improving procrastination. The present research further validates this conclusion by examining emotion regulation in relation to procrastination on specific tasks.

4.2 Emotion Regulation Effectively Reduces Task Aversiveness

Most previous research has investigated how emotion regulation strategies downregulate negative emotions at the questionnaire level or in general emotional contexts (Goldin et al., 2008; Sirois et al., 2019). The innovation of this study is its focus on task aversiveness in the context of task procrastination, specifically examining the relationship between emotion regulation and negative emotions. The findings show that emotion regulation effectively reduced task aversiveness. This is consistent with previous survey research demonstrating that greater use of cognitive reappraisal is associated with fewer negative emotions (Goldin et al., 2008; Sirois et al., 2019). Furthermore, an experience sampling study found that emotion regulation flexibility helps reduce individuals' negative emotional

experiences (Wang et al., 2023). Researchers have also used cognitive reappraisal training to significantly reduce negative emotional responses, including lower math anxiety and cortisol levels (Jamieson et al., 2022). These studies collectively confirm that emotion regulation plays a crucial role in reducing negative emotions. Based on the temporal decision model of procrastination, this study further examined the down-regulating effect of emotion regulation training on task aversiveness, providing theoretical guidance and empirical evidence for intervening in procrastination through emotion regulation.

4.3 The Mediating Role of Task Aversiveness in Emotion Regulation's Effect on Procrastination

Mediation analysis revealed that the reduction in task aversiveness mediated the effect of emotion regulation on procrastination improvement, whereas the enhancement of outcome utility did not. This indicates that emotion regulation primarily improves procrastination by reducing task aversiveness.

The temporal decision model of procrastination posits that procrastination results from a trade-off between task aversiveness and outcome utility, occurring when task aversiveness significantly exceeds outcome utility, with immediate action taken when the opposite is true (Zhang, Liu & Feng, 2019). Thus, both task aversiveness and outcome utility are important factors influencing procrastination. Meta-analytic research has shown that task aversiveness is a significant cause of procrastination (Procee et al., 2013). Empirical studies have also demonstrated that negative experiences during tasks strengthen individuals' procrastination tendencies, with more negative tasks being more likely to be postponed (Sigall et al., 2000). Procrastination is also closely related to hedonism, as individuals in negative moods may permit themselves to abandon unpleasant tasks for self-indulgence (Tice & Wallace, 2000). Additionally, the short-term mood repair theory suggests that procrastination stems from individuals' intense desire to feel immediate pleasure and avoid task-induced discomfort (Sirois & Pychyl, 2013). In other words, procrastination occurs to maximize current self-feeling—pursuing immediate pleasure at the expense of tasks beneficial for long-term self-development. In summary, the avoidance motivation triggered by task aversiveness is a crucial cause of procrastination behavior. Therefore, regulating task aversiveness is essential for improving procrastination.

Strunk et al.'s 2 × 2 model of time-related academic behavior emphasizes that procrastination research should simultaneously consider both time and motivation dimensions (Strunk et al., 2013; Song et al., 2015). The model's "time dimension" ranges from timely action to procrastination, while the "motivation dimension" refers to approach and avoidance motivations. Combining these dimensions yields four behavioral types: procrastination-approach, procrastination-avoidance, timely action-approach, and timely action-avoidance. Procrastination-avoidance refers to procrastination resulting from the desire to avoid unwanted outcomes, typically caused by avoidant coping styles (Song et al., 2015). This supports the view that task aversive-

ness triggers avoidance motivation, thereby exacerbating procrastination. The present study found that emotion regulation improves procrastination primarily by reducing task aversiveness—that is, by decreasing the avoidance motivation triggered by task aversiveness.

These findings align with previous survey research showing that cognitive reappraisal can reduce procrastination by decreasing negative emotions (Sirois et al., 2019) and that more effective regulation of negative emotions leads to less procrastination (Mohammadi Bytamar et al., 2020). In summary, this study reveals that emotion regulation improves procrastination by reducing the avoidance motivation triggered by task aversiveness. In other words, emotion regulation may improve procrastination by reducing task aversiveness (avoidance motivation) to a level significantly below outcome utility (approach motivation), prompting individuals to choose immediate action.

Furthermore, although this study found that emotion regulation can significantly enhance outcome value, it did not reduce procrastination through this mechanism. The temporal decision model also posits that immediate task execution willingness is influenced by individuals' evaluation of task outcome utility (Zhang & Feng, 2020; Zhang, Liu & Feng, 2019). Previous research found that neuromodulation of the self-control brain region (left DLPFC) can significantly enhance outcome value, thereby increasing task execution willingness and improving procrastination (Xu et al., 2023). Similar to this study, the present research also found that training individuals to use an adaptive emotion regulation strategy—positive reappraisal—can effectively enhance their evaluation of task outcome value. However, because the core psychological mechanism of positive reappraisal involves guiding individuals to reinterpret emotional stimuli from a positive perspective (Garnefski et al., 2001; Gross, 1998; Gross & John, 2003), a process extensively shown to reduce negative emotions (Goldin et al., 2008; Sirois et al., 2019), this experimental manipulation may have produced relatively limited enhancement of outcome value. Consequently, the strategy could not improve task execution willingness by altering outcome value evaluation. This result further confirms that the reduction of task aversiveness is the specific mechanism through which emotion regulation influences procrastination behavior.

The present findings validate, from a task procrastination perspective, that emotion regulation effectively improves procrastination and reveal its underlying mechanism. Specifically, the study demonstrates that emotion regulation improves procrastination by reducing the avoidance motivation triggered by task aversiveness. These results provide a solid theoretical foundation for intervening in procrastination from an emotion regulation perspective. Procrastination is a behavior that harms both individuals and society, making intervention imperative. When addressing procrastination, emotion regulation training targeting task aversiveness can be employed to reduce avoidance motivation and thereby decrease procrastination. This approach offers new possibilities for mitigating the harms associated with procrastination.

This study has several limitations. First, it only examined the mechanisms of emotion regulation's effect on procrastination from the perspective of task execution willingness. However, previous research suggests there may be a gap between intention and action (Sheeran & Webb, 2016), meaning that task execution willingness may not fully represent actual task performance. Therefore, future research should investigate actual procrastination levels (e.g., actual completion rates, actual procrastination duration) by examining participants' performance during task execution to further explore and validate the mechanisms through which emotion regulation influences procrastination behavior. Second, this study only used positive reappraisal as the manipulation strategy; the mechanisms through which other emotion regulation strategies affect procrastination remain unclear. Future research could expand to include additional emotion regulation strategies to further examine and compare the effectiveness and mechanisms of different strategies in improving procrastination, thereby identifying more effective intervention approaches. Finally, because this study's sample had an unbalanced gender ratio and consisted primarily of university students, the generalizability of the results is somewhat limited. Future research should recruit samples with balanced gender ratios or investigate child and adolescent populations to further validate the mechanisms through which emotion regulation influences procrastination.

5. Conclusion

This study is the first to use experience sampling to investigate the mechanisms through which emotion regulation influences procrastination. The results demonstrate that positive reappraisal strategies significantly improve task aversiveness and enhance outcome value. Mediation analysis further reveals that the reduction in task aversiveness significantly mediates the relationship between emotion regulation and procrastination improvement, whereas the enhancement of outcome utility does not mediate the association between emotion regulation and procrastination. These findings hold important theoretical significance for understanding the psychological mechanisms underlying emotion regulation's effect on procrastination and have direct practical value for procrastination interventions.

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