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ORIGINAL ARTICLE

The Regulatory Role of Cognitive Reappraisal in the Effect of Neuroticism on Test Anxiety

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Abstract

Background Test anxiety is a prevalent issue that many individuals struggle with. Previous research has indicated that individuals with higher levels of neuroticism are more prone to experiencing test anxiety. However, there is some indirect evidence suggesting that cognitive reappraisal may play a role in moderating this relationship. Thus, the present work aimed to examine the role of cognitive reappraisal in the effect of neuroticism on test anxiety through two studies.

Methods Study 1 used a questionnaire approach, utilizing the Test Anxiety Inventory (TAI), the Neuroticism Extraversion Openness Five-factor Inventory (NEO-FFI), and the Emotion Regulation Questionnaire (ERQ) with a sample of 596 participants. Study 2 conducted a test-related emotional picture rating task to better measure emotional responses. A total of 180 participants took part in Study 2.

Results Study 1 and Study 2 have converged results: (1) neuroticism positively predicted individuals' test anxiety; (2) the predictive effect of neuroticism on test anxiety was moderated by cognitive reappraisal—the higher cognitive reappraisal ability, the lower the predictive effect of neuroticism on test anxiety.

Conclusions These results indicate that individuals with higher levels of neuroticism may experience stronger test anxiety, while cognitive reappraisal can mitigate test anxiety in neurotic individuals.

Keywords Test anxiety · Neuroticism · Cognitive reappraisal · Emotional response

Introduction

Test anxiety is a common phenomenon characterized by feelings of fear or worry regarding the evaluation of test-related information, leading to various physical and emotional reactions (Zeidner, 1998). Test anxiety is both a situationally relevant state of anxiety (Conley & Lehman, 2012; King et al., 2000), such that most people experience a state of anxiety during a test, and an anxiety trait, such that some people are always more prone to inducing anxiety about test-related information than others (Lang & Lang, 2010; Spielberger & Vagg, 1995). Individuals with high trait test anxiety are more susceptible to the influence of test-related information (Spielberger & Vagg, 1995). Researchers have conducted thorough examinations of trait test anxiety (Lang & Lang, 2010; Hoferichter et al., 2014; Shen et al., 2018).

Decades of research into the structural dimensions of test anxiety have yielded convergent evidence, indicating that this phenomenon is a multidimensional construct comprising at least two distinct components, conventionally referred to as emotionality and worry (Liebert & Morris, 1967). Subsequent investigations have alternatively proposed a four-dimensional classification, encompassing elements like worry, emotionality, interference, and lack of confidence (Hoferichter et al., 2016; Stober, 2004) or tension, test-irrelevant thinking, bodily symptoms, and worry (Sarason, 1984). Despite the absence of uniformity in the conceptualization of test anxiety, the majority of research is grounded in the dimensions of worry and emotionality (Cassady & Johnson, 2002; Krispenz et al., 2019; Lang & Lang, 2010; Shen et al., 2018; Stowell et al., 2008).

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Recent studies have shown that approximately 15 to 30% of students experience test anxiety (Li et al., 2021; Putwain & Daly, 2014; Thomas et al., 2018), which adversely affects test-related cognitive processing efficiency and undermines test performance (Song et al., 2022). Additionally, test anxiety has been associated with psychological factors, including self-esteem and control beliefs (Sarı et al., 2018; Xie et al., 2019), and increases the risk of developing cardiovascular disease (Conley & Lehman, 2012). Hence, it is crucial to delve into the underlying causes and influences of test anxiety to pinpoint effective interventions and strategies for its mitigation.

Neuroticism and Test Anxiety

Neuroticism is a foundational personality trait reflecting emotional stability (Verbeke & Kenhove, 2002). Individuals with higher levels of neuroticism are prone to increased susceptibility to emotional influences and heightened experiences of negative emotions and stress (Ebstrup et al., 2011; Lee & Guajardo, 2011). Neuroticism usually reflects a generalized tendency to experience negative emotional states (Miller et al., 2009). Individuals with high levels of neuroticism make more negative judgments and interpretations under negative emotional conditions (Rafienia et al., 2008).

Many studies have established a relationship between neuroticism and test anxiety (Hoferichter et al., 2014). Specifically, individuals with higher levels of neuroticism are more likely to experience test anxiety (Zhang et al., 2021). Hoferichter and Raufelder (2015) discovered a significant positive relationship between students' neuroticism scores and their test anxiety levels. Furthermore, Malone and Bertsch (2016) found that neuroticism can positively predict test anxiety and identified that the impact of neuroticism on test anxiety is due to negative judgments generated by observing peers. Some researchers even suggested that test anxiety may be a sub-component of the neuroticism personality trait due to the close relationship between them (e.g., Chamorro-Premuzic et al., 2008; Hoferichter et al., 2014). A recent meta-analysis on test anxiety revealed a significant positive correlation between neuroticism and test anxiety (von der Embse et al., 2018). These findings indicate that an individual's level of neuroticism can predict their level of test anxiety.

Test Anxiety, Neuroticism, and Emotional Response

Previous research suggests that test anxiety can be treated as a situation-specific trait (Spielberger & Vagg, 1995), with individuals experiencing varying levels of test anxiety based on the testing context (Hayes & Embretson, 2013; Reeve et al., 2008). For instance, Segool et al. (2013) found that students reported elevated test anxiety in high-stakes testing situations, while Ringeisen and Buchwald (2010) found that the interaction between test anxiety and situational factors influences the intensity of test-related emotional states, with certain situations amplifying the perceived risk of failure and engendering heightened threatening emotions. Recently, Chin et al. (2017) also found that individuals with higher levels of test anxiety reported more intense negative emotional experiences linked to the testing situation. On the other hand, a fundamental trait of neuroticism involves heightened sensitivity and stronger emotional responses to negative stimuli, leading individuals with high neuroticism to exhibit greater emotional fluctuations when encountering stimulus events (Sauer-Zavala et al., 2017). Reynaud et al. (2012) observed that individuals with high neuroticism displayed more pronounced emotional responses to even mild stressors. Larsen and Ketelaar (1991) identified increased susceptibility to negative affect and heightened emotional reactions to negative stimuli among those with high neuroticism. Similarly, Barlow et al. (2014) suggested that individuals with high neuroticism have more worries about negative events, stronger emotional responses, and a tendency to process emotional information more negatively. Importantly, Moutafi et al. (2006) found that individuals with high neuroticism are more stressed under testing conditions than low neuroticism. These findings suggested that individuals with neuroticism felt stronger emotional responses when faced with test situations.

The Moderating Role of Cognitive Reappraisal

In the field of emotion regulation, cognitive reappraisal is one of the most common emotion regulation strategies, which refers to regulating emotions by changing one's understanding of emotional events (Gross & John, 2003). Previous research has found that cognitive reappraisal can alleviate anxiety symptoms (Chen et al., 2020; Pizzie et al., 2020; Xu et al., 2020). Test anxiety usually consists of two dimensions: emotionality and worry (Liebert & Morris, 1967). Worry pertains to cognitive apprehension related to test failure, while Emotionality encompasses self-perceived autonomic arousal. Evidence from meta-analyses suggests the effectiveness of cognitive intervention methods in reducing test anxiety (Von Der Embse et al., 2013). For example, Priebe and Kurtz-Costes (2022) used cognitive interventions (i.e., mindfulness) to reduce test anxiety in college students, and found that individuals maintained lower levels of test anxiety if they were able to regulate their appraisal of the test well. The above evidence suggests that test anxiety

can be well reduced by changing an individual's perceptions about test-related thoughts. Cognitive reappraisal can be effective in changing individuals' perceptions of negative events. It can be equally effective in reducing worries about exams. For example, Brady et al. (2018) found that a reappraisal intervention prior to a stressful exam reduced students' worries about the exam.

Furthermore, cognitive reappraisal serves as both an emotion regulation strategy and a cognitive ability (McRae et al., 2012a, b). Specifically, more frequent and effective use of cognitive reappraisal strategies implies greater cognitive reappraisal ability and lower emotional response. For instance, Efinger et al. (2019) utilized an emotional picture rating task and demonstrated that employing cognitive reappraisal effectively diminished negative emotional responses. Similarly, when comparing acceptance to cognitive reappraisal, Goldin et al. (2019) found that cognitive reappraisal resulted in a significant reduction in self-reported negative emotions and bilateral amygdala responses. In a study involving highly anxious females, Qi et al. (2020) demonstrated the efficacy of cognitive reappraisal in regulating emotional responses to negative stimuli. In addition, it has been suggested that cognitive reappraisal may be particularly helpful for people with neuroticism (Dawel et al., 2023). Luo and Huang (2016) found that applying cognitive reappraisal to emotional events can mitigate the association between neuroticism and negative emotions. Thus, cognitive reappraisal appears to be effective in moderating test anxiety on neuroticism.

The Present Study

This study aims to investigate the role of cognitive reappraisal in the effect of neuroticism on test anxiety and comprises two studies. In Study 1, we employed questionnaires to assess individuals' neuroticism, test anxiety, and cognitive reappraisal. Subsequently, we utilized a moderated model to analyze these data, aiming to elucidate how cognitive reappraisal moderates the relationship between neuroticism and test anxiety. However, as previously noted, test anxiety is situation-specific anxiety and dependent on the testing situation, leading test-anxious individuals to display anxiety symptoms in test situations (Ringeisen & Buchwald, 2010). In this regard, Study 2 introduced an emotional picture rating task containing the test-related picture, aimed to refine situational dependence to further investigate the role of cognitive reappraisal in neuroticism influencing test anxiety. Moreover, recognizing the adverse impact of face-to-face assessments on individuals with anxiety (Kocovski & Endler, 2000), we chose the Internet-based method to eliminate the need for in-person interactions, thereby enhancing the study's reliability.

The hypotheses of the present study are as follows:

Hypothesis 1 Neuroticism positively predicts test anxiety, that is, individuals with higher neuroticism scores are more likely to show greater test anxiety.

Hypothesis 2 Cognitive reappraisal moderates the effect of neuroticism on test anxiety. Specifically, the predictive effect of neuroticism on test anxiety decreases with the improvement of cognitive reappraisal ability.

Study 1

Method

Participants

There were 648 participants taking part in the survey online, and 52 of them had to be excluded because they did not fill out all scales as completely or carefully as required. Consequently, the data analysis included 596 participants, with females accounting for 66.28% ($N = 395$) of the sample. The mean age was 21.33 years ($SD = 2.07$). We obtained the consent of all participants participating. The study has been approved by the local Ethical Committee of the Institute.

Measurements

Test anxiety

The test anxiety was assessed by the Test Anxiety Inventory (TAI) (Spielberger, 1980). The TAI was used as the measurement instrument to assess individual differences in test anxiety as a situation-specific trait. The inventory consists of 20 items, and each of the 8 items subscales assesses the main components of test anxiety: worry and emotionality. The scale is scored on a Likert-4 point scale (1 = "never", 4 ="always"). A higher score indicates greater levels of test anxiety. The Cronbach's α was 0.95 in this study.

Neuroticism

The neuroticism was measured by the Neuroticism Extraversion Openness Five-factor Inventory (NEO-FFI) (Costa & McCrae, 1992). The dimension of neuroticism has 12 items. The scale is scored on a Likert-5 point scale (1 = "very non-conforming", 5 ="very conforming"). The higher the score, the higher levels of neuroticism. The Cronbach's α was 0.76 in the present study.

Table 1 Descriptive statistics and correlation analysis of each variable ($N = 596$)

Variable	$M \pm SD$	1	2	3	4
1. Neuroticism	33.96 ± 8.93	1			
2. CR	29.22 ± 5.89	–0.26***	1		
3. TAI-W	15.34 ± 4.67	0.60***	–0.20***	1	
4. TAI-E	16.74 ± 4.90	0.65***	–0.24***	0.82	1

Note: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$. *M*: mean value, *SD*: standard deviation. CR = Cognitive reappraisal. TAI-W = Worry, TAI-E = Emotionality. The same below

Cognitive reappraisal

Cognitive reappraisal was assessed by the Emotion regulation questionnaire (ERQ) (Gross & John, 2003). The ERQ consists of 10 items, each item is rated on a seven-point Likert scale ranging from 1 = "strongly disagree" to 7 = "strongly agree". The dimension of cognitive reappraisal has 6 items. The higher the score, the more the individual tends to adopt a certain emotion regulation strategy. The Cronbach's α was 0.81 in this study.

Data Analysis

Descriptive statistics were conducted in SPSS 25.0, and PROCESS 3.3 in the SPSS software was utilized to compute the moderated model between neuroticism scores, test anxiety, and cognitive reappraisal.

Results

Descriptive Statistics and Correlation Analysis between Variables

The correlation results (see Table 1) showed that neuroticism scores were significantly positively correlated with worry and emotionality, whereas it was negatively correlated with cognitive reappraisal. And cognitive reappraisal was significantly negatively correlated with worry and emotionality.

Model Validation Analysis

The moderated model was tested using Model 1 in the PROCESS, controlling for gender. As the result is shown (see Table 2), after putting cognitive reappraisal into the model, it could be observed that neuroticism was a significant predictor of worry, $\beta = 0.61$, $t = 17.94$, $p < 0.001$, and emotionality, $\beta = 0.63$, $t = 19.45$, $p < 0.001$. There was a significant interaction between neuroticism and cognitive reappraisal on worry, $\beta = -0.07$, $t = -2.28$, $p < 0.05$, and emotionality, $\beta = -0.09$, $t = -2.98$, $p < 0.01$. The results indicated that cognitive reappraisal moderated the relationship between neuroticism and test anxiety.

To further probe the moderation, simple slope analyses were performed (see Fig. 1). The results showed that participants with low cognitive reappraisal ($M - 1SD$) had a significant positive predictive effect of neuroticism on worry, *simple slope* = 0.68, $t = 14.86$, $p < 0.001$, and emotionality, *simple slope* = 0.72, $t = 16.40$, $p < 0.001$; the same held true for high cognitive reappraisal, but the predictive effect reduced, *simple slope (worry)* = 0.54, $t = 11.36$, $p < 0.001$; *simple slope (emotionality)* = 0.54, $t = 12.03$, $p < 0.001$. It indicated that cognitive reappraisal can decrease the predictive effect of neuroticism on test anxiety.

Discussion

In Study 1, we employed a questionnaire approach to investigate how cognitive reappraisal moderates the relationship between neuroticism and test anxiety. Consistent with Hypothesis 1, the results repeated previous findings that

Table 2 Moderating effect test of cognitive reappraisal ($N = 596$)

Regression equation		Overall fit index			Significance of regression coefficients		
Result variables	Predictive variables	*R*	R^2	*F*	*β*	*SE*	*t*
TAI-W		0.62	0.38	91.62***			
	Gender				0.11	0.03	3.24**
	Neuroticism				0.61	0.03	17.94***
	CR				–0.03	0.03	–1.00
	Neuroticism × CR				–0.07	0.03	–2.28*
TAI-E		0.66	0.44	113.41***			
	Gender				0.04	0.03	1.15
	Neuroticism				0.63	0.03	19.45***
	CR				–0.07	0.03	–1.49*
	Neuroticism × CR				–0.09	0.03	–2.89**

Note: All variables are brought into the regression equation using standardized variables, the same below

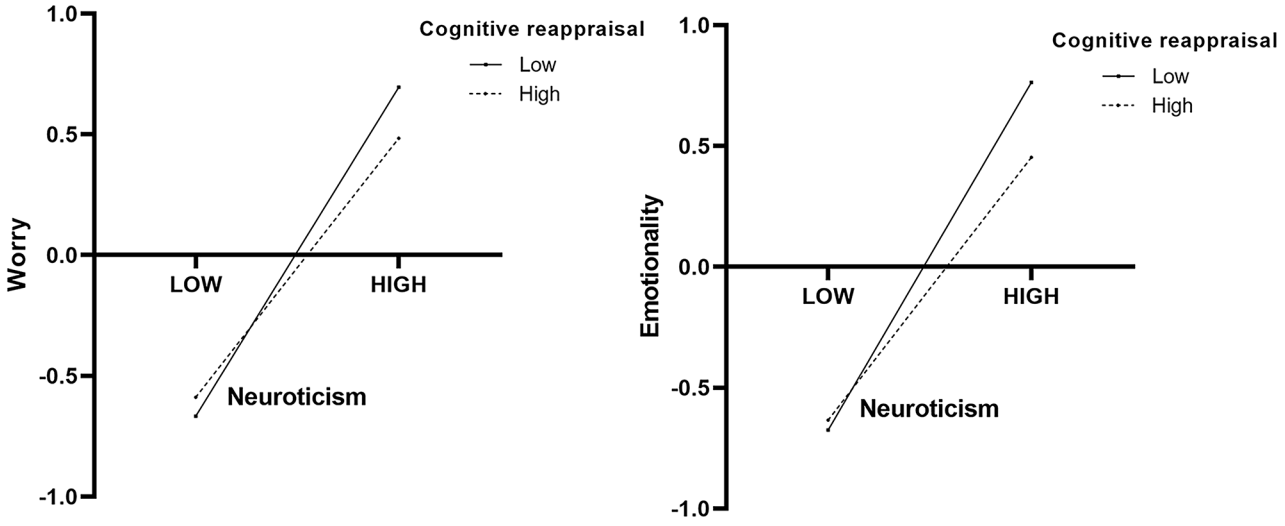

Fig. 1 The moderating role of cognitive reappraisal in the relationship between neuroticism and test anxiety (worry and emotionality)

neuroticism positively predicts test anxiety (von der Embse et al., 2018). Importantly, the results indicated that cognitive reappraisal moderates the influence of neuroticism on test anxiety. This is consistent with Hypothesis 2. Specifically, neuroticism exhibits a weaker predictive effect on test anxiety among individuals with high levels of cognitive reappraisal, while it exerts a stronger predictive influence on test anxiety in those with lower levels of cognitive reappraisal.

However, test anxiety is a situation-specific anxiety, and the questionnaire method employed in Study 1 may not adequately capture its situational nature. Previous research has demonstrated that individuals experiencing test anxiety exhibit heightened emotional responses in test situations (Ringeisen & Buchwald, 2010; Stowell et al., 2008; Zajenkowska et al., 2015). Therefore, in Study 2, we introduced a test-related emotional picture rating task to better capture the situational nature and assess participants' emotional responses more accurately.

Study 2

Method

Participants

A total of 180 participants took the online survey. All participants were between 17 and 25 years old, with the mean age being 20.72 ± 2.21 years. Participants were given full instructions and all provided written informed consent before the study. The study has been approved by the local Ethical Committee of the Institute.

Measurements

Materials

Forty-three neutral pictures and forty-three test-related pictures were selected as emotional stimuli materials. The neutral pictures were obtained from the International Affective Picture System (IAPS); the test pictures were obtained from test-related pictures on the Internet (including answer cards, test bags, test sites, and test situations). Before the emotional picture rating task, 40 additional participants were recruited to rate each picture on valance (1 = "very unpleasant"; 5 = "no apparent pleasant or unpleasant experience"; 9 = "very pleasant"), arousal (1 = "very relaxing"; 9 = "very exciting"), and test relevance (1 = "not at all relevant"; 9 = "very relevant") on a 9-point scale. The scores of the two pictures in terms of valance, arousal, and test relevance are shown in Table 3.

A t-test analysis was employed to compare the arousal and valence of the neutral pictures with the original arousal and valence scores from the IAPS dataset. The findings revealed that there was no significant difference between the valence of the neutral pictures and the valence scores in the IAPS dataset, $t = 0.17$, $p > 0.05$. Similarly, there was no significant difference between the arousal of the neutral pictures and the arousal scores in the IAPS dataset, $t = 1.75$, $p > 0.05$. This implies that the arousal and valence of these neutral pictures remain consistent and can serve as a reliable emotional baseline. The difference in test relevance between neutral pictures and test pictures was significant, $t = -76.28$, $p < 0.01$, indicating a strong association between test-related pictures and test-related situations. These findings above

Table 3 Valence, arousal and test relevance scores of emotional pictures ($M \pm SD$)

Rating Items	Neutral pictures	Test-related pictures
Valence (IAPS)	5.03 ± 1.23	
Valence	5.01 ± 0.29	4.07 ± 1.11
Arousal (IAPS)	2.97 ± 1.93	
Arousal	2.70 ± 0.43	5.19 ± 1.42
Test relevance	1.59 ± 0.42	8.36 ± 0.51

indicate the validity of the experimental stimuli utilized in this study.

Emotional picture rating task

Before the task, participants filled out the TAI, NEO-FFI, and ERQ questionnaires. Then, participants accessed the web link for the emotional picture rating task.

The emotional picture rating task was used to measure participants' emotional responses. Pictures in the task were presented randomly, and participants rated each picture before moving on. Participants were asked to rate the valance (1 = "very unpleasant"; 5 = "no apparent pleasant or unpleasant"; 9 = "very pleasant") and arousal (1 = "very relaxing"; 9 = "very exciting") of each picture independently, based on immediate true feelings after viewing the picture (see Fig. 2).

Data Analysis

Descriptive statistics were analyzed using SPSS 25.0. Then, the PROCESS in SPSS was utilized to compute the moderated model between neuroticism scores, test anxiety, emotional response and cognitive reappraisal. In the emotional picture rating task, emotional response was determined by differences in the emotions and arousal levels between the two picture types. If the valence score of test-related pictures minus that of neutral pictures is below 0, it indicates a stronger emotional response to the test-related stimuli. If the arousal score of test-related pictures minus that of neutral pictures is greater than 0, it suggests a stronger emotional response to the test-related stimuli.

Results

Descriptive Statistics and Correlation Analysis between Variables

The correlation results (see Table 4) showed that neuroticism scores were positively correlated with worry, emotionality and emotional response (arousal), and negatively correlated with cognitive reappraisal and emotional response (valance). Cognitive reappraisal was negatively correlated with emotionality.

Model Validation Analysis

Test anxiety

The moderated model was tested using Model 1 in the SPSS macro, controlling for gender. As the result is shown (see Table 5), after putting cognitive reappraisal into the model, it could be observed that neuroticism scores were a significant predictor of worry, $\beta = 0.47$, $t = 6.41$, $p < 0.001$, and emotionality, $\beta = 0.51$, $t = 7.46$, $p < 0.001$. There was a significant interaction between neuroticism and cognitive reappraisal on worry, $\beta = -0.14$, $t = -2.28$, $p < 0.05$, and emotionality, $\beta = -0.20$, $t = -3.35$, $p < 0.01$. The results indicated that cognitive reappraisal moderated the relationship between neuroticism and test anxiety.

To further probe the moderation, simple slope analyses were performed (see Fig. 3). The results showed that participants with low cognitive reappraisal ($M - 1SD$) had a significant positive predictive effect of neuroticism scores on worry, *simple slope* = 0.61, $t = 6.77$, $p < 0.001$, and emotionality, *simple slope* = 0.70, $t = 8.36$, $p < 0.001$; the same held true for high cognitive reappraisal, but the predictive effect

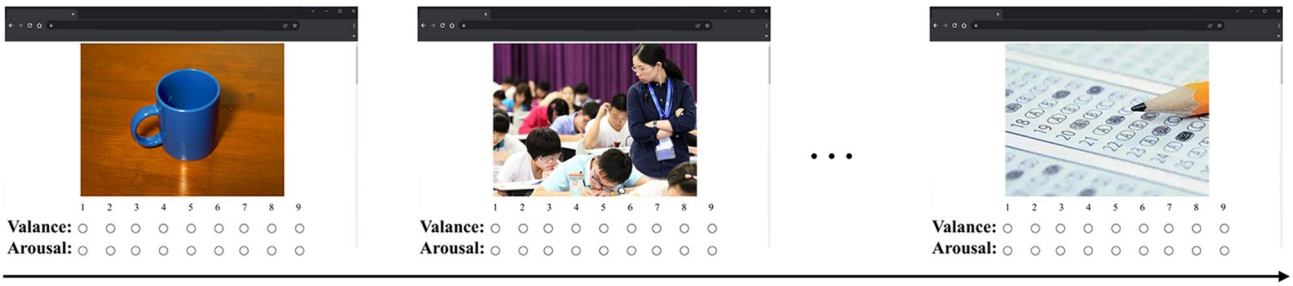

Fig. 2 Trial procedure of emotional picture rating task. The test-related pictures in the figure are samples of test situations and answer cards

Table 4 Descriptive statistics and correlation analysis of each variable ($N = 180$)

Variable	$M \pm SD$	1	2	3	4	5	6
1. Neuroticism	32.89 ± 7.91	1					
2. CR	32.77 ± 5.33	–0.21**	1				
3. TAI-W	14.42 ± 4.16	0.45***	–0.06	1			
4. TAI-E	15.91 ± 3.90	0.52***	–0.15*	0.69***	1		
5. ER(arousal)	1.99 ± 1.66	0.24**	–0.09	0.22**	0.36***	1	
6. ER(valence)	–0.78 ± 0.89	–0.28***	0.14	–0.23**	–0.40***	–0.65***	1

Note: ER: scores on emotional response

Table 5 Moderating effect test of cognitive reappraisal ($N = 180$)

Regression equation		Overall fit index			Significance of regression coefficients		
Result variables	Predictive variables	R	R^2	F	β	SE	t
TAI-W		0.48	0.25	12.82***			
	Gender				–0.05	0.07	–0.72
	Neuroticism				0.47	0.07	6.41***
	CR				0.06	0.07	–0.82
	Neuroticism × CR				–0.14	0.06	–2.28*
TAI-E		0.57	0.32	20.68***			
	Gender				0.06	0.06	0.96
	Neuroticism				0.51	0.07	7.46***
	CR				0.01	0.07	0.98
	Neuroticism × CR				–0.20	0.06	–3.35**

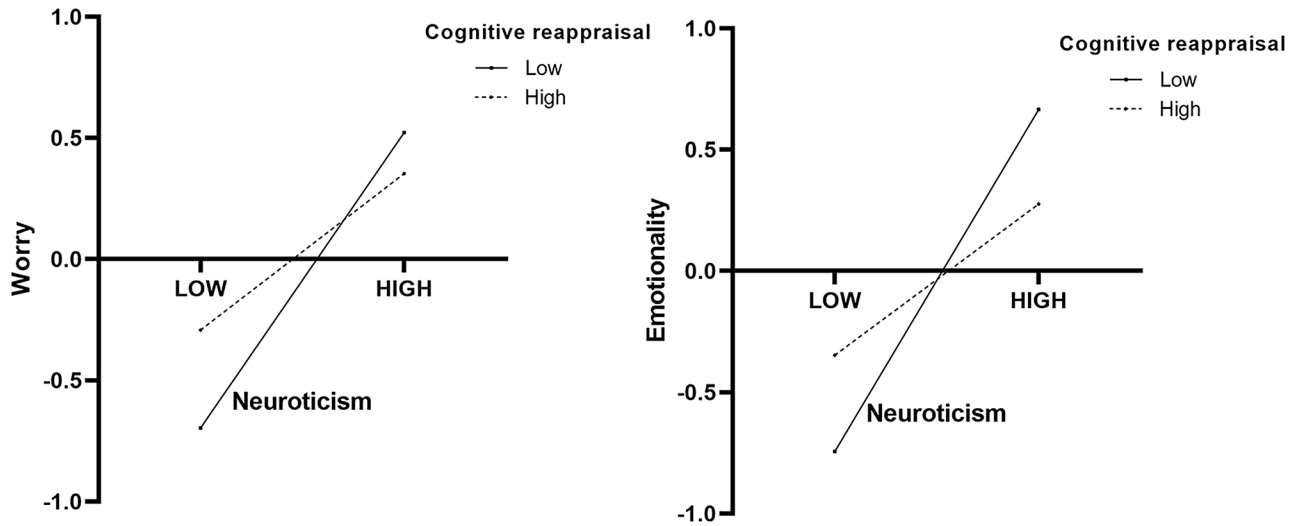

Fig. 3 The moderating role of cognitive reappraisal in the relationship between neuroticism and test anxiety (worry and emotionality)

reduced, *simple slope (worry)* = 0.33, $t = 3.26$, $p < 0.01$; *simple slope (emotionality)* = 0.32, $t = 3.37$, $p < 0.01$. It indicated that cognitive reappraisal can decrease the predictive effect of neuroticism on test anxiety.

Emotional response

The moderated model was tested using Model 1 in the PROCESS, controlling for gender, after putting cognitive reappraisal into the model. As the result is shown (see Table 6), neuroticism scores were a significant predictor of emotional response (arousal), $\beta = 0.21$, $t = 2.79$, $p < 0.01$. There was a significant interaction between neuroticism scores and cognitive reappraisal on the emotional response (arousal), $\beta = -0.15$, $t = -2.24$, $p < 0.05$. Moreover, neuroticism scores were a significant predictor of emotional response (valance), $\beta = -0.23$, $t = -3.03$, $p < 0.01$. There was a significant interaction between neuroticism scores and

Table 6 Moderating effect test of cognitive reappraisal ($N = 180$)

Regression equation		Overall fit index			Significance of regression coefficients		
Result variables	Predictive variables	R	R^2	F	β	SE	t
Arousal		0.30	0.09	4.17**			
	Gender				0.12	0.20	0.59
	Neuroticism				0.21	0.08	2.79**
	CR				–0.01	0.07	-0.10
	Neuroticism × CR				–0.15	0.07	–2.24*
Valance		0.35	0.12	5.93***			
	Gender				–0.1	0.07	–1.44
	Neuroticism				–0.23	0.08	–3.03**
	CR				0.04	0.08	0.57
	Neuroticism × CR				0.16	0.07	2.43*

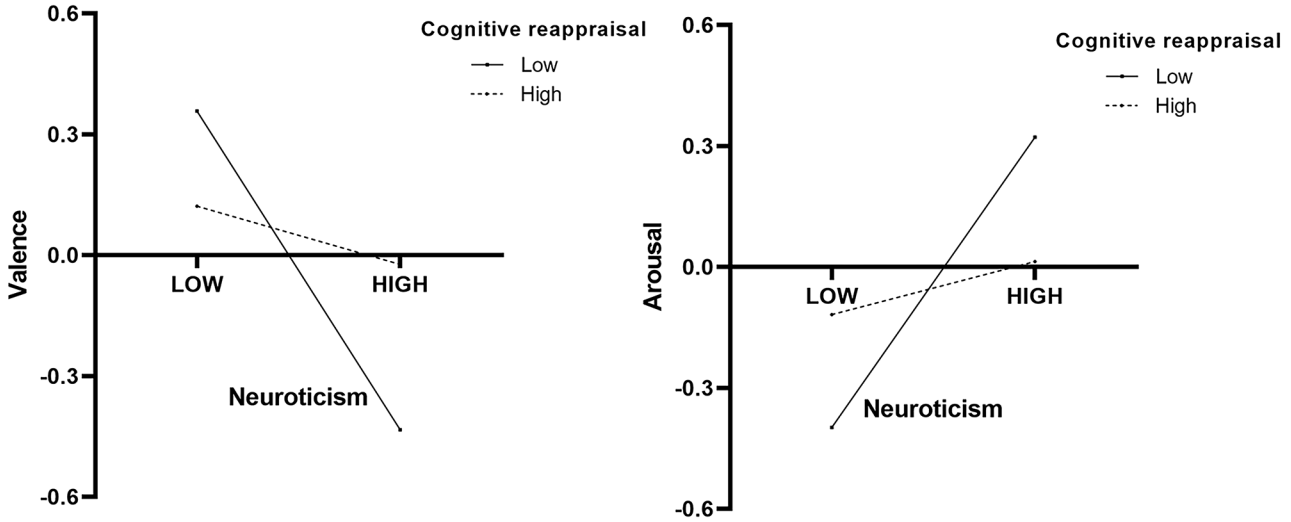

Fig. 4 The moderating role of cognitive reappraisal in the relationship between neuroticism and emotional response (valance and arousal)

cognitive reappraisal on the emotional response (valance), $\beta = 0.16$, $t = 2.43$, $p < 0.05$. This illustrates that cognitive reappraisal moderates the relationship between neuroticism and emotional response.

To further probe the moderation, simple slope analyses were performed (see Fig. 4). In terms of emotional responses, the results showed that participants with low cognitive reappraisal (M–1SD) had a significant positive predictive effect of neuroticism scores on emotional response, *simple slope* (arousal) = 0.36, $t = 3.80$, $p < 0.001$; *simple slope* (valance) = −0.39, $t = -4.13$, $p < 0.001$. But when participants were at a high level of cognitive reappraisal (M+1SD), the predictive effect of neuroticism scores on emotional responses to exams was not significant, β simple slope (arousal) = 0.07, $t = 0.66$, $p > 0.05$; *simple slope* (valance) = −0.08, $t = -0.72$, $p > 0.05$. It demonstrated that cognitive reappraisal can decrease the predictive effect of neuroticism on emotional responses.

Discussion

Study 2 introduced an emotional picture rating task containing test-related pictures, and combined it with corresponding questionnaires to examine the role of cognitive reappraisal in the effect of neuroticism on test anxiety. The questionnaire results replicated those of Study 1, indicating that higher neuroticism scores positively predicted test anxiety scores, with this predictive effect weakening as cognitive reappraisal ability increased.

More importantly, the emotional picture rating task assessed emotional responses through arousal and valence, demonstrating that neuroticism was predictive of these emotional reactions, aligning with Hypothesis 1. Consistent with Hypothesis 2, the further findings based on the emotional picture rating task was that cognitive reappraisal played a moderating role in the effect of neuroticism on test anxiety, that is, the predictive effect of neuroticism on test anxiety would increase as cognitive reappraisal ability decreased.

General Discussion

The present work aimed to examine the role of cognitive reappraisal in the effect of neuroticism on test anxiety, and consisted of two studies. In Study 1, a questionnaire method assessed participants' neuroticism, test anxiety, and cognitive reappraisal abilities. Study 2 introduced an emotional picture rating task containing test-related pictures, and combined it with the questionnaire.

As hypothesized, the present study found that neuroticism positively predicts test anxiety, encompassing both worry and emotionality. This is consistent with prior findings that neuroticism predicted test anxiety (Hoferichter et al., 2014; Hoferichter & Raufelder, 2015; Thomas & Cassady, 2019). Furthermore, through an emotional picture rating task containing test-related pictures, we observed that neuroticism predicted emotional responses to test-related pictures. Test anxiety is often manifested through heightened emotional responses to test-related stimuli, particularly in challenging situations (von der Embse et al., 2018). Neuroticism was associated with threat appraisals and negative emotional experiences (Schneider, 2004). Individuals with neuroticism and test anxiety tend to perceive test-related stimuli as threatening information. Consequently, individuals with neuroticism exhibit more pronounced emotional responses when confronted with test-related pictures. Those results adequately support the stability of neuroticism in predicting test anxiety, so we continue to explore based on this.

The present study further revealed that the moderating role of cognitive reappraisal in the effect of neuroticism on test anxiety. Specifically, neurotic individuals showed lower test anxiety and lower emotional responses when cognitive reappraisal ability was stronger. Liebert and Morris (1967) indicate that test anxiety typically comprises test-related worry (Worry) and various indices of autonomic arousal (Emotionality). The present study found that cognitive reappraisal effectively reduced both the worry and emotionality aspects of test anxiety among individuals with neuroticism. In the worry dimension, previous research found that altering cognition can mitigate test anxiety (Lotfi et al., 2011). For example, a study improved the performance of individuals with high cognitive test anxiety by increasing their self-perceived competence and perceptions of competence (Lang & Lang, 2010). Jamieson et al. (2010) increased GRE scores by manipulating the utilization of cognitive reappraisal among participants. These studies suggest that altering perceptions regarding the test can alleviate test anxiety. In terms of emotionality, cognitive reappraisal has been demonstrated to be a common and effective strategy for changing individuals' cognition, which can also reduce emotional experiences (Mohammed et al., 2021). Numerous studies have demonstrated the relative effectiveness of cognitive reappraisal in mitigating negative emotional responses (Ochsner & Gross, 2008). Ray et al. (2010) demonstrated that cognitive reappraisal can be employed to regulate responses to negative stimuli. Hence, individuals with high neuroticism traits, who tend to be more sensitive to test-related worries, often experience heightened academic pressure and increased negative emotions. A better comprehension of test concerns and consequences may contribute to their well-being and reduced test anxiety.

In summary, this study identified a moderating effect of cognitive reappraisal in the relationship between neuroticism and test anxiety. Previous studies have shown that individuals can increase the efficacy of cognitive reappraisal through repeated practice as a way to reduce self-reported negative emotions (Denny & Ochsner, 2014; Shore et al., 2017). Hence, the findings of this study indicate that it is possible to intervene in the test anxiety of neurotic individuals by training their cognitive reappraisal skills. Proper cognitive appraisal of the test contributes to the reduction of test anxiety.

Several limitations require further attention. Firstly, the study demonstrated the role of cognitive reappraisal in the effect of neuroticism on test anxiety. However, the impact of distinct cultural values on emotion regulation varies (Haga et al., 2009). For example, Kwon et al. (2013) found that Korean students utilize reappraisal more frequently than their American counterparts. Thus, future research may employ cross-cultural samples to explore the impact of cultural context. Secondly, research indicates that cognitive reappraisal skills tend to improve with age (McRae et al., 2012). Test anxiety exists at different stages of development (von der Embse et al., 2018). Future research could further explore the impact of cognitive reappraisal on test anxiety across various age groups. Third, researchers have recently shifted their focus to automatic emotion regulation, which consumes fewer cognitive resources than conscious emotion regulation (Gao et al., 2018) and effectively reduces the physiological consequences of negative emotion (Yuan et al., 2015). According to the existing literature, there are three types of automatic emotion regulation tasks: sentence unscrambling task, word matching task, and implementation intention paradigm. All of these task paradigms have been shown to be effective in reducing negative emotions (Webb et al., 2012; Williams et al., 2009; Yang et al., 2015). Future studies could further investigate the effect of nonconscious cognitive reappraisal on test anxiety. Furthermore, emotion regulation typically occurs interpersonally (Barthel et al., 2018; Hofmann, 2014). This study has exclusively focused on intrapersonal processes. Therefore, future research could continue to explore the role of interpersonal emotion regulation.

Conclusion

The present work aims to examine the role of cognitive reappraisal in the effect of neuroticism on test anxiety through two studies. In Study 1, a questionnaire approach was utilized, involving a sample of 596 college students; Study 2 utilized an emotional picture rating task containing test-related pictures to refine situational dependency. The results of Study 1 and Study 2 converged to find that: (1) neuroticism positively correlated with test anxiety. (2) The predictive effect of neuroticism on test anxiety was moderated by cognitive reappraisal. Specifically, as cognitive reappraisal ability increased, the predictive impact effect of neuroticism on test anxiety decreased. These findings imply that cognitive reappraisal training is likely to have a promising future in test anxiety interventions.

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Authors' Contributions Yu Tian conceived and designed the study. Yang Xu collected and analyzed the data. Jiajin Yuan aided in write-up. All authors contributed to the writing and approved the final manuscript.

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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