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Emotion regulation ability compensates for the depression-related negativity bias☆

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ABSTRACT

Emotion regulation ability (ERA) enables individuals to disengage from negative stimuli. In this study, we investigated the role of ERA in the depression-related negativity bias. Seventy-four individuals with major depressive disorder and eighty-three nonclinical individuals were screened for depressiveness using the Beck Depression Inventory. ERA was assessed using the Action Orientation After Failure Subscale of the Action Control Scale. We used a classical Stroop task variant, wherein the color words were preceded by either a self-relevant positive (success-related), negative (failure-related), or neutral word prime. The expected depressiveness × emotional prime interaction did not reach significance but the expected ERA × emotional prime interaction did. The latter effect was qualified by a three-way interaction between ERA, depressiveness, and emotional prime. Specifically, ERA predicted the negativity bias in individuals with high depressiveness scores. Using the Johnson–Neyman technique, we found that this effect was significant at the level of mild to moderate depression and beyond. Thus, poor ERA in individuals with depression may cause the depression-related negativity bias, whereas (at least) moderate ERA may protect individuals with depression from this bias. Future studies should assess ERA in individuals with depressive symptomatology and investigate how it influences their everyday functioning and treatment outcomes.

1. Introduction

Individuals with major depressive disorder or depressive tendencies typically exhibit a negative information processing bias. Additionally, they experience strong tendencies to ruminate and find it difficult to adequately meet everyday life and job demands. Negativity-biased processing is an important vulnerability factor for major depression (Beck, 1976; Bower, 1981; for a review, see Beck & Bredemeier, 2016; Gotlib & Krasnoperova, 1998). Accordingly, psychological treatments such as cognitive behavioral therapy aim to mitigate the effects of the depression-related negativity bias (e.g., Beck, 1991; Hollon et al., 2002).

Major depression is also related to poor emotion regulation ability (Joormann & Stanton, 2016). Thus, poor ERA (e.g., Gross, 1998), such as difficulties in disengaging from negative stimuli (e.g., Jostmann et al., 2005; Jostmann & Koole, 2007; Koole & Fockenberg, 2011), may moderate the relationship between depression vulnerability and the negativity bias. Insights into the potentially protective effects of ERA on the depression-related negativity bias will bear significant clinical relevance and contribute to the development of effective therapeutic interventions.

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In the following sections, we first review the empirical literature on the negativity bias in depression, including the results of studies that have used the classical Stroop task. Next, we provide an overview of the concept of ERA and the present study. Specifically, using a sample of nonclinical individuals and individuals with depression, we investigated the moderating effect of ERA on the negativity bias, which was measured using a variant of the classical Stroop task.

1.1. Negativity bias in depression

Several literature reviews have focused on the pronounced bias toward negative information that characterizes individuals with depression (Gotlib & Joormann, 2010; Mathews & MacLeod, 2005; Mogg & Bradley, 2005; Williams et al., 1996). For example, in past studies that had used an emotional Stroop task, individuals with depression had slower reaction times for depressed-content words than non-depressed-content words (Gotlib & Cane, 1987; Gotlib & McCann, 1984; Nunn et al., 1997). Similarly, slower reaction times were observed in studies that had used self-selected self-descriptive color words as Stroop stimuli, whereby additional emotional/self-descriptive priming strengthened the emergent effects (Segal et al., 1995; Segal & Vella, 1990). Moreover, recalling stressful life events, when asked to recall specific events from one's life, has been found to be associated with depressive symptoms (Gibbs & Rude, 2004). While performing the dot-probe task, individuals with depression pay more attention to socially threatening words (Mathews et al., 1996) and depression-related words (Bradley et al., 1997; Mogg et al., 1995; Shane & Peterson, 2007). Further, individuals with depression have been found to selectively attend to angry (Leyman et al., 2007) and sad faces (Duque & Vázquez, 2015; Fritzsche et al., 2010; Gotlib et al., 2004) and prefer viewing scenes that evoke sadness (Eizenman et al., 2003).

Researchers have also used the classical Stroop task (Stroop, 1935) to investigate the depression-related negativity bias. In the Stroop task, participants are required to respond to the hue of a color word (e.g., yellow, green, blue, red), which may differ from its meaning (e.g., the word *yellow* presented in a blue hue). Typically, participants respond more slowly to words with hues that differ from their meaning than to a colored nonword (e.g., *xxx*) or to words with a congruent color and meaning (e.g., the word *black* presented in a black hue).

The Stroop task has been widely used in studies on depression. Six studies that had investigated the effect of mild depressive disorder on Stroop performance (Degl'Innocenti et al., 1998; Lemelin et al., 1996; Lemelin et al., 1997; Lemelin & Baruch, 1998; Paradiso et al., 1997; Trichard et al., 1995), which were included in a literature review (Ottowitz et al., 2002) and a more recent meta-analysis (Snyder, 2013), found that Stroop performance was poorer among depressed participants than among nonclinical participants. The authors of the original reports have speculated that psychomotor slowing, a reduced rate of information processing, an impaired ability to inhibit distractors, and resource-processing deficits may play a role in this effect. A meta-analysis of studies that had used the Stroop task yielded findings that supported the existence of the depression-related negativity bias (Peckham et al., 2010).

1.2. Emotion regulation ability

Based on the available definitions of emotion regulation (see Gross, 2014, for a definition of emotion regulation), we conceptualized ERA as individual differences in the flexibility to autonomously and effectively change the trajectory of one's affective reactions. In other words, ERA refers to individual differences in the ability to downregulate affect after arousal rather than in the readiness to generate affective responses to emotional stimulation ("emotional sensitivity"; Baumann et al., 2007; Gross et al., 2011).

ERA has been found to moderate the influence of negative affect and stress on cognitive performance, well-being, and neuroendocrine correlates. This has been demonstrated using the Action Control Scale (ACS; Kuhl & Beckmann, 1994), which measures individual differences in ERA. Specifically, action orientation is inextricably linked to the ability to cope with negative affect and reduced rumination (Kuhl, 2000; Kuhl & Beckmann, 1994). Moreover, action orientation has been found to moderate the relationship between stress-related cortisol increases and (a) performance on an intuition task (Radtke et al., 2020) and (b) frontal alpha asymmetries (Düsing et al., 2016; Haehl et al., in press).

Action orientation is also associated with increased disengagement from negative stimuli and affect. For example, after the subliminal presentation of angry faces, action-oriented individuals tend to report lower levels of unpleasant affect than their state-oriented counterparts (Jostmann et al., 2005). Similarly, in a demanding context, negative affective priming effects tend to be less pronounced among action-oriented individuals than among state-oriented individuals (Koole & Fockenberg, 2011).

These findings are compatible with the well-established process model of emotion regulation (Gross, 1998). For example, it has been proposed that attentional disengagement (or "deployment") is a component of automatic emotion regulation that reduces negative emotion experience and elicits adaptive physiological responses (Mauss et al., 2007). In one study, individuals who were able to focus on happy faces and avoid attending to angry faces were able to persist longer on a stressful anagram task (D. R. Johnson, 2009). According to the aforementioned theory, attentional deployment is a specific mechanism that underlies emotion regulation (e.g., Gross, 2002; Ochsner & Gross, 2005).

Although ERA is likely to be impaired in individuals with depressive symptomatology or tendencies (Joormann & Stanton, 2016), individuals with similar levels of depressiveness may vary in their ERA. Individuals with major depression constitute a heterogeneous group, and dysfunctionalities and causal factors other than poor ERA may be constitutive of the disorder (e.g., negative experiences and trauma, genetic risk factors, differences in biological stress reactivity, and depressogenic beliefs; Beck, 1976; Bower, 1981; for a review, see Beck & Bredemeier, 2016; Gotlib & Krasnoperova, 1998). Thus, given the established link between action orientation (high ERA) and disengagement from negative stimuli, ERA may moderate the relationship between depressiveness and the biased processing of negative stimuli.

1.3. The present study and hypotheses

We investigated the role of ERA, which was measured using the Action Orientation After Failure Subscale of the ACS, in the depression-related negativity bias. Depressiveness was measured using the Beck Depression Inventory (BDI; Beck & Steer, 1987; German version: Hautzinger et al., 1994). The negativity bias was operationalized as longer reaction times for targets that follow negative rather than neutral or positive primes. The emotional primes were self-relevant negative (and positive) words that the participants chose to remind themselves of past experiences of failure (and success) and neutral words, which were included by the experimenter.

We expected to find the interaction between depressiveness and emotional prime to be significant. Specifically, we expected depressiveness to predict longer reaction times for color words preceded by negative rather than neutral primes (depression-related negativity bias). Additionally, we expected to observe an analogous interaction between ERAs and emotional prime. Finally, we expected these interactions to be qualified by a three-way interaction between ERAs, depressiveness, and emotional prime. Specifically, we hypothesized that individuals with strong ERA, including those with high depressiveness, will demonstrate a weaker negativity bias. This prediction is consistent with the contention that not all individuals with high depressiveness have poor ERA.

2. Materials and methods

2.1. Participants and design

We invited 219 individuals (117 individuals with depression and 102 nonclinical individuals) to participate in this study. The sample consisted of 110 women, 106 men, and three individuals who did not indicate their gender. They were aged 18–64 years ($M = 39.11$, $SD = 11.79$). We personally contacted and recruited patients (individuals with depression) who were receiving treatment at the Department of Psychiatry and Psychotherapy, Philipps-University Marburg, Germany. Nonclinical individuals were recruited from the urban area of Marburg through online and print advertisements.

To determine their eligibility for inclusion, an individual interview was conducted with each potential participant (clinical and nonclinical). Eligible participants were aged 18–65 years, native German speakers, right-handed, and not colorblind and did not have any of the following conditions: eyesight problems, writing and reading difficulties, diabetes, dementia, multiple sclerosis, epilepsy, neurological or cardiovascular diseases, and past or current substance abuse. We determined whether the invited individuals met these inclusion criteria using a standardized self-report that had been developed at the Philipps-University Marburg. Additionally, a structured clinical interview was conducted with each potential participant to determine the presence of psychological disorders. To receive a diagnosis of major depression, the patients had to meet the Diagnostic and Statistical Manual of Mental Disorders, fourth edition (DSM-IV), criteria (Saß et al., 1998) for major depression (DSM-IV 296.2× and 296.3×), in accordance with the German version of the Structured Clinical Interview for the DSM-IV (SKID; Wittchen et al., 1997). In the final sample, 56.76%, 25.68%, 14.86%, and 2.70% of the participants who met the criteria of a major depression had zero, one, two, or three comorbid disorders, respectively. These comorbidities included harmful drug use (27.03%, no acute intoxication or abstinence), neurotic and somatoform disorders (20.27%), personality disorders (9.46%), behavioral syndromes with physiological disturbances (4.05%), socialized conduct disorder (1.35%), and a specific spelling disorder (1.35%). In the patient sample, 91.90% had received at least one medication for depression (e.g., SSRIs, SNRIs).

Nonclinical individuals were included if they had no current or past diagnosis of an Axis I disorder (as assessed during the SKID), had not received psychological or psychiatric treatment for depressive symptoms, and used drugs that affect the central nervous systems (assessed through self-reports).

This study was conducted in accordance with the Declaration of Helsinki and was reviewed and approved by the Ethics Committee of the Medicine Faculty at the Philipps-University Marburg. All participants provided written informed consent prior to participation. Each participant was paid 8 Euros per hour, and the testing procedure lasted for approximately 3 h.

2.2. Materials

2.2.1. Emotion Regulation Abilities

To assess ERA, we used the ACS (Kuhl, 1994). Of particular interest to this study was the failure-/threat-related dimension, because this factor moderates the disruption of rumination processes and facilitates disengagement from negative affect. In addition, this scale measures trait rumination, which is a factor that is linked to depression-related biased information processing (Donaldson et al., 2007). The participants read twelve short descriptions of different situations (e.g., "*If, after working on a project for several weeks, everything goes completely wrong*"). Then, they were required to indicate which of two alternative reactions was most characteristic of them. One answer represented an action-oriented approach (e.g., "*It would bother me for a while, but, then, I won't think about it anymore*"), whereas the other represented a state-oriented approach (e.g., "*It would take me a long time to come to terms with it*"). The total number of action-oriented responses represents the action orientation score (range = 0–12). When conducting multiple regression analysis, the dichotomization of continuous variables should be avoided because this procedure can reduce power and cause a true relationship to remain undetected. Therefore, instead of performing a median split, we used continuous scores in our analyses. (Irwin & McClelland, 2003; Royston et al., 2005). The reliability (Cronbach's α) of this scale was .848 in this study.

2.2.2. Depressiveness

We used the BDI (Beck & Steer, 1987; German version: Hautzinger et al., 1994) to assess the severity of the subjective symptoms of depression. It consists of 21 items, which are rated on a Likert scale that ranges from 0 to 3. The BDI was designed to measure the severity of depressive symptoms, not to diagnose depression. As a continuous variable, the BDI scores offer more information than dichotomous variables such as a diagnosis of depression or psychiatric admission history would (i.e., yes vs. no). Indeed, some control participants may have had significant depressive symptoms (as measured by the BDI) but not sought treatment. In this study, these individuals were adequately screened using the BDI. The reliability (Cronbach's α) of this assessment was .943 in this study.

2.2.3. Emotional Prime Generation

To generate personally relevant prime words, the participants were asked to complete the Critical Life Events Questionnaire (CLEQ; Kuhl & Kazén, 1999; see also Kazén & Kuhl, 2005). During this process, the participants generated negative and positive words that reminded them of prior failures and successes, respectively. Next, the participants chose ten subjectively neutral words from a list of 60 words, and the experimenter matched six of them to the positive and negative words so that these neutral words could be included in the following Stroop task. In total, the participants generated six success-related words, six failure-related words, and six neutral words. Achievement-related words have been found to be particularly effective in reducing the Stroop interference (Kazén & Kuhl, 2005), and depression has been found to be associated with perfectionism and achievement motivation, at least among adolescents (Accordino et al., 2000). Each participant was presented with their own self-generated primes. Previous studies have shown that attentional biases are mainly oriented toward self-relevant negative information (Mogg & Bradley, 2005; Segal & Gemar, 1997). Therefore, we chose to use self-relevant stimuli and a relatively long presentation time.

2.2.4. Stroop Task

We used a modified version of the Stroop test (Stroop, 1935). As a proxy for biased processing, we used a sequential design. Specifically, Stroop-task-irrelevant emotional words were presented as prime words, which preceded the classical Stroop color words. We adopted this paradigm, which has been used in past studies (Kazén & Kuhl, 2005; Kuhl & Kazén, 1999), to ensure that there is enough time for ERAs to exert their effect. In this version, one Stroop trial included the presentation a fixation cross (500 ms), a prime word (1500 ms), a blank screen (500 ms), and two Stroop words, which were sequentially presented for a maximum duration of 3 s each and to which the participants were required to respond as quickly and accurately as possible. In accordance with what has been followed in past studies (Kazén & Kuhl, 2005; Kuhl & Kazén, 1999), responses to the second Stroop word were not analyzed; they were presented to merely increase working memory load. Half of the trials were congruent (i.e., across both the Stroop words, the hue of the word corresponded to the meaning of the word), and the other half were incongruent (i.e., across both the Stroop words, the hue of the word differed from the meaning of the word). Responses to only the first Stroop word were analyzed.

The two Stroop conditions (congruent vs. incongruent) were paired with three prime conditions (negative, neutral, and positive). Thus, there were six different conditions. Pairing the 18 prime words (six negative, six neutral, and six positive) with the 16 Stroop trials (eight congruent and eight incongruent) yielded 288 trials. Trials with the same prime type did not follow one another sequentially, and the same Stroop type appeared in succession for a maximum number of two times. The trials were presented to the participants in three blocks of 96 trials each, with self-paced breaks in between. There were 24 possible ways to assign the four colors to the four answer keys. The participants were randomly assigned to a condition.

2.3. Procedure

This experiment was a part of a larger electroencephalogram (EEG) study that included different subtasks of which only the relevant aspects have been described in this section. The other tasks were unrelated to the Stroop task, and the results presented here are independent of those derived using the EEG data. Prior to the experiment, the patients participated in an interview that lasted for up to 2.5 h. This interview was conducted using the SKID, and questions that assessed whether the participants met the inclusion criteria were posed to them. Additionally, they were provided with the self-report questionnaires (including the ACS and BDI), which they were required to complete and return when they come for their next session. The nonclinical individuals received the questionnaires (including the ACS and BDI) via post. They completed them at home and returned them when they came to participate in the experiment. After arriving at the clinic (to participate in the experiment), all the participants responded to the CLEQ, which was used to generate prime words. While one experimenter applied the EEG cap, another experimenter entered the prime words into the Stroop experiment program. First, the participants completed the Flanker task (~ 17 min), followed by the Stroop task, which took approximately 35 min to complete. Next, resting-state EEG was measured (2 min), following which the participants completed a bias competition task (~ 25 min) and the go/no-go task (~ 13 min). Finally, the nonclinical participants completed the SKID, which the patients had already completed prior to the experiment.

2.4. Participant flow and data preparation

Fig. 1 presents the participant flowchart. Complete data were obtained from 202 of the 219 invited participants. On average, the participants failed to provide an answer in 0.65% (*SD* = 1.44%) of the trials. Specifically, they pressed the button after 3 s or pressed the incorrect button. Moreover, they provided an answer within 200 ms in 0.05% (*SD* = 0.16%) of the trials (Whelan, 2010, have recommended a cutoff value of 100–200 ms) and provided an incorrect answer in 18.69% (*SD* = 28.33%) of the trials. The data collected during these trials were excluded from further analyses, and only reaction times for correct answers (*M* = 80.22%, *SD* = 28.67%) were analyzed. Further, 38 participants were excluded because the program had malfunctioned, and seven participants were excluded because the percentage of errors and missing responses to the questionnaire items was greater than 75%. Thus, 157 individuals (74 individuals with depression and 83 nonclinical individuals) constituted the final sample. Descriptive statistics for these participants are presented in Table 1.

3. Results

3.1. Statistical analysis

Table 1 presents means, SDs, and intercorrelations for age, years of education, ERA, and depressiveness (BDI). ERA and depressiveness

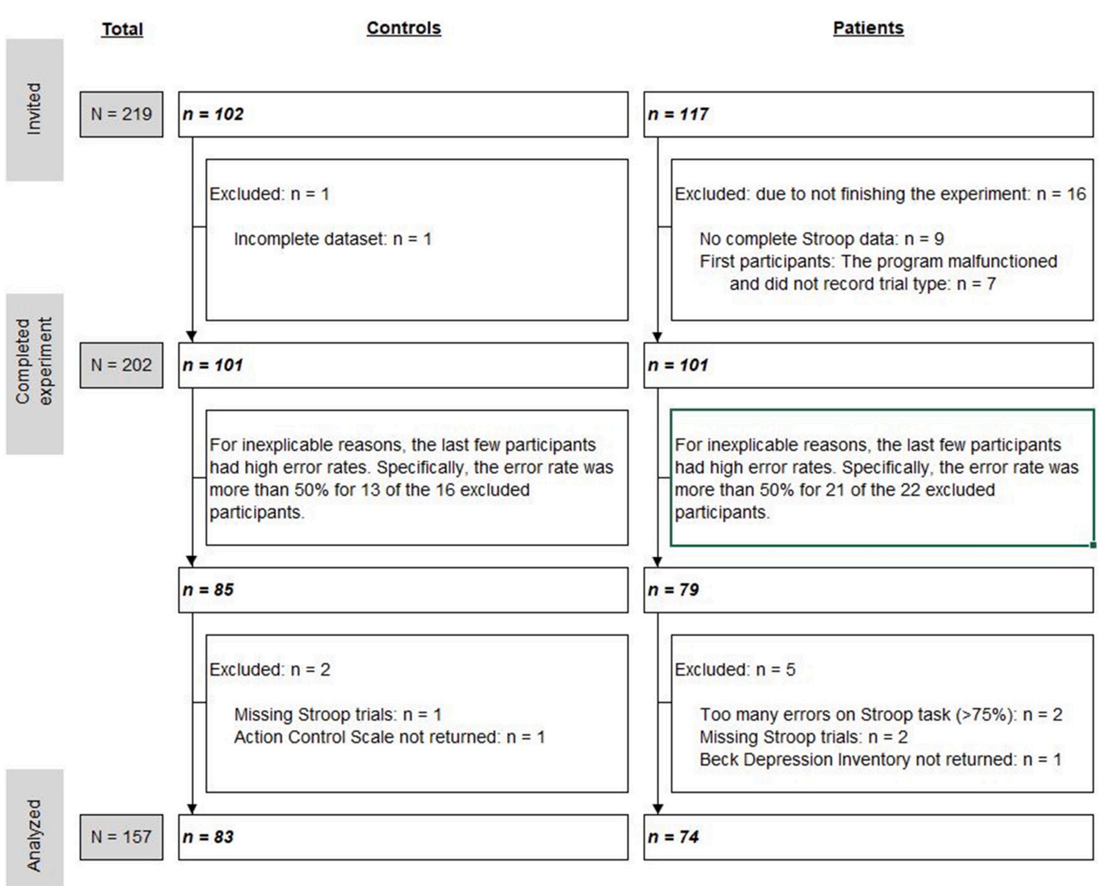

Fig. 1. Participant flowchart.

Table 1
Descriptive statistics and intercorrelations for the study variables (N = 157).

Variable	Patients (40 ♀, 34 ♂)		Controls (44 ♀, 39 ♂)		Group differences	Total (84 ♀,73 ♂)			Correlation coefficients				
	M	(*SD*)	*M*	(*SD*)		*M*	(*SD*)	Range	Years of education		ERA score	BDI score	
Age	39.16	(11.82)	37.86	(11.16)		38.47	(11.46)	18–60	−0.42	***	0.07	−0.08	
Years of education	10.76	(1.59)	11.60	(1.51)		11.20	(1.60)	9–13			0.02	−0.13	
ERA score	2.69	(2.83)	6.08	(3.22)	***	4.48	(3.48)	0–12				−0.62	***
BDI score	23.03	(10.05)	4.98	(6.44)	***	13.48	(12.28)	0–44					

Notes. BDI = Beck Depression Inventory; ERA = emotion regulation ability. ***$p < .001$, all other *ps* > 0.10.

shared a moderately strong negative relationship. Using SPSS (version 25), we conducted analysis of covariance (ANCOVA; a general linear model) with two continuous predictors. To facilitate the interpretation of the main effects and two-way interactions, we mean-centered the ERA and BDI scores. Because the reaction times were positively skewed, we used the Box–Cox transformation with $\lambda = 0$ to perform a log transformation (Box & Cox, 1964; Pituch & Stevens, 2016) to normalize the data (Table 2). The log-transformed reaction times (dependent variable) were subjected to a 2 × 3 ANCOVA. Stroop (congruent vs. incongruent) and emotional prime (negative vs. neutral vs. positive) type served as the within-subject factors, and the mean-centered ERA and BDI scores served as the continuous between-subject covariates.

3.2. Manipulation check and exploratory analyses

As a manipulation check of the effectiveness of the Stroop paradigm, we investigated the main effect of Stroop type, $F(1, 153) = 262.488$, $p < .001$, $\eta_p^2 = .632$. The participants were faster in the congruent trials (*EMM* = 6.768, *SE* = 0.021) than in the incongruent trials (*EMM* = 6.891, *SE* = 0.024). This indicated that the congruency manipulation was effective.

The Stroop type × emotional prime type interaction also reached significance, $F(2, 306) = 4.921$, $p = .008$, $\eta_p^2 = .031$. In the incongruent trials, the participants provided slower responses after they had been primed with positive words (*EMM* = 6.901, *SE* = 0.024) than with neutral (*EMM* = 6.886, *SE* = 0.024, $p = .021$) or negative (*EMM* = 6.885, *SE* = 0.024, $p = .032$) words, but the last two mean reaction times did not differ from each other significantly, $p = .905$. In the congruent trials, the participants provided slower responses after they had been primed with negative words (*EMM* = 6.778, *SE* = 0.022) than with neutral (*EMM* = 6.758, *SE* = 0.021, $p = .011$) words. Their reaction times after they had been primed with positive words (*EMM* = 6.767, *SE* = 0.021) fell in between the two aforementioned values, but the differences were not significant (p = .135 and .208, respectively). Exploratively, we examined our data for possible influences of ERA on the Stroop type × emotional prime type interaction, following the approaches by Cohen, Henik, and Moyal, (2012), who in investigated the influence of reappraisal. The results were descriptively similar, although not significant (all *ps* > .054).

All the other effects of the model, for which we had not formulated a priori hypotheses, failed to reach significance. Nevertheless, these nonsignificant results are presented in the supplementary material.

3.3. The moderating effect of emotion regulation ability on depression-related negativity

Contrary to our prediction, the emotional prime × BDI interaction did not reach significance, $F(2, 306) = 1.249$, $p = .288$, $\eta_p^2 = .008$. However, as predicted, the emotional prime × ERAs interaction did reach significance, $F(2, 153) = 3.757$, $p = .024$, $\eta_p^2 = .024$, and was qualified by the predicted emotional prime × ERA × BDI interaction, $F(2, 153) = 5.249$, $p = .006$, $\eta_p^2 = .033$. To disentangle this three-way interaction, we conducted separate ANCOVAs to analyze the emotional prime × ERA interaction effect at low (BDI scores centered at -1 SD and entered as a covariate) and high BDI levels (BDI scores centered at +1 SD and entered as a covariate). The results are illustrated in Fig. 2. At the low BDI level, none of the effects reached significance, *ps* > .300. At the high BDI level, the emotional prime × ERA effect reached significance, $F(2, 153) = 6.562$, $p = .002$, $\eta_p^2 = .041$ (all other *ps* > .100). In particular, at the high BDI and low ERA level, prime type

Table 2
Normality distribution and outlier diagnostics.

Reaction times	Normality distribution of residuals Before log transformation: Lilliefors-corrected Kolmogorov-Smirnov Test	Skewness	Kurtosis	Normality distribution of residuals After log transformation: Lilliefors-corrected Kolmogorov-Smirnov Test	Skewness	Kurtosis	Influential points: Cook's distance (Maximum) scores for the first ANCOVA: Before log transformation	After log transformation
Congruent trials								
Negative primes	$D(157) = 0.093, p = .002$ *	$z = 3.639$ *	$z = 0.236$	$D(157) = 0.056, p > .200$	$z = 1.258$	$z = -1.704$	0.051	0.039
Neutral primes	$D(157) = 0.106, p < .001$ *	$z = 3.469$ *	$z = 0.548$	$D(157) = 0.066, p = .091$	$z = 0.907$	$z = -1.509$	0.069	0.047
Positive primes	$D(157) = 0.079, p = .019$ *	$z = 3.242$ *	$z = 0.081$	$D(157) = 0.053, p > .200$	$z = 0.768$	$z = -1.603$	0.063	0.046
Incongruent trials								
Negative primes	$D(157) = 0.055, p > .200$	$z = 3.021$ *	$z = 0.761$	$D(157) = 0.059, p > .200$	$z = 0.402$	$z = -1.306$	0.063	0.052
Neutral primes	$D(157) = 0.065, p = .100$	$z = 4.289$ *	$z = 3.561$ *	$D(157) = 0.042, p > .200$	$z = 0.969$	$z = -0.322$	0.058	0.046
Positive primes	$D(157) = 0.082, p = .012$ *	$z = 3.418$ *	$z = 1.239$	$D(157) = 0.040, p > .200$	$z = 0.680$	$z = -0.735$	0.060	0.049

Note. ANCOVA = analysis of covariance; Problematic scores with $p < .05$ are marked with an asterisk. With regard to skewness and kurtosis, scores were considered to be problematic if the z-score was >1.96 or if Cook's distance was >1 (Cook & Weisberg, 1982). Outliers and influential points are reported for the analysis conducted with untransformed data. All the values that emerged for the transformed dataset were smaller than those that emerged for the untransformed dataset.

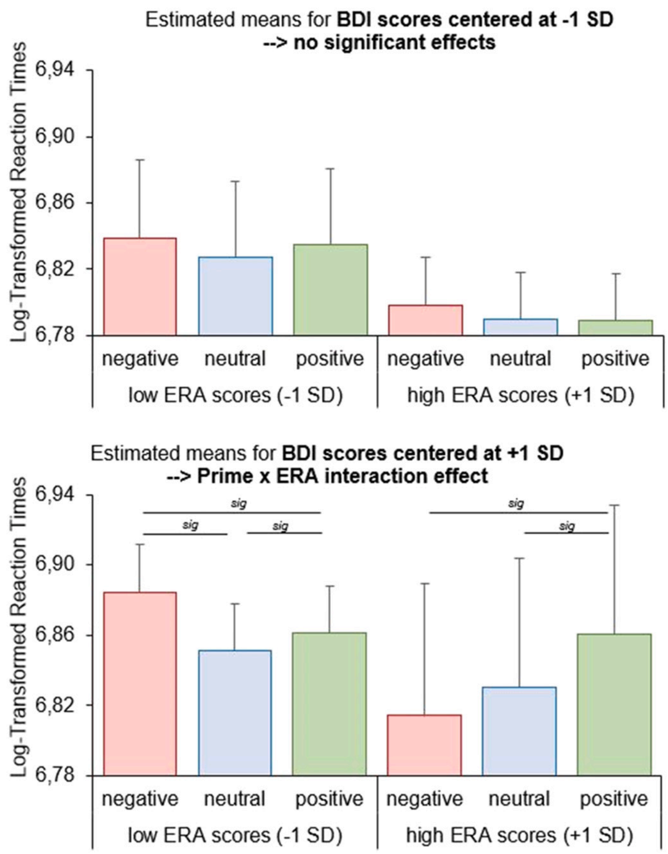

Fig. 2. Visualization of the emotional prime × ERA interaction effect among participants with high depressiveness. The estimated means range from (log scores of) 6.789 to 6.884, which correspond to the reaction times of 888.025 and 976.577 ms, respectively. The lines above the bars indicate significant differences between trial types. ERA = emotion regulation ability, BDI = Beck Depression Inventory.

had a significant effect, $F(2, 153) = 12.835$, $p < .001$, $\eta_p^2 = .077$. Specifically, the participants had provided the fastest responses after neutral priming (*EMM* = 6.851, *SE* = 0.027) but were slower after positive (*EMM* = 6.861, *SE* = 0.027, $p = .060$) and negative priming (*EMM* = 6.884, *SE* = 0.028, $p = .002$). Interestingly, at the high BDI and high ERA level, prime type had a converse effect, $F(2, 153) = 3.307$, $p = .038$, $\eta_p^2 = .021$. The participants were slower after positive priming (*EMM* = 6.860, *SE* = 0.073) than after neutral (*EMM* = 6.830, *SE* = 0.073, $p = .045$) and negative (*EMM* = 6.814, *SE* = 0.075, $p = .021$) priming, but the last two mean reaction times did not differ from each other significantly, $p = .414$.

3.4. *Simple slope analysis and Johnson–Neyman approach to examine the effect of emotion regulation abilities*

The aforementioned results indicate that, at low levels of depression, priming and ERA had no effect on reaction times. However, at high levels of depression, higher ERA scores were linked to faster (and slower) reaction times after negative (and positive) priming than after neutral priming. First, we calculate simple slopes for meaningful values of the moderator (i.e., BDI scores). To determine the score at which the effect of the predictor variable (i.e., ERA scores) transitions between statistically significant and nonsignificant at $p = .05$, we used the Johnson-Neyman-approach (Huitema, 2011; Johnson & Fay, 1950; Johnson & Neyman, 1936), which was executed using the PROCESS toolbox for SPSS (Hayes, 2017).

To compute reaction times for "negative priming," we subtracted post-neutral-priming reaction times from post-negative-priming reaction times. Similarly, to generate an indicator of "positive priming," we subtracted post-neutral-priming reaction times from post-positive-priming reaction times. To ensure the interpretability of the reaction time scores and differences, in particular, we used the original reaction time scores rather than the log-transformed scores in the analysis. ERA and BDI scores were entered as a predictor and moderator, respectively. In the first analysis, we tested the ERA × BDI interaction effect on negative priming, which reached significance, $p = .050$. The second analysis was conducted to examine the ERA × BDI interaction effect on positive priming, which did not reach significance, $p = .287$.

The German version of the BDI manual (Hautzinger et al., 1994) classifies the severity of depressive symptoms into the following categories: 0–10 = not clinically relevant, 11–17 = mild to moderate, and 18–63 = clinically relevant. Accordingly, to interpret the conditional effect, $\Theta_{X \rightarrow Y}$ (as per Hayes' naming convention), of ERA on reaction time differences, we used the midpoints of each category and a threshold of 18 points, which is widely used by clinicians. The conditional effects were $\Theta_{X \rightarrow Y} = -1.253$ ms (*SE* = 1.962, CI [-5.129, 2.623]), $p = .524$, for a BDI score of 5; $\Theta_{X \rightarrow Y} = -4.027$ ms (*SE* = 2.129, CI [-8.233, 0.179]), $p = .060$, for a BDI score of 14; $\Theta_{X \rightarrow Y} = -5.260$ ms (*SE* = 2.471, CI [-10.142, -0.379]), $p = .035$, for a BDI score of 18; and $\Theta_{X \rightarrow Y} = -12.196$ ms (*SE* = 5.431, CI [-22.926, -1.466]), $p = .026$, for a BDI score of 40.5. The negative priming effect as a function of ERA and BDI scores is illustrated in Fig. 3.

When the reaction times for the negative priming condition were entered as the dependent variable in the Johnson–Neyman analysis, the conditional effect $\Theta_{X \rightarrow Y}$ of ERA transitioned from non-significant, $p > .05$, to significant, $p \leq .05$ at a BDI score of 15.108. The conditional effect of ERA was $\Theta_{X \rightarrow Y} = -4.369$ (*SE* = 2.211, CI [-8.738, 0.000], see Fig. 4). It should be borne in mind that the BDI should not be used to diagnose depression but to assess the severity of the symptoms of depression.

In sum, ERA had a significant effect even at a mild to moderate level of depressive symptoms and beyond. The effect was not significant at the midpoint of the second category (14), but was significant at a point very close to the score of 16 points. Moreover, this effect strengthened beyond the well-known threshold score of 18 points. Among those who obtained 18 points on the BDI, per point in the ERA score, reaction times after negative (vs. neutral) priming decreased by approximately 5.260 ms. When the score was 40 points (i.e., an approximate midpoint for the severe-symptom category), the effect was strong. Specifically, per point in the ERA score, reaction times after negative (vs. neutral) priming decreased by approximately 12.196 ms.

4. Discussion

This study aimed to investigate the role of ERA in the depression-

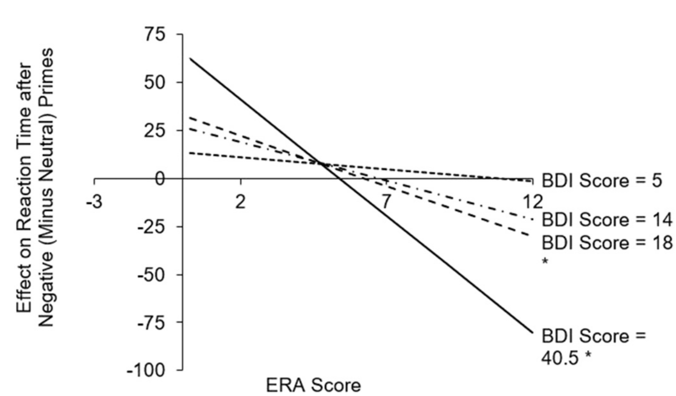

Fig. 3. Visualization of the effect of ERAs across different levels of BDI scores. The BDI scores for which the effect of ERA is significant are marked with an asterisk. ERA = emotion regulation ability, BDI = Beck Depression Inventory.

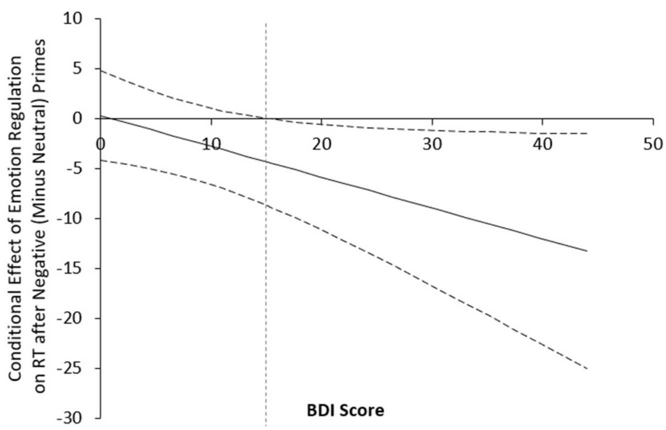

Fig. 4. Visualization of the Johnson–Neyman test results. The straight line reflects the conditional negative effect, $\Theta_{X \rightarrow Y}$ (i.e., decrease in reaction time), of a one-point increase in emotion regulation on reaction times alongside the increase in BDI scores. This conditional effect becomes significant when the BDI score is 15.11. RT = reaction time; BDI = Beck Depression Inventory.

related negativity bias, which has been reported in the literature. In contradistinction to the proposed depression-related negativity bias, the effect of depressiveness on reaction times for color words after negative versus neutral priming was not significantly different. In contrast, there was an analogous effect for ERA, which was qualified by a three way-interaction with depressiveness. Specifically, ERA compensated for the negativity bias in individuals with high depressiveness. This finding suggests that individuals with high depressiveness and strong ERA may be able to disengage from negative events and concentrate on a task better than their counterparts with poor ERA.

Our findings are consistent with the observation that high ERA (action-oriented) individuals can disengage from negative affect in adverse and task-irrelevant situations (Koole & Fockenberg, 2011). The present findings extend the literature in this domain because they suggest that ERA not only are associated with the successful downregulation of affect (Jostmann et al., 2005; Koole & Jostmann, 2004; Kuhl, 2000; Kuhl & Beckmann, 1994) but also counteract the negative effects of the depression-related negativity bias. However, the ERA strategies that individuals with high depressiveness use may be influenced by several different underlying factors. Differences in attentional bias may be attributable to the immediate attentional processes, such as *early attention*, *orientation*, *engagement*, and *sensitivity* to a stimulus, rather than the delayed attentional processes, such as *disengagement* from a stimulus (e.g., Cisler et al., 2009; Fox, 2004; MacLeod et al., 1986; Wilson & Wallis, 2013).

Past findings suggest that, similar to extraversion (Derryberry & Reed, 1994) and dysphoria (Caseras et al., 2007), major depression is largely unrelated to increased *sensitivity* and a preconscious negativity bias but is related to difficulties in *disengaging* from negative stimuli (Bradley et al., 1997, as cited in Gotlib et al., 2004). Past findings also support the *impaired disengagement* hypothesis, which has been formulated by Koster et al. (2011, 2005). Specifically, this hypothesis postulates that difficulties in disengaging one's attention constitute one of the core factors associated with increased rumination in individuals with depression. In general, the Stroop test cannot adequately distinguish between attentional effects and disengagement effects (Fox, 2004; MacLeod et al., 1986). Nevertheless, given its sequential design (i.e., performing the Stroop task *after* viewing a prime), our findings suggest that the observed moderating role of ERAs is attributable to differences in disengagement abilities.

Contrary to our predictions, the depressiveness × emotional prime interaction (i.e., indicative of the depression-related negativity bias) was not significant. This finding is inconsistent with the results of a past meta-analysis (Peckham et al., 2010) but consistent with the results of some studies that have failed to replicate this effect (MacLeod et al., 1986; Mogg et al., 1993, 2000). This observation concurs with our proposition that ERA constitute a central factor that underlies the negativity bias. Specifically, because some individuals with high levels of depressiveness may have at least moderately strong ERA (as indicated by the moderate rather than strong correlation that emerged between depressiveness and ERA in this study), findings related to the depression-related negativity bias may depend on the characteristics of the study population and sample. As shown in Fig. 2 (left side), the expected negativity bias was observed among participants with high depressiveness and poor ERA (i.e., increased reaction times after negative priming). Therefore, ERA should be assessed in future studies that examine the negativity bias in depression or even other depression-related phenomena.

An in-depth analysis of this three-way interaction revealed that ERA compensated for the negativity bias in individuals with depressiveness scores ≥16 (i.e., a score slightly lower than the well-established cutoff score of 18 points, which is a commonly used indicator of clinically relevant depressive symptoms). This suggests that levels of depressiveness other than those indicated by the established cutoff score may reflect diagnostically relevant inflections of symptom severity.

We also replicated the depression-related positivity bias that has been reported in the literature. Specifically, we observed increased reaction times after success-related primes were presented to individuals with high depressiveness. This positivity bias in individuals with high depressiveness can be interpreted as a strong tendency to seek the rewards embedded within one's environment (e.g., emotional attachment, food, alcohol, drugs). This effect was not different for participants with high vs. low ERA. This observation is plausible, because we measured ERA using the ACS after presenting failure-related primes. Future studies should investigate whether constructs such as reward sensitivity and reward-seeking behaviors (i.e., low levels) influence the depression-related positivity bias.

The present study focused on the overall ability to regulate emotions rather than the specific strategies adopted by an individual. Past studies have sought to identify the specific types of emotion regulation strategies that are commonly used by individuals with high levels of depressive symptoms. Specifically, individuals with depression have been found to use ineffective emotion regulation strategies (e.g., rumination, suppression) more frequently and effective (e.g., distraction, reappraisal) emotion regulation strategies less frequently. (Joormann & Stanton, 2016). On the one hand, individuals with depression are more likely to ruminate in response to negative affect (response styles theory; Nolen-Hoeksema, 1991), and rumination has been found to predict future depressive episodes (Nolen-Hoeksema et al., 2008). On the other hand, consistent with the preceding discussion on impaired emotion regulation, less frequent use of habitual reappraisal has been linked to greater depression severity (Garnefski & Kraaij, 2006; Joormann & Gotlib, 2010). These findings have been supported by the results of studies in which individuals with depression (D'Avanzato et al., 2013) or previous depression (Aker et al., 2014) were found to be more likely to engage in habitual rumination and less likely to engage in habitual reappraisal than normal controls. Therefore, future studies should investigate if specific emotion regulation strategies explain the present results.

In this study, we used a paradigm that incorporated emotional word primes into the classical Stroop task. Kazén and Kuhl (2005) observed reductions in reaction time in incongruent (vs. control) trials after success-related (rather than neutral) primes were presented. They attributed this finding to the facilitative effect of cognitive control ("volition") trigged by the activation of achievement motivation. In contrast, they recorded longer rather than shorter reaction times for affiliation-related primes. This was attributed to the activation of affiliation motivation, which can hamper task performance in an achievement-focused context (i.e., performing well on the Stroop task). However, in the present study, success-related primes increased rather than decreased reaction times in the incongruent trials (i.e., they had the same effect as acceptance-related primes). This can be interpreted in at least two different ways. First, in contradistinction to the interpretation offered by Kuhl and Kazén (1999), the present findings are indicative of a positivity bias that was potentiated in the incongruent trials, which necessitated increased cognitive control. Because individuals with depression tend to have poor cognitive control (Fales et al., 2008; Harvey et al., 2005), we also explored its potential relationship with depressiveness and ERA, which, however, did not reach significance.

Second, this may be a more general mechanism which originates from the congruent condition and negative primes. Similar to our results, Cohen et al. (2011) found in two experiments that negative cues (vs. neutral cues) lead to longer reaction times in the congruent but not the incongruent condition. The authors argue that this may be a result from a top-down regulatory mechanism, which reduces emotional influence when the task requires conflict resolution processes and cannot executed in an automatic manner. In a similar vein, this may also contribute to increased reaction times after positive primes in incongruent condition, as mentioned above. Positive stimuli may be more indicative and hence facilitate the execution of simple tasks and automatic behaviour (Isen & Diamond, 1989; Kuhl, 2000). By contrast, incongruent trials do need additional executive control, which needs to be (re-)activated to solve the more difficult task of incongruent trials, which in turn leads to prolonged reaction times, since the positive primes (wrongly) indicated a simple, automatic task. We did not find evidence for an interaction of this effect with ERA, but this is not surprisingly. ERA was operationalized the failure-/threat-related dimension of the ACS, which focuses more on the regulation of negative affect, rather than positive affect. Nonetheless, exploratory analyses of our data (not presented here) showed descriptively similar patterns as compared to the results by Cohen et al. (2012), who investigated the influence of reappraisal.

Past studies have demonstrated that individuals can be trained to disengage from negative stimuli and maintain their attention toward positive pictures (Ferrari et al., 2016). Thus, such training may have a positive effect on attention biases and subsequent depressive symptoms (Wells & Beevers, 2010). In a past study, oxytocin reduced stress-related cortisol increases in low ERA individuals (Quirin, Kuhl, & Düsing, 2011). Our findings suggest that strengthening ERA may dampen the negativity bias in individuals with high levels of depression. However, extreme caution must be exercised, because some strategies may be beneficial to high ERA individuals but detrimental to low ERA individuals. For example, subliminal primes of self-referential information are associated with the downregulation of negative affect in action-oriented individuals and with the persistence of negative affect in individuals with poor ERA (Koole & Coenen, 2007; see also Quirin, Bode, & Kuhl, 2011). They attributed this finding to the facilitative effect of cognitive control ("volition") trigged by the activation of achievement motivation. Additionally, training of executive control functions has been shown to reduce state rumination after negative stimuli (Cohen et al., 2015), which is in line with the trait-like positive influence of high ERA. Future studies should investigate whether training participants to ignore task-irrelevant stimuli or use reappraisal strategies (by providing them with instructions) counteracts the negativity bias and whether these strategies eventually evolve into automatic strategies.

The present findings also bear clinical relevance to the diagnosis and treatment of depression. First, our findings suggest that individuals with depressive disorders vary in their levels of ERA. Second, these abilities predict how these individuals will react to reminders of negative experiences. Specifically, the negativity bias is more pronounced in individuals with poor ERA and less evident (or absent) in individuals with strong ERA. Thus, ERA may have protective effects on the daily life experiences of individuals with depression. Therefore, treatments that aim to improve ERA (see Berking et al., 2008; Smyth & Arigo, 2009) or utilize preexisting skills (e.g., action orientation) may help individuals with depression cope with their daily challenges, although these strategies may not (at least immediately) reduce their level of depressiveness.

This study has two noteworthy limitations, which complicate the interpretation of our results. First, differences between action- and state-oriented participants (ERA) in cognitive processing are generally more pronounced under demanding, threatening, and stressful situations (Kuhl et al., 2021). Both the clinical and nonclinical participants responded to the same measure of ERA, which yielded continuous scores. The clinical participants may generally suffer higher levels of stress. Therefore, the results may have been confounded by group differences in other relevant variables that were not examined. In future studies, current stress levels should be assessed using a questionnaire or a physiological marker of chronic stress (e.g., Schulz et al., 1998) or by experimentally inducing stress in participants.

Second, we used the Stroop paradigm and emotional primes to investigate the negativity bias. Although the primary focus of this study was not the Stroop effect itself, this design may have influenced our results. Indeed, reaction times are influenced by not only color-word conflicts (Stroop effect) but also task conflicts, which may arise in congruent trials as compared to non-word neutral stimuli (e.g., Goldfarb & Henik, 2007; Monsell et al., 2001) and be pronounced in individuals with specific traits, such as anxiety (Kalanthroff et al., 2016). These effects can be disentangled by introducing a third condition with a neutral target (e.g., "XXXX") and contrasting this against color words (Kalanthroff et al., 2018). Therefore, we cannot rule out the possibility that the observed differences in reaction times are in part attributable to this source of systematic variation.

Declaration of competing interest

All authors declare to have no conflict of interest nor any financial and personal relationships with other people or organizations that could inappropriately influence (bias) their work.

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Appendix A. Supplementary material

Supplementary material to this article can be found online at https://doi.org/10.1016/j.actpsy.2021.103414.

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