



# Role of Positive and Negative Emotion Regulation in Well-being and Health: The Interplay between Positive and Negative Emotion Regulation Abilities is Linked to Mental and Physical Health

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## Abstract

Appropriate regulation of emotions is vital to daily functioning. Previous studies have shown that regulating negative emotions can improve health and wellbeing. However, the relationship between positive and negative emotion regulation and their interactions with positive and negative affect, life satisfaction, and health is not well understood. In addition, no studies have investigated the role of attention control and trait mindfulness in positive and negative emotion regulation. This study examined the associations between positive and negative emotion regulation abilities and health, affect, life satisfaction, attention control, and trait mindfulness. A total of 490 participants (284 females and 206 males, mean age =  $25.8 \pm 2.9$  years, range = 20–29 years) completed questionnaires and attention measuring tasks. Multiple regression analyses revealed that negative emotion regulation ability was associated with affect, life satisfaction, and health, whereas positive emotion regulation ability was related to negative affect and mental and physical health. Additionally, negative rather than positive emotion regulation ability was more strongly associated with trait mindfulness and attention control. Positive emotion regulation may benefit those who have difficulty in regulating negative emotions. By focusing on both negative and positive emotion regulation, this study elucidates the relationship between emotion regulation ability, positive and negative affect, life satisfaction, health, mindfulness, and attention control.

**Keywords** Emotion regulation · Positive and negative affect · Life satisfaction · Health · Mindfulness · Attention control

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## 1 Emotions and Emotion Regulation

Emotions can be either adaptive or maladaptive, making their regulation vital for good health and well-being. Positive emotions promote mental and physical health (Diener & Seligman, 2002; Richman et al., 2005) and broaden the scopes of attention and cognition (Fredrickson, 2004; Isen, 1999). Contrastingly, actions such as smiling in front of a depressed person may worsen relationships with others, and increased positive emotions may be maladaptive if they lead to environmental dangers being overlooked (Gross, 2015; Wadlinger & Isaacowitz, 2011). Negative emotions can promote avoidance behaviors to escape danger or induce a state of vigilance (Kashdan & Biswas-Diener, 2014; Sweeny & Dooley, 2017). Contrastingly, chronic negative emotions are associated with psychiatric disorders (Bradley et al., 2011; Charles et al., 2013). Thus, emotion regulation, which influences the types of emotions a person experiences, when they experience them, and how they express them (Gross, 1998), is crucial in daily life.

## 2 Relationships between Positive and Negative Emotion Regulation, Well-being, and Health

Emotion regulation is a core element of mental health, and the improper use of it is related to psychiatric disorders (Aldao et al., 2010; Mennin & Farach, 2007). For example, maladaptive strategies for regulating negative emotion such as rumination, suppression, and avoidance are associated with more symptoms of psychopathologies and ongoing and next-time negative affect; whereas adaptive strategies such as reappraisal, acceptance, and problem-solving show an inverse association (Aldao et al., 2010; Boemo et al., 2022). In addition, negative emotion regulation ability—the ability to effectively regulate one’s negative emotions—leads to better mental and physical health and well-being (Aldao et al., 2010; Saxena et al., 2011). Within a patient sample, a significant association was identified between negative emotion regulation ability and well-being (Kraiss et al., 2020).

Although prior research on positive emotion regulation, regulating positive emotions, is scarce compared to that on regulating negative emotions (Young et al., 2019), the former also plays an important role in health and well-being. *Savoring* is one of the most commonly used and effective strategies of positive emotion regulation (Silton et al., 2020), which is a form of paying attention to and appreciating favorable experiences in one’s life (Bryant, 2003; Bryant & Veroff, 2017). For example, the daily use of effective positive emotion regulation strategies, including savoring, has been linked to higher positive affect (Jose et al., 2012) and life satisfaction (Livingstone & Srivastava, 2012; Quoidbach et al., 2010) as well as lower perceived stress and negative affect (Doorley & Kashdan, 2021; Kearns & Creaven, 2017). Contrastingly, attempts to dampen experiences of positive emotions are positively associated with symptoms of depression (van Kleef et al., 2022; Werner-Seidler et al., 2013).

Both negative and positive emotion regulation abilities are predictors of mental disorder symptoms (Preece et al., 2018, 2021). According to the undoing hypothesis, positive emotions play a role in mitigating the lingering impact of negative emotions (Fredrickson & Levenson, 1998; Waugh, 2020). Given the role of positive emotions, individuals who struggle to regulate negative emotions may benefit from improving their ability to man-

age positive emotions, thereby enhancing their overall health and well-being. There exists a negative correlation between savoring and anxiety symptoms in college students who exhibited lower levels of proficiency in regulating negative emotions (Chiu et al., 2020). However, to our knowledge, no study has directly compared the effects of positive and negative emotion regulation abilities or their interaction on positive and negative affect, life satisfaction, and physical health. Since ill-being and well-being can be viewed as largely separate aspects of mental functioning (Ryff et al., 2006), it is crucial to compare the effects of positive and negative emotion regulation abilities on not only ill-being but also positive aspects and the interactive association between positive and negative emotion regulation abilities with positive and negative affect, and life satisfaction. Positive psychology interventions aimed at increasing positive emotions, cognitions, and behaviors have positive impacts on well-being and mental health, albeit with small effects (Bolier et al., 2013). Thus, positive emotion regulation could be a viable approach to address mental challenges or enhancing well-being for individuals who have difficulty regulating negative emotions by examining the interaction between positive and negative emotion regulation abilities.

### 3 Emotion Regulation and Attention Control

We also investigated individual variables—specifically, trait mindfulness and attention control—which serve as underlying factors of positive and negative emotion regulation abilities. Given the occasional challenges associated with facing emotions (Kashdan et al., 2006), it is essential to investigate potential associations between emotion regulation and other factors that may contribute to the enhancement of individuals' emotion regulation abilities. Gross and Thompson (2007) divided the sequence of the process involved in the generation of emotions into four stages (situation, attention, appraisal, and response). In this model, emotional responses occur through attention to emotion-inducing situations and evaluation of those stimuli and events. In the process model of emotion regulation (Gross, 1998), *attentional deployment*, shifting the focus of attention toward or away from emotional situations to influence emotional experiences, is a family of regulatory processes in a relatively early stage: attention. Self-reported attention control predicts the ability to spontaneously downregulate emotions after exposure to pictures evoking disgust (Morillas-Romero et al., 2015). Therefore, the ability to control attention is highly related to one's ability to regulate emotions. Attention control can be divided into three categories: alerting, orienting, and executive attention (Fan et al., 2002; Posner & Petersen, 1990). Alerting refers to the function of preparing and sustaining alertness to process high-priority signals. Orienting refers to the function of selecting information from a sensory input. Executive attention refers to the function of monitoring and resolving conflicts between responses. Participants with lower attention-orienting performance reported more negative feelings toward distressing films (Compton, 2000). In addition, although directing attention to positive information may help maintain a positive mood (Wadlinger & Isaacowitz, 2011), prolonged attention to negative emotions can lead to symptoms of depression and anxiety (LeMoult & Gotlib, 2019; Nolen-Hoeksema & Morrow, 1993). Therefore, different attentional processes may influence the maintenance or modification of different emotional responses to varied degrees, and we focused on the relationship between different factors of attention control and emotion regulation.

## 4 Emotion Regulation and Mindfulness

Mindfulness improves negative emotion regulation ability (Huang et al., 2019; Vago & Silbersweig, 2012). Mindfulness has been described as “paying attention in a particular way; on purpose, in the present moment, and nonjudgmentally” (Kabat-Zinn, 1994, p.4). Earlier work (Baer et al., 2008) suggests that mindfulness includes five facets: observing (noticing internal and external experiences), non-reactivity (allowing thoughts and feelings to come and go without taking away or pushing away), non-judging (taking a non-evaluative stance toward thoughts and feelings), describing (expressing internal experiences with words), and acting with awareness (attending to one’s activities of the moment). Trait mindfulness contributes to clarity of experience, which improves the ability to regulate negative emotions (Coffey et al., 2010). In a meta-analysis examining the relationship between the mindfulness facets and other outcomes (Mattes, 2019), emotion regulation was correlated with describing, acting with awareness, non-judging of inner experience, and non-reactivity. Mindfulness promotes reappraisal, which could be accomplished through the mental operation of mindfulness such as stepping back from one’s thoughts and emotions (Garland et al., 2009, 2011).

Regarding positive emotion regulation, trait mindfulness and savoring are moderately related constructs (Kiken et al., 2017). In addition, acceptance training from mindfulness interventions plays an important role in increasing positive affect (Lindsay et al., 2018). However, to our knowledge, there has been no examination focusing on the difference between positive and negative emotion regulation abilities related to mindfulness. Brain imaging studies have found common and distinct regions between positive and negative emotion regulation, suggesting that they involve common and distinct processes (Dörfel et al., 2014; Tsujimoto, 2022b; Kim & Hamann, 2007). Because of the differences between negative and positive emotion regulation, it is possible that different factors are associated with each. Therefore, it is important to examine these relationships in greater detail to clarify the background on individual differences in emotion regulation ability.

## 5 This Study

This study had two goals. The primary purpose was to determine the relationships between positive and negative emotion regulation abilities, positive and negative affect, life satisfaction, and health. We propose the following two hypotheses:

H1: Even when controlling for negative emotion regulation ability, positive emotion regulation ability remains significantly associated with positive and negative affect, life satisfaction, and health.

H2: Positive emotion regulation ability is more positively associated with health, positive and negative affect, and life satisfaction, especially when negative emotion regulation ability is low.

The secondary purpose was to examine what factors of attention control and mindfulness are related to negative and positive emotion regulation abilities. Identifying these relationships would provide insights into how positive and negative emotion regulation are related to other factors that could enhance positive and negative regulation ability. We hypothesized a positive correlation between attention control/mindfulness and emotion regulation

abilities. However, we did not have specific hypotheses regarding what subscales would show correlations with emotion regulation. Consequently, the relationship between emotion regulation and the subscales of attention control and mindfulness was investigated in an exploratory manner without a specific hypothesis. To test the above associations, we conducted an online experiment using the Attention Network Test (ANT; Fan et al., 2002) and psychological scales.

## 6 Methods

### 6.1 Participants

To calculate the appropriate sample size, we used an effect size of  $f^2 = 0.02$  for the multiple regression analysis with two independent variables. Because the effect size that would be obtained was unknown, it was assumed to be small to avoid a lack of power. Choosing a power of 80%, at least 485 participants were required to reach statistical significance. A total of 501 participants were recruited using CrowdWorks (<https://crowdworks.jp/>), a crowdsourcing service. The inclusion criteria were as follows: native speakers of Japanese, aged 20–29 years, no history of psychiatric disorders, and right-handed. Considering the age differences in attentional task performance (Gamboz et al., 2010; Williams et al., 2016) and the ease of performing tasks with the dominant hand related to the computer keyboard position, we recruited right-handed participants in their 20s. Participants were assessed for these criteria based on self-reported information. Data from two participants who falsified their age, eight who did not complete the questionnaire and the task, and one who did not wish to reveal their sex were excluded, leaving data from 490 participants (284 females and 206 males, mean age =  $25.8 \pm 2.9$ , range = 20–29 years) to be analyzed. This study was approved by the Ethics Committee of Tohoku University School of Medicine and conducted in accordance with the Declaration of Helsinki.

### 6.2 Procedure

Subjects participated in the online survey. After providing informed consent, they answered their demographic information and required questionnaires, and underwent ANT. The survey was conducted using Lab.js (<https://lab.js.org/>), which is a JavaScript library for conducting surveys; and Open Lab (<https://open-lab.online/>), a hosting service for secure online experiments.

### 6.3 Measures

#### 6.3.1 Abilities of Positive and Negative Emotion Regulation

The Japanese version of the Perth Emotion Regulation Competency Inventory (Preece et al., 2018; Tsujimoto, 2022a) was used to measure participants' emotion regulation ability. It is a comprehensive measure of positive and negative emotion regulation abilities, and it can assess the ability to modify the subjective experience of positive and negative emotions, behaviors associated with them, and the ability to tolerate emotions when necessary. Par-

ticipants responded to 32 items on emotion regulation on a scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). The measure includes four subscales related to negative emotion regulation and four subscales about positive: negative-controlling experience (e.g., “When I’m feeling bad, I don’t know what to do to feel better”), negative-inhibiting behavior (e.g., “When I’m feeling bad, I have trouble controlling my actions”), negative-activating behavior (e.g., “When I’m feeling bad, I can’t get motivated to do important things [work, chores, school, etc.]”), negative-tolerating emotions (e.g., “When I’m feeling bad, I must try to totally eliminate those feelings”), positive-controlling experience (e.g., “I don’t know what to do to create pleasant feelings in myself”), positive-inhibiting behavior (e.g., “When I’m feeling good, I can’t keep control over myself [in terms of my behaviors]”), positive-activating behavior (e.g., “When I’m feeling good, I have trouble completing tasks that I’m meant to be doing”), and positive-tolerating emotions (e.g., “When I’m feeling good, I believe those feelings are unacceptable”). We calculated the following scores in addition to the subscales: the negative emotion regulation composite (negative emotion regulation ability), which combined all four negative subscales as an indicator of people’s overall ability to regulate negative emotions; the positive emotion regulation composite (positive emotion regulation ability), which combined all four positive subscales as an indicator of people’s overall ability to regulate positive emotions; and the general emotion regulation composite (general emotion regulation ability), which combined all eight subscales as an indicator of people’s overall ability to regulate emotions that generalize to both valences (Preece et al., 2018). All scores were reversed such that higher scores indicated greater emotion regulation ability. Previous studies have indicated acceptable to good reliability and validity of the original and Japanese versions of the inventory (Preece et al., 2018; Tsujimoto, 2022a). The Cronbach’s alphas of the subscales in this study ranged from .69 to .89, indicating acceptable internal consistency.

### 6.3.2 Positive and Negative Affect

Positive and negative affect were assessed using the Japanese version of the Positive Affect and Negative Affect Schedule (Watson et al., 1988; Kawahito et al., 2011). It comprises 10 positive and 10 negative adjectives related to mood and requires responses on a 6-point scale ranging from 1 (*not at all*) to 6 (*extremely*). The total values were calculated for each valence. It was suitable for measuring positive and negative affect and adequate in both reliability and validity (Watson et al., 1988; Kawahito et al., 2011). The Cronbach’s alphas of the subscales in this study ranged from .87 to .91, indicating excellent internal consistency.

### 6.3.3 Life Satisfaction

The Japanese version of the Satisfaction with Life Scale (Diener et al., 1985; Sumino, 1994) was used to assess participants’ life satisfaction. The scale comprises five items rated on 7-point scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Previous research has established the reliability and validity of this scale in the original and Japanese versions (Diener et al., 1985; Sumino, 1994). The Cronbach’s alpha of this scale in this study was .89, indicating good internal consistency.

### 6.3.4 Mental Health

The Japanese version of the Depression Anxiety Stress Scales-21 (Lovibond & Lovibond, 1995) was used to assess mental health. The scale is a 21-item measure of depression, anxiety, and stress symptoms in the past week. It comprises three subscales: depression (e.g., “I felt that I had nothing to look forward to”), anxiety (e.g., “I felt scared without any good reason”), and stress (e.g., “I found it difficult to relax”). Participants rated questions from 0 (did not apply to me at all) to 3 (applied to me very much or most of the time). Scores were calculated for each subscale. The Cronbach’s alphas of the subscales in this study ranged from .78 to .88, indicating acceptable internal consistency.

### 6.3.5 Physical Health

To assess physiological health, we used the Japanese version of the Somatic Symptom Scale-8 (Gierk et al., 2014; Matsudaira et al., 2017), an 8-item self-report measure for the assessment of the somatic symptom burden during the past seven days. The scale requires responses to questions about gastrointestinal status, pain, fatigue, and cardiopulmonary aspects of the general somatic symptom burden on a scale ranging from 0 (*not at all*) to 4 (*very much*). Higher scores indicate poorer physical condition. The original and Japanese versions have good internal reliability and acceptable to good validity (Gierk et al., 2014; Matsudaira et al., 2017). The Cronbach’s alpha of this scale in this study was .76, indicating acceptable internal consistency.

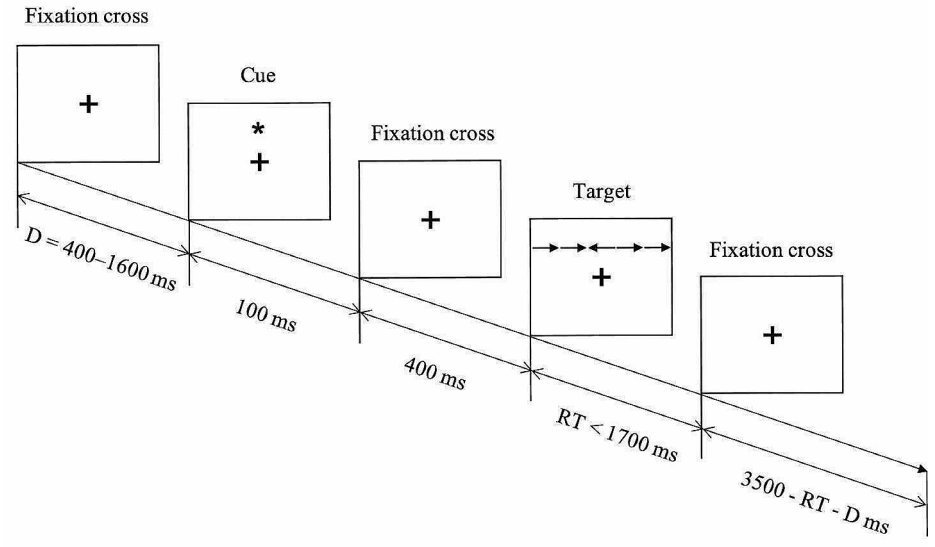
### 6.3.6 Trait Mindfulness

The degree of trait mindfulness was gauged using the Japanese version of the Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006; Sugiura et al., 2012). It comprises 39 items across five subscales: observing (e.g., “I pay attention to sensations, such as the wind in my hair or sun on my face.”), non-reactivity (e.g., “I perceive my feelings and emotions without having to react to them.”), non-judging (e.g., “I make judgments about whether my thoughts are good or bad.”), describing (e.g., “I’m good at finding words to describe my feelings.”), and acting with awareness (e.g., “When I do things, my mind wanders off and I’m easily distracted.”). Participants rated the questionnaire on a 5-point scale from 1 (*never or very rarely true*) to 5 (*very often or always true*). Scores were calculated for each subscale. Previous use of the scale demonstrated acceptable to good reliability and validity (Baer et al., 2006, 2008; Sugiura et al., 2012). The Cronbach’s alphas of the subscales in this study ranged from .66 to .87, indicating acceptable internal consistency.

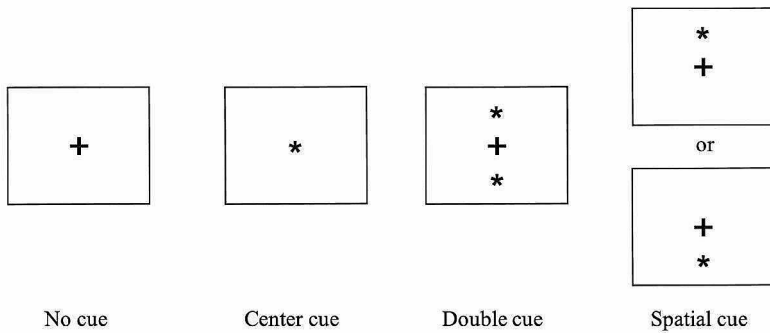
### 6.3.7 Attention Control

The ANT was used to assess three functions of attention. The procedure followed was as described in a previous study (Fan et al., 2002). As shown in Fig. 1a, each trial included a fixation cross for the 400–1600 ms, a cue for 100 ms, a fixation cross for 400 ms, a target for less than 1700 ms until response, and a fixation cross for a duration derived by subtracting the first fixation cross time and the response time (RT) from 3500 ms. Each session com-

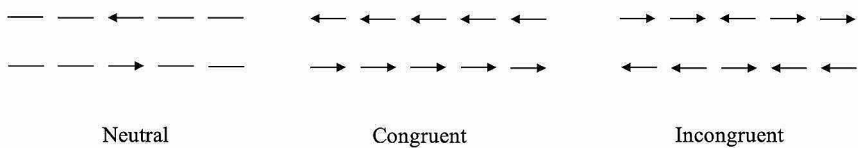
(a)



(b)



(c)



**Fig. 1** Experimental procedure. *Note.* (a) The procedure of one trial of the ANT, (b) The four cue conditions, and (c) The three target conditions

prised a practice block of 24 trials with feedback and three experimental blocks of 96 trials. The trials were presented in a random order.

There were four cues and three target conditions (Fig. 1b, c). The no cue, center cue, and double cue provided no information about the target's location, and the center and double



cues suggested only when the target would appear. The spatial cue indicated where the target would appear. Targets could appear either above or below the fixation cross. The target was the central arrow in the row of five arrows. In the neutral condition, all but the target were lines. In the congruent condition, all five arrows pointed in the same direction. In the incongruent condition, the arrows across the target pointed in the opposite direction to the target arrow. Each attention function was calculated using the following formula based on the conditions:

$$\text{Alerting} = RT_{\text{no-cue}} - RT_{\text{double-cue}}$$

$$\text{Orienting} = RT_{\text{center-cue}} - RT_{\text{spatial-cue}}$$

$$\text{Executive attention} = RT_{\text{incongruent}} - RT_{\text{congruent}}$$

Participants were instructed to answer the direction of the arrow in the center of the five arrows as quickly and accurately as possible using the keyboard of their individual computers. The accuracy of each participant was measured, and those with a high number of errors (>20%, including no response) were excluded from the analysis regarding attention control ( $n=21$ ). A total of 469 individuals (271 females and 198 males, mean age= $25.8 \pm 2.9$ , range=20–29 years) were included in this analysis. The data from the trials with incorrect responses or with an RT shorter than 200 ms or longer than 1500 ms were also excluded to eliminate outliers.

## 6.4 Statistical Analyses

All analyses were conducted using R (<https://www.R-project.org/>). Correlation analyses were conducted to examine the overall relationship between emotion regulation ability and the other indicators. In addition, to examine the effects of both positive and negative emotion regulation abilities on positive and negative affect, life satisfaction, and health, we conducted multiple regression analyses with life satisfaction, positive and negative affect, stress, depression, anxiety, and physical health as dependent variables. We included positive and negative emotion regulation abilities and these interactions as independent variables in the model following centering procedures. We also included sex as a covariate because sex differences in health and well-being can exist (Hyde, 2014; McLean et al., 2011). When the interaction was significant, simple slopes were evaluated at the mean scores of negative emotion regulation  $\pm 1$  SD to examine the effect of positive emotion regulation ability on the outcome at different levels of negative emotion regulation ability. To determine the associations between positive and negative emotion regulation abilities and attention control and trait mindfulness, we conducted multiple regression analyses. In each analysis, positive and negative emotion regulation scores were used as dependent variables, and attention control and trait mindfulness subscales as independent variables.

## 7 Results

### 7.1 Manipulation Check

To check the manipulation of ANT, a two-factor analysis of variance was conducted with RTs as the dependent variable and cue (no, center, double, and spatial)  $\times$  target (neutral, congruent, and incongruent) as the independent variables. The results showed significant main effects of cues and targets (cue:  $F(3, 1404)=1494.4, p<.001$ ; target:  $F(2, 936)=3648.5, p<.001$ ). There were longer RTs in the no, center, and double cue conditions than in the spatial cue condition, and in the incongruent condition than in the neutral and congruent conditions. Mean RTs and standard deviations of the correct responses in each condition are displayed in Supplementary Table 1.

### 7.2 Correlations between Emotion Regulation Abilities and Other Indices

To examine the relationship between emotion regulation abilities and various aspects of positive and negative affect, life satisfaction, and health, correlation analyses were performed (Table 1). General emotion regulation ability was significantly positively correlated with positive affect and life satisfaction, and showed moderate correlations with negative affect, depression, anxiety, stress, and poorer physical health. Both positive and negative emotion regulation abilities showed significant positive correlations with positive affect and life satisfaction. While the correlations with positive affect and life satisfaction for positive emotion regulation ability were weak, negative emotion regulation ability exhibited stronger correlations. Positive emotion regulation ability showed weak, significant, negative correlations with negative affect and poorer physical health, and moderate, significant, negative correlations with depression, anxiety, and stress. Negative emotion regulation ability showed weak negative correlations with anxiety and poorer physical health, and moderate negative correlations with negative affect, depression, and stress. For each subscale, similarities and differences were found between positive and negative emotion regulation. Similar patterns of correlations were also found in the controlling experience subscales of positive and negative emotion regulation, as in general emotion regulation ability. Life satisfaction and all subscales of negative emotion regulation were significantly positively related, whereas the subscales of activating behavior, inhibiting behavior, and tolerating emotions in positive emotion regulation were not associated with life satisfaction.

### 7.3 Predicting Affect, Life Satisfaction, or Health with Emotion Regulation Abilities

To investigate the relationship between positive and negative emotion regulation abilities and positive and negative affect, life satisfaction, and health, we conducted multiple regression analyses (Table 2). Negative emotion regulation ability, but not positive emotion regulation ability, was a significant predictor of life satisfaction and positive affect. Both negative and positive emotion regulation abilities were associated with negative affect, mental health, and physical health. Generally, negative emotion regulation ability had stronger impacts on positive and negative affect, life satisfaction, and health compared to positive emotion regulation ability; however, they had almost the same impact on anxiety. The interactions of positive and negative emotion regulation abilities were significant predictors of negative

**Table 1** Correlations among measures

	PERCI negative				PERCI positive				PERCI composites		
	Controlling experience	Activating behavior	Inhibiting behavior	Tolerating emotions	Controlling experience	Activating behavior	Inhibiting behavior	Tolerating emotions	Negative total	Positive total	General total
<b>PANAS</b>											
Positive affect	.381***	.291***	.135**	.054	.363***	.024	-.068	-.036	.276***	.109*	.235***
Negative affect	-.330***	-.280***	-.419***	-.272***	-.354***	-.251***	-.278***	-.235***	-.406***	-.380***	-.463***
<b>SWLS</b>	.407***	.292***	.251***	.157***	.385***	.070	.023	.042	.350***	.187***	.324***
<b>DASS-21</b>											
Depression	-.503***	-.365***	-.423***	-.324***	-.521***	-.239***	-.228***	-.239***	-.507***	-.423***	-.550***
Anxiety	-.313***	-.246***	-.386***	-.318***	-.327***	-.297***	-.319***	-.325***	-.393***	-.427***	-.479***
Stress	-.418***	-.355***	-.486***	-.357***	-.418***	-.286***	-.310***	-.271***	-.505***	-.437***	-.556***
<b>SSS-8</b>	-.314***	-.198***	-.317***	-.232***	-.291***	-.107*	-.172***	-.067	-.331***	-.223***	-.331***

Note. \*\*\* $p < .001$ , \*\* $p < .01$ , \* $p < .05$ . PANAS, Positive Affect and Negative Affect Schedule; SWLS, Satisfaction with Life Scale; DASS-21, Depression Anxiety Stress Scales-21, SSS-8 = Somatic Symptom Scale-8; PERCI = Perth Emotion Regulation Competency Inventory

affect, mental health, and physical health. To illustrate the interaction of positive  $\times$  negative emotion regulation for negative affect, depression, anxiety, stress, and physical health, we plotted the regression analyses in Fig. 2. Simple slope tests revealed that regression coefficients for positive emotion regulation ability were greater for low than for high negative emotion regulation ability. In detail, positive emotion regulation ability was inversely associated with negative affect (high negative emotion regulation ability:  $\beta = -0.15$ ,  $p = .014$ ; low negative emotion regulation ability:  $\beta = -0.30$ ,  $p < .001$ ) and anxiety (high negative emotion regulation ability:  $\beta = -0.17$ ,  $p = .007$ ; low negative emotion regulation ability:  $\beta = -0.42$ ,  $p < .001$ ) at all levels of negative emotion regulation ability. Importantly, positive emotion regulation ability was associated with stress (high negative emotion regulation ability:  $\beta = -0.11$ ,  $p = .056$ ; low negative emotion regulation ability:  $\beta = -0.37$ ,  $p < .001$ ), depression (high negative emotion regulation ability:  $\beta = -0.11$ ,  $p = .068$ ; low negative emotion regulation ability:  $\beta = -0.34$ ,  $p < .001$ ), and physical health (high negative emotion regulation ability:  $\beta = -0.03$ ,  $p = .692$ ; low negative emotion regulation ability:  $\beta = -0.18$ ,  $p = .001$ ) at lower levels of negative emotion regulation ability but not higher levels.

In addition, to determine the influence of emotion regulation abilities on overall health, structural equation modeling was conducted using health as a latent variable. Furthermore, we conducted a multiple regression analysis with hedonic balance as a dependent variable and emotion regulation abilities and sex as independent variables. Hedonic balance was calculated by subtracting negative affect score from positive affect score. See Supplementary Tables 2 and 3 and Supplementary Fig. 1 for results. Those results were almost consistent with our main results.

## 7.4 Predicting Emotion Regulation Abilities with Attention Control or Trait Mindfulness

Supplementary Table 4 shows the relationship between emotion regulation abilities and attention control and trait mindfulness. Multiple regression analyses indicated that orienting in attention control significantly predicted negative emotion regulation ability, but not positive emotion regulation ability. Regarding mindfulness, non-reactivity, non-judging, describing, and acting with awareness factors of trait mindfulness significantly predicted negative emotion regulation ability, whereas only describing and acting with awareness were significant predictors of positive emotion regulation ability.

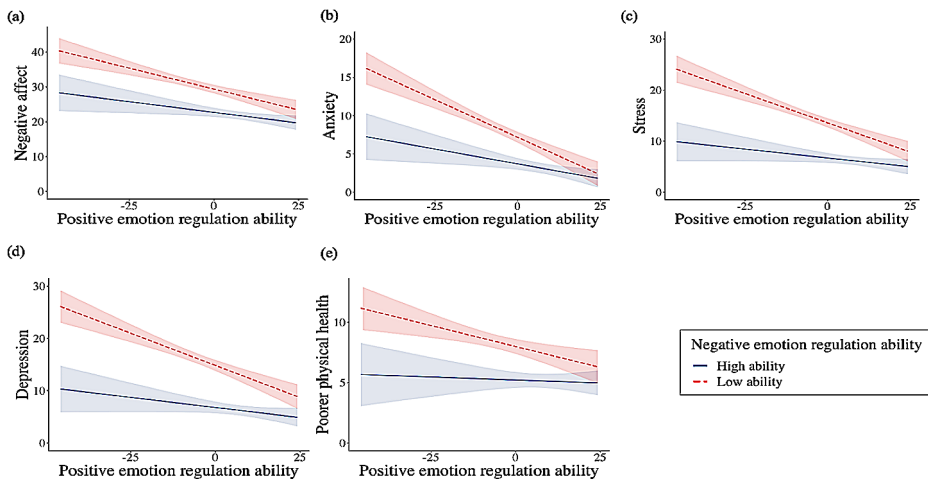
## 8 Discussion

This study reports on the relationships between positive and negative emotion regulation abilities and affect, life satisfaction, and health. We found that positive emotion regulation ability, as with negative emotion regulation, plays an essential role in health. In addition, we examined the factors of trait mindfulness and attention control related to emotion regulation abilities. We observed that negative emotion regulation ability, rather than positive, was more associated with both mindfulness and attention control. The results indicated that the roles of positive and negative emotion regulation abilities in health and well-being do differ.

**Table 2** Results of multiple regression analyses for predicting positive and negative affect, life satisfaction, and mental and physical health

Dependent variables	Independent variables	$\beta$	t	p	95% CI		R <sup>2</sup>
					Lower	Upper	
<b>Positive affect</b>							.075
	Sex	0.155	1.734	.084	-0.174	2.790	
	Positive emotion regulation	-0.002	0.045	.964	-0.064	0.061	
	Negative emotion regulation	0.265	5.296	<.001	0.089	0.194	
	Positive emotion regulation $\times$ negative emotion regulation	0.026	0.657	.512	-0.002	0.004	
<b>Negative affect</b>							.217
	Sex	0.111	1.351	.177	-0.525	2.835	
	Positive emotion regulation	-0.228	4.998	<.001	-0.253	-0.110	
	Negative emotion regulation	-0.321	6.973	<.001	-0.271	-0.152	
	Positive emotion regulation $\times$ negative emotion regulation	0.074	2.007	.045	0.000	0.007	
<b>Life satisfaction</b>							.125
	Sex	-0.180	2.077	.038	-2.420	-0.067	
	Positive emotion regulation	0.028	0.586	.558	-0.035	0.065	
	Negative emotion regulation	0.343	7.051	<.001	0.108	0.191	
	Positive emotion regulation $\times$ negative emotion regulation	0.019	0.495	.621	-0.002	0.003	
<b>Depression</b>							.316
	Sex	0.021	0.273	.785	-1.227	1.623	
	Positive emotion regulation	-0.224	5.250	<.001	-0.222	-0.101	
	Negative emotion regulation	-0.426	9.902	<.001	-0.305	-0.204	
	Positive emotion regulation $\times$ negative emotion regulation	0.117	3.386	<.001	0.002	0.008	
<b>Anxiety</b>							.246
	Sex	0.003	0.033	.973	-0.957	0.990	
	Positive emotion regulation	-0.292	6.519	<.001	-0.178	-0.096	
	Negative emotion regulation	-0.283	6.262	<.001	-0.145	-0.075	
	Positive emotion regulation $\times$ negative emotion regulation	0.126	3.492	<.001	0.002	0.006	
<b>Stress</b>							.325
	Sex	0.052	0.677	.499	-0.804	1.649	
	Positive emotion regulation	-0.239	5.640	<.001	-0.202	-0.097	
	Negative emotion regulation	-0.420	9.834	<.001	-0.261	-0.174	
	Positive emotion regulation $\times$ negative emotion regulation	0.128	3.724	<.001	0.002	0.008	
<b>Physical health</b>							.144
	Sex	-0.341	3.965	<.001	-2.526	-0.852	
	Positive emotion regulation	-0.104	2.193	.029	-0.075	-0.004	
	Negative emotion regulation	-0.280	5.815	<.001	-0.118	-0.058	
	Positive emotion regulation $\times$ negative emotion regulation	0.079	2.038	.042	0.000	0.004	

Note.  $\beta$ =standardized partial regression coefficient



**Fig. 2** Interactive relationships of positive and negative emotion regulation abilities for predicting (a) negative affect; (b) anxiety; (c) stress; (d) depression; and (e) physical health. *Note.* The transparent area represents the respective 95% confidence interval of the prediction

## 8.1 Emotion Regulation, Affect, Life Satisfaction, and Health

We hypothesized that the ability to regulate positive emotions is related to positive and negative affect, life satisfaction, and health even when controlling for negative emotion regulation ability (H1). Our findings were partially consistent with this hypothesis, and positive emotion regulation ability was a significant predictor of mental and physical health. However, positive emotion regulation ability did not predict positive affect or life satisfaction when controlling for negative emotion regulation ability. Negative emotion regulation ability was a stronger predictor of mental health than positive in a previous study (Preece et al., 2018), and this tendency was particularly apparent for positive affect and life satisfaction in this study. This could be attributed to the fact that people pay more attention to and are more psychologically affected by negative information than positive (Vaish et al., 2008).

Moreover, the interaction between positive and negative emotion regulation abilities was related to mental and physical health, and the effect of positive emotion regulation ability on stress, depression, and physical health appeared only at lower negative emotion regulation ability. These results were partially consistent with our hypothesis (H2): positive emotion regulation ability is more positively associated with health, positive and negative affect, and life satisfaction, especially when negative emotion regulation ability is low, and also with a previous study showing that savoring is effective in alleviating anxiety symptoms in individuals with low negative emotion regulation ability (Chiu et al., 2020). Since positive emotions can have a buffering effect on negative emotions (Fredrickson & Levenson, 1998), it is inferred that regulating positive emotions counteract negative outcomes.

Our findings contribute to the existing body of research by expanding our understanding in several ways. First, our results highlight the importance of prioritizing negative emotion regulation in the pursuit of positive affect and life satisfaction. Additionally, we demonstrate that positive emotion regulation ability is equally crucial for mental and physical health, alongside negative emotion regulation ability. Furthermore, our findings suggest that posi-

tive emotion regulation may have an interactive effect when combined with the ability to regulate negative emotions, leading to reductions in negative affect and anxiety. Moreover, we provide evidence for a greater interactive effect of positive and negative emotion regulation abilities on outcomes such as stress, depression, and physical health, which may be particularly pronounced for individuals with limited skills in negative emotion regulation.

Interestingly, the subscales of controlling subjective experiences in positive and negative emotions were particularly relevant to affect, life satisfaction, and health. This result was consistent with existing research showing that the use of an emotion regulation strategy aimed at enhancing the subjective experience of positive emotions contributes to well-being and health (Katana et al., 2019). It may also be important to shift attention to the importance of regulating the subjective experience of positive emotions.

In addition, even after controlling for emotion regulation abilities, sex differences were still associated with life satisfaction and physical health. This is consistent with the fact that women report more frequent somatic symptoms (Barsky et al., 2001) and higher life satisfaction (Tiefenbach & Kohlbacher, 2013) than men, and may indicate that emotional experience alone cannot resolve the sex differences in frequent symptoms and life satisfaction.

## 8.2 Emotion Regulation and Attention Control

Differences were also found in attention control related to emotion regulation abilities. Orienting was the only attentional function related to negative emotion regulation ability. Tortella-Feliu et al. (2014) indicated that a decrease in attentional orienting could increase the tendency to engage in depressive rumination. Therefore, enhanced orienting may reduce ruminating frequency and contribute to improved negative emotion regulation. Contrastingly, no attention functions were positively associated with the ability to regulate positive emotions. As positive emotions are pleasant and increasing positive emotions are relatively easier than decreasing negative emotions (Kim & Hamann, 2007; Ochsner et al., 2012), strong attention switching and focus may not be necessary.

## 8.3 Emotion Regulation and Mindfulness

The association between trait mindfulness and emotion regulation abilities differed depending on emotional valence. Non-reactivity, non-judging, describing, and acting with awareness in mindfulness were positive predictors of negative emotion regulation ability. This result was consistent with that of a previous meta-analysis (Mattes, 2019). Mindfulness improves reappraisal abilities and contributes to a high level of well-being (Garland et al., 2009, 2011, 2015). Mindfulness may be adjunct to effective negative emotion regulation strategies. Contrastingly, only describing and acting with awareness were significant predictors of positive emotion regulation abilities. Intentional attention to pleasant experiences (a brief mindfulness intervention) was associated with increased intensity and frequency of positive emotions (Erisman & Roemer, 2010). Our findings suggest that expressing positive emotions or experiences using words and concentrating on positive moments are important for appropriate positive emotion regulation. As expected, common and different features were found in the degree of association between mindfulness components and negative and positive emotion regulation.

## 8.4 Limitations and Future Directions

This study had several limitations. First, it was impossible to determine directionality or causality because this was a cross-sectional study. For example, increased mental health may lead to a greater perspective and better ability to regulate emotions. Future studies should employ longitudinal designs to shed light on directionality and causality. Second, this study limited the target population to young adults in their 20s to investigate attention control. Attention functions can change with age (Gamboz et al., 2010; Williams et al., 2016). To generalize the results, it is necessary to verify whether the same effect can be obtained for different age groups (e.g., older persons). A third concern is cultural differences. The sample in this study was all Japanese. Asians tend to suppress emotions more than others to maintain interpersonal relationships (Butler et al., 2007). Therefore, the impact of emotion regulation on the outcomes may vary across cultures.

## 9 Conclusions

This study provides evidence that both positive and negative emotion regulation are associated with health, but only negative emotion regulation is related to positive affect and life satisfaction when controlling for each effect. Positive emotion regulation ability may benefit mental and physical health in individuals with low negative emotion regulation ability. In addition, negative emotion regulation ability was more strongly associated with mindfulness than positive, and describing and acting with awareness were commonly associated with both emotion regulation abilities. Regarding attention control, orienting was associated only with negative emotion regulation ability. By focusing on both negative and positive emotion regulation, this study helps elucidate the relationship between emotion regulation ability, positive and negative affect, life satisfaction, health, mindfulness, and attention control.

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**Data availability** The data and materials are publicly available via UMIN and can be accessed at <https://upload.umin.ac.jp/filesare/registrant.cgi>.

## Declarations

**Conflict of interest** The authors report no conflicts of interest.



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