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How to Deal With Negative Climate Emotions? An Experimental Study on Emotion Regulation in the Context of the Climate Crisis Among Activists and Non-Activists

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Badges for Good Research Practices: Code. Data. Diversity Statement. Materials. Preregistration.

Abstract

Emotion regulation (ER) is essential for psychological resilience amid climate change. This preregistered study evaluated the effectiveness of two ER strategies — reappraisal and expressive suppression — in reducing negative emotional responses to climate-related imagery in climate activists and non-activists. In line with previous research on ER in non-environmental contexts, we expected reappraisal to be a more effective ER strategy than suppression. A sample of 274 individuals (75 activists and 199 non-activists) participated in an online experiment. In 24 trials, participants were presented with images from the Affective Climate Images Database and instructed to either apply reappraisal, suppression, or passively observe the image (control trials). As indicators of ER effectiveness, we assessed and compared pre- and post-regulation ratings of affective valence and arousal. Additionally, participants indicated the effort of implementing the ER strategies. As hypothesized, reappraisal emerged as the most effective strategy, while

suppression was even less effective than merely viewing the images in the control trials. Reappraisal and suppression effectiveness did not differ between activists and non-activists, but activists found reappraisal more effortful than non-activists. Neither reappraisal nor suppression effectiveness was significantly associated with self-reported pro-environmental behavior. Our findings indicate a high-effectiveness-high-effort trade-off for reappraisal and underline the ineffectiveness of suppression when confronted with climate change's consequences.

Keywords

climate change, climate anxiety, emotion regulation, reappraisal, activists

Non-Technical Summary

Background

People are increasingly confronted with information on the devastating consequences of climate change. These impressions can cause a variety of negative feelings, for example, fear, sadness, or anger, which are natural and understandable reactions. However, for some individuals, these emotions may become distressing or overwhelming, leading them to seek ways to alleviate them.

Why was this study done?

In this study, we wanted to explore two strategies that are often used to alleviate negative feelings: (1) reappraisal, where people try to find new interpretations for a situation, for example by having more positive thoughts, and (2) suppression, where people voluntarily inhibit their outward emotional expressions, for example by maintaining a neutral facial expression, even if they feel upset or anxious. This study not only investigated both strategies in the general population but also in organized climate activists in Germany, who may be especially exposed to information on climate change. Finally, we wanted to explore whether the use of these strategies would be related to more or less eco-friendly behavior.

What did the researchers do and find?

In an online experiment, 274 participants (75 climate activists and 199 non-activists) viewed a set of 24 images related to climate change (e.g., wildfire, flood). For each image, we asked participants to either use reappraisal, suppression, or simply view the image without using a specific strategy. Participants rated how they felt before and after each image and reported how much effort it took to use the strategies while seeing the images. We found that reappraisal was the most effective strategy, helping participants feel less negatively about the images. Suppression was the least effective strategy, as participants experienced even more negative feelings using this strategy than merely viewing the images without any strategy. Both activists and non-activists benefited statistically equally from reappraisal and suppression in alleviating negative affect and arousal. Activists, however, reported more effort to use reappraisal than non-activists. The ability to successfully use reappraisal or suppression in our experiment was not related to participants' self-reported eco-friendly behavior.

What do these findings mean?
This study highlights the importance of using appropriate strategies to manage the emotional toll of climate change information. Finding more positive interpretations for these situations seems more useful than hiding one's emotional expression. However, for climate activists, this reappraisal requires comparably more effort compared to non-activists. Given the persistent and large-scale nature of the climate crisis, activists are particularly at risk of emotional exhaustion and frustration. This makes it crucial to adopt effective and sustainable coping strategies that foster resilience, maintain hope, and prevent burnout.

Highlights

- Emotion regulation (ER) plays a pivotal role in maintaining psychological resilience in the face of climate change, both for climate activists and non-activists.
- Experimental study tested two ER strategies (reappraisal vs. suppression) and a control condition (view only) in response to climate-change-related negative imagery.
- Reappraisal was significantly more effective in modulating valence and arousal than suppression and was perceived as more effortful by activists than non-activists.
- Habitual suppression, but not suppression effectiveness in the ER experiment was negatively associated with pro-environmental behavior, while no association with trait/state reappraisal was observed.
- Reappraisal seems effective to alleviate negative emotional response to climate threat, but further research into the implicit ER and reappraisal tactics is needed.

Climate change stands as one of the most pressing global crises of the 21st century, unfolding not only on planetary health but also on an individual's emotional and psychological well-being. The psychological impact can either be direct (e.g., traumatic responses to extreme weather events), psychosocial (e.g., climate-related migration or post-disaster adjustment), or indirect (e.g., anxiety or uncertainty about future risks) (Doherty & Clayton, 2011). Climate change threat and (projected) consequences can evoke complex, distressing affective responses such as anxiety, guilt, grief, hopelessness, or anger (Clayton, 2020; Cunsolo et al., 2020; Stanley et al., 2021), often referred to as "climate emotions" or "eco-emotions" (Pihkala, 2022, p. 1). Global data reveal that almost two-thirds of children and young adults are very or extremely worried about climate change (Hickman et al., 2021) and, for example, report even more distress from climate change than from COVID-19 (Lawrance et al., 2022). Following a more clinically oriented perspective, the functional and cognitive-emotional impairments of climate anxiety (Clayton & Karazsia, 2020) have been associated with decreased mental well-being, exhibiting both correlational and neural patterns that mirror those observed in clinical anxiety disorders (Carlson et al., 2024). Negative affective responses to climate change tend to be particularly pronounced in individuals who are directly exposed to climate

change (Gibson et al., 2020) or engage deeply with climate issues, whether through advocacy or dedicated involvement in environmental reform (Kleres & Wettergren, 2017). For example, Wang et al. (2018) found that climate scientists report stronger emotional responses to climate change than the general population, and Martiskainen et al. (2020) reported that 21% of interviewed climate activists experience anxiety to an extent that it interferes with their daily functioning, such as sleep quality. However, affective reactions to climate change can also include positive reactions such as constructive hope and empowerment (Ojala, 2023), and negative feelings about climate change may not necessarily be pathological per se (for a critical discussion, see Kurth & Pihkala, 2022). Accordingly, previous research has identified these experiences as characteristic of an adaptive process ("learning to live with climate change", Verlie, 2019) and a motivating source for pro-environmental behavior (Brosch, 2021; van Valkengoed & Steg, 2019). Climate anxiety, for example, when experienced at manageable levels, may be an adaptive response to the real, existential, and immediate threat of climate change, mobilizing individuals to engage in meaningful climate action (for an overview, see Pihkala, 2020). This trade-off between decreased mental well-being and increased pro-environmental behavior (PEB) was found not only for climate anxiety (Wullenkord et al., 2021) but also for eco-guilt and ecological grief (Zeier & Wessa, 2024). Leveraging the motivating aspect of these emotional reactions while maintaining mental health and resilience would require individuals to have adequate and effective emotion regulation (ER) strategies at their disposal, i.e., attempts to alter emotional experience (for an overview see McRae & Gross, 2020).

Individuals may choose from a variety of emotion regulation strategies to achieve these goals. The extended process model of emotion regulation (Sheppes et al., 2015), for example, encompasses different strategies to regulate emotions at different points in the emotional process: antecedent-focused strategies (i.e., before emotions have fully developed) and response-focused strategies (i.e., after emotions have been activated). To contrast these two groups of ER strategies, previous research has largely focused on the antecedent-focused ER strategy of cognitive reappraisal, i.e., changing the way one thinks about a situation to alter its emotional impact, and the response-focused ER strategy of expressive suppression, i.e., reducing facial and behavioral expression of emotion once it has been activated or solidified (Gross, 1998). According to the circumplex model of emotion (Russell, 1980), (changes in) affective states can be described alongside the two dimensions valence (i.e., degree of pleasantness or unpleasantness) and arousal (i.e., the level of physiological activation or intensity). While individuals may not always consciously aim to change their affective state, shifts in valence and arousal often emerge as a result of regulatory efforts. As such, valence and arousal represent typical outcome variables in ER research (e.g., Bernat et al., 2011). Both experimental and individual differences research consistently demonstrates that cognitive reappraisal is more effective than expressive suppression in ameliorating negative affect (Goldin et al., 2008;

Gross, 1998; Gross & John, 2003; Webb et al., 2012). However, there is limited empirical work on how these strategies interact with climate-related emotions and behaviors. Previous research (Panno et al., 2015; Panno et al., 2020) revealed a positive relationship between the habitual use of reappraisal, climate change perception, and PEB. In an experimental context, Wenzel et al. (2023) examined reappraisal strategies by presenting participants with a narrative on biodiversity loss due to climate change (threatened state of bumblebees) and instructing them to either engage in problem-focused reappraisal (addressing obstacles to taking action), emotion-focused reappraisal (reframing negative feelings) or reflect on the environmental threat without active ER (control condition). Participants in both the problem-focused and emotion-focused reappraisal groups were more effective at decreasing guilt and fear and increasing hope than participants in the control group. Although no significant differences in threat mitigation behavior emerged between the groups, correlational analyses suggested that participants who effectively used emotion-focused reappraisal were less likely to engage in PEB.

In summary, a limited amount of previous research hinted at the effectiveness of reappraisal in the environmental context, but more nuanced effects of this ER strategy on PEB. To our knowledge, there is a lack of experimental evidence regarding the impact of expressive suppression on both climate emotions and PEB. Furthermore, it remains unclear how climate activists, who may experience more intense emotional reactions to climate change (Marczak et al., 2021; Martiskainen et al., 2020), compare to non-activists in their ER strategies and the outcomes of these strategies. Individuals are less likely to engage in reappraisal in situations of high emotional intensity (Sheppes et al., 2011). For activists, reappraisal may be particularly challenging, as the process of contextualizing climate-related images in a way that reduces their negative impact could conflict with their intrinsic motivations and commitment to climate action. As a result, compared to non-activists, they may find reappraisal less effective and more effortful when instructed to use this emotion regulation strategy. The current study thus:

a. Aimed to investigate the effectiveness of antecedent (reappraisal) and response-focused (expressive suppression) ER strategies in alleviating affective response when confronted with climate-change-related imagery. Drawing on previous work in the non-environmental (Gross & John, 2003) and environmental domains (Wenzel et al., 2023), we expected a higher reduction of negative emotional responses (in terms of affective valence and arousal) for reappraisal than for suppression.
b. Furthermore, we explored differences between climate activists and non-activists in ER-strategy effectiveness and implementation effort.
c. Investigated the association of ER effectiveness (in the ER task) and frequency (via self-report) and PEB.

Method

Participants

Participants were recruited through academic newsletters (e.g., faculties of psychology, general studies), social media, and SurveyCircle. Climate activists from Germany and Austria were recruited via e-mail by various activist groups (e.g., Last Generation, Students for Future, Fridays for Future, Parents for Future, Artists for Future, and Scientists for Future). The inclusion criterion was, Age ≥ 16 years. We excluded datasets with missing values (listwise deletion) and individuals who stated that they did not believe in man-made climate change. Participants who completed the experiment could take part in a voucher raffle (20 x 10 EUR or a donation to a non-profit environmental organization), and psychology students of the University of Mainz received extra course credit for participation.

From the 461 individuals who started the survey, 178 participants (38.6%) were excluded due to missing data, and nine (1.9%) for not believing in man-made climate change. A flowchart per group can be found in Supplement A (see Hennemann et al., 2026). Finally, 274 participants were included in the analyses (75 activists and 199 non-activists). In the total sample, the average age was 33.2 years (SD = 14.8, range 16–73), 210 individuals (76.6%) indicated female gender, 63 (23%) were parents, and the majority were highly educated (at least A-level graduation: 252, 92%). Two-thirds of participants (n = 181, 66%) rated themselves as "Strongly" or "Very strongly" affected by climate change (5-point scale from 1 "Not at all" to 5 "Very strongly"). Activists were significantly older (d = 0.65 [0.37, 0.93]), more strongly affected by climate change (76% vs. 62% responding "Very strongly" or "Strongly"), more often parents (54% vs. 46%), reported less intolerance of uncertainty (d = -0.41 [-0.68, -0.14]), higher negative climate affectivity (d = 0.67 [0.39, 0.94]) and more pro-environmental behavior (d = 1.70 [1.38, 2.01]) than non-activists, see Table 1.

Study Design and Procedure

The study was conducted online, and the data collection was carried out anonymously via soscisurvey.de (Leiner, 2019) from July 27 to September 8, 2023. The study was preregistered (see Schröder, 2023). Other than pre-registered, the psychometric analyses of the self-constructed Climate Emotions Questionnaire (CEQ) are not reported in full detail here (see Supplement C, Hennemann et al., 2026, for more details). Furthermore, we formulated Hypothesis (a) regarding differences between the two ER strategies as a specific hypothesis rather than exploratively (corresponding to additional hypotheses under "secondary analyses" in the pre-registration), based on the latest evidence (Wenzel et al., 2023), and extended the explorative analyses (c) on the association of ER effectiveness and frequency with PEB.

Table 1

Demographic Characteristics of the Total and Sub-Samples

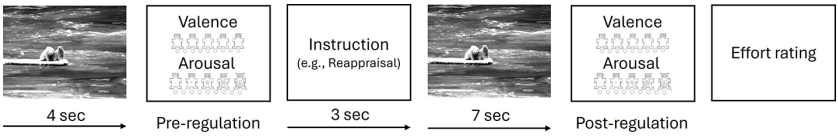
Characteristic	Total sample (*N* = 274)	Activists (*n* = 75)	Non-Activists (*n* = 199)	Test statistics
Age, *mean* (*SD*), *range*	33.2 (14.8), 16–73	40.4 (17.2), 16–73	30.5 (12.9), 18–70	$t(106.77) = 4.51$, $p < .001$, $d = 0.65$ [0.37, 0.93]
Gender, *n* (%)				
Male	60 (21.9)	23 (30.7)	37 (18.6)	$\chi^2(2) = 6.0$, $p = 0.05$
Female	210 (76.6)	50 (66.7)	160 (80.4)	
Non-binary	4 (1.5)	2 (2.7)	2 (1.0)	
Parenthood, *n* (%)	63 (23.0)	34 (54.0)	29 (46.0)	$\chi^2(1) = 29.11$, $p < .001$
Affected by climate change, *mean* (*SD*), scale 1–5	3.75 (0.89)	4.08 (0.93)	3.62 (0.84)	$t(272) = 3.93$, $p < .001$, $d = 0.53$ [0.26, 0.80]
Highest level of education, *n* (%)				
No degree	2 (0.7)	2 (2.7)	0	$\chi^2(8) = 37.71$, $p < .001$
Completed Apprenticeship	17 (6.2)	2 (2.7)	15 (7.5)	
Secondary school leaving certificate[1]	3 (1.1)	2 (2.7)	1 (0.5)	
A-level graduation[2]	70 (25.5)	14 (18.7)	56 (28.1)	
Bachelor/Master	160 (58.4)	45 (60.0)	115 (57.8)	
Doctoral Degree	11 (4.0)	5 (6.7)	6 (3.0)	
Other	11 (4.0)	5 (6.7)	6 (3.0)	
Depressiveness/Anxiety; PHQ-4, *mean* (*SD*)	7.34 (2.61)	7.3 (2.5)	7.34 (2.66)	$t(272) = -0.32$, $p = .749$
EcoERQ suppression, *mean* (*SD*)	9.6 (4.5)	8.9 (4.3)	9.87 (4.55)	$t(272) = -1.57$, $p = .117$
EcoERQ reappraisal, *mean* (*SD*)	19.9 (5.7)	18.8 (6.2)	20.25 (5.42)	$t(272) = -1.87$, $p = .062$
Intolerance of uncertainty; IUS-12, *mean* (*SD*)	34.4 (8.7)	31.9 (8.1)	35.40 (8.72)	$t(272) = -3.04$, $p = .003$, $d = -0.41$ [-0.68, -0.14]
Climate emotions; CEQ, negative climate affectivity, *mean* (*SD*)	4.0 (0.7)	4.3 (0.5)	3.91 (0.75)	$t(190.12) = 5.36$, $p < .001$, $d = 0.67$ [0.39, 0.94]
Climate emotions; CEQ, climate guilt, *mean* (*SD*)	3.1 (0.9)	3.0 (0.9)	3.11 (0.92)	$t(13.49) = -1.26$, $p = .210$
Climate emotions; CEQ, climate hopelessness, *mean* (*SD*)	3.0 (0.8)	3.0 (0.8)	3.00 (0.79)	$t(272) = -0.01$, $p = .992$
Pro-environmental behavior; PEB, *mean* (*SD*)	36.1 (7.9)	43.5 (5.0)	33.25 (6.91)	$t(13.49) = 11.73$, $p < .001$, $d = 1.70$ [1.38, 2.01]

Note. [1]German „Realschulabschluss“, [2]German „Fachhochschulreife“ or „Abitur“. CEQ = Climate Emotions Questionnaire (see Supplement D, Hennemann et al., 2026), EcoERQ = Emotion Regulation Questionnaire Climate version (see Supplement E, Hennemann et al., 2026), IUS-12 = Intolerance of Uncertainty Scale short form, PEB = Pro-Environmental Behavior (see Supplement F, Hennemann et al., 2026), PHQ-4 = Patient Health Questionnaire 4. Welch's *t*-test reported in case of variance inhomogeneity.

Participants were first informed about the background and procedure of the study and provided informed consent. Next, participants completed a set of questionnaires regarding demographics, climate emotions, emotion regulation, intolerance of uncertainty, PEB, and current mental distress. Afterward, participants completed the ER task, which followed a 3 (trial condition: reappraisal vs. suppression vs. control) x 2 (group: activists vs. non-activists) x 2 (time: pre- vs. post-regulation) mixed factorial design. Trial condition and time were within-subject factors, group was a between-subject factor, and affective valence and arousal served as dependent variables. First, participants were introduced to the two ER strategies, reappraisal and suppression, and the control condition via 3-minute information videos (text version see Supplement B, Hennemann et al., 2026). This was followed by a practice trial for each of the ER strategies and the control condition. After ensuring an understanding of the ER task and strategies, participants completed the main ER task with 24 trials (eight trials per condition). The trial procedure is shown in Figure 1. Emotion-eliciting images were presented in random order for 4 seconds, followed by a first rating of affective valence and arousal. Then, also in random order, one of the three trial conditions was prompted in the center of the screen ("reappraisal", "suppression", or "view") for 3 seconds and the same image was presented for 7 seconds, during which the respective strategy should be applied. Subsequently, affective valence and arousal were rated again, as well as the effort of implementing the respective strategy. The sequence, stimulus presentation times, and rating procedures were designed in accordance with established ER paradigms and have demonstrated validity and reliability in prior studies (Ochsner et al., 2002; Schnabel et al., 2022; Waugh et al., 2022).

Figure 1

Procedure of the Emotion Regulation Task



Note. Image from https://affectiveclimateimages.weebly.com/

Material

The ER video instructions were adapted from Schnabel et al. (2022). Each video contained general (i.e., not climate-related) information about the respective strategy and provided examples, see Supplement B, Hennemann et al. (2026). As stimulus material, 24 negative climate images from the Affective Climate Images Database (Lehman et al., 2023) were selected, with the highest relevance and negative valence ratings within the database, so that the images showed as much variance as possible in terms of their content (e.g.,

ice floes, floods, animal suffering, etc.). The relevance to climate change of the selected images varied between 6.5 and 8.2 (M = 7.3, Scale 1–9), their valence from 1.4 to 3.3 (M = 2.6), and the arousal between 4.9 and 5.6 (M = 5.2) on a scale from 1 to 9, with low values indicating negative valence and low arousal. The list of images selected for this study can be found in Supplement C, Hennemann et al. (2026). The images were edited using GIMP, Version 2.10.34 (Natterer, 2023) for presentation in SoSci Survey and scaled to a width (or height for vertical images) of 600 pixels.

Valence and arousal were assessed with a 9-point self-assessment manikin scale (Bradley & Lang, 1994), ranging from 1 ("Unpleasant") to 9 ("Pleasant") for valence and 1 ("Excited") to 9 ("Calm") for arousal. For better understanding, both scales were recoded (1–"Pleasant to 9–"Unpleasant" and 1–"Calm" to 9–"Excited") so that higher pre-post-regulation difference scores indicated more effective emotion regulation. The effort of ER implementation ("How difficult was it for you to implement the strategy?") was rated on a 5-point scale from 1 ("Very difficult") to 5 ("Very easy") and was inversely recoded afterwards for better understanding (higher values indicating more effort).

Questionnaires

Negative climate emotions (fear, sadness, anger, guilt, hopelessness) were assessed with a self-constructed questionnaire including 25 items that were answered on a 5-point scale from 1 ("Does not apply") to 5 ("Does apply"). The questionnaire was intended as a "short version" based on a set of established questionnaires and findings suggested a 3-factorial structure with the factors 'negative climate affectivity' (McDonald's ω = .93), 'climate guilt' (ω = .90) and 'climate hopelessness' (ω = .54), total scale ω = .92 (see Supplement D, Hennemann et al., 2026, for all items). Furthermore, we adapted the items of the Emotion Regulation Questionnaire (ERQ; Gross & John, 2003) to assess the preference for emotion regulation (reappraisal, suppression) in the context of the climate crisis. The ERQEco contained 8 items (see Supplement E, Hennemann et al., 2026), which are answered on a 7-point Likert scale (from 0–"Not true at all" to 6–"Completely true"). Internal reliability of the total scale was ω = .75. Individual and collective PEB over the past 12 months was assessed with 10 items based on the PEB measure by Stanley et al. (2021) with a 5-point answer scale (1–"Strongly disagree" to 5–"Strongly agree"), see Supplement F, Hennemann et al. (2026), for items. Internal reliability of the total scale was ω = .84. Intolerance of uncertainty was assessed with 12 items of the Intolerance of Uncertainty Scale short form (IUS-12; Carleton et al., 2007), which are rated on a 5-point answer scale ranging from 1 (Not at all characteristic of me) to 5 (Entirely characteristic of me). Internal reliability was ω = .89. Mental distress (i.e., depression, anxiety) in the past two weeks was assessed using the Patient Health Questionnaire 4 (PHQ-4; Kroenke et al., 2009) with two items each, which are rated on a 4-point scale from 0 ("Not at all") to 3 ("Nearly every day"). Internal reliability was ω = .82.

Statistical Analysis

For sample size estimation, a power analysis with G*Power, Version 3.1 (Faul et al., 2007) for a repeated measure (rm)ANOVA (time x trial condition x group) and two dependent variables (affective valence, arousal) yielded a necessary sample size of N = 152 to detect a small to moderate effect (η^2p = 0.05) with a power of .80 and a .05 level of significance. To test group differences in demographics and self-report measures, we conducted independent t-tests for continuous and χ^2 tests for categorical data. To analyze ER effectiveness, repeated-measures analyses of variance (rmANOVAs) were conducted separately for valence and arousal, testing the effects of time (pre- vs. post-regulation), trial condition (reappraisal vs. suppression vs. control), and group (activists vs. non-activists). To investigate whether reappraisal would be more effective at decreasing negative affect and arousal than suppression and the control condition (Hypothesis A), we analyzed the main and interaction effects of time and trial condition and report effect sizes as partial η^2. As an indicator of potential ER differences between activists and non-activists (Hypothesis B), we explored time x trial condition x group interactions. For more in-depth analyses, we calculated difference scores for valence and arousal (pre minus post-regulation) as indicators of ER effectiveness, with higher scores indicating a stronger decrease in negative valence and arousal. With these ER effectiveness scores, we conducted independent t-tests to compare both groups for each ER strategy using a conservative level of significance of .005 to account for multiple testing (Benjamin et al., 2018). Differences in effort ratings were tested using dependent (within-trial conditions) and independent (between groups) t-tests. For the effort ratings, individual missing values occurred (n = 14 participants) and were addressed using item-wise mean imputation. We tested the relationship between ER effectiveness and PEB (Hypothesis C) by conducting Spearman correlations ($corr_\rho$) between the difference scores for valence and arousal ratings (pre minus post-regulation) and self-reported PEB. We also exploratively analyzed the correlation between reappraisal and suppression frequency in the ERQEco and PEB using the same correlation procedure. Data processing and statistical analyses were conducted with R, Version 4.2.1 (2022-06-23 ucrt) (R Core Team, 2023) and JASP, Version 0.17.3 (JASP Team, 2023) with an alpha of 0.05 (two-sided testing). All materials, data, and code are openly available through the Open Science Framework (see Hennemann et al., 2025).

Results

Effectiveness of Emotion Regulation Strategies

Mixed ANOVAs revealed significant main effects of *time* (pre- vs. post-regulation) for valence (F(1,272) = 182.51, p < .001, η^2 = 0.40) and arousal (F(1,272) = 115.74, p < .001, η^2 =

Table 2

Pre-Post-Regulation Differences for Trial Conditions (Reappraisal, Suppression, Control) in Valence and Arousal Ratings

Pre-Post Regulation Differences	Trial condition	*t*	*df*	*p*	Mean Difference	SE Difference	Cohen's *d* [95% CI]
Valence	Reappraisal	13.88	273	< .001	0.70	0.05	0.84 [0.70, 0.98]
	Suppression	8.00	273	< .001	0.29	0.04	0.48 [0.36, 0.61]
	Control	10.83	273	< .001	0.42	0.04	0.65 [0.52, 0.78]
Arousal	Reappraisal	12.49	273	< .001	0.62	0.05	0.75 [0.62, 0.89]
	Suppression	5.00	273	< .001	0.27	0.05	0.30 [0.18, 0.42]
	Control	9.79	273	< .001	0.48	0.05	0.59 [0.46, 0.72]

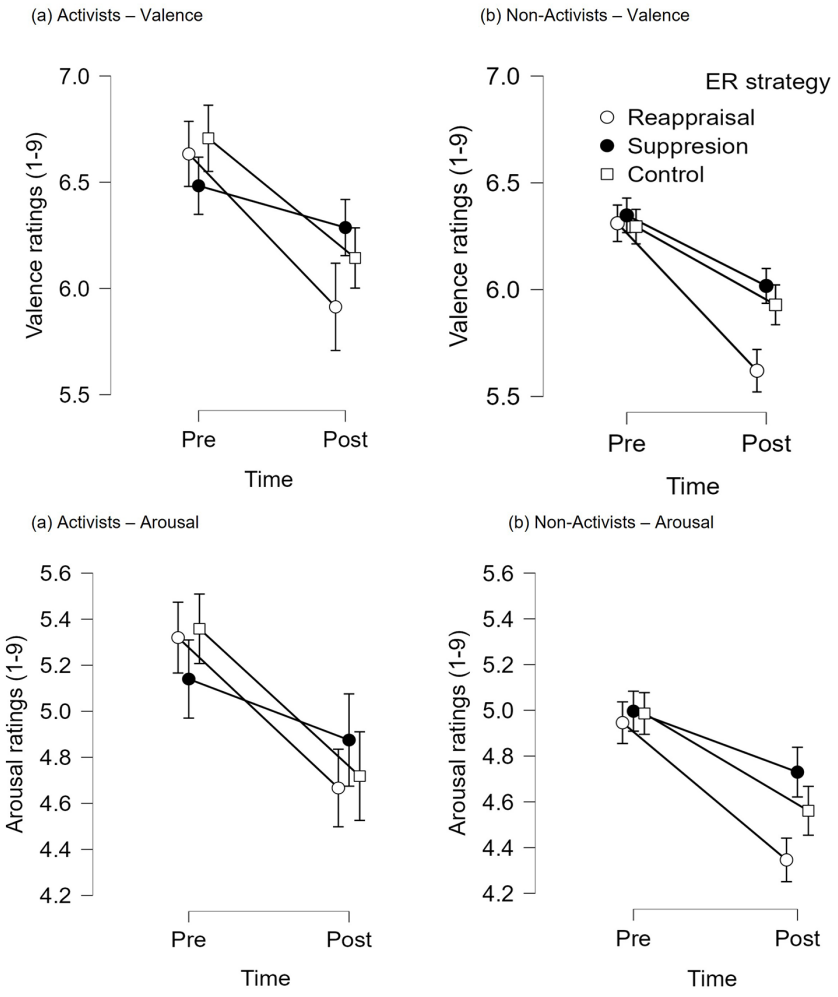
0.30). Accordingly, participants reported a decrease in negative affect from before to after the regulation phase (see Table 2).

The analysis furthermore revealed a significant main effect of *ER strategy* on valence, $F(2,544) = 5.52$, $p = .004$, $\eta^2 = 0.02$, but not on arousal, $F(2,544) = 2.13$, $p = .119$, $\eta^2 = 0.008$, and a significant main effect of *group* on valence, $F(1, 272) = 4.92$, $p = .027$, $\eta^2 = 0.02$, but not on arousal, $F(1, 272) = 1.49$, $p = .223$, $\eta^2 = 0.005$. Average pre-regulation values for valence ($ps \geq .638$) and arousal ($ps \geq .327$) did not differ significantly between trial conditions. Activists showed higher pre-regulation valence values, $t(272) = 2.32$, $p = .021$, but not arousal values, $t(272) = 1.38$, $p = .169$, than non-activists.

The *time x strategy* interaction effects were significant for valence, $F(2,544) = 32.68$, $p < .001$, $\eta^2 = 0.11$, and arousal, $F(2,544) = 18.33$, $p < .001$, $\eta^2 = 0.06$. In line with Hypothesis (a), within-subjects post-hoc tests of pre-post-regulation difference values indicated that reappraisal was significantly more effective than suppression for both valence, $t(273) = 7.42$, $p < .001$, $d = 0.45$, and arousal, $t(273) = 5.84$, $p < .001$, $d = 0.35$. Participants were also significantly more effective in the reappraisal trials compared to the control trials at decreasing negative valence, $t(273) = 5.48$, $p < .001$, $d = 0.33$, and arousal, $t(273) = 2.55$, $p = .011$, $d = 0.15$. Suppression was significantly less effective compared to the control trials for both valence, $t(273) = -3.05$, $p = .003$, $d = -0.18$, and arousal, $t(273) = -4.01$, $p < .001$, $d = -0.24$; see also Figure 2.

Figure 2

Pre-Post-Regulation Differences in Valence and Arousal for the Reappraisal, Suppression, and Control Trials Separated by Group (Activists vs. Non-Activists)



Note. Error bars depict 95% confidence intervals.

Regarding group differences in the effectiveness of emotion regulation (b), the *time x strategy x group interaction effects* were significant for valence, $F(2,544) = 4.57$, $p = .013$, $\eta^2 = 0.02$, but not for arousal ratings, $F(2,544) = 1.65$, $p = .194$, $\eta^2 = 0.006$. Between-group posthoc tests of pre-post-regulation difference values revealed non-significant group differences for reappraisal and suppression for either valence or arousal ($ps \geq .105$).

However, activists, compared to non-activists, reported significantly higher decreases in negative affect, $t(272) = 2.28$, $p = .023$, $d = 0.31$, and marginally non-significant decreases in arousal, $t(272) = 1.95$, $p = .053$, $d = 0.26$, in the view trials; see also Figure 2.

Participants rated the ER strategies on average as moderately effortful ($M = 2.69$ to 2.99 on a 1 – 5 rating scale, see Supplement G, Hennemann et al., 2026). Reappraisal was rated significantly more effortful than view only, but not than suppression. The control condition was rated as the least effortful strategy. Activists rated reappraisal on average significantly more effortful to implement than non-activists ($p = .033$, $d = 0.30$), with no significant group differences for suppression or the control condition, see Table 3.

Table 3

Group Differences in Effort Ratings for Reappraisal, Suppression, and Control (View Only)

ER Strategy	Group	*n*	*Mean*	*SD*	Test statistic
Reappraisal	Activists	75	3.12	0.66	$t(272) = 2.21$, $p = .028$, $d = 0.30$ [0.03, 0.57]
	Non-Activists	199	2.93	0.63	
Suppression	Activists	75	2.92	0.79	$t(272) = 0.03$, $p = .975$
	Non-Activists	199	2.91	0.72	
Control (view only)	Activists	75	2.69	0.65	$t(272) = 0.07$, $p = .939$
	Non-Activists	199	2.69	0.68	

Note. Higher values represent higher effort (scale 1 to 5).

Association With Pro-Environmental Behavior

To test associations of ER effectiveness and PEB (see Research Question C), we investigated correlations between pre- vs. post-regulation difference scores for valence and arousal in the ER task and PEB total scores. Neither reappraisal nor suppression effectiveness scores for valence or arousal were significantly associated with PEB. Only the view-only strategy for decreasing arousal was significantly positively associated with PEB ($corr_\rho = .22$, $p < .001$), see also Table 4. Stratified by group, this correlation became significant in activists ($corr_\rho = .23$, $p < .001$) but not in non-activists ($corr_\rho = .18$, $p = .118$).

Exploratively, we analyzed correlations between self-reported habitual ER, assessed by the ERQEco, with PEB. Habitual reappraisal did not correlate significantly with PEB ($corr_\rho = -.004$, $p = .539$), and habitual expression suppression correlated negatively with PEB ($corr_\rho = -.27$, $p < .001$).

Table 4

Correlation of Pro-Environmental Behavior (PEB) and Pre-Post-Regulation Valence and Arousal Difference Scores for Reappraisal, Suppression, and Control (View Only)

		Pro-environmental behavior		
Affective Reaction	**ER Strategy**	**Total sample**	**Activists**	**Non-activists**
Valence	Reappraisal	0.04	0.11	0.05
	Suppression	-0.07	-0.08	-0.03
	Control	0.11	-0.09	0.11
Arousal	Reappraisal	0.06	0.01	0.08
	Suppression	0.03	0.06	0.08
	Control	0.22***	0.18	0.23**

*$p < .05$. **$p < .01$. ***$p < .001$.

Discussion

This study sought to deepen our understanding of how ER strategies impact the emotional responses to climate change and the potential for PEB in both activists and non-activists. In line with our first hypothesis, the results revealed reappraisal as a more effective ER strategy than expressive suppression on both affective valence and arousal aspects of negative emotions. This result is in line with the majority of findings in the field of ER research in non-environmental contexts (Goldin et al., 2008; Gross, 1998; Gross & John, 2003; McRae & Gross, 2020) but also with recent experimental evidence on reappraisal effectiveness in the environmental domain (Wenzel et al., 2023). As proposed by theories on human resilience (e.g., Kalisch et al., 2015), cognitive reappraisal seems to be an effective strategy to protect an individual's affective well-being from the indirect psychological impact of environmental threats. Interestingly, our results indicated reappraisal to be more effective than merely viewing the images only for affective valence but not arousal ratings. In fact, participants in the control trials reported a significant decrease in both affective indicators, although they were explicitly instructed not to actively downregulate their emotions in these trials. This decrease in negative affect may be a result of more implicit ER processes in reaction to the visual stimuli (Gyurak et al., 2011) or by using their habitual ER strategies (Opitz et al., 2015).

Suppressing the emotional expression, as expected, was relatively ineffective at decreasing negative emotions in response to climate change threat as compared to reappraisal, which replicates findings from previous ER research (Goldin et al., 2008; Gross, 1998). These studies have furthermore identified paradoxical effects of suppression with increases in physiological (e.g., skin conductance; Gross, 1998) and neural (e.g., amygdala and insula activity; Goldin et al., 2008) affective responses. Consistent with this research,

participants in our study have indicated a weaker decrease in arousal in the suppression trials than in the control trials. Consequently, individuals who refrain from verbally or non-verbally communicating their climate-related emotions may experience adverse effects on their (physiological) well-being. Additionally, the frequent use of suppression is associated with poorer social well-being and impaired interpersonal relationships (Chervonsky & Hunt, 2017). As social protection and cohesion (Tamasiga et al., 2024), in turn, foster climate resilience, a lack of communication regarding climate emotions may increase vulnerability to climate change stressors.

In line with our second hypothesis, we compared how climate activists (e.g., members of the German Fridays for Future movement) and non-activists would differ in regulating negative affective responses to climate change threat. Our results revealed both groups to be equally effective at implementing reappraisal and suppression to decrease negative affect (i.e., valence scale). Previous research identified cognitive reappraisal to be less effective in situations of high emotional intensity (Shafir et al., 2015). In our study, activists compared to non-activists reported significantly more negative affective valence (but not arousal) as an initial reaction to climate-change-related images. However, affective responses in both groups were overall rather moderate, which in turn may have enabled most participants to effectively implement reappraisal. Although activists successfully utilized reappraisal, they reported more effort using this ER strategy compared to non-activists. This elevated implementation effort for reappraisal in activists may be tied to the discrepancy between the ability and the preference to implement reappraisal. For instance, research has shown that when individuals have the option to choose a regulation strategy, they tend to use reappraisal less frequently than suppression or distraction (Brans et al., 2013; Suri et al., 2015). In laboratory studies, reappraisal has generally been rated as requiring moderate mental effort (see for example, Morawetz et al., 2017) and Troy et al. (2018) could demonstrate equal effort for reappraisal and acceptance to regulate (general) negative affect. Furthermore, climate activists might hold complex knowledge of the situation, prioritizing different ER goals (Tamir, 2016) in a more naturalistic setting and, e.g., put instrumental ER goals (wanting to achieve a long-term goal) over hedonic (wanting to immediately feel better) goals. Accordingly, activists would prefer to maintain a certain level of negative affect to leverage the motivational aspects of these emotions for climate action (Verlie, 2019) and therefore show less willingness (and more effort) to engage in effective ER, e.g., via reappraisal. Also, the images used in this study might yield a range of different associations, and they likely have a lot of information to draw on for reappraisals. However, activists compared to non-activists reported a stronger decrease in negative valence in the control trials of our experiment. Possibly, activists habituate faster to climate change-related stimuli or profit from more implicit ER strategies (Aldao et al., 2010).

Regarding our third hypothesis, we did not find significant relationships between reappraisal effectiveness in the ER experiment or habitual frequency with self-reported

PEB. These results contribute to the ambiguous evidence of a limited set of previous studies showing both positive (Panno et al., 2015; Panno et al., 2020) or negative (Wenzel et al., 2023) associations with PEB. These mixed findings may be due to the heterogeneity of this ER strategy, as previous research identified a variety of reappraisal *tactics*, i.e., ways to reinterpret a situation (McRae et al., 2012; Ottenstein, 2020; Vlasenko et al., 2024). In a similar experimental task (Vlasenko et al., 2024), for example, participants would most frequently make use of the tactic *reality challenge*, i.e., challenging the authenticity of the situation (e.g., "This is not real"), but achieving the highest reappraisal effectiveness when using the tactic *change current circumstances*, i.e. reinterpreting a situation as better than it first seemed (e.g., "It is not as bad is it looks"). These tactics may not only come with different affective but also motivational consequences, e.g., by reducing the tendency to take (political) action (Ford et al., 2019). Reality challenge, for example, could be akin to denial (McRae et al., 2012), which, in the form of climate change denial, was associated with decreased pro-environmentalism (Wullenkord & Reese, 2021). Similarly, Wenzel et al. (2023) found more effective emotion-focused (but not problem-focused) reappraisal to be associated with less engagement in a pro-environmental task. This aligns with the work of Ojala on climate change related coping mechanisms in adolescents and emerging adults, differentiating problem-focused coping (e.g., taking concrete actions to address climate change) from meaning-focused coping (e.g., finding a sense of purpose or benefit, reframing challenges as opportunities for growth), which proved to be more effective than emotion-focused coping strategies such as distancing or denial (which would be related to suppression) with regard to negative affect or PEB (see for example, Ojala & Chen, 2024). In the present study, we did not instruct specific reappraisal tactics but only asked participants to "find an alternative interpretation to decrease their unpleasant emotions". Consequently, future studies should include more specific reappraisal instructions for a more nuanced understanding of this ER strategy.

To our knowledge, this is the first study to investigate relationships between the use of expressive suppression and self-reported PEB. The results of this study indicate a negative association between suppression frequency (but not effectiveness) with both individual and collective PEB. The outward expression of climate emotions (e.g., publicly mourning environmental loss; Cunsolo et al., 2020; Varutti, 2024; Zurba et al., 2024) can be construed as a collective form of PEB or social environmentalism (Larson et al., 2015). Implementing expressive suppression will, by definition, reduce the communication of thoughts and feelings regarding environmental threats, which may undermine the motivation to engage in PEB not only on the individual but also societal level (Zheng et al., 2019). Conversely, some studies suggest that individual and collective PEB itself can mitigate some of the emotional impact associated with climate change by fostering hope and a sense of purpose (Kleres & Wettergren, 2017; Zeier et al., 2025). More expressive and active engagement with environmental issues may therefore be more beneficial than

expressive suppression. However, this correlational evidence should be interpreted with caution and warrants replication with larger samples to confirm the robustness of these associations. Furthermore, we assessed PEB via questionnaire, which rather represents the propensity to engage in PEB rather than actual PEB in everyday life (for a critical overview, see Lange & Dewitte, 2019). As Wenzel et al. (2023) found negative associations between emotion-focused reappraisal effectiveness and engagement in a consequential PEB task, future ER studies may focus more on behavioral PEB measures. The integration of PEB tasks in future research may be particularly revealing with regard to the ambiguous relationships of suppression frequency and effectiveness with PEB in our study. As the frequent use of suppression was consistently associated with lesser well-being and more symptoms of psychopathology in previous research (McRae & Gross, 2020), future studies should more closely investigate the potentially harmful repercussions of this ER strategy on both environmental engagement and individual health.

Limitations

Despite the strengths of this study, several limitations should be acknowledged that may influence the interpretation of the findings. Firstly, although the sample comprises some demographic diversity and includes different levels of activism, it remains representative rather for a mostly young, female, well-educated, central European ("WEIRD") population (Henrich et al., 2010), limiting the generalizability, especially to individuals in other countries with higher imminent exposure to environmental threats. As research points towards gender differences in emotion regulation for example that women tend to use a greater variety of emotion regulation strategies and demonstrate more flexibility in their implementation (Goubet & Chrysikou, 2019; McRae et al., 2008; Nolen-Hoeksema, 2012) and considering the high percentage of female participants in our sample, future research should further investigate how different gender identities influence the effectiveness and preference of emotion regulation strategies in the context of emotions in response to climate change threat. However, most participants in our sample indicated to be at least strongly affected by climate change. Future studies could investigate ER processes in populations that are exposed to different levels of environmental threat. Secondly, compared to a more controlled laboratory setting, conducting the ER task online may have compromised internal validity, primarily due to the inability to ensure participants' full attention and adherence. However, ensuring instruction adherence is a general challenge in ER tasks, regardless of the setting. For example, in an ER task by Opitz et al. (2015), at least half of the participants did not adhere to the instructed reappraisal strategy. Another limitation is that automatic and implicit regulation processes can interfere with instructed ER strategies. To mitigate this, we implemented a brief initial stimulus presentation (4 seconds). However, automatic regulation processes could not be fully controlled throughout the trial. In this context, previous research has highlighted the diverging effects of instructed versus habitual emotion regulation, for example, through

studies employing regulatory choice paradigms (Mauersberger et al., 2018; Schnabel et al., 2022). Thirdly, the use of non-specific instructions for ER strategies concerning climate change could have led to heterogeneity in implementation tactics and should be adapted more closely to the subject. Additionally, the specificity of our findings to "climate emotions" remains uncertain, as no comparator stimuli were included (e.g., neutral images or negative images with non-climate-related content). Along those lines, we confined the experiment to two prominent ER strategies, i.e., reappraisal and (expression) suppression. Future research should include other frequently used ER strategies, e.g., distraction or acceptance (Lennarz et al., 2019), and use regulatory choice trials to provide a more holistic understanding of ER preferences and flexibility (Aldao et al., 2015). For example, problem-solving tactics and acceptance were used most frequently to reappraise everyday life stressors in an ecological momentary assessment study in college students (Marciniak et al., 2024). Fourthly, the number of trials was kept rather low to increase retention within the online experimental design and could be increased for more robust results. Finally, we only included a retrospective self-report measure of PEB in our study, which suffers from limited validity (for a systematic review, see Lange, 2023). Future experimental studies should consequently implement consequential behavioral paradigms to assess PEB, such as the Work for Environmental Protection Task (Lange & Dewitte, 2022).

Conclusion

In this experimental study, we corroborated cognitive reappraisal as an effective strategy to decrease negative emotions when confronted with climate change-related imagery. Additionally, both activists and non-activists were able to effectively implement reappraisal, although activists experienced more effort. As previous research identified potential drawbacks of reappraisal use on political action, we suggest a closer investigation of reappraisal tactics in future studies. Similar to previous research, expressive suppression was identified as an ineffective strategy for the reduction of negative emotions in response to climate change threat. As the frequent use of expressive suppression was additionally associated with less self-reported PEB, individuals and communities may rather profit from expressing emotions related to climate change threat. In sum, a constructive approach to climate change requires ER strategies that reconcile affective well-being with the motivation to act pro-environmentally. Although reappraisal can be effortful, it may achieve both goals.

Openness and Transparency Statements

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Severin Hennemann: Conceptualization. Project administration. Supervision. Methodology. Formal analysis. Writing – original draft. Writing – review & editing.
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Diversity Statement. In the list below, the check mark (☑) indicates which steps were taken to increase diversity within the context of this paper. Steps that were not taken or did not apply are unmarked (☐).

- ☑ Ethnically or otherwise diverse sample(s)
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Data Availability. All materials, data, and code are openly available through the OSF (see Hennemann et al., 2025).

Supplementary Materials. The following table provides an overview of the accessibility of supplementary materials (if any) for this paper.

Type of supplementary material	Availability/Access
Data	
Rawdata	Hennemann et al. (2025)
Code	
Rscript.Rmd	Hennemann et al. (2025)
Material	
Analyses	Hennemann et al. (2025)
Supplement A: Survey groups flowchart	Hennemann et al. (2026)
Supplement B: Text instruction for emotion regulation strategies	Hennemann et al. (2026)
Supplement C: Affective Climate Images Database items and CEQ chart analyses	Hennemann et al. (2026)
Supplement D: Climate Emotions Questionnaire and factor loadings	Hennemann et al. (2026)
Supplement E: Emotion Regulation Questionnaire - Eco version	Hennemann et al. (2026)
Supplement F: Pro-environmental behaviours measure items	Hennemann et al. (2026)
Supplement G: Tables for effort ratings and their Student's *t*-tests	Hennemann et al. (2026)
Study/Analysis preregistration	
Pre-Registration	Hennemann et al. (2025)
Other	
Codebook - Rawdata	Hennemann et al. (2025)

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