



A glimmer of hope: Pro-environmental behavior increases positive emotions after confrontation with environmental threat

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ABSTRACT

When confronted with ecological crises, people may experience a variety of emotions ranging, e.g., from fear to anger and guilt. The increasing prevalence of *eco-emotions* raises the question of how to manage these emotional states. Although individuals can choose from a variety of emotion regulation strategies, some strategies have been found to thwart pro-environmental behavior. In a series of experimental studies, we examined the emotion regulation potential of pro-environmental behavior itself. Participants in exploratory Studies 1a and 1b were presented a text about the loss of biodiversity and then decided how much time to spend on an effort task that yields donations to an environmental organization. More pro-environmental behavior was associated with an increase in hope and a decrease in fear in both studies and a decrease in guilt in Study 1b. However, more pro-environmental behavior was confounded with a greater time interval between emotional ratings. In preregistered Study 2, we controlled for possible cool-down effects by having participants complete a time-limited task that would either yield donations to an environmental organization or have no pro-environmental consequences after reading the biodiversity text. Similar to Studies 1a and 1b, participants in the pro-environmental behavior group compared to the control group reported a stronger increase in hope. However, both groups reported a similar decrease in fear and guilt. Consistent with previous research, pro-environmental behavior seems especially effective in upregulating positive emotions. Drawing hope from pro-environmental behavior while maintaining a certain level of concern and responsibility is discussed as an adaptive emotional response to environmental threat.

In the face of ecological crises, such as climate change and loss of biodiversity, people experience a variety of stress responses. Accordingly, a state of knowledge report emphasizes the devastating consequences of ecological crises on not only people's physical but also mental health (World Health Organization & Convention on Biological Diversity, 2015). More specifically, recent theoretical and empirical studies identified peoples' various emotional reactions to environmental issues. These *eco-emotions* (for an overview, see Pihkala, 2022) can range from fear, to guilt, anger, or grief as a reaction to experienced or impending environmental loss. However, the consequences of these emotions appear to be multifaceted: while some studies have found

associations between these emotions and impaired mental health (e.g., Ogunbode et al., 2021), other research has suggested self-reported eco-emotions as predictors of increased pro-environmental behavior (e.g., van Valkengoed & Steg, 2019). The motivational potential of emotion-focused interventions is supported by a limited number of recent experimental studies. For example, in one study (Adams et al., 2020), inducing guilt through false feedback in a carbon footprint calculator increased subsequent pro-environmental behavior (e.g., reducing water use, eating organic food). Other researchers have studied whether fear appeals (i.e. messages highlighting that a situation or development is threatening; Tannenbaum et al., 2015) can motivate

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people to engage in pro-environmental behavior. According to the Extended Parallel Process Model (Witte, 1992), messages that lead individuals to expect that they are likely to be affected by a severe threat (e.g., ecological crises) induce fear, which can result in behavior change, provided that the behavior is appraised as effective and feasible. Individuals presented with environmental threat messages have been found to report higher levels of fear and in turn stronger intentions to act pro-environmentally and support environmental policies (Hartmann et al., 2014; but see Chen, 2016). However, this effect did not extend to the promotion of actual pro-environmental behavior (Vlasceanu et al., 2024; Wenzel et al., 2023a).

Because eco-emotions appear to be, at least to some extent, adaptive responses to environmental crises, individuals should carefully consider how to deal with these emotional states. Previous research on emotion regulation (ER; for an overview, see McRae & Gross, 2020), i.e., means to deliberately influence emotions, has identified a set of strategies for responding to emotional experiences (e.g., cognitive reappraisal, distraction, and suppression). In the present set of studies, we aim to examine the emotional impact of pro-environmental behavior itself. More specifically, we expect pro-environmental behavior to effectively downregulate negative and upregulate positive emotions.

1. Hedonic and instrumental goals in emotion regulation

Not only can individuals choose from a variety of ER strategies, but they can also apply ER to achieve different goals (Tamir, 2016). On the one hand, individuals can use ER to pursue hedonic goals, i.e., maximizing immediate pleasure and minimizing pain. ER strategies differ in terms of their effectiveness in increasing pleasant or decreasing unpleasant emotions (Webb et al., 2012). For example, distraction and cognitive reappraisal, i.e., reinterpreting a situation to alter its emotional impact (Gross & John, 2003), are more effective at regulating emotions than suppressing one's thoughts about the emotional situation. On the other hand, individuals may use ER to pursue instrumental goals, i.e., achieving more distant goals (e.g., promoting social relationships, increasing performance, acquiring knowledge, or attaining autonomy). For example, individuals who increase their anger before entering a negotiation enforce their demands more successfully (Tamir & Ford, 2012). In some situations, hedonic motives conflict with instrumental motives. Individuals who effectively downregulate negative emotions via cognitive reappraisal have been found to be less likely to engage in collective action and more likely to tolerate social injustice (for an overview, see Ford & Troy, 2019). For example, a set of questionnaire and experimental studies investigated the extent to which individuals upset by the results of the 2016 U.S. presidential election engaged in political action (Ford et al., 2019). The results indicated that individuals who successfully applied cognitive reappraisal to downregulate their negative emotions were politically more inactive than individuals who did not actively regulate their emotions.

When experiencing environmental threat and in turn more negative emotions, individuals may be confronted with similar conflicts between hedonic (wanting to feel better) and instrumental (wanting to counteract the environmental damage) motives. Along these lines, an experimental study (Wenzel et al., 2023b) investigated the effects of ER on subsequent pro-environmental behavior. After reading a text on the threatened state of bumblebees in the UK, participants were instructed to either: (1) apply emotion-focused reappraisal (i.e., reinterpreting the situation to reduce negative emotions), (2) problem-focused reappraisal (i.e., think of problem solutions), or (3) in a control condition, passively reflect on the text. Finally, participants could voluntarily work on a pro-environmental behavior task. The results revealed similar levels of pro-environmental behavior in all groups. However, further correlational analysis revealed that more successful emotion-focused reappraisal was associated with less pro-environmental behavior, suggesting a trade-off between hedonic and instrumental goals in the effective use of this ER strategy. Considering that emotion-focused reappraisal may

interfere with environmental protection, it may be societally more desirable if individuals responded to eco-emotions in a way that benefits the environment (i.e., through pro-environmental behavior). Pro-environmental behavior is, by definition (Steg & Vlek, 2009), instrumental for mitigating environmental issues and thus changing the source of eco-emotions. The question then is if pro-environmental behavior can also serve to attain hedonic goals of ER.

2. Emotion regulation via pro-environmental behavior

Previous research (Taufik et al., 2015; van der Linden, 2018; Venhoeven et al., 2016) indicates that pro-environmental behavior in itself has the potential to satisfy both hedonic and instrumental goals, as *doing* good can also *feel* good. In line with studies on the rewarding consequences of pro-social behavior, individuals who act pro-environmentally may experience positive emotions as a result of their moral action (Andreoni, 1990). In a set of experimental studies (Tezer & Bodur, 2020), for example, participants reported feeling better when using green vs. conventional products. Similarly, individuals associated sustainable actions with positive rather than negative emotions in another set of studies, especially if these actions were considered meaningful (Venhoeven et al., 2020). Positive emotions related to pro-environmental behavior have been linked to improved self-images (Venhoeven et al., 2016) and have been primarily associated with low-cost but not high-cost pro-environmental behavior (van der Linden, 2018). Complementary to these findings, a recent meta-analysis (Zawadzki et al., 2020) revealed positive associations of engaging in pro-environmental behavior with subjective well-being in general, but also with hedonic and eudaimonic happiness in particular (although this association might be restricted to low-impact behaviors; Krumm, 2024). Another study indicates that this association might be particularly strong when the behavior is observable, provides opportunities for social interaction, and requires more financial costs, time, and effort (Schmitt et al., 2018). Finally, in a randomized controlled experience sampling study, individuals experienced higher levels of happiness and meaning in life after incorporating pro-environmental behavior into their daily routines (Prinzinger, 2024). Taken together, these findings suggest the potential of pro-environmental behavior to reconcile multiple ER goals.

Although previous research related pro-environmental behavior to increased positive emotions, it remains, to our knowledge, unclear how pro-environmental behavior would affect negative emotions as a reaction to environmental threats. Interestingly, a related line of research (Han et al., 2018; Lazar & Eisenberger, 2022; Raposa et al., 2016) indicated the potential of prosocial behavior to buffer the negative emotional and physiological consequences of laboratory and everyday stressors and to increase positive feelings (Aknin et al., 2018) and well-being (Curry et al., 2018; Hui et al., 2020). As pro-environmental behavior can be classified as a specific form of pro-social behavior (De Groot & Steg, 2009), these findings may transfer to the environmental context. Complementary, another body of research has demonstrated the ER effects of problem solving, i.e., attempts to counteract stressful situations or limit their consequences. Accordingly, the frequent use of problem solving was associated with fewer symptoms of psychopathology in a meta-analysis (Aldao et al., 2010). In the environmental domain, an experimental study (Wenzel et al., 2023b) identified problem-focused reappraisal as an effective ER strategy to decrease fear and guilt after receiving information on loss of biodiversity. Taken together, previous studies suggest a promising ER potential of pro-environmental behavior, especially regarding the increase of positive emotions. However, further experimental evidence is necessary to provide information on causality.

3. The present research

In a series of experimental studies, we aimed to investigate the ER potential of pro-environmental behavior. More specifically, we expected

that engaging in pro-environmental behavior after being confronted with threatening information on biodiversity loss would increase hope and decrease fear and guilt. In all three studies, participants were presented with a text about the endangered status of bumblebees and subsequently worked on a consequential pro-environmental behavior task, i.e., the Work for Environmental Protection Task (WEPT; Lange & Dewitte, 2022). Compared to self-report methods, such behavioral tasks involve multiple advantages in terms of validity and experimental control (for an overview, see Lange & Dewitte, 2023). Most critically, they allow observing (Study 1a and 1b) and randomly manipulating (Study 2) participants' engagement in behavior with actual ecological consequences and thus to causally study the possible emotional benefits of pro-environmental behavior.

In Studies 1a and 1b, we investigated whether the number of completed WEPT trials would be positively associated with an increase in hope and decreases in fear and guilt. In Study 2, we aimed to rule out that ER effects of pro-environmental behavior in Study 1a and 1b were merely based on a cool-down effect, as the number of completed WEPT trials was confounded with the time that had passed since the exposure to threatening information. To account for this alternative explanation, participants worked on a modified, version of the WEPT with a fixed time interval between emotional responses. Furthermore, participants, depending on experimental group, worked on a WEPT version either with or without ecological consequences.

4. Studies 1a and 1b

4.1. Methods

In Studies 1a and 1b, we conducted an exploratory re-analysis of two datasets (Wenzel et al., 2023a, Wenzel et al., 2023a). In their first study, these authors have examined whether perceived threat versus perceived efficacy had different effects on conservation behavior (Wenzel et al., 2023a). In their second study, these authors have investigated the differential effects of problem-focused versus emotion-focused reappraisal on threat-mitigating conservation behavior following a threat manipulation (Wenzel et al., 2023b). Here, we will use those datasets to analyze associations between pro-environmental behavior and emotions at the end of the task. In both studies, the WEPT (Lange & Dewitte, 2022) was used to assess pro-environmental behavior and emotional experiences were assessed before and after the task. In the present research, we only present methods and measures that were relevant for the current research question. The full methods of both studies are described in detail in the published manuscripts. All data were retrieved from and are publicly available on OSF (Study 1a: <https://osf.io/6mdhx>; Study 1b: <https://osf.io/qnx5t/>).

4.1.1. Participants and design

4.1.1.1. Study 1a. For the original research question of Study 1a, 510 participants were planned to recruit, providing us with 95% for detecting $r = .16$ correlations and 80% power for detecting $r = .12$ correlations (given $\alpha = .05$, two-sided). Participants who were at least 18 years old, had completed five or more previous studies, had an approval rate of 90% and had not participated in a pilot study were recruited via Prolific (<http://www.prolific.co>). The UK minimum wage of £9.20 in 2022 was used as the basis for financial compensation: for a planned duration of 19 min of participation, participants received £2.90 as financial compensation. Participants who failed an attention check by selecting something other than "not at all likely" for the item: please tick "not at all likely" ($n = 14$) or did not finish the study ($n = 16$) were automatically replaced by Prolific, resulting in the planned sample size of $N = 510$.

4.1.1.2. Study 1b. For the original research question of Study 1b, 760

participants were recruited. Assuming an $\alpha = .05$ (two-sided), this sample size allowed us to detect correlations of $r = .13$ at 95% power and correlations of $r = .10$ at 80% power. Again, participants were recruited via Prolific using the same inclusion criteria as described for Study 1a. Again, based on the UK minimum wage in 2022 and a planned duration of 20 min of participation, all individuals received £3.10. As in the original study (Wenzel et al., 2023b), 67 participants were excluded for failing the attention check, resulting in $N = 693$ participants included in the analyses.

4.1.2. Procedure

4.1.2.1. Study 1a. The online experiment was conducted using Sosci Survey (Leiner, 2022). After giving consent, providing demographic characteristics, and completing a personality questionnaire, participants were asked to report their current emotional experiences as a baseline measure (t_1). Depending on experimental condition, participants then read a text about the declining bumblebee population and the associated threat to humanity, which were manipulated regarding threat intensity (high vs. low threat manipulation) and whether they induced efficacy beliefs or did not (high vs. low efficacy manipulation). Emotions were then measured a second time (t_2). Participants' intentions to engage in pro-environmental behavior and additionally their actual pro-environmental behavior (WEPT) were then measured. Finally, current emotional experiences were assessed for a third time (t_3).

4.1.2.2. Study 1b. The procedure for Study 1b was similar to Study 1a with the only difference that there was no threat manipulation but a reappraisal manipulation, in which participants, depending on experimental condition, were instructed to apply problem-focused or emotion-focused reappraisal or no emotion regulation strategy. Emotional experiences were again measured at the three time points described above (baseline, pre- and post-assessment of the WEPT).

4.1.3. Materials and measures

As described before, all materials (including texts and other manipulations) and measures used in Studies 1a and 1b can be found on OSF. Please note that we only present measures here that are relevant to the present research question.

4.1.3.1. Threat manipulation. To manipulate exposure to a concrete environmental threat, individuals were presented with a text on the decline of bumblebee populations in the UK. Bumblebees and other wild bees as important pollinators are key agents for the maintenance of biodiversity (Potts et al., 2010). Accordingly, participants reported more negative and less positive affect after reading the text on threatened state of bumblebee populations (Wenzel et al., 2023a, Wenzel et al., 2023a).

4.1.3.2. Emotional experiences. In both Study 1a and Study 1b, individuals were asked three times to indicate their current level of fear (afraid, worried, concerned), guilt (ashamed, embarrassed, guilty), and hope (encouraged, hopeful, optimistic) on a scale from 0 (*not at all*) to 6 (*very much*). Each emotional state was measured with three items, which were used to calculate an average score of fear, guilt and hope, respectively.

4.1.3.3. Work for Environmental Protection Task. The WEPT (Lange & Dewitte, 2022) provided participants with the opportunity to engage in consequential pro-environmental behavior. On a voluntary basis, individuals could decide how many pages containing 50 numbers (up to 15 pages) they wanted to screen for numbers consisting of an even first digit and an odd second digit (e.g., 27). For each page screened correctly, £.10 was donated to the Bumblebee Conservation Trust, which helps to save and to reintroduce rare bumblebee species. Thus,

individuals had to repeatedly decide whether to keep working for more donations or to stop, which, like many everyday environmental behaviors, involves a trade-off between behavioral costs and environmental benefits. Before starting the WEPT, all individuals were introduced to the procedure of the task by being asked to identify the target numbers from 20 numbers that were presented on a first page. The actual task then began with a page presenting 50 numbers. With the completion of the first 50-number page, individuals were informed about the potential donations and could continue to work on the WEPT on a voluntary basis (for the complete instructions, see Wenzel et al., 2023b, p. 5). After each completed page, participants had the option to stop the task and be forwarded to the end of the experiment, or to continue the task for up to 15 pages. When participants stopped the task earlier, emotions were measured earlier than when individuals continued the task to the end.

4.2. Analytic approach

The data were prepared in Stata 17 and analyzed in RStudio (R Core Team, 2020). To examine whether working on the WEPT helped individuals to improve their current emotional experiences, we computed linear regression models, in which an emotional state at time point t_3 (i. e., after the WEPT) was predicted by the number of completed WEPT trials, our measure of pro-environmental behavior. In addition, we controlled for the emotional state at time point t_2 (i.e., before the WEPT) to model change in the emotional state, as well as for the experimental manipulations of the respective study to account for their potential effects. We report standardized regression coefficient to ease interpretation and comparison between the estimates of the two studies. Finally, we used a significance criterion of .05.

4.3. Results

On average, participants completed 5.7 pages of the task ($SD = 6.0$, $Mdn = 3$, $Min = 0$, $Max = 15$) in Study 1a and 5.3 pages ($SD = 6.0$, $Mdn = 2$, $Min = 0$, $Max = 15$) in Study 1b. As shown in Table 1, the number of completed WEPT trials was significantly associated with an increase in hope. This was the case for both preliminary Studies 1a and 1b. Similarly, in both studies a greater engagement in the WEPT was associated with a stronger decrease in fear from before to after the WEPT. The evidence for guilt was mixed, as a decrease in guilt was significantly associated with more completed WEPT pages only in Study 1b and not in Study 1a. Thus, we found consistent evidence that engaging in pro-environmental behavior predicted an increase in hope and a decrease in fear, while the evidence regarding guilt was mixed.

5. Study 2

Studies 1a and 1b hinted at an association between effective ER and pro-environmental behavior. However, in both studies, working on the WEPT was confounded with the time interval between emotion ratings. To rule out that the associations between ER effects and pro-environmental behavior were merely based on a cool-down effect,

participants in Study 2 worked on a modified version of the WEPT with a fixed time interval between emotional responses. Furthermore, participants were randomly allocated to a pro-environmental behavior group (PEBG) or a control group (CG). While working on the modified WEPT yielded donations to an environmental organization for participants in the PEBG, participants in the CG worked on the same effort task (checking numbers) without their efforts generating pro-environmental donations. Similar to Studies 1a and 1b, we expected participants in the PEBG, compared to the CG, to experience a greater increase in hope and a greater decrease in fear and guilt regarding emotion ratings before and after the WEPT.

5.1. Methods

The design and analyses were preregistered on OSF (https://osf.io/6v3du/?view_only=f34182788d4548428cff474e81ce0f90) before data collection. We conducted this study in line with the principles of the Declaration of Helsinki. Approval was granted by the ethics committee of the Johannes Gutenberg-University Mainz (2023-JGU-psychEK-S034). All participants provided informed consent before participation.

5.1.1. Participants

An a-priori analysis was calculated using G*Power, yielding a total sample size of $N = 266$ with an expected effect size of $f = .10$, $\alpha = .05$, power = .90 for a mixed model ANOVA with 2 groups and 2 measurement time points. The effects size was estimated based on a meta-analysis indicating small to medium effects of various ER strategies (Webb et al., 2012) and on the small effects we observed in Study 1a and 1b. To account for dropouts, we oversampled by app. 10%, leading to a recruitment target of $N = 300$ participants. As in Studies 1a and 1b, participants were recruited via the online recruiting platform Prolific (<http://www.prolific.com>). We recruited participants that had a minimum age of 18 years, a Prolific approval rate of 90% or higher, completed five or more previous studies on Prolific, and resided in the UK. As reimbursement, participants received £3.00 for a study duration of approx. 18 min.

5.1.2. Procedure

In line with Studies 1a and 1b, the experiment was realized on the online platform SoSci Survey (Leiner, 2022). Participants were randomly allocated to the PEBG or the CG. As depicted in Fig. 1, participants first provided demographic information on age, gender, native language, current residency, and profession, and completed trait questionnaires. After indicating their current emotional states at baseline (t_1), participants read a text on the biodiversity crisis as a manipulation of environmental threat and afterwards rated their emotional states again (t_2). Subsequently, participants were presented with the instructions of the modified WEPT and worked on a practice trial. After 12 min, participants were automatically forwarded to a final rating of their current emotional states (t_3). Finally, participants indicated task difficulty and response efficacy (only PEBG) with regard to the WEPT, and political orientation.

5.1.3. Measures

5.1.3.1. Threat manipulation and emotion ratings. In Study 2, we used the same text on the decline of bumblebee populations to increase negative and decrease positive emotions via threat information and applied the same items to measure emotional experiences as in Studies 1a and 1b.

5.1.3.2. Modified Work for Environmental Protection Task. For Study 2, two aspects of the WEPT (Lange & Dewitte, 2022) were modified. First, while participants are able to work on a maximum of 15 pages in the original version of the WEPT, they were limited to working on the task

Table 1
Results of the linear regressions in studies 1a and 1b, in which emotions after the WEPT were predicted by the number of completed WEPT trials controlling for emotions before the WEPT.

Outcome	Study 1a		Study 1b	
	β	95% CI	β	95% CI
Fear	-.20	[-.27, -.13]	-.09	[-.13, -.05]
Guilt	.02	[-.05, .09]	-.16	[-.21, -.11]
Hope	.16	[.11, .21]	.10	[.06, .14]

Note. Standardized regression estimates in bold are significant at $p < .05$, i.e., do not include zero in their 95% confidence interval. WEPT = Work for Environmental Protection Task.

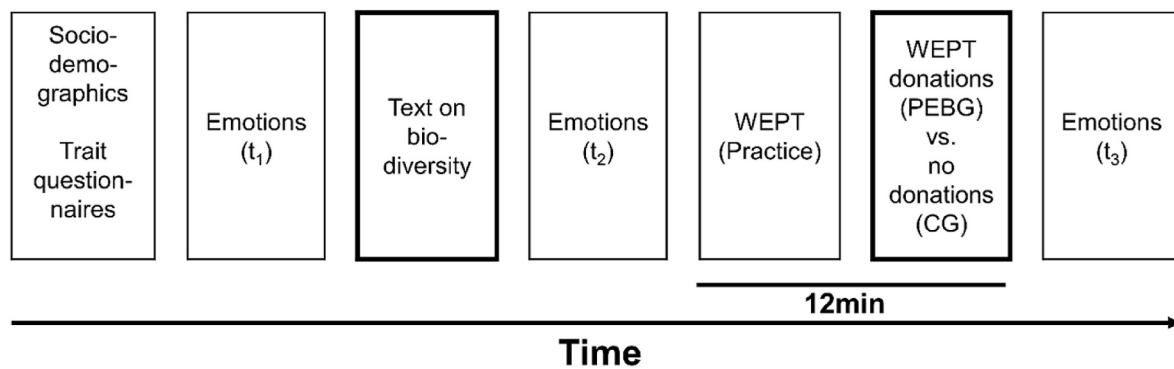


Fig. 1. Experimental Procedure

Note. t = time point; WEPT = Work for Environmental Protection Task; CG = Control group; PEBG = Pro-environmental behavior group.

for a pre-defined duration in the modified version. For this purpose, we started a timer set on 12 min right after the second emotion rating (see Fig. 1). In a pilot study ($N = 87$), participants spent $M = 127$ s ($SD = 61$ s) with the WEPT instructions and the example trial. Accordingly, a duration of approximately 10 min remained for the voluntary main part of the WEPT. Pre-defining a fixed period between the pre-experimental emotion ratings (t_2) and post-experimental emotion ratings (t_3) in this modification allows for an investigation of emotional change controlled for potential confounding effects of time.

Second, we manipulated pro-environmental behavior by providing participants with partly different instructions in the WEPT depending on experimental group. While participants in the PEBG were informed that completing a page in the WEPT would yield donations to an environmental organization, participants in the CG were merely instructed to thoroughly work on the task:

“For the remaining time, please continue with the number identification task.”

[PEBG] If you complete it accurately, you can also do something good for the bumblebees. For every page of numbers that you correctly complete, we will make donations to the Bumblebee Conservation Trust, an environmental non-profit organization in the UK working on increasing the number and distribution of bumblebees. The Bumblebee Conservation Trust invests, for example, in saving the Great Yellow bumblebee and Shrill carder bee in the UK. All donations that you generate will actually be made (they are not hypothetical).

Each page consists of 50 numbers and for each page you complete correctly, we will donate £0.10 to the Bumblebee Conservation Trust.

[CG] Each page consists of 50 numbers.

You can complete these pages as quickly or slowly as you want, but please note that we can only count pages that are at least 90% correct. We will not give you feedback, so please check whether your answers are correct before proceeding to the next page.

After the remaining time has elapsed, you will be automatically forwarded to the last part of the study.”

To further emphasize the pro-environmental consequences of the WEPT in the PEBG, we provided a short feedback between the WEPT pages:

[PEBG] “Thank you for completing the page. Remember: you will donate another £0.10 to the Bumblebee Conservation Trust for each additional completed page. Please try to complete the pages as accurately as possible because we can only count pages that are at least 90% correct.”

[CG] “Thank you for completing the first page. Remember: Please try to complete the pages as accurately as possible.”

5.1.3.3. Trait measures. Out of the additional trait and state measures, we included biospheric values and political orientation in further exploratory analyses, as both measures have been associated with eco-emotions in previous studies (Bouman et al., 2020; Leite et al., 2023). We assessed biospheric values orientation (De Groot & Steg, 2008) with four 9-point items (e.g., “Preventing pollution”; $-1 = “opposed to the value”$, $0 = “not at all important”$, to $7 = “of supreme importance”$; $\alpha = .86$). Participants indicated their political orientation on a single-item left-right scale (11-point scale from $1 = “left”$ to $11 = “right”$; Bauer et al., 2017). Exploratory analyses indicated that neither biospheric values nor political orientation moderated the effects of group on emotional changes (see Appendix A). In addition, our openly available dataset (https://osf.io/p7env/?view_only=c67e38648d7b4a1f84115f981404239) contains measures of nature relatedness, Big Five personality traits, and psychological distress that are not further treated in this manuscript.

Finally, all participants indicated task difficulty (“How easy or hard was it for you personally to work on the number identification task?”; $1 = “extremely hard”$ to $7 = “extremely easy”$) and participants in the PEBG response efficacy of the WEPT (“In your opinion, what effect did your work on the number identification task have on the extinction of bumblebees in the UK?”; $1 = “no effect”$ to $7 = “strong effect”$). Exploratory analyses did not reveal any effects of response efficacy on emotional changes in the PEBG (see Appendix A).

5.2. Analytical plan

For all main analyses, we used a significance level of $p < .05$ and applied the Šidák correction to account for multiple comparisons (Šidák, 1967). We used SPSS 27 (IBM CORP, 2020) to prepare and analyze the data. For the main analyses, we conducted mixed-design ANOVAs with time as within-subject factor (emotional states at t_2 vs. t_3) and group as between-subject factor (PEBG vs. CG) for each emotion separately. Furthermore, we computed paired samples t -tests to examine the emotional impact of the text on biodiversity.

5.3. Results

5.3.1. Preliminary analyses

As preregistered, we collected data from 300 participants in the UK and excluded five participants who completed less than three pages in the WEPT, resulting in a final sample size of $N = 295$ (PEBG: $n = 149$; CG: $n = 146$). The mean age was 40.4 years ($SD = 11.9$) and 52.5% of participants identified as female and 47.5% as male. Most participants were employed full time (64.4%) or self-employed (10.8%).

We conducted paired samples t -tests to examine the emotional impact of the threatening text on biodiversity. Participants reported higher levels of fear after reading the text ($M_{t2} = 3.3$, $SD_{t2} = 1.5$) compared to baseline ($M_{t1} = 1.7$, $SD_{t1} = 1.6$), $t(294) = 17.30$, $p < .001$, $d = 1.01$, 95% CI [.87, 1.15]. Similarly, participants reported higher

levels of guilt after reading the text ($M_{t2} = 1.8$, $SD_{t2} = 1.6$) compared to baseline ($M_{t1} = .8$, $SD_{t1} = 1.2$), $t(294) = 11.36$, $p < .001$, $d = .66$, 95% CI [.54, .79]. Finally, participants reported lower levels of hope after reading the text ($M_{t2} = 2.4$, $SD_{t2} = 1.4$) compared to baseline ($M_{t1} = 3.5$, $SD_{t1} = 1.4$), $t(294) = -14.38$, $p < .001$, $d = -.84$, 95% CI [- .97, -.70]. Consistent with previous studies, the biodiversity threat text increased negative emotions and decreased positive emotions (Wenzel et al., 2023a, Wenzel et al., 2023a).

Regarding the WEPT, participants found it overall neither hard nor easy to work on the number identification task ($M = 5.3$, $SD = 1.3$) and participants in the PEBG estimated a small to medium effect of their work on the task on the extinction of bumblebees in the UK ($M = 3.0$, $SD = 1.6$). Finally, we examined whether participants in our two experimental groups differed in how thoroughly they completed the WEPT. Participants in the PEBG completed on average 10.6 pages ($SD = 3.0$, $Mdn = 11$, $Min = 4$, $Max = 15$), while participants in the CG likewise completed on average 10.6 pages ($SD = 3.4$, $Mdn = 11$, $Min = 3$, $Max = 15$). The number of completed pages of the WEPT did not significantly differ between both groups, $p = .867$, $d = .02$, 95% CI [- .21, .25].

5.3.2. Preregistered main analyses

In line with our main hypotheses, we expected participants in the PEBG (vs. CG) to experience stronger decreases in fear and guilt and a stronger increase in hope after the WEPT (t_3) compared to before the WEPT (t_2). As preregistered, we corrected for multiple comparisons due to testing three emotional outcomes by using the Šidák-corrected threshold of $p < .017$ to interpret the significance of the results. Regarding fear, a mixed-design ANOVA revealed a significant main effect of time, but no significant main effect of group on fear ratings (see Table 2). Contrary to our hypothesis, there was no significant time $\times$ group interaction effect on fear. As shown in Fig. 2, participants in the CG reported a similar, significant decrease in fear, $t(145) = 14.72$, $p < .001$, $d = 1.22$, 95% CI [1.00, 1.43], as participants in the PEBG, $t(149) = 14.31$, $p < .001$, $d = 1.34$, 95% CI [.96, 1.38], when comparing ratings before and after the WEPT.

For guilt ratings, we found a similar pattern with a significant main effect of time, but no significant main effect of group, nor a significant time $\times$ group interaction effect (Table 2). Accordingly, when comparing ratings before and after the WEPT, participants in the CG reported a similar decrease in guilt, $t(145) = 9.31$, $p < .001$, $d = .77$, 95% CI [.59, .95], as participants in the PEBG, $t(149) = 7.00$, $p < .001$, $d = .57$, 95% CI [.40, .75], as shown in Fig. 2b.

Finally, we examined the effect of pro-environmental behavior on hope ratings. Again, we found a significant main effect of time, but no significant main effect of group. However, the ANOVA indicated a significant time $\times$ group interaction effect (Table 2): Although both experimental groups reported a significant increase in hope from before to after working on the WEPT (see Fig. 2c), this increase was significantly weaker in the CG, $t(145) = -5.36$, $p < .001$, $d = -.44$, 95% CI [- .61, -.27], than in the PEBG, $t(149) = -9.94$, $p < .001$, $d = -.81$, 95% CI [-1.00, -.63]. In summary, participants experienced an overall decrease in negative emotions irrespective of group, but generating donations to an environmental organization was associated with a stronger increase in positive emotions.

Table 2

Results of the mixed design ANOVAs on the effects of time, group, and their interaction on fear, guilt, and hope ratings.

	Fear			Guilt			Hope		
	<i>F</i>	<i>p</i>	η^2	<i>F</i>	<i>p</i>	η^2	<i>F</i>	<i>p</i>	η^2
Time (t_2 vs. t_3)	421.20	<.001	.59	133.73	<.001	.31	114.30	<.001	.28
Group (CG vs. PEBG)	3.59	.060	.12	.94	.333	<.01	.10	.754	<.01
Time $\times$ Group	2.68	.103	.01	3.36	.068	.01	7.82	.006	.03

Note. For all ANOVAs: $df = 1, 293$. CG = Control group; PEBG = Pro-environmental behavior group; t_2 = before the number identification task; t_3 = after the number identification task. Significant effects highlighted in bold.

6. Discussion

In a series of studies, we investigated the ER potential of pro-environmental behavior. Specifically, we hypothesized that engaging in pro-environmental behavior would reconcile hedonic and eudaimonic ER goals and consequently decrease fear and guilt and increase hope after being confronted with environmental threats. In Studies 1a and 1b, we reanalyzed experimental data and consistently found significant associations between time spent on a pro-environmental behavior task and increases in hope and decreases in fear, but decreases in guilt only in Study 1b. To examine whether these associations with pro-environmental behavior in both studies were merely due to longer time intervals between emotional ratings when spending more time on the pro-environmental behavior task, we controlled for the experimental duration in Study 2. Similar to the previous studies, participants who worked on the task with environmental donations reported stronger increases in hope than participants who worked on a neutral task without donations. However, participants in both groups experienced similar decreases in fear and guilt.

6.1. Emotion-specific effects of pro-environmental behavior

Taken together, our results most consistently support the notion of pro-environmental behavior increasing positive emotions. This finding is consistent with previous research, which has found robust correlational evidence for a positive association of pro-environmental behavior with positive emotions and well-being (Zawadzki et al., 2020). Individuals may feel more positive after pro-environmental behavior due to an improved self-image (Venhoeven et al., 2016), a sense of meaningfulness (Venhoeven et al., 2020), and increased self-worth (Tezer & Bodur, 2020). Although not all pro-environmental behavior is necessarily driven by moral reasons (e.g., insulating a home to save money; Gifford & Nilsson, 2014), participants in our studies were not offered any incentives to work on the pro-environmental behavior task apart from donating to an environmental organization. Therefore, it is plausible that participants saw themselves as morally good after working on the WEPT and consequently felt more positive. Additionally, participants who acted pro-environmentally in our studies may have experienced an increased self-efficacy regarding the environmental threat. Previous research has shown that individuals with a high sense of personal control report higher levels of happiness (Verme, 2009) and increased pro-environmental behavior (Engqvist Jonsson & Nilsson, 2014). Future research could focus on the potentially reciprocal relationships between pro-environmental behavior, self-efficacy, and positive emotions. In this context, constructive hope (in contrast to hope based on denial) may be particularly relevant, as it has been positively associated with environmental engagement (Geiger et al., 2023; Lagomarsino & Lemarié, 2024; Ojala, 2015) and policy support (Feldman & Hart, 2018).

Although decreases in fear ratings were correlated with more pro-environmental behavior in Studies 1a and 1b, these emotional changes may be attributed to a cool-down or distraction effect, as individuals who worked on the pro-environmental behavior task did not experience a stronger decrease in fear than individuals who worked on the neutral task in Study 2. Possibly, participants in the PEBG maintained a certain

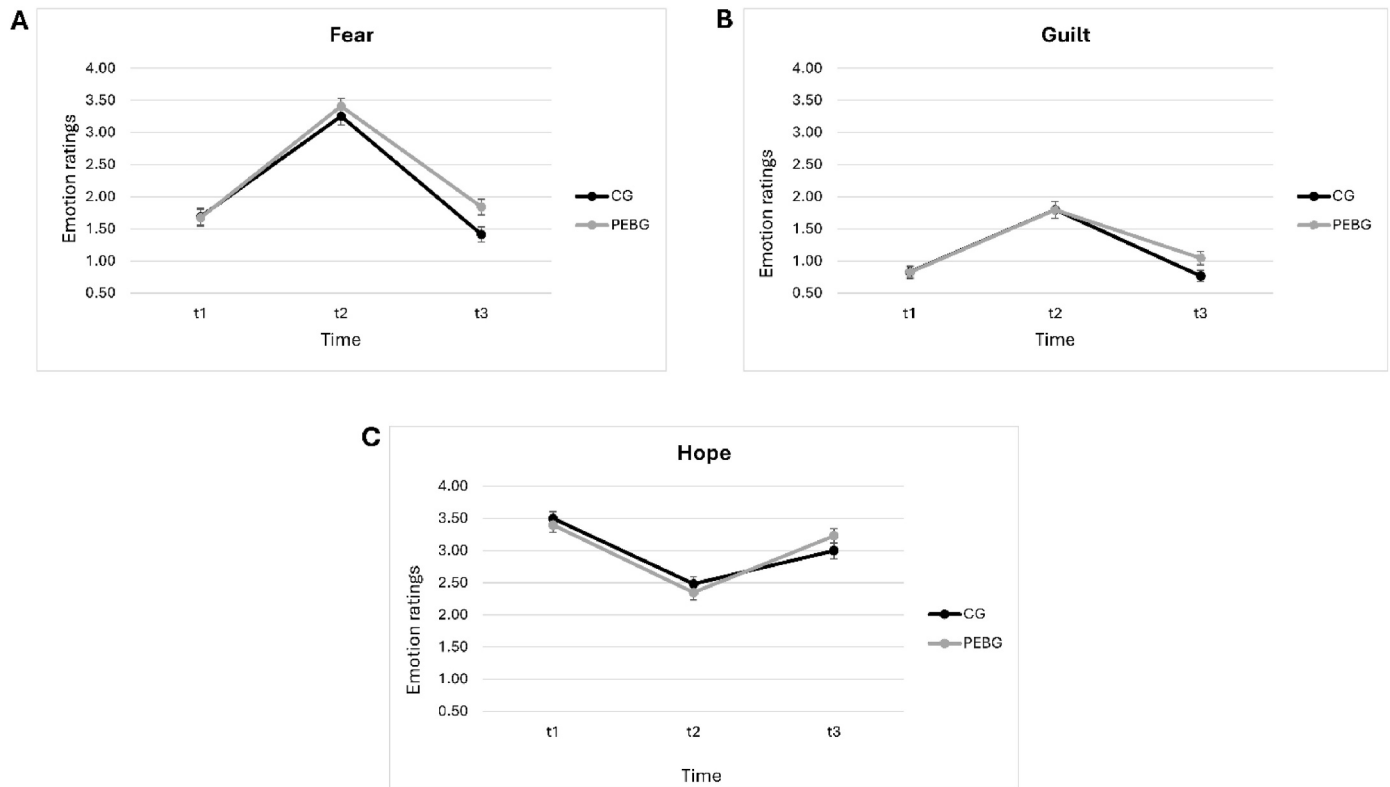


Fig. 2. Emotional Changes Over Time Depending on Experimental Group.

Note. CG = Control group; PEBG = Pro-environmental behavior group; t₁ = before the biodiversity text; t₂ = before the number identification task; t₃ = after the number identification task. Error bars represent standard error of the mean.

level of environmental concern, as the conservation-related information after every WEPT page acted as a reminder of the environmental threat. As recent research emphasized the potentially motivating effects of ecological worry on pro-environmental behavior (Ágoston et al., 2022; Bouman et al., 2020), maintaining a certain level of fear despite acting pro-environmentally may be an adaptive mechanism. Accordingly, an overregulation of fear could hinder the achievement of instrumental ER goals. However, a limited number of qualitative and quantitative studies indicated elevated distress in populations who regularly engage in pro-environmental behavior, e.g., climate activists (Bird et al., 2024) or environmental workers (Noy et al., 2022). Future studies are necessary to investigate possible increases of fear depending on the type and frequency of pro-environmental behavior as well as adaptive extents of fear regulation to manage the possible trade-off between instrumental and hedonic ER goals.

Similar to fear, the association between decreases in guilt and pro-environmental behavior in Study 1a was likely based on a cool-down effect, as Study 2 did not indicate significant differences in guilt change between both experimental groups. Notably, participants reported overall rather low levels of guilt in our studies and the threat manipulation was less effective at increasing guilt than increasing fear and decreasing hope. Previous experimental research specifically induced guilt by providing false feedback on a carbon footprint calculator (Adams et al., 2020). The biodiversity text in our studies, in contrast, did not explicitly manipulate or emphasize the participant's personal responsibility for the environmental threat, possibly resulting in overall low guilt scores. In the prosocial domain, the decrease in guilt via reparative action was found to depend on the effectiveness of the reparative action with less decrease for partial than for full repairs (De Hooge, 2012). Participants in Study 2 estimated the effect of their work on the WEPT on the endangered status of bumblebees in the UK as overall small and therefore potentially insufficient to alleviate guilt. To follow up on this hypothesis, future studies on guilt regulation should

include low and high-impact pro-environmental behavior.

6.2. Strengths and limitations

Although a few previous studies experimentally investigated the positive emotional consequences of pro-environmental behavior, they mainly focused on green consumption (Tezer & Bodur, 2020) or hypothetical behavior (Venhoeven et al., 2020). In the present research, we implemented a consequential and effortful task with a high external validity for pro-environmental behaviors that involve a trade-off between effort and environmental benefits (Lange & Dewitte, 2023). Furthermore, we were able to control for several confounding variables in Study 2 by implementing a similar task in both experimental groups and solely manipulating the environmental consequences. For example, a fixed time interval ensured that the emotional change in the course of pro-environmental behavior was not merely a product of *hedonic adaptation* (Frederick & Loewenstein, 1999), i.e., emotions returning to a relatively neutral set point over time. Furthermore, as participants in both groups worked on the same number identification task, we controlled for task complexity, which was found to influence mood regulation (Van Dillen & Koole, 2007). Finally, we assessed participants' biospheric values and political orientation and the emotion regulation effects were not affected by both variables. Thus, various populations may emotionally profit from pro-environmental behavior. However, as we conducted all three studies in Prolific samples, replications in other populations are necessary to examine the generalizability of our findings.

Despite the benefits of the experimental design, our studies are limited in several ways. First, we compared pro-environmental behavior to a rather tedious task. Although this comparison contributed to a high internal validity, the number identification task most likely represents monotonous work. Future studies may compare pro-environmental behavior to more hedonic activities or other established ER strategies

(e.g., cognitive reappraisal) to test the generalizability of our findings. Second, we may have underestimated the ER effects of pro-environmental behavior in our studies. Previous research found the highest correlations between life satisfaction and pro-environmental behavior that was observable, provided opportunities for socially interactive, and required financial costs, time, and effort (Schmitt et al., 2018). Although work on the WEPT is certainly effortful, it is neither observable by others nor does it include any social interactions. Consequently, individuals may experience an even greater increase in positive emotions with a pro-environmental behavior intervention that integrates these social factors.

6.3. Conclusion

Across all three studies, we found increased hope for individuals who acted pro-environmentally. Fear and guilt, on the other hand, diminished over time regardless of pro-environmental behavior. Drawing hope from pro-environmental behavior, while maintaining a certain level of concern and responsibility, may be an adaptive emotional response in the face of ongoing environmental crises. These findings may be especially relevant for environmental interventions that could take advantage of the potentially reciprocal relationship between hope and pro-environmental behavior. For example, environmental communicators could highlight the affective benefits of acting pro-environmentally to leverage hedonic motives, which is in line with recent research suggesting to frame pro-environmental behavior as intrinsically desirable rather than a burden or self-sacrifice (Prinzing, 2023). Furthermore, the current findings may inform counseling services for individuals who are exposed to acute or subacute environmental threat. As these individuals are especially vulnerable to mental health problems (Crane et al., 2022), engaging in personally meaningful

forms of pro-environmental behavior may be an effective strategy to regain a sense of control and affective well-being. In sum, while hedonically motivated emotion regulation strategies can get in the way of instrumental goals, pro-environmental behavior can satisfy both motives. After all, doing good can also feel good.

CRedit authorship contribution statement

Peter Zeier: Writing – original draft, Visualization, Software, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Florian Lange:** Writing – review & editing, Methodology, Conceptualization. **Zarah Rowland:** Writing – review & editing, Writing – original draft, Visualization, Formal analysis, Data curation. **Michèle Wessa:** Writing – review & editing, Supervision. **Mario Wenzel:** Writing – review & editing, Supervision, Software, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization.

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Declaration of Interest

None.

Appendix A

Exploratory analyses of biospheric values and political orientation as moderators of the group effects on emotional changes and effects of response efficacy on emotional changes in the Pro-environmental behavior group.

We computed ANCOVAs to explore whether the effects of the pro-environmental behavior intervention on emotional changes were moderated by biospheric values and political orientation. Furthermore, we explored whether emotional changes in the Pro-environmental behavior group were associated with the level of response efficacy. Similar to the main analyses, we corrected for multiple comparisons due to testing three emotional outcomes by using the Sidák-corrected threshold of $p < .017$ to interpret the significance of the results. As shown in Table A1, the ANCOVAs did not indicate significant time $\times$ group $\times$ biospheric values interactions on fear, guilt, or hope. In other words, the effects of experimental group on emotional changes were not moderated by biospheric values. Interestingly, the ANCOVA revealed significant two-way interactions regarding biospheric values and time for all three emotions, indicating that participants experienced stronger increases in hope and stronger decreases in fear and guilt with higher levels of biospheric values. Regarding political orientation, the ANCOVAs likewise indicated no significant time $\times$ group $\times$ political orientation effects on fear, guilt, or hope nor time $\times$ political orientation effects. Finally, the analyses did not reveal time $\times$ response efficacy interactions for any emotion in the Pro-environmental behavior group. However, the ANCOVAs revealed a significant main effect of response efficacy on hope, i.e. participants who had overall higher hope ratings before and after the experimental task also rated their work on the experimental task as more impactful.

Table A1

Results of the mixed design ANCOVAs on the effects of time, group, moderator (biospheric values and political orientation), and their interactions on fear, guilt, and hope ratings.

	Fear			Guilt			Hope		
	<i>F</i>	<i>p</i>	η^2	<i>F</i>	<i>p</i>	η^2	<i>F</i>	<i>p</i>	η^2
Biospheric values as moderator									
Time (t2 vs. t3)	436.43	<.001	.60	134.01	<.001	.32	117.86	<.001	.29
Group (CG vs. PEBG)	2.02	.157	<.01	.43	.512	<.01	.32	.858	<.01
Biospheric values	25.82	<.001	.08	9.26	.003	.03	1.58	.210	<.01
Time $\times$ Group	4.37	.038	.02	4.49	.035	.02	6.08	.014	.02
Time $\times$ Biospheric values	16.28	<.001	.05	7.12	.008	.02	11.92	<.001	.04
Group $\times$ Biospheric Values	.36	.549	<.01	.25	.618	<.01	1.21	.272	<.01
Time $\times$ Group $\times$ Biospheric values	.02	.902	<.01	.71	.790	<.01	.13	.719	<.01
Political orientation as moderator									
Time (t2 vs. t3)	424.71	<.001	.59	135.80	<.001	.32	113.51	<.001	.28

(continued on next page)

Table A1 (continued)

	Fear			Guilt			Hope		
	F	p	η^2	F	p	η^2	F	p	η^2
Group (CG vs. PEBG)	3.49	.063	.01	.88	.348	<.01	.16	.691	<.01
Political orientation	15.00	<.001	.05	7.31	.007	.02	23.07	<.001	.07
Time × Group	2.76	.098	.01	3.43	.065	.01	7.82	.006	.03
Time × Political orientation	1.66	.199	.01	.27	.602	<.01	.17	.684	<.01
Group × Political orientation	.61	.437	<.01	2.62	.107	.01	.07	.791	<.01
Time × Group × Political orientation	2.49	.116	<.01	4.77	.030	.02	.58	.449	<.01

Note. For all ANCOVAs: df = 1, 291. CG = Control group; PEBG = Pro-environmental behavior group; t₂ = before the number identification task; t₃ = after the number identification task. Significant effects highlighted in bold. Biospheric values and political orientation centered at the mean.

Table A2

Results of the repeated measures ANCOVAs on the effects of time, response efficacy, and their interactions on fear, guilt, and hope ratings.

	Fear			Guilt			Hope		
	F	p	η^2	F	p	η^2	F	p	η^2
Time (t ₂ vs. t ₃)	205.13	<.001	.58	49.43	<.001	.25	98.37	<.001	.40
Response efficacy	<.01	.951	<.01	.98	.323	<.01	22.63	<.001	.13
Time × Response efficacy	1.34	.248	<.01	2.21	.139	.01	.50	.483	<.01

Note. For all ANCOVAs: df = 1, 147. t₂ = before the number identification task; t₃ = after the number identification task. Significant effects highlighted in bold. Response efficacy centered at the mean.

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