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Worth more than 1000 words: how photographs can bolster viewers' valuing of biodiversity

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Summary

For many, declining biodiversity represents an emotionally and psychologically distant 'cost' – similar to how a number of people perceive climate change. Using an expectancy-value theory framework, we showed participants photographs that visibly illustrated the threat of biodiversity loss. Specifically, we tested a combination of preregistered and exploratory hypotheses through an online experiment (n = 843) to understand whether viewing photographs of plants and animals (with and without captions) bolstered people's valuing of biodiversity and willingness to donate to a nature-focused charity relative to a control group. Participants who viewed photographs (without captions) valued biodiversity more and donated more to the nature-focused charity; those who viewed photographs with captions showed similar though more muted (non-statistically significant) effects. Follow-up mediation analyses on the photographs-only participants suggested that the photographs may have catalysed negative emotions that increased valuing of biodiversity and, in turn, increased donations. This study provides preregistered evidence that thoughtfully selected photographs boost people's valuing of biodiversity and exploratory evidence that the pathway through which that might occur is more likely via negative emotions than through reduced psychological distance. Educators, conservationists, journalists and others may find these results informative as they develop strategies for addressing the acute problem of biodiversity loss.

The United Nations' expert group on biodiversity and ecosystems recently released a bleak forecast of the state of the world's flora and fauna (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services 2019). Declining biodiversity exacts high costs on all of humanity, including impacts on energy (e.g., wood fuel), medicines, food and even the air people breathe. As the cause of much of the loss of biodiversity, humans can still mitigate some of this decline and many of its repercussions. Thus, increasing people's valuing of biodiversity and understanding of the costs of biodiversity loss, as well as their desire to take action represent particularly urgent problems.

However, getting people to notice, care about and ultimately act to prevent declining biodiversity faces an unusual paradox. On the one hand, species of all sorts are highly visible to almost everyone across the entire planet. On the other hand, people struggle to observe species' rapid disappearance (Pett et al. 2016). Similar to people's perceptions of climate change, the extinction of species represents the kind of distant, non-immediate threat that our brains struggle to perceive and process (Gifford 2014, Clayton et al. 2015). Moreover, experts estimate that we have discovered only a small fraction of all the species on the planet (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services 2019). Consequently, it is even harder to comprehend how valuable yet-to-be-discovered species are and how costly their loss would be.

Expectancy-value theory (Wigfield & Eccles 2000) provides a lens to help understand how people's values contribute to their motivation. Typically invoked in achievement domains, expectancy-value theory suggests that people will be motivated to pursue certain goals based on the degree to which they might reasonably expect to achieve those goals and how much they value those goals. The third key element of the theory – the costs of pursuing a particular goal – has typically been thought to work in opposition to the valuing of that goal (Flake et al. 2015). For example, a student who is motivated to get an A on an exam but perceives the costs of missing out on a party as too high might not ultimately be motivated to study. Therefore, this theoretical paradigm views costs as a counterbalance that undermines motivation.

As a theoretical contribution of our study, we explore the possibility that perceived costs could enhance motivation (rather than assuming that values and costs will necessarily function in opposition). Specifically, we test whether making visible the hard-to-see 'costs' of biodiversity

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loss might increase people's valuing of biodiversity. Scholarship on loss aversion (Kahneman 2011), which argues that people feel losses more acutely than corresponding gains, also suggests that this approach of using potential costs to increase valuing could be effective.

How might perceived costs lead to greater valuing in the specific context of biodiversity? Expectancy-value theory suggests that seeing photographs and/or captions illustrating the effects of biodiversity loss might help people more clearly focus on an issue that otherwise seems abstract, scientific and unemotional, thereby making it seem more salient, resonant, important and, potentially, more valued. Correspondingly, the strategies to mitigate this loss might seem more useful and necessary.

In addition to photographs being used regularly by conservation groups, scholars have examined the use of images in domains such as animal conservation (e.g., Gunnthorsdottir 2001, Colléony et al. 2017). Related research suggests that images rated as being highly relevant to climate change tend to make people feel more emotionally aroused and more negative (Lehman et al. 2019). Given the mixed results that informational campaigns have had in persuading people to increase their concerns about climate change (Hart & Nisbet 2012, Geiger et al. 2017), photographs or other visual illustrations of what might be lost may better enhance people's valuing of different species. Presumably, this strategy needs to be enacted with finesse, however; when participants become overwhelmed by dire messages they may feel a sense of helplessness (Salomon et al. 2017) and/or a lack of efficacy to act on the problem (Feinberg & Willer 2011, Curnock et al. 2019). In other words, photographs that tell a story that is too intense or depressing might inhibit viewers from taking action by making the emotional costs to the self too great. On the other hand, and perhaps most relevant to the present study, Swim and Bloodhart (2015) use photographs and an emotion-related induction and find that emotions do facilitate pro-environmental behaviour, thus suggesting that finding the right level of emotional arousal to produce behavioural changes is a tractable challenge.

Alternatively, perhaps photographs' potential effectiveness for increasing people's valuing of biodiversity stems not from their capacities to elicit negative emotions but instead from their concrete, tangible nature. Seeing that which is hard to otherwise perceive may reduce the psychological distance of otherwise abstract issues such as biodiversity loss (Schuldt et al. 2018). Furthermore, even if pictures are worth 1000 words, captions offering brief explanations and interpretations might offer an even better way to frame viewers' understandings of what they are seeing. The multimedia principle establishes that people learn more from visual images and text than from either alone (Mayer 2009). Moreover, strategic framing can affect people's attitudes about climate issues (Hurlstone et al. 2014). On the other hand, framing issues of biodiversity is complicated (Elliott 2020); the meaning that is intended by a caption author might not be the meaning that is received by a caption reader. So knowing whether and the extent to which captions enhance the photographic approach will be useful for those working to change people's attitudes and behaviours regarding biodiversity.

In the current study, we tested whether photographs could bolster participants' valuing of biodiversity (as assessed by a survey scale) and subsequently impact their behaviours (specifically their willingness to donate to an environmental charity) as compared to a control group that saw no photographs. Because the framing of environmental issues is particularly important (Clayton et al. 2015), we included two treatment groups: one that saw photographs only and another that saw the same photograph and a caption that explained the content of the photograph. Because there is no real-world analogue to a caption without a photograph and because our captions explicitly reference the content of our photographs, we did not test a 'captions-only' treatment condition. Relatedly, the conflicts in the aforementioned literature suggest that predicting which treatment approach is more effective would be premature; thus, we did not preregister a hypothesis comparing the two treatment groups. We selected the photographs deliberately to signal the value of biodiversity specifically by highlighting the costs of what would be lost if the declines in biodiversity continue (Curnock et al. 2019). We tested two preregistered hypotheses (Gehlbach & Robinson 2018), specifically that (1) participants who view photographs and (2) those who view photographs with captions will report higher valuing of biodiversity than participants who do not see photographs (see https://osf.io/632dk/ for the full preregistration).

Methods

Participants

We first conducted four pilot tests to help calibrate the efficacy of our intervention using different stimuli, the sensitivity of our measures, the magnitude of our effects and an appropriate sample size for a preregistered experiment with three conditions given those effects. From these pilots, we knew that we wanted a final sample size of 250 participants per condition – which would give us 80% power to detect an effect size of 0.19 or greater – and thus we recruited a greater number of participants to allow for attrition (see our preregistration at https://osf.io/632dk/ for more details). After preregistering the study, we used Amazon's Mechanical Turk to obtain a final sample of 843 participants (47% female, 48% male, with 5% choosing not to answer). Our participants had a mean age of 38.4 years; their median education level was a bachelor's degree. Politically, 410 participants identified as liberals, 162 as moderates and 262 as conservatives (with 9 participants not reporting). To help compare our sample to a US-based, nationally representative sample on a small but important aspect, we asked our participants the most relevant question of those posed in Yale's Climate Survey (Leiserowitz et al. 2019): 'How much do you think global warming will harm plant/animal species?'. Our respondents were slightly more concerned (82% reporting 'a moderate amount' or 'a great deal') than respondents of the most recent Yale Climate Survey (71%) at the time of data collection.

We arrived at our final sample from an original group of 1007 after having excluded participants who failed a screener question ($n = 164$) that tested whether they were reading the initial instructions and were never assigned to a condition, as well as one participant who failed the screener question but advanced in the survey due to a technical glitch. In line with our preregistration, we removed participants ($n = 7$) who produced 10 or more identical, sequential responses on the emotion items after our valuing of biodiversity scale. There were also three participants who did not complete the biodiversity scale. Finally, two participants took the survey twice, and we removed the data from the second time they took it.

Measures

Our preregistration and Table 1 list all composite and outcome measures collected in the study; here, we report on the focal measures for the analyses of interest. Four self-report measures and one

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Table 1. Means, standard deviations and correlations of study variables.

	M	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Valuing of biodiversity	3.44	0.78										
(2) Affinity for nature	3.16	0.69	0.63									
(3) Environmental optimism	2.66	0.93	0.38	0.40								
(4) Negative emotions	19.40	22.73	0.28	0.14	0.13							
(5) Concern for biodiversity	3.16	1.02	0.77	0.50	0.37	0.36						
(6) Psychological distance	0.40	0.24	0.52	0.31	0.26	0.29	0.59					
(7) Biodiversity psychological distance	0.46	0.20	0.64	0.44	0.33	0.35	0.73	0.80				
(8) Valuing of environmental education	3.95	0.88	0.59	0.39	0.29	0.17	0.68	0.57	0.64			
(9) Biodiversity knowledge test	7.46	1.92	0.03	0.03	−0.25	−0.09	0.04	−0.08	−0.04	0.10		
(10) Donation to environmental charity (cents)	25.19	18.00	0.39	0.23	0.05	0.18	0.43	0.35	0.43	0.39	0.12	
(11) Number of biodiversity-related articles read	2.39	2.34	0.43	0.33	0.34	0.21	0.43	0.33	0.38	0.33	−0.05	0.19

Note: n-values ranged from 839 to 843.

behavioural item comprised our main measures. First, participants completed a five-item measure assessing how much they value biodiversity ($\alpha = 0.82$). In the treatment conditions, a relevant image selected by the research team to convey the cost of losing different elements of biodiversity was displayed alongside each item. For example, the item 'How important do you think it is for humans to take action to make sure that endangered species survive?' was paired with the photograph of a man feeding a baby elephant that appears in ill health. In the caption condition, participants read how volunteers in Africa were helping to protect elephants from ivory poachers but that the loss of elephants has nearly doubled in the past 20 years. The intervention photographs, including the full set of pairings between each survey item, photograph and caption, are available from the first author upon request.

In addition, participants completed two five-item measures of psychological distance. The first focused on psychological distance from climate change in general ($\alpha = 0.87$), while the second focused on distance from the effects of declining biodiversity in particular ($\alpha = 0.74$). See Supplementary Table S1 (available online) for the full measures. Finally, we created a composite of five negative emotions ($\alpha = 0.93$) – sad, guilty, worried, frustrated and scared – by instructing participants to use a slider bar to 'please indicate how much you're feeling each different emotion right now'.

In addition to the self-report measures, participants gave a small donation to a non-profit organization of their choice in response to the following invitation: 'We would like to offer you US$0.50 to donate to charities of your choosing. Donating to a charity will not affect your compensation.' Participants then used slider bars on the web interface to allocate how much money went to The Nature Conservancy, Save the Children and/or the American Cancer Society and were provided with a brief description of each. The outcome of interest was the amount donated to The Nature Conservancy.

Procedure

After being randomly assigned to a control group (n = 281), a treatment group that saw only photographs (n = 280) or a treatment group that saw photographs and captions (n = 282), all participants responded to the valuing of biodiversity scale. Next, participants recorded their current emotional state (including the five negative emotions of interest), the two scales on psychological distance, the donation item, several additional measures and demographic items. We paid participants US$2.00 upon completion of the survey.

All materials, data and statistical code are available from the lead author upon request.

Results

To guide the testing of our preregistered hypotheses, we first evaluated whether our randomization produced equivalent groups in comparing each treatment group against the control condition. A multinomial logistic regression identified no significant discrepancies between groups based on gender, age, education or political orientation ($\chi^2_{(8)} = 14.01$, $p = 0.082$). The remainder of our analyses follow Cumming's (2014) recommendations by focusing on confidence intervals (CIs) – 97.5% CIs for our two pre-specified hypotheses and 95% CIs for our exploratory analyses – and effect sizes (rather than p-values). See Table 1 for the descriptive statistics of the variables collected.

Pre-specified hypotheses

We first expected to see significantly greater valuing of biodiversity from the participants who saw (only) photographs relative to our control group. An ordinary least squares regression supported this hypothesis ($B = 0.73$, SE = 0.066, 97.5% CI = 0.025, 0.320, Cohen's $d = 0.22$). Next, we predicted that the photographs-plus-captions treatment group would also value biodiversity to a greater extent than the control group. The support for this hypothesis was weaker and the CI for the difference between these two groups does include 0 ($B = 0.123$, SE = 0.066, 97.5% CI = −0.024, 0.270, Cohen's $d = 0.16$).

Exploratory analyses

Based on a combination of our pilot data and literature suggesting that changes in valuing could result in changes in behaviours (Eccles 1984, Hulleman et al. 2010), we thought that increased valuing of biodiversity might affect participants' behaviour – specifically a greater willingness to donate to a cause that supports biodiversity. We found that participants in the photographs-only condition donated more of their allotted US$0.50 to the environmental charity than their control counterparts (B = US$0.036, SE = 0.015, 95% CI = 0.006, 0.065, Cohen's $d = 0.20$; see Fig. 1).

With this evidence that participants in the photographs-only condition came to value biodiversity more and donated more than their control counterparts, we sought to understand why this might have been the case by comparing these two groups further. Based on the prior literature suggesting that psychological distance may play a substantial role in people's failure to value and act upon the

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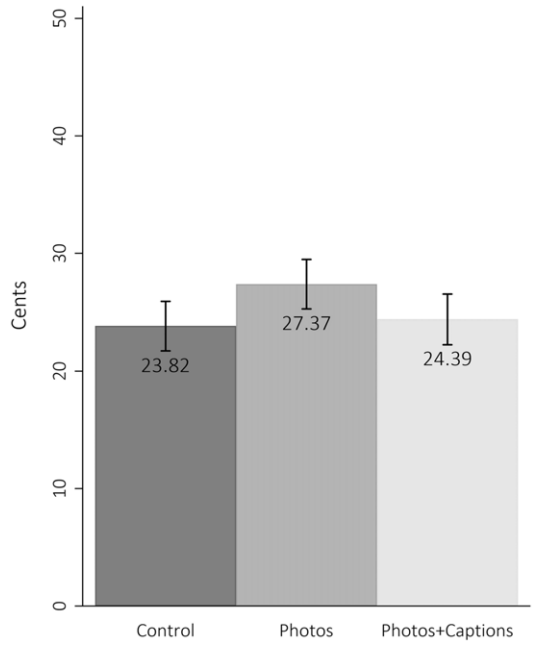

Fig. 1. Donation to environmental charity by condition. Error bars represent 95% confidence intervals. A statistically reliable difference emerged between the control and photographs-only groups but not between the control and photographs-plus-captions groups.

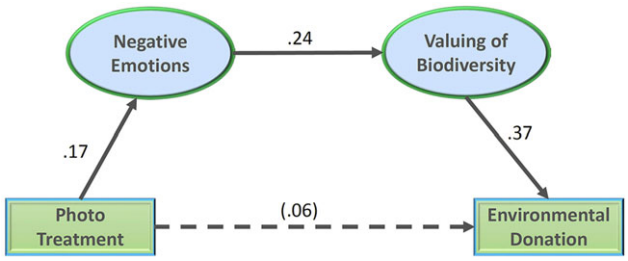

Fig. 2. Mediation model of the effect of the treatment on donations through negative emotions and valuing of biodiversity. Standardized regression coefficients are given for the associations between photographs-only treatment (as compared to the control group), negative emotions, valuing of biodiversity and donations to The Nature Conservancy. The effect of the treatment on the outcome after accounting for the mediators (in parentheses) is not statistically distinguishable from 0.

growing evidence of climate change (e.g., Van Lange & Bastian 2019), we examined two measures of psychological distance. One measure assessed perceptions that climate change, in general, remained a distant threat; the other assessed how distant of a threat biodiversity loss seemed to be. Neither measure of psychological distance appeared plausible as a mediator that could explain the effectiveness of the treatment on participants' valuing of biodiversity. As compared to the control group, the photographs-only treatment did not reduce general psychological distance ($B = 0.005$, SE = 0.020, 95% CI = –0.036, 0.045) or distance from the effects of declining biodiversity ($B = 0.023$, SE = 0.017, 95% CI = –0.010, 0.056).

On the other hand, photographs induced significantly more negative emotions in the photographs-only treatment group. Specifically, as compared to control participants, these treatment participants felt stronger negative emotions ($B = 6.874$, SE = 1.855, 95% CI = 3.232, 10.515, Cohen's $d = 0.35$). We also observed that the photographs-plus-captions participants reported even stronger negative emotions compared to the control group ($B = 14.657$, SE = 1.852, 95% CI = 11.021, 18.292, Cohen's $d = 0.67$).

For the photographs-only participants, we then wondered whether these negative emotions could plausibly explain why they valued biodiversity more than the control group. In turn, could participants' valuing of biodiversity plausibly explain why the photographs-only treatment participants donated more to the environmental charity? We tested this conjecture through a path model (see Fig. 2). This model provided a good fit for our data ($\chi^2_{(2,\ n=556)} = 2.84$, p = 0.24, comparative fit index = 0.994, root mean square error of approximation = 0.027). The path model suggests that this interpretation – that seeing our photographs induces negative emotions that spark a greater valuing of biodiversity, which, in turn, leads to greater environmental donations – was plausible given our data. Path models of (1) treatment → valuing of biodiversity → negative emotions → donation and (2) that allowed for separate, parallel paths from treatment to donation – one path through negative emotions and one path through valuing of biodiversity – fit the data poorly and thus were not considered plausible. Because we did not find a statistically reliable difference between the photographs-plus-captions group and the control group, our path model did not include the photographs-plus-captions participants.

Discussion

One finding emerged consistently: the presence of selected photographs boosted people's valuing of biodiversity. This result raises the question of why photographs might be effective. Identifying mediating mechanisms is a lifelong pursuit that cannot be uncovered through single studies (Bullock et al. 2010). However, a single study can provide data that contribute to our understanding of whether a particular mediating mechanism is plausible in a certain context. We explored psychological distance and negative emotions as possible mechanisms that might explain the efficacy of photographs.

Across two different measures of psychological distance, we found no evidence that psychological distance mediated the effects of the treatment on participants' valuing of biodiversity. Thus, we are sceptical that a reduction in psychological distance explains the effects of our photographs.

By contrast, our study provides evidence that thoughtfully selected photographs could bolster people's valuing of biodiversity through engendering negative emotions. In other words, photographs might help remind people of the importance of biodiversity's role in different ecosystems, the intrinsic pleasure derived from being surrounded by a host of different species or how critical it is for humans to take action. Our photographs, which illustrated different costs associated with the continued loss of biodiversity, caused participants to feel greater sadness, guilt, worry, frustration and fear.

Furthermore, we find evidence that the effect of the treatment on donating to environmental charities may plausibly be explained by participants' increased valuing of biodiversity. On the one hand, we caution against over-interpreting these exploratory results. Our path model was not preregistered; the effect sizes of the treatment on the mediators (negative emotions and valuing of biodiversity) and the donation outcome were modest; and this finding was not replicated for photographs-plus-captions treatment group, who did not give more to the

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environmental charity. Furthermore, the sequencing of our study – viewing photographs alongside the valuing of biodiversity items, then completing the emotion items, then the donation item – does not exactly parallel the path model. Although it may be reasonable to assume that participants' emotional reactions to the photographs precede their attitudes towards biodiversity (Zajonc 1980), a future research design might be able to leverage better sequencing to test a path model. On the other hand, ours is not the first time that photographs have been shown to effectively shift people's emotions, values and behaviours (Baberini et al. 2015). If replicated, this finding has a host of implications for applied contexts – not just for those fighting for environmental conservation.

The effects of the photographs-plus-caption treatment raises perhaps the biggest question in our data. Based on both theory and a previous pilot study, we anticipated that the captions would help readers frame the photographs clearly in the context of what would be lost if the present rates of declining biodiversity continue. We found that the photographs-plus-captions participants did experience more negative emotions, yet these emotions did not translate into valuing of biodiversity to the same degree as for participants in the photographs-only condition. Moreover, photographs-plus-captions participants appeared no more likely to donate to The Nature Conservancy than the control group. This finding could be interpreted as being congruent with the notion that too much pessimism can cause people to lose their sense of agency for addressing these dire problems (Feinberg & Willer 2011, Salomon et al. 2017). The finding also aligns with prior work in the expectancy-value tradition in which personal costs such as negative emotions can undermine motivation if they are perceived as too great (Flake et al. 2015). Alternatively, perhaps the captions we wrote assigned a framing (Hurlstone et al. 2014, Elliott 2020) that diverged from participants' interpretations of the photographs. In this case, the resultant mismatch between the 'stories' told by the photographs and those of the captions may have reduced the impact of the treatment.

Despite the clear need for additional research to address these lingering questions, we are cautiously optimistic about the implications of the study. First, for researchers, our data, situated within a novel context for expectancy-value theory, show that costs can be leveraged to amplify values rather than acting as a countervailing force that undermines motivation. This existence proof strikes us as particularly important as it paves the way for other expectancy-value theorists to explore the idea of using external costs to enhance motivation. Similarly, while negative affect has previously been shown to potentially undermine valuing (Eccles 1984), we show that negative emotions might play a key role in enhancing values in particular circumstances. Second, for those individuals (conservationists, teachers, journalists, policymakers, textbook publishers, etc.) who are trying to motivate audiences to value biodiversity more, strategic use of photographs appears to be an approach worth trying. Finally, our findings underscore the need for more research into the quantity and quality of the negative emotions that may catalyse or inhibit the actions that people ultimately take. How much negative emotion is the right amount to spark desired behaviours is a challenging but important question.

Given the urgent need to address declining biodiversity, strategies to make people value the planet's variety of plants and animals are in high demand. Photographs appear to represent a promising strategy for making the bleak circumstances of Earth's plant and animal species resonate emotionally. Unless Earth's flora and fauna begin to be more deeply valued and action is taken to preserve them, the picture will look similarly bleak for the human species.

Supplementary material. For supplementary material accompanying this paper visit https://doi.org/10.1017/S0376892922000042.

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Conflict of interest. The authors declare none.

Ethical standards. The authors assert that all procedures contributing to this work comply with applicable ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. This research was approved by the local institutional review board prior to conducting the pilot studies.

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