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

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ABSTRACT

Many individuals struggle to see, comprehend, and care about the planet's accelerating loss of biodiversity. Scholars suggest that the impact of declining biodiversity remains emotionally and psychologically distant—similar to how many perceive climate change. Yet, because people see representations of species and habitats routinely throughout their daily lives, carefully selected images could make this issue feel less psychologically distant and/or more emotionally resonant. Leveraging photos that underscored the idea of “costs” within an expectancy-value theory framework, we tested a combination of preregistered and exploratory hypotheses through an online experiment ($N = 843$). Our goals were 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. The negative emotions arising from the photographs may partially explain the impact of this treatment; reduced psychological distance does not.

Keywords: Biodiversity; Climate Change; Environmental Attitudes/Behavior; Environmental Psychology; Expectancy-Value Theory

The United Nations' expert group on biodiversity and ecosystems recently released a bleak forecast regarding the state of the world's flora and fauna. The report's summary cautions, "Biodiversity – the diversity within species, between species and of ecosystems – is declining faster than at any time in human history" (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, 2019, p. 2). The ripple effects of declining biodiversity exact high costs on all of humanity, ranging from energy (e.g., wood fuel), to medicines, to food, and even to the air we 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, understanding of the costs of biodiversity loss, and 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 (Clayton et al., 2015; Gifford, 2014). Moreover, experts estimate that we have discovered only a small fraction of all the species on our 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. Thus, this theoretical paradigm views costs as a counter-balance that serves to undermine motivation.

As a core 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, external “costs” of biodiversity loss might increase people’s valuing of biodiversity. In other words, while the personal costs associated with biodiversity loss may be too diffuse for individuals to feel, people may more easily grasp the negative impact on society. Scholarship on loss aversion (Kahneman, 2011), which argues people feel losses more acutely than corresponding gains, also suggests this approach of using potential costs to increase valuing could be effective.

How might perceived societal costs lead to greater valuing in the specific context of biodiversity? Expectancy-value theory suggests that seeing photos and 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 fact, images have been used in a number of past studies of people’s attitudes towards animal conservation (e.g., Colléony et al., 2017; Gunnthorsdottir, 2001). Specifically, 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 concern about climate change (Geiger et al., 2017; Hart & Nisbet, 2012), 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 (Curnock et al., 2019; Feinberg & Willer, 2011). In other words, photos that tell a story that is too intense or depressing might inhibit viewers from taking action by making the 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 behavior, thus suggesting that finding the right level of emotional arousal to produce behavioral changes is a tractable challenge.

Alternatively, perhaps photos’ 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' understanding 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, prior studies have shown that strategic framing can affect people's attitudes about climate issues (Hurlstone et al., 2014). 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 behaviors 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 behaviors (specifically, their willingness to donate to an environmental charity) as compared to a control group which saw no photos. Because prior research suggests that the framing of environmental issues is particularly important (Clayton et al., 2015), we included two treatment groups: one that saw photographs only, the other that saw the same photograph and a caption that explained the content of the photo¹. We selected the photographs deliberately to signal the value of biodiversity specifically by highlighting the costs of what the global community would lose if the declines in biodiversity continue (Curnock et al., 2019). We tested two preregistered hypotheses in accordance with current recommendations (Gehlbach & Robinson, 2018):

1. Participants who view photos will report higher valuing of biodiversity than participants who do not see photos.
2. Participants who view photos and captions will report higher valuing of biodiversity than participants who do not see photos.

METHODS

Participants

After receiving Institutional Review Board approval, 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 we wanted a final sample size of approximately 250 participants per condition—which would give us 80%

¹ Because there is no real-world analog to a caption without a photo, and because our captions explicitly reference the content of our photos, 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.

power to detect an effect size of .19 or greater—and thus recruited a greater number of participants to allow for attrition (see our preregistration in the SOM appendix for more detail). 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 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 (a) failed a screener question ($n = 164$) that tested whether they were reading the initial instructions and were never assigned to a condition, (b) 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, (c) 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 (d) 3 participants who did not complete the biodiversity scale. Finally, (e) 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 the composite and outcome measures collected in the full study; here we report on the focal measures for the analyses of interest in our study. Four self-report measures and one behavioral item comprised our main measures. First, participants completed a 5-item measure assessing how much they value biodiversity ($\alpha = .82$). 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 photo of a man feeding a baby elephant that appears in ill health. In the caption condition, participants learned 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. See Measure 1 in the Appendix for the full set of pairings between each survey item, photo, and caption.

In addition, participants completed two 5-item measures of psychological distance. The first focused on psychological distance from climate change in general ($\alpha = .87$), while the second focused on distance from the effects of declining biodiversity in particular ($\alpha = .74$). Finally, we created a composite of five negative emotions ($\alpha = .93$)—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 \$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 \$2.00 upon completion of the survey.

The full list of measures collected is reported in our preregistration (OSF URL blinded for review; See SOM Appendix for blinded copy of preregistration); we present the measures and photographs of interest relevant to the current study in the appendix. 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 $LR \chi^2(8) = 14.01, p =$

.082. The remainder of our analyses follow Cumming's (2014) recommendations by focusing on confidence intervals 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) photos relative to our control group. An OLS regression² supported this hypothesis, $B = 0.173$, $SE = 0.066$, 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 confidence interval 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 behaviors (Eccles, 1984; Hulleman et al., 2010), we thought that increased valuing of biodiversity might spur changes in participants' behavior—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 allocated 50 cents to the environmental charity than their control counterparts, $B = 3.55$ cents, $SE = 1.521$, 95% CI: 0.566, 6.538; *Cohen's d* = 0.20. See Figure 1 for a comparison of the three donation amounts.

With this evidence that participants in the photographs-only condition came to value biodiversity more and donate 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 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

² 97.5% confidence intervals were used to account for the fact that we tested two separate hypotheses.

Table 1. Means, Standard Deviations, and Correlations of Study Variables

	<i>M</i>	<i>SD</i>	(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	.63									
(3) Environmental Optimism	2.66	0.93	.38	.40								
(4) Negative Emotions	19.40	22.73	.28	.14	.13							
(5) Concern for Biodiversity	3.16	1.02	.77	.50	.37	.36						
(6) Psychological Distance	0.40	0.24	.52	.31	.26	.29	.59					
(7) Biodiversity Psychological Distance	0.46	0.20	.64	.44	.33	.35	.73	.80				
(8) Valuing of Environmental Education	3.95	0.88	.59	.39	.29	.17	.68	.57	.64			
(9) Biodiversity Knowledge Test	7.46	1.92	.03	.03	-.25	-.09	.04	-.08	-.04	.10		
(10) Donation to Environmental Charity (cents)	25.19	18.00	.39	.23	.05	.18	.43	.35	.43	.39	.12	
(11) Number of Biodiversity-related Articles Read	2.39	2.34	.43	.33	.34	.21	.43	.33	.38	.33	-.05	.19

Notes: *Ns* ranged from 839-843. Correlations stronger than .10 are significant at $p < .001$; Correlations stronger than .07 are significant at $p < .05$

Figure 1. Donation to Environmental Charity by Condition

Error bars represent 95% confidence intervals. A statistically reliable difference emerged between the control and photographs-only group but not between control and photographs+captions.

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 both treatment groups. Specifically, as compared to control participants, the photographs-only participants felt stronger negative emotions after the treatment ($B = 6.874$, $SE = 1.855$, 95% CI: 3.232, 10.515; *Cohen's d* = 0.35); the photographs-plus-captions participants reported even stronger negative emotions, $B = 14.657$, $SE = 1.852$, 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 group³. 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 as shown in Figure 2. This model provided a good fit for our data: $\chi^2_{(2, n=556)} = 2.84, p = .24, CFI = .994, RMSEA = 0.027$. 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—is plausible, given our data.

Figure 2. Mediation model of the effect of the treatment on donations through negative emotions and valuing of biodiversity

Standardized regression coefficients for the association 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 non-significant; all other paths are significant at $p < .001$.

³ Because we did not find a statistically reliable difference between the photographs+captions group and the control group, our path model did not include the photographs+captions participants.

DISCUSSION

One finding emerged consistently across each of our pilot tests as well as in this final preregistered study: 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 life-long pursuit that cannot be uncovered through single studies (Bullock et al., 2010). However, a single study can provide data that contributes 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 it mediated the effects of the treatment on participants' valuing of biodiversity. Thus, we are skeptical 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, photos 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 that would be borne by society with 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 exploratory, 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+captions treatment group who did not give more to the environmental charity. On the other hand, if replicated, the finding that photographs could be effectively leveraged to shift people's emotions, values, and behavior has a host of implications for applied contexts—not just for those fighting climate change.

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 society would lose if the

present rates of declining biodiversity continue. Congruent with our expectations, we found that the photos-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, photos-plus-captions participants appeared no more likely to donate to the Nature Conservancy than the control group. This finding could be interpreted as congruent with the notion that too much pessimism can cause people to lose their sense of agency to address 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 like negative emotion 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) that diverged from participants' interpretations of the photos. In this case, the resultant mismatch between the "stories" told by the photos 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 societal 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—teachers, climate activists, policymakers, textbook publishers, etc.—who are trying to motivate the public 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 negative emotions that may catalyze or inhibit the actions that people ultimately take. How much negative emotion is the right amount to spark desired behaviors 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 be a promising strategy for making the bleak circumstances of earth's plant and animal species

resonate emotionally. Unless we begin to more deeply value the earth's flora and fauna and act to preserve them, the picture will look increasingly bleak for our own species.

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