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The Moral Significance of Aesthetics in Nature Imagery

Eunsoo Kim[1], Julia Lee Cunningham[2], and Anocha Aribarg[2]
[1]Nanyang Business School, Nanyang Technological University, and [2]Stephen M. Ross School of Business, University of Michigan

Abstract
To solicit support for nature and wildlife conservation, mission-driven organizations rely on professional nature and wildlife imagery in their media outlets and campaigns. We investigated whether—and if so, why—the aesthetics of images increase social media engagement (e.g., number of likes) and the extent to which images elicit moral concern for nature and wildlife. In Study 1 (N = 782 U.S. adults), we trained a neural network to predict image aesthetics in National Geographic's Instagram data and identified image-specific attributes that influence aesthetics. We found that image aesthetics predicted engagement with the Instagram posts. In Study 2 (N = 775 U.S. adults), we established the causal effect of aesthetics on engagement and moral concern, which is explained by self-transcendent emotions (awe and inspiration) and purity associated with an image. Study 3 (N = 406 U.S. adults) replicated the results, showing that our key effects were stronger for individuals who place higher importance on beauty. By demonstrating the moral significance of image aesthetics, we highlight the potential of the beauty of nature to invigorate global conservation efforts.

Keywords
nature and wildlife imagery, aesthetics, awe, inspiration, purity, machine learning, deep learning, image processing, open data, preregistered

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> Beauty is nature's way of acting at a distance.
>
> —Denis Dutton (2014, p. A316)

Amid the global issues surrounding climate change, many mission-driven organizations attempt to increase public awareness of and engagement with pressing issues such as deforestation and wildlife endangerment. Leveraging the power of imagery is a long-standing approach to promoting these objectives, and organizations such as National Geographic, Discover Magazine, BBC Wildlife, and the National Wildlife Federation have partnered with photographers to capture images of wildlife. Drawing on research that has identified sadness as one of the strongest predictors of charitable donations (Small & Verrochi, 2009), these organizations have used iconic photos such as emaciated polar bears on melting glaciers or rhinoceroses with their horns cut off when calling for collective action to protect these animals. However, much less attention has been paid to images that do not induce negative emotions but rather capture the beauty of nature and wildlife. As images of nature become increasingly accessible through social media, it is imperative to understand the impact of aesthetics in such imagery above and beyond emotional features, such as valence and arousal. In this research, we investigated whether—and if so, why—the aesthetics of nature imagery increase individuals' social media engagement and attributions of moral standing (i.e., the extent to which one believes the target entity deserves one's moral concern; Goodwin, 2015). In so doing, we sought to unpack and lend additional support to the

Corresponding Author:
Julia Lee Cunningham, University of Michigan, Stephen M. Ross School of Business
Email: profjlee@umich.edu

biophilia hypothesis (Kellert & Wilson, 1993; Wilson, 1984), the argument that human beings are predisposed to have an innate need for connection with the natural world.

The Psychology of Aesthetics

In a typology of the values reflecting the biophilic tendency, Kellert (1996) identified the aesthetic value of nature, highlighting a primarily emotional response of intense pleasure when an individual views the physical beauty of nature. Emerging literature has similarly identified aesthetics as a key attribute that increases the observer's engagement. For instance, studies have found that the beauty of attractive targets captures human attention (Faust et al., 2019; Lindell & Lindell, 2014), and the aesthetic quality of an image has been linked to more "likes" on social media, which was associated with increased brain activity in social-reward-related regions (Sherman et al., 2018). Conceptualizing social media engagement as a form of social reward or endorsement, we proposed that image aesthetics in nature and wildlife photography would increase social media engagement. The latest research by Klebl et al. (2021, 2022) also experimentally established a link between aesthetics and judgment of moral standing by comparing targets with maximally different levels of beauty (beautiful vs. ugly). Using the natural variation in the image aesthetics in a large set of archival photos, we tested the proposition that image aesthetics would play an important role in promoting moral-standing attributions for the target.

What might explain the relationship between image aesthetics and social media engagement as well as moral-standing attributions? We proposed two specific self-transcendent emotions (awe and inspiration) and purity intuitions (one of the human intuitions about purity that underpins morality) as such mechanisms. We expected appreciation of aesthetics in nature and wildlife imagery to increase people's experience of awe/inspiration and purity intuitions. As empirically demonstrated in the past (Shiota et al., 2007; Thrash & Elliot, 2003), both self-transcendent emotions are triggered by observing beauty. In addition, observing beauty in nature and wildlife in particular reminds us of something that is pure (Klebl et al., 2022). We further examined whether these emotions and purity intuitions that arise from observing beauty would serve as potential mediators of the effect of image aesthetics on both social media engagement and moral-standing attributions.

Awe and inspiration are self-transcendent emotions that help us turn our minds outward, thereby "pulling our attention outside the self toward something to be understood and appreciated—a feature of the natural world" (Shiota et al., 2014, p. 363). Awe, an emotion that is characterized by perceived vastness and need for cognitive accommodation (Keltner & Haidt, 2003; Nelson-Coffey et al., 2019), has been shown to help people feel connected to something larger, thereby enabling self-transcendence and prosocial behavior (Jiang & Sedikides, 2021; Piff et al., 2015). Inspiration is viewed as an affective and motivational state that stems from appreciation of an evocative object (Thrash & Elliot, 2003; Thrash et al., 2010). Thus, we hypothesized that these self-transcendent emotions would not only increase engagement with the awe-inspiring images (see also Berger & Milkman, 2012) but also increase moral-standing attributions for the nature and wildlife depicted, consistent with the moral qualities of these emotions (Jiang & Sedikides, 2021; Piff et al., 2015).

Purity is one of the fundamental moral intuitions that arise from observing beauty (Klebl et al., 2022). Experimental research has also shown that purity encourages people to attach higher moral value to the beautiful targets than ugly targets (Klebl et al., 2022). Some indirect evidence speaks to the possibility that purity intuitions triggered by nature and wildlife imagery may increase social media engagement as a form of social reward or endorsement (Sherman et al., 2018).

Statement of Relevance

Organizations often seek to leverage the power of images to tackle some of society's grand challenges through social media. Environmental organizations are paradigmatic adopters of this strategy and tend to deploy nature-based images to encourage engagement. Yet our understanding of why some images are better for this purpose than others is limited. Using a machine-learning technique and a series of studies, we found empirical evidence that it is the aesthetics of nature and wildlife imagery that increase people's engagement with social media posts and foster their moral concern. More specifically, we found that awe and inspiration as well as the purity associated with an image underlie the effect of image aesthetics. Our results not only lend credence to the long-standing practice of featuring beautiful images of nature but also support the *biophilia hypothesis*, the argument that human beings are predisposed to connect with the natural world.

For instance, purity-based concerns have a positive effect on people's attitudes toward the environment and moral concern for the environment (Feinberg & Willer, 2013; Rottman et al., 2015), as they are associated with an increased motivation to protect what is pure. Combining these theoretical perspectives, we hypothesized that purity intuitions would explain why image aesthetics increase people's willingness to engage with images on social media and to increase moral-standing attributions.

All three studies reported here were reviewed and approved by the institutional review board of the University of Michigan. Data files and code used for analyses, as well as study materials, can be found in the OSF repository for this project (https://osf.io/c9pqd/). One exception is the proprietary data used in Study 1, which was provided by the National Geographic social media team, and open-source Python code, which is posted at GitHub (see the Supplemental Material available online).

Study 1: The Impact of Image Aesthetics on Social Media Engagement

This study established a link between image aesthetics and social media engagement utilizing the imagery data archive ($N = 12{,}095$) from National Geographic's account on the social media platform Instagram (@natgeo). In conducting the analysis, we asked online participants to assign aesthetic and emotion ratings to a set of sample images, which allowed us to predict ratings for the full data set by utilizing machine learning. We also examined how image attributes influence aesthetic perception of nature imagery.

Method

Overview of data and procedure. The data consisted of all posts on National Geographic's Instagram account (@natgeo) from January 1, 2015, to November 25, 2018. National Geographic has been promoting the wildlife photos of the magazine's contributing photographers on their Instagram page since November 2011. It should be noted that National Geographic does not take down poorly performing posts or use algorithms to promote specific photos, as earning the highest number of likes is not the end goal. In February 2019, this Instagram account became the world's first brand account to surpass 100 million followers, and it has garnered more than 4 billion likes to date. Given that the featured photos were provided by professional photographers worldwide as part of the organization's effort to foster a community of visual storytellers, the overall quality of the images is high, and the images are highly diverse. Thus, this context provides a unique opportunity to examine the effect of image aesthetics across different artistic styles and objects (including humans, animals, and landscapes).

This study involved three steps: (a) conducting a pilot study to obtain ratings for a subset of images on particular dimensions (including aesthetics) and training deep neural networks to predict ratings of the full set of images; (b) performing a regression analysis to examine how image aesthetics affect social media engagement, holding various covariates constant; and (c) assessing how different objective attributes of an image predict its aesthetics.

Step 1: pilot study and image ratings. We hired two research assistants to separately categorize 12,095 images into four categories: humans, animals, both humans and animals, and landscapes (without any humans or animals). After removing 873 images we deemed irrelevant, we had 11,222 images. The research assistants then identified the images that were coded inconsistently and reconciled their differences in consultation with us. We then randomly selected 300 images from each of the four categories, which yielded a total of 1,200 images to be rated in the pilot study. Although our research question related to wildlife and landscape images, we included human images to further generalize our results in Study 1.

Our goal was to have 800 people evaluate 12 randomly selected images from the pool of 1,200 images, so we had eight raters per image, on average. This average number of raters is consistent with practice in computer science (Kim et al., 2018). We did not know what effect size to predict in this first data collection. We used convenience sampling and recruited 795 adults in the United States from Lucid (https://luc.id), an online market-research platform, to complete a survey for $1. After removing 12 participants who had technical issues and one participant who chose the same answer option throughout the survey, we had a total of 782 participants (age: $M = 45.27$ years, $SD = 17.32$; 51.66% female).

Each randomly selected image was displayed, followed by questions about the aesthetic quality of the image itself as well as the emotions it evoked. The same set of questions was repeated for each of the 12 images. For aesthetic quality ($M = 5.685$, $SD = 1.178$), we asked two questions ($\alpha = .923$): "To what extent is this photo aesthetically beautiful?" and "To what extent is this photo visually artistic?" Responses were made on a 9-point scale (1 = *not at all*, 9 = *extremely*). For emotion ratings, we used two 9-point Self-Assessment Manikin (Bradley & Lang, 1994) scales to capture the two dimensions of emotion (valence and arousal) that participants experienced from viewing each image (valence: $M = 5.701$, $SD = 1.239$; arousal: $M = 4.201$, $SD = 1.097$). Participants also rated images on six discrete emotions (sadness, fear, disgust, happiness, anger, and surprise)

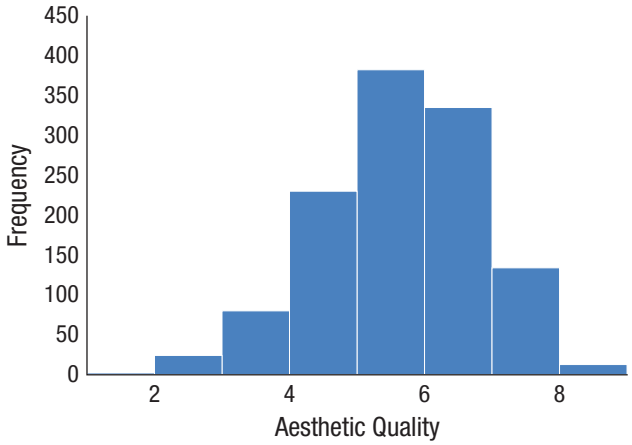

Fig. 1. Study 1: frequency of aesthetic-quality ratings.

using a 7-point scale (1 = *none at all*, 7 = *very much*). In addition, we asked participants to rate the extent to which the photo was memorable (1 = *not at all*, 9 = *extremely*) as an exploratory measure, but we did not use those ratings for this study. Although the images were taken by professional photographers, we observed a reasonable variation of aesthetic-quality ratings in our data set, as can be seen in Figure 1.

To predict the rating of each image in the full data set for aesthetics, valence, and arousal, we constructed and trained three deep-neural-network models with the same architecture. Deep-neural-network models have been used to predict subjective evaluation of images, such as emotion ratings (Kim et al., 2018). To train (i.e., estimate) each model, we first extracted 1,736 features from each image as independent variables (for details on feature extraction, see Section S2 in the Supplemental Material). These features corresponded to the number of neurons in the input layer of the model. Fig. S1 in the Supplemental Material shows a simple visual illustration of the network architecture. In addition to the input layer, each model had three hidden layers with 3,000, 1,000, and 1,000 neurons, respectively, consistent with the architecture used in previous emotion-prediction models (Kim et al., 2018). In the output layer, there was one neuron, which represented the predicted ratings for image aesthetic quality, valence, and arousal in each respective model. To train these models, we supplemented our training data from the 1,200 images with existing data sets in which aesthetic-quality ratings were known. Compared with models reported in the previous literature, our models performed well in holdout (i.e., out-of-sample) prediction (for details about these existing data sets, the machine-learning procedure, and model validation, see Section S3 in the Supplemental Material).

Step 2: analysis of social media engagement and image aesthetics. We performed a multiple linear regression analysis for social media engagement, which was measured as the number of likes divided by the number of followers (multiplied by 100 to generate a percentage); aesthetic-quality rating was our main independent variable. We included multiple sets of control variables to account for potential confounds. For summary statistics for these variables, see Table S1 in the Supplemental Material.

Prior research has shown that consumers tend to spread text content that evokes high-arousal positive or negative emotions (Berger & Milkman, 2012). Thus, we first controlled for the emotion ratings (image arousal and image valence) predicted by the deep-neural-network models. Second, we controlled for the type of object depicted in the image (baseline was images with humans only). Third, we controlled for emotions arising from text information, because the images posted on Instagram appear with the photographer's description. We used the Evaluative Lexicon to rate the valence of the text (0 = *very negative*, 9 = *very positive*; Rocklage et al., 2018) and the Dictionary of Affect in Language to rate the arousal of the text (Whissell, 2009). Both the Evaluative Lexicon and Dictionary of Affect in Language are widely used computational linguistic tools. The Evaluative Lexicon rates valence, emotionality, and extremity, whereas the Dictionary of Affect in Language rates pleasantness (valence) and activation (arousal). Because there is a high correlation between the arousal and valence measures in the Dictionary of Affect in Language ($r = .967$, $p < .001$), we used the valence measure from the Evaluative Lexicon and the arousal measure from the Dictionary of Affect in Language. Next, we incorporated different temporal factors, such as month and year fixed effects, as well as (a) the number of days each image was posted in our data set (to control for recency) and (b) the order in which each image was posted by each photographer. Last, we accounted for possible confounds: Reputable photographers featured on National Geographic's Instagram page may garner more social media engagement regardless of their photos' aesthetic quality, and experienced photographers may take and post photos in a style that they know will attract their fans' attention. We accounted for these possible confounds using two methods. First, we included each photographer's number of followers as a control variable. Second, following an econometric approach, we included photographer fixed effects (i.e., dummy variables for photographers).

Step 3: analysis of image aesthetics and objective image attributes. Using a regression analysis, we examined the relationship between the aesthetic-quality

ratings the survey participants provided for 1,200 images and the image characteristics that are commonly used in photography. Following previous literature, we focused on attributes of color and composition (Hou et al., 2019; Wang et al., 2013; Zhang et al., 2021). *Color attributes* consisted of the proportion of warm hue, color saturation (or vividness), image clarity, and contrast or variation of brightness. The first two attributes were obtained from the hue and saturation values from the hue, saturation, and value (or brightness) numerical index of each pixel in the image. Image clarity and contrast involved converting the image to gray scale and then calculating the attributes at the pixel level. *Composition attributes* involved two aspects. The first included attributes that capture the compositional location of salient or focal regions in the image: (a) the rule of thirds (the average distance from four intersection points created by two equidistant vertical lines and two equidistant horizontal lines), (b) diagonal dominance (the shortest distance from the two diagonal lines), (c) object centrality (the distance from the center point of the image), and (d) horizontal balance (whether the focal object is located along the horizontal line). We utilized *OpenCV* (Version 4.1.2), an open-source computer vision library in *Python* (Bradski & Kaehler, 2008), to detect the salient region and its centrality. The second aspect involved the symmetry of intensity and the symmetry of color, which show whether the intensity and color are distributed evenly on the left and right.

Results

Impact of image aesthetics on social media engagement. Table 1 reports results from the regression analyses. Model 1 was the baseline model without any control variables, and we incrementally added sets of control variables in Models 2 through 6. The baseline model showed that image aesthetics significantly increased social media engagement ($b = 0.149$, $p < .001$). The positive impact of image aesthetics ($b = 0.021$, $p < .001$) persisted even after we included control variables, suggesting that the role of image aesthetics in social media engagement is robust.

Some interesting results emerged from Model 6. First, images with more positive valence ($b = 0.066$, $p < .001$) and lower arousal ($b = -0.088$, $p < .001$) garnered more social media engagement; however, we saw a slightly different pattern for text. We found that positive emotion associated with text led to high social media engagement ($b = 0.007$, $p < .001$), yet the impact of arousal was not evident in our data. The significant effects of positive valence for image and text are consistent with the findings of Li and Xie (2020) and Zhang et al. (2021), respectively. Second, we found the highest social media engagement for animal images ($b = 0.243$, $p < .001$), followed by images with both humans and animals ($b = 0.152$, $p < .001$) and landscape images ($b = 0.129$, $p < .001$). In our context, including humans led to lower social media engagement. It is possible that these results are specific to the research context; that is, the followers of National Geographic's Instagram may be self-selected individuals who expect to see nature and wildlife photos, even though it is within the National Geographic Society's mission to promote cultural and linguistic diversity among human societies and even though their Instagram account features images of humans.

Last, certain images may gain more social media attention because they are displayed more prominently. We conducted a robustness check to see whether our results held even after we controlled for impression. We were able to obtain impression data for only a subset of images posted from May 2018 to November 2018. Using these data ($N = 1{,}358$), we conducted the same analysis while controlling for impression in all models (see Table S2 in the Supplemental Material). Our findings were consistent with those based on the full data set. We still found a significant positive effect of aesthetics on social media engagement ($b = 0.012$, $p = .011$; see Table S2, Model 5).

Drivers of image aesthetics. We found that the higher the saturation level (i.e., vividness; $b = 0.002$, $p < .001$), the higher the image clarity ($b = 0.411$, $p = .077$), the lower the contrast or variation in brightness ($b = -0.004$, $p = .085$), and the closer the focal object was to the center ($b = 0.575$, $p = .047$), the more the participants perceived the image as aesthetic (see Table S3, Model 3, in the Supplemental Material). Interestingly, a different set of image attributes predicted the perceived quality of property images for Airbnb (i.e., warm hue, diagonal dominance, and vertical balance; Zhang et al., 2021). These results provide useful guidance to mission-driven organizations that aim to enhance their audience's perception of the aesthetics of the images used in their social media campaigns.

Discussion

Although Study 1 established the relationship between image aesthetics and social media engagement using data from a real-world setting, the use of observational data on individuals who follow National Geographic's Instagram account precluded us from ensuring the generalizability of our findings and understanding the mechanisms underlying the effects. In Study 2, we examined the mechanisms with a broader sample of individuals who were not selected on the basis of their preference for nature images.

Table 1. Study 1: Results of Regression Models Predicting Social Media Engagement

Predictor	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Image aesthetic quality[a]	0.149***	0.103***	0.056***	0.054***	0.049***	0.021***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Image valence[a]		0.062***	0.081***	0.077***	0.072***	0.066***
		(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Image arousal[a]		−0.171***	−0.104***	−0.104***	−0.100***	−0.088***
		(0.008)	(0.008)	(0.008)	(0.008)	(0.007)
Only animal images			0.331***	0.320***	0.303***	0.243***
			(0.009)	(0.009)	(0.009)	(0.011)
Both human and animal images			0.193***	0.191***	0.182***	0.152***
			(0.016)	(0.016)	(0.015)	(0.015)
Landscape images			0.164***	0.158***	0.150***	0.129***
			(0.011)	(0.011)	(0.011)	(0.011)
Text valence[a]				0.009***	0.010***	0.007***
				(0.001)	(0.001)	(0.001)
Text arousal[a]				0.069**	0.034	−0.020
				(0.024)	(0.023)	(0.025)
Text word count				−0.0003***	−0.0003***	−0.0001
				(0.0001)	(0.0001)	(0.0001)
Log(recency)	−0.336***	−0.335***	−0.333***	−0.335***	−0.314***	−0.245***
	(0.016)	(0.015)	(0.015)	(0.014)	(0.014)	(0.014)
Log(post order)[b]	−0.001	−0.008*	−0.030***	−0.032***	−0.083***	−0.224***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.007)
Number of followers in photographer account					0.054***	
					(0.003)	
Constant	4.365***	4.382***	4.272***	4.323***	3.601***	3.231***
	(0.118)	(0.114)	(0.109)	(0.109)	(0.112)	(0.114)
Photographer fixed effects	No	No	No	No	No	Yes
Observations	11,222	11,222	11,222	11,222	11,222	11,222
Adjusted R^2	.590	.612	.651	.653	.666	.711

Note: The table shows unstandardized coefficients; standard errors are given in parentheses. Social media engagement was calculated by dividing the number of likes by the number of followers and then multiplying the result by 100. Year and month fixed effects were included in all models.

[a]This variable was centered at the mean. [b]*Post order* refers to the order in which each image was posted by each photographer.

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

Study 2: Mechanisms That Link Image Aesthetics to Social Media Engagement and Moral Standing

In Study 2, we tested the role of aesthetics in participants' intention to engage on social media and likelihood of conferring moral standing—a construct that reflects the extent to which one believes that a target entity deserves one's moral concern—to nature and wildlife. We also tested the mediating role of awe/inspiration and purity intuitions.

Method

Participants and procedure. In the pilot survey in Study 1, participants rated 1,200 images on their aesthetic quality and the different aspects of emotion—arousal and valence—evoked by the images. In Study 2, we coupled the pilot-survey data with new survey data collected from an additional 802 participants from Lucid (adults residing in the United States who were recruited on the basis of convenience sampling). These participants were paid $1 to complete a survey only on mediators and dependent variables. As in Study 1, our goal was to have 800 people evaluate 12 randomly selected images from the pool of 1,200 images, so we would have eight raters per image, on average; we did not know what effect size to predict. After removing 12 participants who had technical issues and 15 participants who chose the same answer option throughout the survey, we retained a total of 775 participants (age: $M = 45.58$ years, $SD = 17.43$; 51.35% female). We recruited two nonoverlapping groups of participants

to complete the two surveys in order to minimize common-method-variance bias (correlations between variables measured using the same method, such as self-reported responses on the same survey, tend to be inflated). In the new survey, we asked participants to provide ratings for awe/inspiration and purity intuitions and for moral standing and intention to engage on social media—our two mediators and two dependent variables, respectively.

Measures. The survey in Study 2 largely followed the structure of the pilot-study survey. Previous research has validated that a self-reported measure of willingness to share news articles correlates with actual sharing (Mosleh et al., 2020). Thus, for our key dependent variables, we used hypothetical questions about social media engagement and moral standing on a 7-point scale (1 = *none at all*, 7 = *very much*). For social media engagement, following Study 1, we asked participants to rate their intent: specifically, how likely they were to like each image on social media (such as Facebook, Twitter, or Instagram). For an exploratory analysis, we asked participants three additional questions: If someone in their network posted the image on their social media account, how likely would they be to (a) post the image on their social network platform, (b) share the image with their social network, and (c) comment on the image. These four scales loaded in one factor with high reliability ($\alpha = .956$), though we treated only the like scale as our dependent variable. Our results based on the average intention to engage on social media were largely consistent with those based only on the like scale.

To explore moral standing (the extent to which one believes the target entity deserves one's moral concern; a three-item scale adapted from Piazza et al., 2014), we asked participants to indicate the extent to which they agreed or disagreed with the following statements: "I feel a desire to protect what appears in the photo above," "What appears in the photo above deserves to be treated with compassion," and "It would be morally wrong to harm what appears in the photo above." Drawing on research linking empathy and moral standing (Tangney et al., 2007), we also collected an item on empathy: "I feel empathy for what appears in the photo above." We combined this item with the moral-standing scale, as the factor analysis showed that the scales loaded in one factor with high reliability ($\alpha = .937$).

We also proposed that awe/inspiration and purity intuitions would explain the extent to which an image's aesthetic quality relates to social media engagement and attributions of moral standing to nature and wildlife. Given that awe and inspiration are both considered self-transcendent emotions that arise from observing beauty, we combined their measures in our empirical analysis. Despite our focus on awe and inspiration, we measured them alongside a host of other self-transcendent emotions (Nelson-Coffey et al., 2019). Participants rated the extent to which they felt the following emotions: inspired, elevated, in awe, optimistic, grateful, compassionate, and in love ($\alpha = .962$ for all aforementioned emotions; $\alpha = .818$ for inspired and in awe; Nelson-Coffey et al., 2019). All items were rated on a 7-point scale (1 = none at all, 7 = very much). We conducted an exploratory analysis with self-transcendent emotions as a mediator (excluding compassion, which overlapped conceptually with our measure of moral standing; the correlation between compassion and moral standing was high, $r = .859$, $p < .001$). The results largely mirrored the patterns of those based on the two self-transcendent emotions. For purity intuitions, we asked participants to rate the extent to which the image made them "think of something pure" (Klebl et al., 2022).

Results

Using the same set of 1,200 images from our pilot study, we first tested the relationship between aesthetics and both social media engagement and attributions of moral standing. We then identified theoretically driven mechanisms: The aesthetic quality of an image was positively associated with the viewer's awe/inspiration and purity intuitions, which encouraged social media engagement and higher moral standing conferred on nature.

Analytical approach. Because the dependent and independent variables in this study came from two different surveys with independent sets of participants, we did not analyze data at the individual level. Instead, we took the average of all the ratings for each image to conduct our analysis at the image level. Controlling for valence and arousal and for dummy-coded image type (baseline was images with humans only), we first tested whether the aesthetic qualities of the image were related to social media engagement and moral standing. We then investigated what drives the effects of aesthetic quality by testing whether our proposed mediators (awe/inspiration and purity intuitions) explain the relationship between aesthetics and social media engagement. We examined the two mediators simultaneously to assess their relative influence, controlling for the same set of variables.

Influence of image aesthetics on social media engagement and moral standing. We found a significant positive relationship between image aesthetics and social media engagement ($b = 0.151$, $p < .001$, 95% confidence interval [CI] = [0.085, 0.217]) as well as moral standing ($b = 0.133$, $p < .001$, 95% CI = [0.073, 0.192]), confirming our hypothesis. Table 2 shows the results for social media engagement and moral standing (Models 1 and 3, respectively).

Table 2. Study 2: Results of Regression Models Predicting Social Media Engagement, Moral Standing, Awe and Inspiration, and Purity Intuitions

	Social media engagement (likes)		Moral standing		Awe/ inspiration	Purity intuitions
Predictor	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Aesthetics	0.151***	0.012	0.133***	−0.003	0.182***	0.178***
Arousal	−0.043†	0.003	−0.066**	−0.007	−0.039†	−0.103***
Valence	0.139***	0.012	0.065*	−0.073***	0.144***	0.209***
Only animal images	0.449***	0.153**	0.319***	0.021	0.372***	0.408***
Both human and animal images	0.188*	0.039	0.284***	0.139***	0.195**	0.190*
Landscape images	0.221**	0.009	−0.375***	−0.547***	0.334***	0.160*
Awe/inspiration		0.517***		0.296***		
Purity intuitions		0.254***		0.461***		
Adjusted R^2	.161	.574	.139	.678	.219	.225

Note: The table shows unstandardized coefficients.
†$p < .10$. *$p < .05$. **$p < .01$. ***$p < .001$.

Some additional findings are noteworthy. First, we found a significant relationship between positive valence and social media engagement ($b = 0.139$, $p < .001$, 95% CI = [0.079, 0.200]) and between positive valence and moral standing ($b = 0.065$, $p = .019$, 95% CI = [0.011, 0.120]). In contrast, high arousal was negatively associated with social media engagement ($b = −0.043$, $p = .077$, 95% CI = [−0.091, 0.005]) and moral standing ($b = −0.066$, $p = .003$, 95% CI = [−0.109, −0.023]). Second, participants tended to engage less with human images compared with other categories of images (animals only: $b = 0.449$, $p < .001$, 95% CI = [0.302, 0.597]; both humans and animals: $b = 0.188$, $p = .011$, 95% CI = [0.043, 0.333]; landscapes: $b = 0.221$, $p = .004$, 95% CI = [0.070, 0.373]). These results are consistent with what we observed with National Geographic's Instagram followers in Study 1, although our survey participants were drawn from a more representative population without drawing attention to the National Geographic Society, suggesting the generalizability of our Study 1 results. Images that included animals or animals and humans together induced higher ratings for moral standing than those with landscapes ($b = −0.375$, $p < .001$, 95% CI = [−0.511, −0.239]). This finding is consistent with prior research showing that sentient beings such as animals are viewed as more deserving of moral concern than nonsentient objects (Crimston et al., 2016).

Mediators. We used Hayes's PROCESS Model 4 (Hayes, 2018) with 10,000 bootstrapping resamples to quantify the indirect effect of image aesthetics on social media engagement (i.e., likes) via awe/inspiration as well as via purity intuitions. After we entered awe/inspiration and purity intuitions as mediators, image aesthetics were no longer a significant predictor of social media engagement ($b = 0.012$, $p = .624$, 95% CI = [−0.036, 0.060]), whereas awe/inspiration ($b = 0.517$, $p < .001$, 95% CI = [0.446, 0.587]) and purity intuitions ($b = 0.254$, $p < .001$, 95% CI = [0.192, 0.317]) significantly affected social media engagement (Table 2, Model 2). The indirect paths of image aesthetics via awe/inspiration ($b = 0.094$, $SE = 0.018$, 95% CI = [0.060, 0.129]) and purity intuitions ($b = 0.045$, $SE = 0.011$, 95% CI = [0.026, 0.069]) were both positive and significant for social media engagement (see Table S4 in the Supplemental Material).

We then repeated the same analysis with moral standing as the dependent variable (Table 2, Model 4). After we incorporated self-transcendent emotions and purity intuitions, the effect of image aesthetics on moral standing was no longer significant ($b = −0.003$, $p = .868$, 95% CI = [−0.040, 0.034]), whereas awe/inspiration ($b = 0.296$, $p < .001$, 95% CI = [0.242, 0.351]) and purity intuitions ($b = 0.461$, $p < .001$, 95% CI = [0.412, 0.509]) had a significantly positive impact on moral standing. The indirect paths via awe/inspiration ($b = 0.054$, $SE = 0.011$, 95% CI = [0.034, 0.076]) and purity intuitions ($b = 0.082$, $SE = 0.017$, 95% CI = [0.050, 0.116]) were positive and significant (see Table S4 in the Supplemental Material).

Observing that human images drew less social media engagement in Studies 1 and 2, we examined how participants rated these images on awe/inspiration and purity intuitions. One-way analyses of variance revealed that participants reported different level of awe/inspiration, $F(3, 1196) = 33.35$, $p < .001$, $\eta^2 = .077$, 95% CI = [.049, .106], and purity intuitions, $F(3, 1196) = 23.42$, $p < .001$, $\eta^2 = .055$, 95% CI = [.032, .081], for different image types. To replicate the findings on image types in Study 1, we then compared the responses from images of

humans with those of other types. Human images evoked the least awe/inspiration: human – animal: mean difference = −0.585, 95% CI = [−0.728, −0.443], $t(1196) = -8.05$, $p < .001$, Cohen's $d = -0.657$, 95% CI = [−0.819, −0.495]; human – both human and animal: mean difference = −0.256, 95% CI = [−0.399, −0.114], $t(1196) = -3.52$, $p < .001$, Cohen's $d = -0.288$, 95% CI = [−0.448, −0.127]; human – landscape: mean difference = −0.631, 95% CI = [−0.774, −0.489], $t(1196) = -8.68$, $p < .001$, Cohen's $d = -0.709$, 95% CI = [−0.871, −0.546]. Similarly, human images were also rated least pure compared with all other types of images—human – animal: mean difference = −0.639, 95% CI = [−0.802, −0.476], $t(1196) = -7.69$, $p < .001$, Cohen's $d = -0.627$, 95% CI = [−0.789, −0.465]; human – both human and animal: mean difference = −0.249, 95% CI = [−0.412, −0.086], $t(1196) = -2.99$, $p = .003$, Cohen's $d = -0.244$, 95% CI = [−0.404, −0.084]; human – landscape: mean difference = −0.513, 95% CI = [−0.677, −0.350], $t(1196) = -6.17$, $p < .001$, Cohen's $d = -0.504$, 95% CI = [−0.665, −0.342].

Last, we ruled out a few alternative mechanisms (such as arousal, valence, and discrete emotions); our results were robust even after we controlled for additional measures of emotions (for additional analyses, see Section S6, Table S5, and Table S6 in the Supplemental Material). Overall, we found support for the mechanisms (awe/inspiration as well as purity intuitions) that link image aesthetics to social media engagement and moral standing.

Discussion

Study 2 provided evidence that image aesthetics drive people's self-transcendent emotions (such as awe and inspiration) and purity intuitions toward the target entity, thereby encouraging social media engagement and higher moral standing conferred to the target. Although Study 2 helped us understand the mechanisms through which image aesthetics influence social media engagement and moral standing, this study's analysis was at the image level, not the individual level. Although this alleviated the concern about common-method-variance bias, it did not allow us to examine heterogeneous effects across individuals or establish boundary conditions for our effects. We conducted Study 3 to achieve this goal and to replicate our results in Study 2.

Study 3: Testing Mechanisms Using Individual-Level Data and the Moderating Effects

Because not all individuals value aesthetics equally (Lundy et al., 2010), we hypothesized that the effect of image aesthetics on social media engagement and moral standing may depend on the extent to which individuals place importance on beauty. Previous research has shown that individuals with high aesthetics centrality are more influenced than individuals with low aesthetics centrality by product aesthetics in their purchase intentions (Bloch et al., 2003). Thus, we hypothesized that the impact of image aesthetics on social media engagement and moral standing would be stronger for individuals who place higher importance on beauty.

Method

Participants and procedure. Study 3 was preregistered (see https://aspredicted.org/wv7f7.pdf). A power analysis in G*Power (Version 3.1; Faul et al., 2007) indicated that a sample size of 400 participants would be necessary to detect an effect size (Cohen's f^2) of 0.02 with an error probability (α) of .05 and power of .80. We therefore originally planned to recruit at least 400 participants (adults residing in the United States) from Lucid (a convenience sample). A total of 447 participants signed up and completed the survey in exchange for $1, but 41 participants did not pass the attention checks. As a result, only 406 individuals (age: $M = 49.34$ years, $SD = 17.90$; 46.55% female) were retained for analyses. Given our focus on nature and wildlife conservation, we ran Study 3 with only the 300 animal and 300 landscape images used in the previous studies. Each participant was asked to rate one animal image and one landscape image. We asked participants to rate images using two blocks of questions. The first block contained measurement scales for aesthetic quality, arousal, and valence. The second block contained measures for the same dependent and mediating variables as in Study 2, except that we measured only awe and inspiration, omitting the other self-transcendent emotions.

Measures. The importance of beauty was measured using a subset of scales from previous literature (Lundy et al., 2010). Participants rated the extent to which they agreed or disagreed with the following statements on a 7-point scale: "One of the reasons I love traveling is seeing gorgeous scenery," "I often find myself staring in awe at beautiful things," and "I love taking photos of beautiful images." The three items loaded on one factor (Cronbach's $\alpha = .777$).

Results

Influence of image aesthetics on social media engagement and moral standing. Following our preregistered plan, we first ran separate regression analyses without any control variables. We found a positive significant effect of

Table 3. Study 3: Results of Regression Models Predicting Social Media Engagement, Moral Standing, Awe and Inspiration, and Purity Intuitions

	Social media engagement (likes)		Moral standing		Awe/ inspiration	Purity intuitions
Predictor	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Aesthetics	0.460***	0.227***	0.292***	0.042	0.423***	0.403***
Arousal	0.116***	0.072**	0.065***	0.017	0.095***	0.053*
Valence	0.194***	0.057	0.142***	−0.001	0.207***	0.295***
Landscape images	−0.183	−0.195	−0.767***	−0.788***	0.102	−0.083
Awe/inspiration		0.320***		0.388***		
Purity intuitions		0.241***		0.213***		
Adjusted R^2	.371	.470	.345	.560	.506	.438

Note: The table shows unstandardized coefficients.
*p < .05. **p < .01. ***p < .001.

image aesthetics on social media engagement (b = 0.616, p < .001, 95% CI = [0.556, 0.675]) and on moral standing (b = 0.388, p < .001, 95% CI = [0.344, 0.433]). Next, we performed separate regression analyses for social media engagement and moral standing on image aesthetics, controlling for arousal, valence, and image type (baseline was images with animals) without incorporating mediators. We found a significant positive relationship between image aesthetics and social media engagement (b = 0.460, p < .001, 95% CI = [0.378, 0.542]) as well as moral standing (b = 0.292, p < .001, 95% CI = [0.232, 0.351]). Table 3 shows the results for social media engagement and moral standing (Models 1 and 3, respectively). These findings are consistent with those of Study 2.

Mediators. We used Hayes's PROCESS Model 4 (Hayes, 2018) with 10,000 bootstrapping resamples to quantify the indirect effect of image aesthetics on social media engagement (i.e., likes) and moral standing via awe/inspiration as well as purity intuitions (see Models 2 and 4 in Table 3). Unlike in Study 2, image aesthetics continued to be a significant predictor of social media engagement after we entered mediators (b = 0.227, p < .001, 95% CI = [0.143, 0.312]), and awe/inspiration (b = 0.320, p < .001, 95% CI = [0.214, 0.426]) and purity intuitions (b = 0.241, p < .001, 95% CI = [0.153, 0.328]) significantly affected social media engagement (Table 3, Model 2). We saw a consistent pattern for moral standing (Table 3, Model 4). After entering mediators, we found that image aesthetics became a nonsignificant predictor of moral standing (b = 0.042, p = .137, 95% CI = [−0.013, 0.096]), whereas awe/inspiration (b = 0.388, p < .001, 95% CI = [−0.013, 0.096]) and purity intuitions (b = 0.213, p < .001, 95% CI = [0.157, 0.270]) significantly affected moral standing.

As predicted in our preregistration, we found awe/inspiration and purity intuitions to be significant mediators of the relation between aesthetic quality and both social media engagement and moral standing. Notably, we found partial mediation via awe/inspiration and purity intuitions for social media engagement (awe/inspiration: b = 0.135, SE = 0.029, 95% CI = [0.082, 0.194]; purity intuitions: b = 0.097, SE = 0.025, 95% CI = [0.051, 0.15]) and full mediation for moral standing (awe/inspiration: b = 0.164, SE = 0.021, 95% CI = [0.125, 0.205]; purity intuitions: b = 0.086, SE = 0.016, 95% CI = [0.056, 0.120]; see Table S7 in the Supplemental Material).

Boundary condition. We conducted the moderation analysis using Hayes's PROCESS Model 1 (Hayes, 2018) with 10,000 bootstrapping resamples. In the model specification, we included image aesthetics, each moderating factor one at a time, and the interaction between the two. We controlled for valence and arousal from the image as well as from the image type (baseline was images with animals). All the predictors were mean centered. For social media engagement, the extent to which individuals placed importance on beauty moderated the effect of image aesthetics (b = 0.089, SE = 0.026, p = .006, 95% CI = [0.038, 0.139]), suggesting that image aesthetics had a stronger effect on social media engagement for individuals who placed greater importance on beauty relative to those who did not. However, for moral standing, the interaction effect was not significant (b = 0.018, SE = 0.019, p = .349, 95% CI = [–0.019, 0.055]), suggesting that the extent to which individuals placed importance on beauty did not change the strength of the relationship between image aesthetics and moral standing.

To visualize the moderation effect, we plotted the conditional effect of image aesthetics on social media engagement and moral standing at values of importance of beauty as the moderator. As shown in the top graph

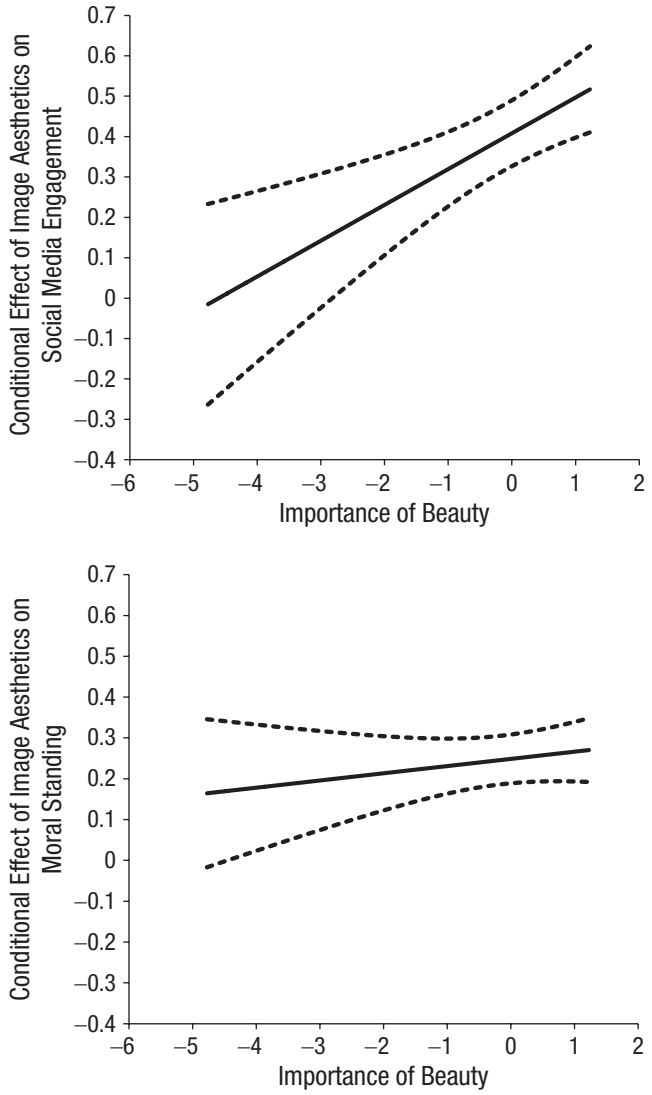

Fig. 2. Study 3: conditional effect of image aesthetics on social media engagement (top) and moral standing (bottom) as a function of importance of beauty. Dashed lines indicate the upper and lower limits of 95% confidence intervals around the point estimates.

in Figure 2, we observed an even more pronounced positive impact of image aesthetics on social media engagement for those who placed high importance on beauty. In contrast, we did not find prominent differences in the conditional effect of image aesthetics on moral standing between the different levels of importance of beauty (bottom graph in Fig. 2). Finally, we ran an additional preregistered analysis that explored the potential interaction effects with two additional moderators: enjoyment of nature and beliefs about beauty. However, neither of the interactions was significant (for results and figures, see Section S8 in the Supplemental Material).

Discussion

In sum, Study 3 provided evidence that our core results from Study 2 were robust, even though Study 3's analysis was at the individual level rather than the image level. This study also demonstrated that the relationship between image aesthetics and social media engagement was stronger for individuals who placed more importance on beauty, but the effect of image aesthetics on moral standing was not sensitive to whether individuals placed more or less importance on beauty.

General Discussion

Our studies present evidence for the power of image aesthetics in elevating social media engagement and promoting nature's moral standing. All three studies showed the effects of the aesthetic qualities of nature imagery, above and beyond image valence and arousal, because they induce an emotional state specific to aesthetics (such as awe and inspiration) as well as purity intuitions (Study 2). We also found support for our moderation hypothesis that the relationship between image aesthetics and social media engagement would be more pronounced for individuals who place greater importance on aesthetics (Study 3).

Most previous research (Holbrook & Batra, 1987; Teixeira et al., 2014) views the basic emotions of arousal and valence or six discrete emotions (sadness, happiness, fear, anger, surprise, and disgust) as the dominant drivers of consumer behavior. Instead, we drew from the moral-psychology literature to theorize the unique value of awe and inspiration (Keltner & Haidt, 2003; Shiota et al., 2014). By elucidating the affective processes that underlie the aesthetics of nature imagery, we tested the biophilia hypothesis and the value of nature aesthetics and added to the growing literature connecting aesthetics and morality (Klebl et al., 2021, 2022).

Our research also has implications for mission-driven organizations that seek to engage the public and garner support for their conservation efforts. Our data validate the idea that beautiful images of nature and wildlife can increase public engagement and enhance people's assignment of moral standing. Our findings in Study 3 suggest that conservation organizations could specifically target individuals who place high value on aesthetics in general, as they tend to be more responsive to aesthetic nature imagery. Last, our investigation of the specific image attributes associated with high aesthetics ratings (clarity, color vividness, and the object's centrality) could be used to train photographers whose goal is to help viewers experience awe and inspiration.

Despite its methodological strengths in combining different approaches, our research may not generalize to other samples and contexts. Our research sample included only participants who engaged on specific social media platform and thus represent the population who have access to the Internet and social media (Study 1) and are U.S.-based adults (Studies 1–3). Also, the way that our participants interacted with nature and wildlife was primarily virtual and thus does not speak to people's actual exposure to the natural environment. Future research could thus examine whether our findings around aesthetics are culturally variable and can be extended to other types of human–nature interactions. Additionally, the nature photos on National Geographic's social media outlet were selected and curated by its social media team, so we cannot assume that these were a randomly selected set of images. The fact that our data consisted of high-quality photos offers a unique opportunity for a conservative test of our hypothesis, but future research could include a wider set of images and test for other attributes that predict engagement. For instance, we did not find a significant effect of image aesthetics for animal images in Studies 1 and 2 when the analysis was at the image level, but the effect was significant when it was at the individual level. This raises the possibility that other animal-specific factors might be at play. In contrast, the effect on landscape was robust across all of the studies. Although it was beyond the scope of our studies to examine animal-specific factors (e.g., species, sentience, or similarity to humans; e.g., see Bastian et al., 2012) that predict social media engagement and moral standing, we believe that future studies could further examine these factors.

To conclude, our research demonstrates that nature's aesthetic value not only promotes social media engagement but also plays an important role in encouraging moral responsibility to protect nature and wildlife. We unveiled the underlying mechanisms for how the beauty of nature translates to care for nature. By capturing humans' biophilic tendency in the age of social media, we provide compelling evidence for the biophilia hypothesis and highlight the potential of the beauty of nature to invigorate global conservation efforts.

Transparency

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Author Contributions

E. Kim, J. Lee Cunningham, and A. Aribarg designed and performed the research, E. Kim and A. Aribarg analyzed the data, and E. Kim, J. Lee Cunningham, and A. Aribarg wrote the manuscript. All the authors approved the final manuscript for submission.

Declaration of Conflicting Interests

The author(s) declared that there were no conflicts of interest with respect to the authorship or the publication of this article.

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Open Practices

All data and analysis code have been made publicly available via OSF and can be accessed at https://osf.io/c9pqd/. The design and analysis plans for Study 3 were preregistered on AsPredicted (https://aspredicted.org/wv7f7.pdf). This article has received the badges for Open Data and Preregistration. More information about the Open Practices badges can be found at http://www.psychologicalscience.org/publications/badges.

ORCID iD

Julia Lee Cunningham https://orcid.org/0000-0002-6650-7088

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Supplemental Material

Additional supporting information can be found at http://journals.sagepub.com/doi/suppl/10.1177/09567976221083543

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