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An occasion for unselfing: Beautiful nature leads to prosociality

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ABSTRACT

Past studies have documented interpersonal benefits of natural environments. Across four studies, we tested the hypothesis that exposure to more beautiful nature, relative to less beautiful nature, increases prosocial behavior. Study 1 yielded correlational evidence indicating that participants prone to perceiving natural beauty reported greater prosocial tendencies, as measured by agreeableness, perspective taking, and empathy. In Studies 2 and 3, exposure to more beautiful images of nature (versus less beautiful images of nature) led participants to be more generous and trusting. In Study 4, exposure to more beautiful (versus less beautiful) plants in the laboratory room led participants to exhibit increased helping behavior. Across studies, we provide evidence that positive emotions and tendencies to perceive natural beauty mediate and moderate the association between beauty and prosociality. The current studies extend past research by demonstrating the unique prosocial benefits of beautiful nature.

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"In the woods we return to reason and faith. There I feel that nothing can befall me in life — no disgrace, no calamity (leaving me my eyes), which nature cannot repair. Standing on the bare ground — my head bathed in the blithe air and lifted into infinite space — all mean egotism vanishes."

Ralph Emerson. *Nature* (1983, p. 39)

1. Introduction: scientific studies on the benefits of nature

An emerging literature in psychology demonstrates that exposure to nature yields many positive outcomes (Kaplan, 1995; Wilson, 1984). For instance, several studies have examined whether exposure to nature enhances health (see Bratman, Hamilton, & Daily, 2012 for a review). In one study, hospital patients who had a window view of nature, compared to patients without such a view recovered faster and had shorter post-operative hospital stays (Ulrich, 1984). More recent studies extend this initial finding. For instance, patients in hospital rooms furnished with plants and flowers consumed fewer postoperative pain killers, showed lower systolic blood pressure, and experienced less pain, anxiety, and fatigue than patients in a room without plants and flowers (Park & Mattson, 2008, 2009).

Others have found that immersion in outdoor nature influences cognitive processes in beneficial ways. For example, participants who watched a video with images of nature exhibited improved executive function as evidenced by better performance on the digit span backward test compared to participants who watched a video depicting urban scene (Berman, Jonides, & Kaplan, 2008). In a related study, participants who took a 50-min walk in nature showed better performance on memory tasks than participants who had walked through an urban setting (Berman et al., 2012). In keeping with these results, participants performed better at a problem solving task (Remote Association Test; Mednick, 1962) after a four day hike in natural environments compared to a separate sample of participants that completed the task before the hike (Atchley, Strayer, & Atchley, 2012).

Beyond these health and cognitive benefits, researchers have documented several socio-emotional benefits brought about by exposure to nature. For instance, there are reduced property and violent crimes near residential buildings that are surrounded by greater vegetation (a higher density of trees and grass) (Kuo & Sullivan, 2001). Children with Attentional Deficit Disorder displayed fewer symptoms after playing in a park setting compared to those playing in an indoor setting (Taylor, Kuo, & Sullivan, 2001). Exposure to nature also buffers children from some of the adverse effects associated with stressful life events and trauma (e.g., being bullied; Wells & Evans, 2003). More generally, exposure to nature leads to prolonged and enhanced positive affect, which is a critical component of subjective well-being. For instance, in the aforementioned study in which participants took a 50-min walk in either a natural or urban environment, participants who had spent time in nature reported greater positive affect compared to those who had

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spent time in an urban environment (Berman et al., 2012). This emerging literature points to many psychosocial benefits of natural beauty.

Particularly relevant to the current investigation is research on the link between nature and prosocial tendencies. For instance, researchers have documented a correlation between exposure to nature and prosocial traits (Mayer & Frantz, 2004; Nisbet, Zelenski, & Murphy, 2009). One experimental study demonstrated that exposure to photographs of natural environments, relative to images of urban environments, led participants to endorse greater communal aspirations (e.g., "To have deep enduring relationships"). Furthermore, exposure to plants in laboratory settings led participants to behave more generously in an economic game than those in a no-plants setting (Weinstein, Przybylski, & Ryan, 2009). In another study, participants completed a stress induction task before they observed nature through a glass window or stared at a blank wall (Kahn et al., 2008). Following the stressful task, looking at nature through the glass window led to greater heart rate deceleration – a physiological index of orienting toward and engaging with others (Cacciopo & Sandman, 1978; Eisenberg et al., 1989; Goetz, Keltner, & Simon–Thomas, 2010; Stellar, Manzo, Kraus, & Keltner, 2012) – than did looking at a wall. These findings suggest that exposure to nature may promote other-focused prosocial tendencies.

It is important to note that the experimental studies we have reviewed have predominantly focused on examining the positive consequences of exposure to nature versus exposure to urban or non-nature stimuli. These studies, therefore, give rise to an intriguing question: What factors account for the wide-ranging benefits of nature? To address this question, the present work investigates whether subjective beauty is one property of natural environments that facilitates the effect of nature on prosocial behavior. Guided by conceptual work on subjective perceptions of beauty (Gepshtein & Kubovy, 2000; Kubovy, 2000), we examine the thesis that nature leads to prosociality via subjective perceptions of beauty. Thus, we investigate the possibility that it is not nature per se but rather perceptions of beautiful nature that promotes prosociality. To test this hypothesis, we compared the effects of natural environments that are perceived to be more beautiful against those perceived to be less so.

2. Objective and subjective beauty

Theorists have proposed a variety of answers to how aesthetic judgments of beauty are developed (Feagin, 1995). For instance, landscape research has identified that scenic beauty is influenced by the quality of the environment. In one study, hikers were asked to rate the scenic beauty (e.g., "*How does the scenic beauty of this view compare to others you have seen along this trail?*") of 12 landscapes during a hiking excursion. The landscapes that were rated as more beautiful tended to include more mountains, trees, depth of fields and open sky (Hull & Stewart, 1992; Hull, Stewart, & Yi, 1992). Other studies have highlighted individual difference as a predictor of beauty and attractiveness toward environment. For instance, Kaltenborn and Bjerke (2002) demonstrated that individual's sense of attachment to specific natural settings is associated with finding the settings as more attractive and pleasant. Similarly, people who are prone to experience awe are more likely to appreciate nature's beauty (Güsewell & Ruch, 2012). These findings set the stage for two schools of thought (objective and subjective) that have examined the development of individual's judgment of beauty in the larger neuroaesthetics literature.

For instance, on the objective beauty perspective, some have argued that beauty arises from the property of an object that elicits a positive valenced experience in the perceiver (Tatarkiewicz, 1970). Since then, researchers in the emerging field of empirical aesthetics have found several critical objective features that give rise to perceptions of beauty. These include features such as the symmetry, complexity, clarity of the stimulus, as well as the amount of contrast in it. Researchers have found that symmetry contributes to individuals' ratings of the attractiveness of faces (Rhodes, Sumich, & Byatt, 1999). Further, participants rated circles with high contrast to be prettier than circles with low contrast (Reber, Winkielman, & Schwarz, 1998). In a separate study, pictures of everyday objects (e.g., desk, bird, plane, etc) that were either preceded by a degraded contour of the same or different picture were presented to participants. The matched pictures, enhancing visual identification, led participants to rate it as more likable than non-matched pictures (Reber et al., 1998). This kind of research is in keeping with one philosophical approach, that perceptions of beauty arise from a stimulus's objective characteristics.

Another tradition of scholars working on aesthetic experience is rooted in the assumption that subjective processes give rise to the perception of beauty, independent of objective features of the stimulus (Kubovy, 2000). This subjectivist approach highlights how the perception of beauty arises as a function of the individual's own construal of the object (Rolston, 2008). The British philosopher Samuel Alexander (1968) nicely described this subjectivist perspective:

> "The nature we find beautiful is not bare nature as she exists apart from us but nature as seen by the artistic eye…we find nature beautiful not because she is beautiful herself but because we select from nature and combine… a construction on our part and an interpretation".
>
> pp. 30–31

Prior research in neuroaesthetics has compared individuals' subjective perception with objective features of a stimulus and differential brain activation. For instance, participants listened to their subjectively rated beautiful (ugly) consonant or dissonant chords. The results showed that beautiful consonants, compared to the other conditions, activated the left middle temporal gyrus (visual perception; Suzuki et al., 2008). In a separate study, participants rated black and white geometric patterns on beauty and symmetry (Jacobsen, Schubotz, Hofel, & Cramon, 2006). Symmetry is positively correlated with beauty ratings. However, symmetry ratings were not associated with significant activation, whereas beauty ratings were correlated with significant activation in the fronto-medial cortex. While objective features contribute to beauty judgments, the theoretical and empirical literature we have reviewed suggests an idiosyncratic approach to beauty, one that emphasizes the individual's subjective perceptions of a stimulus (see Gepshtein & Kubovy, 2000 for further review).

In the current research, we are interested in the consequences of individual's subjective perception of nature. A subjectivist approach to beauty and its effects has two important implications. First, beauty should only yield effects for those individuals prone to subjective experiences of beauty. This notion – that individual differences moderate the effects of feelings upon judgments and action – has been widely validated in the literature on emotion and social cognition (e.g., Lerner & Keltner, 2001). Second, more subjectively beautiful stimuli should have more powerful effects than less beautiful stimuli. Guided by these lines of reasoning, the present investigation tested the hypothesis that subjectively beautiful nature leads to more prosociality than less beautiful nature.

3. The psychological effects of beauty

There is little direct evidence linking subjective perceptions of beauty in nature to enhance prosociality—the central hypothesis

guiding our investigation. However, several philosophical and psychological literatures lend indirect support to our predictions, including work on neuroaesthetics (Nadal & Pearce, 2011), trait openness to experience (John & Srivastava, 1999), and the tendency to appreciate beauty (Peterson & Seligman, 2004).

Within contemporary philosophy, there is a long-standing tradition of associating beauty with virtue, justice, and righteousness. For instance, Simone Weil (1951) suggested that people experience a radical decentering of the self when viewing something beautiful. A similar notion has been advanced by philosopher Elaine Scarry (1999) in her observation that people's response to observing beauty may be that "we cease to stand even at the center of our own world (p. 77)." Moreover, in *The Sovereignty of Good over Other Concepts*, the philosopher Iris Murdoch (1967) reasoned that beauty can lead to what she called *unselfing*– a process that motivates the individual to transcend self-interest and become more generous and kind. These observations suggest that subjective perceptions of beauty may shift the individual's perspective away from the self and toward others, a process that should underlie increased prosociality (e.g., Batson & Shaw, 1991).

Several lines of research lend support to these intuitions. For instance, in research on neuroaesthetics, Cela-Conde et al. (2009) asked participants to judge the beauty of various images (e.g., paintings, photographs of landscapes) and observed significant activation of brain regions linked to empathy (e.g., the right angular gyrus and the parietal cortex) when participants judged the images to be beautiful. Other studies in neuroaesthetics have reported activation of the mPFC (medial prefrontal cortex) and IFG (inferior frontal gyrus)—areas of the brain typically associated with prosocial responses (Seitz, Nickel, & Azari, 2006; Shamay-Tsoory, Aharon-Peretz, & Perry, 2009)—when participants were exposed to beautiful music (e.g., fast major-key [sound warm and effervescent], produce chills and induce positively valenced responses), architecture, and visual imagery (see Nadal & Pearce, 2011). Though correlational, these neuroscientific studies suggest that subjective perceptions of aesthetic beauty in stimuli may enhance empathy and prosocial responses.

A separate line of research on individual difference in aesthetic sensitivity lends further support to our hypothesis that subjective perceptions of beauty in nature will increase prosocial responding. For instance, an important facet of the openness personality trait is a sensitivity toward and appreciation of beauty in the external environment (Costa & McCrae, 1992). Moreover, openness has been linked to increase in prosociality. For instance, openness is positively associated with greater volunteering and prosocial inclinations (Carlo, Okun, Knight, & de Guzman, 2005) and increased empathy in children (Del Barrio, Aluja, & García, 2004). Ozer and Benet-Martinez (2006) found that openness is associated with greater religious and spiritual concerns, which in turn are associated with increased prosociality (Saslow et al., 2013). In a similar vein, self-report research on the character strength called appreciation of beauty and excellence (Peterson & Seligman, 2004) finds that it is associated with agreeableness, a trait associated with prosocial responding (e.g., trust, concern for others; Macdonald, Bore, & Munro, 2008). Moreover, in a large scale nation-wide survey (The 2005 Midlife in the United States Survey), Einolf (2011) found that the subjective experience of beauty in life is related to greater charitable giving and increased empathic behavior (e.g., providing emotional support). Together, these lines of evidence suggest that subjective experiences of beautiful stimuli are linked to prosociality. In the current investigation, we test the related hypothesis that subjectively more beautiful nature promotes greater prosociality than subjectively less beautiful nature.

4. Positive emotions as a mediator

Why might subjective perceptions of beauty in nature lead to increased prosociality? One likely cause is positive emotion. Past studies have repeatedly demonstrated that people feel more positive emotions in the presence of nature versus urban settings (Berman et al., 2012; Nisbet, Zelenski, & Murphy, 2011; Ryan et al., 2010). Positive emotions, in turn, may enhance prosociality, an idea that aligns with Fredrickson's (1998, 2001) broaden-and-build theory of positive emotions. According to the broaden-and-build framework, positive emotions broaden people's perspective and motivate them to engage in behaviors that have long-term benefits, including prosocial actions. For instance, happy people self-report more past altruistic acts than less happy people (Krueger, Hicks, & McGue, 2001). Higher trait positive affect is also correlated with greater interest in helping others (Feingold, 1983), and daily positive affect predicts greater daily helping behaviors (Lucas, 2001). Moreover, participants that were experimentally induced to feel positive emotions contributed more money to charity and volunteered to help with extra experiments (see Lyubomirsky, King, & Diener, 2005 for a review). This evidence supports the notion that increased positive emotions can enhance prosocial behaviors.

The research discussed above on subjective perception of beauty, positive emotions, and prosocial behavior sets the stage for the predictions we test in this investigation. Specifically, we test whether subjective perceptions of beauty in nature lead to increased prosocial tendencies and do so, in part, because such perceptions elicit increased positive emotions on the part of the perceiver.

5. Individual differences in perceiving natural beauty

Alongside our hypothesis that beautiful nature leads to greater prosociality, we also sought to explore whether such effects of beauty are moderated by individual differences. Specifically, individuals may vary in the extent to which they perceive or are sensitive to beauty in nature. One dispositional factor that is most relevant to this idea is an orientation to perceiving natural beauty. To capture this construct, Diessner, Solom, Frost, Parsons, and Davidson (2008) developed the Engagement with Beauty Scale, which contains a subscale that measures the degree to which individuals perceive natural beauty (i.e., orientation towards experience/aroused by natures' beauty; PNB). Most central to our investigation, studies have related PNB to prosocial tendencies. For example, PNB has been found to be negatively associated with materialistic values and positively associated with prosocial feelings of gratitude (Diessner et al., 2008). Furthermore, Diessner, Davis, and Toney (2009) demonstrated that PNB is positively correlated with a sense of fairness (Values in Action Scale) and that this association remains significant after controlling for openness to experience. These findings indicate that the effects of PNB are not reducible to the general personality trait of openness. This evidence suggests that individuals prone to perceiving natural beauty also tend to be more prosocial.

Guided by these findings, we reasoned that to the extent that exposure to beautiful nature increases prosociality—our central hypothesis—this effect may be most pronounced amongst individuals prone to perceiving such beauty. This prediction dovetails with studies highlighting person × situation interaction effects in studies of behavior (Mischel & Shoda, 1995). Studies of emotion, for instance, emphasize the utility of studying interactions between individual difference variables and exposure to emotionally evocative stimuli. For instance, in one study, experimentally manipulated feelings of compassion led to greater

generosity in resource allocations for less religious individuals but not among highly religious individuals (Saslow et al., 2013). These findings highlight how emotionally evocative stimuli elicit different responses depending on dispositional tendencies of the individual. We tested the hypothesis that the tendency to perceive natural beauty would moderate the effect of natural beauty on prosociality. We expected that the effects of exposure to subjectively more beautiful nature would be most pronounced among individual high in trait tendencies to perceive beauty in nature.

6. The current research

Four studies tested the differential effects of subjectively more versus less beautiful nature on prosocial behavior. Using a correlational design with a large adult sample, Study 1 tested if individuals with greater tendencies to perceive natural beauty (PNB; Diessner et al., 2008) would exhibit greater prosocial traits, including increased agreeableness, perspective taking, and empathy. Using an experimental approach, Studies 2 and 3 tested whether exposure to stimuli depicting subjectively more or less beautiful nature would increase generous, cooperative behavior in two economic tasks: the Dictator Task (Study 2) and the Trust Game (Study 3). As discussed above, the objective characteristics and subjective perceptions contribute to individual's experience of beauty. Given the focus of the current research is to examine whether people differ in their prosocial tendencies when they are exposed to subjectively less and more beautiful natural environments, it is imperative to rule out the objective characteristics as an alternative explanation. Therefore, we hold the objective characteristics (e.g., symmetry etc) constant in the stimuli that we used in Studies 2 and 3 to ascertain the unique association between subjective differences in perceived natural beauty and prosocial consequences. Finally, Study 4 tested whether ambient exposure to subjectively more beautiful (versus less beautiful) nature in a laboratory setting would lead participants to engage in increased helping behavior (Bringslimark, Hartig, & Pail, 2009; Park & Mattson, 2008, 2009; Weinstein et al., 2009). Across studies, we tested a process model in which the effects of more beautiful nature on prosocial behavior are mediated by positive emotions (Frederickson, 1998; Isen & Levin, 1972; Lyubomirsky et al., 2005). We also tested whether PNB would moderate the effects of more beautiful nature on prosociality, to provide insight into how the effects of beautiful nature may vary across individuals.

7. Study 1: the tendency to perceive natural beauty predicts self-reported prosociality

In Study 1 we examined whether the tendency to perceive natural beauty (PNB; Diessner et al., 2008) underlies individual differences in prosociality. We assessed prosociality in two ways: first, using the Agreeableness factor from the Big Five Inventory (John & Srivastava, 1999); and second, using the perspective taking and empathic concern subscales of the Interpersonal Reactivity Index (IRI; Davis, 1983). Past research has shown that these measures index individual differences in prosocial tendencies and are robust predictors of helping behavior (Dovidio, Piliavin, Schroeder, & Penner, 2006; Graziano, Habashi, Sheese, & Tobin, 2007; Underwood & Moore, 1992). Further, given that individual differences in connectedness with nature (CNS; Mayer & Frantz, 2004) —which indexes the extent to which individuals include nature in the self-concept—are associated with prosociality, we controlled for CNS as well as other demographic variables (e.g., age, gender, ethnicity, and religious attendance) to pinpoint the specific association between PNB and prosociality.

7.1. Method

7.1.1. Participants and procedures

Participants were 846 adult volunteers residing in the US. Participants self-selected to take one or more surveys from a list of approximately 15–20 surveys via the website http://www.yourmorals.org. This website provides an alternative to traditional sample populations and has served as the data source for a number of recent empirical articles (e.g., students; Glenn, Koleva, Iyer, Graham, & Ditto, 2010; Graham et al., 2011; Koleva, Graham, Haidt, Iyer, & Ditto, 2012). All participants had previously registered at the site and provided demographics, including age (M = 39.55 years, SD = 16.34, range = 18–89), gender (41.5% female), ethnicity (74.8% Caucasian), and religiosity (i.e., religious attendance, 0 [*never*] to 5 [*one or more times a week*], M = 1.18, SD = 1.64). Thus, the sample is relatively diverse in terms of age, gender and ethnicity. Visitors to the website can freely complete as many surveys as they wish. Here, we report results for those who completed all of the questionnaires relevant to the current study.

7.1.2. Measures

7.1.2.1. Tendency to perceive natural beauty. The Engagement with Natural Beauty subscale (Diessner et al., 2008) is a 4-item measure that assesses the individual's self-reported tendency to perceive natural beauty ("I notice beauty in one or more aspects of nature"; "When perceiving beauty in nature I feel changes in my body, such as a lump in my throat, an expansion in my chest, faster heartbeat, or other bodily responses"; "When perceiving beauty in nature I feel emotional, it "moves me", such as feeling a sense of awe, or wonder or excitement or admiration or upliftment"; "When perceiving beauty in nature I feel something like a spiritual experience, perhaps a sense of oneness, or being united with the universe, or a love of the entire world"; M = 5.31, SD = 1.39, α = .84) on a seven-point scale (1 = *strongly disagree*; 7 = *strongly agree*). The predictive, convergent, and discriminant validity of this measure has been demonstrated before ($\alpha \leq .80$, test-rest $\leq .84$; Diessner, Rust, Solom, Frost, & Parsons, 2006; Diessner et al., 2008, 2009).

7.1.2.2. Agreeableness. We assessed individual differences in prosocial tendencies with the agreeableness subscale of the 44-item Big Five Inventory (BFI; John & Srivastava, 1999). Participants indicated how much they felt nine different personality characteristics might apply to them on a five-point scale ranging from 1 (*disagree strongly*) to 5 (*agree strongly*). Sample items include, "Is helpful and unselfish with others" and "Is generally trusting." Scores on the nine items were summed and averaged (M = 3.48, SD = .71, α = .85).

7.1.2.3. Interpersonal reactivity index. We further assessed prosocial tendencies using the perspective taking and empathic concern subscales of the Interpersonal Reactivity Index (Davis, 1983). The seven-item perspective taking scale measures the tendency to spontaneously understand others' psychological point of view (e.g., "I sometimes find it difficult to see things from the 'other guy's' point of view; M = 3.62, SD = .77, α = .85). The six-item empathic concern scale evaluates the respondent's feelings of warmth and compassion for others (e.g., "I often have tender, concerned feelings for people less fortunate than me"; M = 3.63, SD = .87, α = .85). Items are rated on a scale ranging from 0 (*does not describe me well*) to 4 (*describes me very well*).

7.1.2.4. Connectedness to nature. The Connectedness to Nature Scale (CNS) is a 14-item questionnaire that measured participants' sense of oneness with the natural world (e.g., "I often feel a sense of oneness with the natural world around me"), their sense of kinship with

animals and plants (e.g., "I recognize and appreciate the intelligence of other living organisms"), and their sense of equality between the self and nature (e.g., "When I think of my life, I imagine myself to be part of a larger cyclical process of living"; Mayer & Frantz, 2004). Participants responded on a seven-point scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*) ($M = 3.48$, SD = .88; $\alpha = .83$).

7.2. Results

Central to our current hypothesis, participants' self-reported PNB was moderately and positively correlated with agreeableness ($r = .31$, $p < .001$), perspective taking ($r = .35$, $p < .001$), and empathic concern ($r = .46$, $p < .001$). To further test our hypothesis, we standardized all variables and entered them into separate hierarchical regression models that predicted agreeableness, perspective taking and empathic concern (see Table 1). The regression model was significant for agreeableness, $F(5, 841) = 39.82$, $p < .001$. Age, religious attendance, and CNS all positively predicted agreeableness. Importantly, PNB remained a positive unique predictor of agreeableness ($b = .15$, $p = .001$) after taking these control variables into account.

The model for perspective taking was also significant, $F(5, 841) = 27.11$, $p < .001$. Age, gender and religious attendance did not significantly predict perspective taking, but CNS positively predicted perspective taking (see Table 1). Importantly, as hypothesized, PNB was a unique positive predictor of perspective taking ($b = .19$, $p < .001$) above and beyond these control variables.

Lastly, the model for empathic concern was significant as well, $F(5, 841) = 67.61$, $p < .001$. Age, gender, religious attendance, and CNS were all significant predictors of empathic concern (See Table 1). However, PNB remained a positive unique predictor of empathic concern ($b = .30$, $p < .001$).

7.3. Discussion

Study 1 demonstrated a moderate positive association between PNB and prosociality. Individuals higher on PNB reported greater agreeableness, empathy, and perspective taking. These effects held after controlling for age, gender, religious attendance, and connectedness to nature. Building on this correlational evidence, in the follo wing studies we experimentally tested whether exposure to natural beauty would cause subsequent increases in prosocial behavior.

8. Study 2: natural beauty and prosociality in the dictator game

In Study 2, we experimentally manipulated natural beauty by exposing participants to different sets of images of nature that had been pre-tested as being subjectively more or less beautiful. After viewing one of the two image sets, participants completed the dictator task, a single trial behavioral measure of generosity (Forsythe, Horowitz, Savin, & Sefton, 1994; Fowler & Kam, 2007). We expected that exposure to the subjectively more beautiful nature stimuli would significantly boost generosity compared to the less beautiful nature stimuli. We also tested a possible mediator (positive emotions) and moderator (PNB) of this effect.

8.1. Method

8.1.1. Pilot study to identify more and less beautiful images of nature

We conducted a pilot study to generate sets of images of nature that differed in their perceived beauty but that were otherwise equivalent along other more objective dimensions, including clarity of image, proportion, symmetry, complexity, and overall quality (for a review of these dimensions, see Reber, Schwarz, & Winkielman, 2004).

First, we collected a total of 100 nature images from Google Image – an internet search engine for digital images. Three research assistants then rated each image in terms of whether it was beautiful from 1 (*not at all*) to 7 (*very beautiful*) (ICC = .98). In order to obtain sets of more and less beautiful nature images, a hierarchical cluster analysis of the ratings with the number of clusters set to two was used that allowed us to identify a more beautiful ($n = 60$) and a less beautiful set of nature images ($n = 40$).

Ten images were then randomly selected from the sets of more and less beautiful sets of nature images. From each set of 10 images, one-minute slide presentations were constructed in which each image was presented for six seconds. Twenty-eight individuals (14 women; age ranged from 20 to 59 years; $M = 40.68$, SD = 11.84; 61% Caucasian) were recruited from Mechanical Turk (Mturk; Buhrmester, Kwang, & Gosling, 2011) and randomly assigned to view *either* the subjectively more beautiful nature images *or* the less beautiful nature images. After viewing the video slideshow, participants indicated whether the video was beautiful on a scale ranging from 1 (*not at all*) to 7 (*very beautiful*). To index the perceived objective aesthetic properties of the nature images, we also asked participants to indicate how clear, proportionate, symmetrical, and complex they found the images, as well as to rate their overall quality, all on scales from 1 (*not at all*) to 7 (*very much*).

The results revealed that participants indicated the beautiful nature images as more beautiful ($M = 6.21$) than the less beautiful nature images ($M = 5.36$), $t(26) = 2.38$, $p = .025$, and the image sets did not differ in clarity ($Ms = 5.78$ versus 5.10, $p = .24$), proportion ($Ms = 5.14$ versus 5.07, $p = .89$), symmetry ($Ms = 4.85$ versus 4.35, $p = .40$), complexity ($Ms = 4.92$ versus 4.50, $p = .47$), or perceived overall quality ($Ms = 6.00$ versus 5.43, $p = .19$). Thus, the results indicate that the images differed in terms of the subjective perceived beauty but were similar in other dimensions relevant to the objective aesthetic properties central to the perception of beauty (Reber et al., 2004). Therefore, we employed these two videos in the main study (see Fig. 1 for sample images). Nevertheless, we should note that a separate sample of 30 individuals

Table 1
Hierarchical regressions predicting agreeableness, perspective taking, and empathic concern in study 1.

IVs	Agreeableness				Perspective taking				Empathic concern			
	Step 1	Step 2	Step 3	Step 4	Step 1	Step 2	Step 3	Step 4	Step 1	Step 2	Step 3	Step 4
	b	*b*	*b*	*b*	*b*	*b*	*b*	*b*	*b*	*b*	*b*	*b*
Age	.28***	.27***	.18***	.18***	.07	.08	−.03	−.03	.28***	.27***	.17***	.16***
Gender	−.04	−.03	.03	.05	−.13***	−.13**	−.04	−.03	−.25***	−.25***	−.16***	−.15***
Religious attendance	–	.17***	.21***	.19***	–	.01	.06	.04	–	.11**	.16***	.13**
CNS	–	–	.30***	.21***	–	–	.35***	.22***	–	–	.34***	.16***
PNB	–	–	–	.15***	–	–	–	.19***	–	–	–	.30***
	ΔR^2	ΔR^2	ΔR^2	ΔR^2	ΔR^2	ΔR^2	ΔR^2	ΔR^2	ΔR^2	ΔR^2	ΔR^2	ΔR^2
	*.08***	*.029***	*.079***	*.013***	*.020***	*.000*	*.104***	*.020***	*.130***	*.012***	*.103***	*.052***

Note. CNS = Connectedness to Nature Scale (Mayer & Frantz, 2004). PNB = Perceive Natural Beauty Scale (Diessner et al., 2008). We entered age and gender in step 1, religious attendance in step 2, CNS in step 3 and PNB in step 4. ΔR^2 reflected the unique change in variance explained by the predictor(s) in each step. *$p < .05$; **$p < .01$; ***$p < .001$.

Fig. 1. Left Column (Study 2): Sample images used in the more (top) and less (bottom) beautiful nature videos. Right Column (Study 3): Sample images used in the more (top) and less (bottom) beautiful nature videos.

recruited from Mturk revealed that the slideshow in the more beautiful condition, compared to the less beautiful condition, possessed more water (e.g., lake, river), presence of sky, open space (e.g., large depth of field) and mixture of natural colors. Thus, while the aesthetic qualities did not differ across conditions, there were some differences in landscape characteristics.[2].

8.1.2. Participants and procedures

One hundred twenty eight individuals (52.6% women) were recruited from MTurk and received a nominal monetary compensation for their participation (after eight individuals were excluded because they engaged but didn't complete the study). Ages ranged from 22 to 72 years ($M = 33.98$, SD = 12.15). Seventy-five percent of participants were Caucasian, 8% Asian American, 7.3% African American, 3% Latino or Latina, 2% Multi-racial.

Participants accessed the study through an online server, provided consent, and were randomly assigned to either the more beautiful or less beautiful nature video condition. In both conditions, participants watched a one-minute video of 10 distinct images (6 s per image). Afterward, participants indicated, in general, how beautiful they thought the images were from 1 (*not at all*) to 7 (*very beautiful*). This question served as our manipulation check. Then, participants completed a measure of positive emotions (Diener & Emmons, 1984), the dictator game (e.g., Piff, Kraus, Cote, Cheng, & Keltner, 2010), and PNB (Diessner et al., 2008). Lastly, participants completed a demographics questionnaire and were debriefed.

8.1.3. Measures

8.1.3.1. Dictator game. Following previous studies that have used the dictator game as an indicator of prosociality (Piff et al., 2010; Saslow et al., 2013), we used it to measure participants' generosity (Forsythe et al., 1994). In this game, participants were informed that they had been paired with an anonymous partner who was also completing the study. Participants were told that they had been randomly assigned to the role of the "Sender." Each participant was told that they had been given 10 points, each of which would equal an additional 5 cents in their final payout. Participants were then informed that they could give any amount (including zero) to their partner, and that their final compensation would depend on how many points they had remaining. Participants were further told that their partner would have no strategic input into the game's outcome and that their responses in the game would remain anonymous (all participants received the full compensation in the end). Higher allocation reflected higher levels of generosity. On average, participants gave away 55% of their points ($M = 5.50$, SD = 2.20), which is comparable to levels of giving observed in previous research (Weinstein et al., 2009).

8.1.3.2. Positive emotions. Positive emotions were measured using seven items from Diener and Emmons' (1984) hedonic valence scale. Participants indicated the extent to which they currently feel: happy, joy, content, pleased, delight, enjoyment/fun, and glad on a 1 (*not at all*) to 7 (*very much*) scale ($M = 4.27$, SD = 1.64; $\alpha = .95$).

8.1.3.3. Tendency to perceive natural beauty. As in Study 1, participants completed the 4-item self-reported tendency to perceive natural beauty subscale (Diessner et al., 2008; $M = 5.03$, SD = 1.26, $\alpha = .81$).

8.2. Results

8.2.1. Manipulation check

As expected, participants in the beautiful condition rated the video as more beautiful ($M = 6.08$, SD = 1.07) than those in the less beautiful condition ($M = 5.17$, SD = 1.30), $t(126) = 4.37$, $p < .001$, suggesting that the manipulation successfully elicited different levels of perceived natural beauty.

We regressed points given away in the dictator game onto condition (−1 for less beautiful nature video, 1 for beautiful nature

[2] We thank an anonymous reviewer for pointing out the importance of landscape differences in the study of nature. It would be important for future research to replicate our findings by taking into account both aesthetic qualities (e.g., symmetry, etc) *and* landscape characteristics (e.g., depth of field, etc).

Table 2
Testing mediation of the link between more beautiful nature and prosocial behaviors through positive emotions.

	Standardized path coefficient (SE)					
	Condition to positive emotions (path a)	Positive emotions to points gave away (path b)	Indirect effects of positive emotions on points gave away (ab paths)	Total effect of condition to points gave away (path c)	Direct effect of condition to points gave away (c-prime path)	95% Confidence Interval
Study 2						
Positive emotions	.33* (.14)	.25* (.11)	.082* (.04)	.42* (.19)	.33 (.19)	(.0011, .2402)
Study 3						
Positive emotions	.25* (.12)	.26** (.07)	.06* (.03)	.18* (.09)	.12 (.08)	(.0849, 1.431)
Study 4						
Positive emotions	.42* (.17)	.33** (.12)	.14* (.07)	.32* (.14)	.18 (.14)	(.0251, .3429)

Note. Mediation effect is supported when: (a) paths a and b are significant, (b) path c is significant, (c) path c-prime is significantly reduced, and (d) the CI [confidence interval] do not include 0 (Preacher & Hayes, 2008; 10,000 resamples). Condition (1 = More beautiful nature; −1 = less beautiful nature). C-prime path statistics: Study 2, $t = 1.71$, $p = .09$; Study 3, $t = 1.40$, $p = .16$; Study 4, $t = 1.24$, $p = .22$. $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$.

video) and found that participants exposed to the video of more beautiful nature gave away more points in the dictator game than participants exposed to the less beautiful nature video, $b = .18$, $t(126) = 2.15$, $p = .033$, $d = .38$. Participants exposed to more beautiful nature also reported greater positive emotions, $b = .20$, $t(126) = 2.32$, $p = .022$, $d = .41$. Furthermore, positive emotions positively predicted the number of points given away ($r = .21$, $p = .015$). We tested a mediation model with the bootstrapping procedure outlined by Preacher & Hayes, 2008. A significant mediation through positive emotions exists if the 95% confidence interval (CI) does not include zero. Table 2 presents the results of this mediation analysis, as well as those in the remaining two studies. As seen in Table 2, (a) condition and positive emotions were both associated with points given away; (b) the direct effect of condition on points given away was significantly attenuated after positive emotions were entered into the model (c-prime path). The bootstrap 95% CI (.0011, .2402) with 10,000 resamples did not include zero, demonstrating positive emotions as a significant mediator of the effects of natural beauty on prosocial giving.

8.2.2. Interaction

To test for the condition by PNB interaction, we formed an interaction term by multiplying standardized PNB by experimental condition (1 = more beautiful nature, −1 = less beautiful nature). The linear regression model revealed a main effect of condition on generosity ($b = .16$, $p = .048$). PNB also positively predicted points given away ($b = .23$, $p = .007$). Importantly, the interaction PNB and condition was also significant ($b = .17$, $p = .042$). We next probed this interaction by testing the effects of PNB between participants in the more and less beautiful condition at one standard deviation above and below the mean of PNB (Aiken & West, 1991). At one standard deviation above the mean of PNB, the effect of exposure to the more beautiful nature imagery was positive and significant ($b = .34$, $p = .005$); however, this effect at one standard deviation below the mean of PNB was not significant ($b = -.05$, $p = .90$) (see Fig. 2). These findings suggest that the effects of beautiful nature on prosocial behavior are most pronounced among individuals who are high in tendencies to perceive natural beauty.[1]

8.3. Discussion

In Study 2, participants who viewed beautiful nature images, compared to participants who viewed less beautiful nature images, gave away more points in the dictator game. Moreover, the effect of beautiful nature on generosity was mediated by positive emotions, suggesting that beautiful nature evokes positive affect, which, in turn, prompts prosocial responding. Further, PNB positively predicted generosity in the dictator game, which parallels the results of Study 1 showing that individuals higher in PNB reported greater trait prosociality. Importantly, PNB moderated the effects of beautiful nature on prosociality: Individuals higher on PNB were more prosocial than their lower-PNB counterparts when they viewed beautiful nature images. In sum, these results suggest that beautiful nature enables greater prosocial tendencies via positive emotions, and that this effect is more pronounced among individuals prone to perceiving beauty in their natural surroundings.

9. Study 3: beautiful nature and prosociality in the trust game

In Study 3we used a different set of slides to ensure that the effects we observed in the prior study were not limited to the specific images used but rather generalize to different stimuli. Moreover, we measured prosocial behavior with a different economic task: the Trust Game (Berg, Dickhaut, & McCabe, 1995). This task assesses participant's willingness to allocate points to their partner despite the potential that their partner may defect and, as such, indexes prosocial trust behavior (e.g., Piff et al., 2010). As in Study 2, we tested positive emotions as the mediator (Diener & Emmons, 1984) and examined whether PNB (Diessner et al., 2008) moderated the relationship between beautiful nature and prosocial trust behavior.

9.1. Method

9.1.1. Participants and procedures

One hundred twelve (27% women) people were recruited from MTurk and received a nominal monetary compensation. Ages

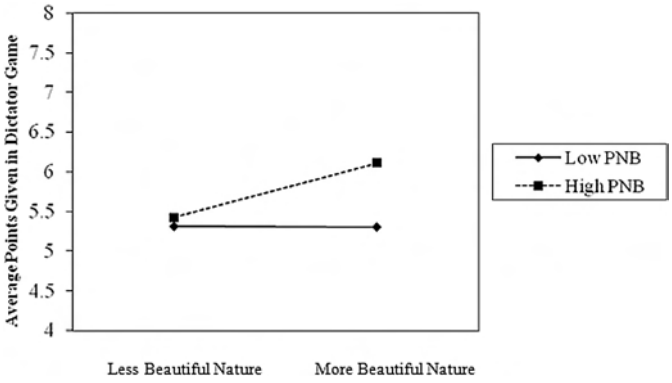

Fig. 2. Condition (1 = beautiful nature, −1 = less beautiful nature) by PNB interaction predicting points given away in the dictator task from Study 2.

[1] We tested mediated moderation. However, the condition × PNB interaction predicting positive emotions was in the correct direction but not significant in the three experiments (*bs* = .10–.18).

ranged from 18 to 66 years ($M = 30.53$, SD = 10.83). Seventy two percent of participants were Caucasian, 17% Asian American, 7% African American, 3% Latino or Latina, and 1% Other. The instructions for Study 3 were identical to those of Study 2.

9.1.2. Measures

9.1.2.1. Slideshow. We randomly selected a different set of 10 images for the more beautiful and less beautiful nature conditions from the pool of images used to select the images in Study 2. None of the images overlapped with those used in Study 2, ensuring that the effects we observed were attributable to an entirely distinct set of images (see Fig. 1 for sample image). One-minute videos were constructed from each set. Twenty-eight individuals (46.4% women, *M*age = 40.68, SD = 11.84; 78.6% Caucasian) completed the same ratings as in Study 2. Participants rated the beautiful nature video as more beautiful ($M = 6.25$) than the less beautiful nature video, ($M = 5.12$), t (26) = 3.75, $p = .001$, and the videos did not differ on clarity (*Ms* = 5.90 versus 5.10, $p = .17$), proportion (*Ms* = 5.16 versus 5.06, $p = .85$), symmetry (*Ms* = 4.83 versus 4.43, $p = .51$), complexity (*Ms* = 4.91 versus 4.56, $p = .56$) and overall quality (*Ms* = 5.91 versus 5.00, $p = .11$). These results confirm that the videos differed in terms of their subjective perceived beauty but were similar in other aesthetic dimensions. Therefore, we employed these two videos in the main study. Similar to the previous study, the same differences in landscape qualities were also found across conditions in the slides used in this study.

9.1.2.2. Trust game. Guided by previous studies (Piff et al., 2010; Saslow et al., 2013), in the current study we used the Trust Game as an index of prosocial behavior (Berg et al., 1995). In this game, participants read a cover story in which they were told that they had 30 points (with each point equaling one cent) to play a game with a randomly selected partner who was also completing the survey at the same time. Participants were instructed that they could choose to give a portion of their points to their partner and that their compensation at the end of the study would depend on how many points they had remaining. However many points they allocated to their partner would then be tripled, and their partner would have the opportunity to give back as many points as they would like to the participant (Berg et al., 1995; Piff et al., 2010; Saslow et al., 2013). In actuality, participants were not paired with a partner and thus only completed the allocation portion of the trust game (all participants received the full compensation in the end). Participants on average gave 59% of their points ($M = 17.95$, SD = 9.72), which is comparable to previous research that used a similar economic task (Weinstein et al., 2009).

Participants completed the same measure of positive emotions ($M = 4.90$, SD = 1.32; $\alpha = .94$) and PNB as described in study 2 ($M = 5.04$, SD = 1.34, $\alpha = .82$).

9.2. Results

9.2.1. Manipulation check

As expected, participants in the more beautiful condition rated their slideshow as subjectively more beautiful ($M = 6.39$, SD = .79) than those in the less beautiful condition ($M = 5.84$, SD = .96), $t(110) = 3.28$, $p = .001$, suggesting that the manipulation successfully elicited different levels of subjective perceived natural beauty.

Replicating the results of Study 2, participants in the more beautiful nature condition gave away more points in the trust game than participants in the less beautiful nature condition, $b = .19$, $t(110) = 2.00$, $p = .048$, $d = .38$. Also, there was a significant positive relationship between condition and positive emotions, $b = .19$, $t(110) = 2.06$, $p = .042$, $d = .38$. Furthermore, positive emotions predicted points given away ($r = .33$, $p < .001$). When we tested our mediation model with the Preacher & Hayes, 2008 script we found that the direct effect of condition on points given away was significantly attenuated after positive emotions were entered into the model (c-prime path; see Table 2). The bootstrap 95% CI (.048, .318) with 10,000 resamples did not include zero, indicating that positive emotions help explain the effects of more beautiful nature on prosociality.

9.2.2. Interaction

We next tested whether the PNB by condition interaction was significant. The linear regression model revealed a significant main effect of condition ($b = .17$, $p = .048$). PNB also positively predicted points given away ($b = .37$, $p < .001$). Importantly, the interaction of PNB and condition was also significant ($b = .18$, $p = .045$). We next probed this interaction by testing the effects of PNB between participants in the more and less beautiful condition at one standard deviation above and below the mean of PNB (Aiken & West, 1991). At one standard deviation above the mean of PNB, the effect of exposure to the more beautiful nature imagery was positive and significant ($b = .33$, $p = .005$); however, this effect at one standard deviation below the mean of PNB was not significant ($b = -.02$, $p = .95$) (see Fig. 3). These findings suggest that the effects of more beautiful nature on prosocial behavior are most pronounced among individuals who are high in tendencies to perceive natural beauty.

9.3. Discussion

The results of Study 3 conceptually replicated and extended the findings of the previous study using different stimuli and a different measure of prosociality. Participants who viewed beautiful nature images, compared to participants who viewed less beautiful nature images, gave away more points in the trust game. Moreover, this effect was mediated by positive emotions and was moderated by individual differences in PNB, such that the effects of more beautiful nature (versus less beautiful nature) on prosociality were strongest among individuals high on PNB.

10. Study 4: beautiful plants and folding cranes for earthquake victims

In our final study, we extend our findings from online samples and assessments to the laboratory, thus testing the generalizability of our findings across different experimental contexts and samples. We adopted an *in-vivo* paradigm used in past research (Beukeboom, Langeveld, & Tanja-Dijkstra, 2012; Bringslimark, Hartig, & Patil, 2009; Park & Mattson, 2008, 2009; Weinstein et al., 2009) in which participants were exposed to actual houseplants (as opposed to images of nature)that varied in their subjective

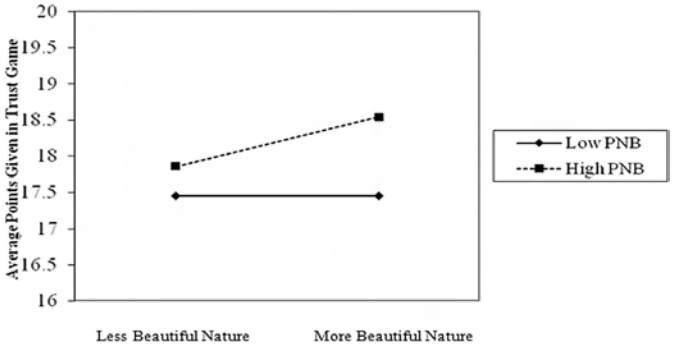

Fig. 3. Condition (1 = beautiful nature, −1 = less beautiful nature) by PNB interaction predicting points given away in the trust game from Study 3.

perceived beauty. We also used a novel behavioral measure of helping behavior in which we assessed the degree to which participants were willing to help the experimenter by folding cranes (ostensibly) for victims of the 2011 Japan earthquake (for similar behavioral measures of helping behavior, see Piff et al., 2010; Twenge, Baumeister, DeWall, Ciarocco, & Bartels, 2007). As in the previous studies, we tested positive emotions as a mediator (Diener & Emmons, 1984) and PNB (Diessner et al., 2008) as a moderator of the relationship between the experience of natural beauty and prosocial behavior.

10.1. Method

10.1.1. Pilot study

We conducted a pilot study to obtain subjectively more beautiful and less beautiful plants to place in the lab. We took high quality photographs of 40 plants of varying types and sizes at a local nursery. The images of each plant were then randomly presented to and rated by thirty participants (Mage = 38.86, SD = 12.14; 63.3% women; 76.7% Caucasian) from Mechanical Turk. They were asked to indicate the extent to which each plant was beautiful from 1 (*not at all*) to 7 (*very beautiful*). Two groups of more and less beautiful plants were formed based on the median cutoff (Mdn = 4.48). Four plants were then randomly selected from each group. Photographs of the beautiful plants were rated by thirty individuals from Mturk as higher on subjective beauty (M = 4.88, α = .75) than the less beautiful plants (M = 3.00, α = .85), $t(29)$ = 11.66, $p < .001$. Therefore, these eight plants (four to serve as our more beautiful plants and four as our less beautiful plants) were purchased from the local nursery and employed as our experimental stimuli in the main study.

10.1.2. Participants and procedure

Forty-five (64.4% women) students were recruited from a large West coast university and received partial course credits for participating. Ages ranged from 18 to 34 years (M = 21.11, SD = 3.21). Twenty-seven percent of participants were Caucasian, 13.3% Latino or Latina, 46.7% Asian American, 8.9% Multi-racial.

Participants registered for the study via an online recruitment service administered by the University. Prior to coming to the lab, participants completed PNB. Upon arrival to the lab, participants were randomly assigned to one of two conditions. In the more beautiful [less beautiful] nature condition, the lab room was furnished with the four more beautiful [less beautiful] plants of varying types and sizes on top of a circular table, directly in front of the participant. The placement of the plants in the room was held constant across conditions. All other characteristics of the room remained unchanged between conditions. When the participants arrived, they were seated within close proximity of the plants and asked by the experimenter to complete a questionnaire that included a measure of positive emotions. The experimenter then left the room and returned with origami papers to administer the measure of helping behavior. The experimenter sat at the corner of the room, out of participant's visibility, and began folding a Japanese paper crane. When participants notified the experimenter that they had finished the questionnaire, the experimenter said:

> The study is complete. You may leave and we will assign credit soon. Before you go, I wanted to tell you that our lab wants to send our best wishes to those that have suffered in the Japan earthquake and tsunami. Therefore, we are making Japanese cranes that represent good luck and fortune to the Japanese people and plan to send them to a correspondent of our lab in Japan, who will deliver them to a local community center. If you think you can help us out, you are welcome to help me fold some but whether you help or not will not affect the credits you receive for your participation today.

10.2. Measures

Participants completed the same measure of positive emotions (M = 3.75, SD = 1.24; α = .94) as described in previous studies and the PNB scale (M = 5.05, SD = 1.40, α = .87) before the folding task.

10.2.1. Folding task

The experimenter provided the participant with step-by-step instructions on how to fold origami paper cranes. Each crane required 14 steps and an average of two minutes to complete. The participants were told that they could stop folding and leave at any time. The number of cranes folded served as the measure of helping behavior. On average, participants folded 1.16 cranes (SD = 1.04). If participants elected to not fold any cranes, they were given a score of zero.

10.3. Results

We first tested whether exposure to subjectively more beautiful natural plants predicted greater willingness to help fold cranes. Participants in the more beautiful nature condition engaged in more helping behavior by folding more paper cranes than participants in the less beautiful nature condition, b = .31, $t(43)$ = 2.12, p = .037, d = .64. Also, there was a significant positive relationship between condition and positive emotions, b = .34, $t(43)$ = 2.40, p = .021, d = .73. Lastly, positive emotions positively predicted the number of cranes folded (r = .45, p = .002). We tested our mediation model with the Preacher & Hayes, 2008 script and found that the direct effect of condition on points given away was significantly attenuated after positive emotions were entered into the model (c-prime path; see Table 2). The bootstrap 95% CI (.0251, .3429) with 10,000 resamples did not include zero, indicating that positive emotions help explain the effects of beautiful nature on prosociality.

10.3.1. Interaction

Using a linear regression framework, we again tested for the PNB by condition interaction. Results revealed a significant effect of condition (b = .21, p = .05). Also, PNB positively predicted points given away (b = .36, p = .017). Importantly, the interaction of PNB by condition was also significant (b = .35, p = .014). We next probed this interaction by testing the effects of PNB between participants in the more and less beautiful condition at one standard deviation above and below the mean of PNB (Aiken & West, 1991). At one standard deviation above the mean of PNB, the effect of exposure to the more beautiful nature imagery was positive and significant (b = .57, p = .003); however, this effect at one standard deviation below the mean of PNB was not significant (b = −.15, p = .50) (see Fig. 4). These findings suggest that the effects of beautiful nature on prosocial behavior are most pronounced among individuals who are high in tendencies to perceive natural beauty.

10.4. Discussion

In Study 4, participants who completed the study in a laboratory furnished with more beautiful plants engaged in more helping behavior—by folding more paper cranes for victims of the 2011 earthquake in Japan—than participants who completed the study in a laboratory with less beautiful plants. As in our previous studies, the effects of natural beauty were mediated by experiences of positive emotion and were more pronounced among higher-PNB individuals.

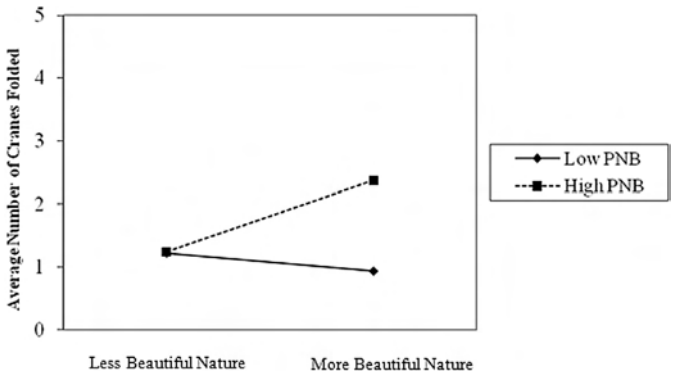

Fig. 4. Condition (1 = beautiful nature, −1 = less beautiful nature) by PNB interaction predicting the number of cranes folded in Study 4.

11. General discussion

Nearly 30 years ago, the biologist E.O. Wilson (1984) advanced his biophilia hypothesis: Humans have an innate affinity with nature and this connection is accompanied by many psychological benefits, including enhanced kindness and sympathy toward others. Since then, empirical evidence has linked greater prosociality to having a personal connection with nature and with exposure to natural environments relative to urban settings (Kahn et al., 2008; Mayer & Frantz, 2004; Nisbet et al., 2009; Weinstein et al., 2009). We extended these past studies to show that beyond mere exposure to nature, subjective experiences of beauty in nature are specifically linked to prosocial behavior. In Study 1, individuals higher on PNB reported increased prosociality as indexed by greater agreeableness, empathic concern, and perspective taking, relative to individuals lower in PNB. Studies 2 and 3 provided experimental evidence suggesting that exposure to subjectively more beautiful nature (via visual imagery) caused greater generosity in resource allocation tasks, relative to exposure to subjectively less beautiful nature. Finally, in Study 4, ambient exposure to subjectively more beautiful natural plants in a lab setting led to increased helping behavior, relative to exposure to subjectively less beautiful plants.

Why does exposure to subjectively more beautiful nature enhance prosociality? Our studies point to one pathway: The increased positive emotions experienced in response to beautiful nature help produce increase prosociality. These findings dovetail with prior work showing that personal connection with nature promotes positive emotions (Berman et al., 2012; Cervinka, Roderer, & Hefler, 2012; Ryan et al., 2010; Zelenski & Nisbet, 2012) and positive emotions predict prosociality (Frederickson, 1998; Isen & Levin, 1972; Krueger et al., 2001; Lucas, 2001; Lyubomirsky et al., 2005). Together, positive emotions may be especially relevant to the understanding of nature's psychological and physical benefits. Nevertheless, future research should continue to investigate other more specific mechanisms that might play a role in explaining the relationship between beautiful nature and prosociality. For example, we speculate that awe may be a particularly relevant in understanding the association between nature and prosociality (Keltner & Haidt, 2003). Researchers have found that participants are more likely to mention nature experiences as an elicitor of awe (Shiota, Keltner, & Mossman, 2007). Further, features of narratives about beauty experiences tend to include nature as one main cause (Cohen, Gruber, & Keltner, 2010). More importantly, participants who are made to feel awe, compared to happiness, were more willing to volunteer their time to help others (Rudd, Vohs, & Aaker, 2012). On the basis of these previous studies, we suggest that awe-related experiences of nature may be strong predictors of prosociality.

Our investigation also yielded consistent evidence that the effect of exposure to subjectively more beautiful nature is particularly significant among individuals higher on PNB. This finding extends previous studies on nature and prosociality in which participants were instructed to actively immerse ("How completely were all your senses engaged?") themselves in the environment (Weinstein et al., 2009). This prior work found that the more participants immersed themselves in the nature scenes (as compared to urban scenes), the greater their reported prosocial aspirations ("To have deep enduring relationships"; "To work toward the betterment of society"; Weinstein et al., 2009). Future research, however, could examine what mechanism underlies our interaction finding. We speculate that it may be individual's higher on perceive nature's beauty being satisfied with certain personal experience as a result exposure to beautiful nature. Interestingly, a recent study discussed the association between relatedness need satisfaction (e.g., sense of closeness with others) and perceived beauty in various spaces (Weinstein, Legate, & Przybylski, 2013). For instance, they found that whether individuals rated a specific place (e.g., a nearby river, library, etc) as beautiful is associated with whether they felt relatedness need satisfaction as a result of being around these places. Thus, it is possible that our interaction finding could be mediated by greater relatedness need satisfaction. Indeed past research has shown that people who are primed to feel relatedness satisfaction are more likely to volunteer, have greater intention to help, and donated more money to charity (Pavey, Greitemeyer, & Sparks, 2011). This is an interesting direction that future research could explore.

Further, we extended prior work (Weinstein et al., 2009) to document an individual difference variable that underlies divergent responses to exposure to subjectively more beautiful versus less beautiful nature. We believe this person by situation perspective will prove critical to understanding the individual-level factors that moderate the positive benefits of nature, as suggested by previous research (e.g., Weinstein et al., 2009). For instance, a number of existing measures assess people's personal connection/relatedness with nature (Mayer & Frantz, 2004; Nisbet et al., 2009; Perkins, 2010; Schultz, 2000), but research has yet to examine these constructs as potential moderators of nature's positive benefits (e.g., improved memory, decreased stress, well-being etc). It will be interesting for future research to examine whether individuals who express increased personal connection to nature are especially likely to experience the benefits of exposure to nature.

11.1. Limitations and future directions

Future investigations should extend our studies in several ways. First, the central aim of the current research was to examine the subjective perception of beautiful nature on prosocial behaviors. While the usage of participants' subjective ratings of more and less beautiful nature parallels previous studies (Aharon et al., 2001; Cela-Conde et al., 2009; Gepshtein & Kubovy, 2000; Kawabata & Zeki, 2004; Weinstein et al., 2013), the pattern of results we found raises the question of what specific features of nature lead to the perception of more versus less beauty (Weinstein et al., 2013). Guided by the argument that beautiful nature tends to possess vegetation, water, sky, open space and is colorful (Dutton, 2009), one might explore how variations in these attributes produces increases in subjective perceptions of beauty, which in turn drive different patterns of prosocial behavior. As we pointed out in the method section, while there were no aesthetic differences across images, pilot studies did find difference in landscape qualities across images used in the more and less beautiful conditions. These preliminary

findings suggest that certain characteristics of natural stimuli; including depth of field and the complexity of color made up by the nature (e.g., various leaves, trees, blue sky, flowers, etc), strongly influence subjective perceptions of beauty. We hope that these initial findings provide some direction for more in-depth investigations of the dynamics and dimensions on judgments of natural beauty.

Further, our research relied largely on static images of nature and nature indoors. Future research should seek to extend our findings to other settings, most notably outdoor natural settings (e.g., Atchley et al., 2012; Berman et al., 2008, 2012; Ryan et al., 2010; White, Pahl, Ashbullby, Herbert, & Depledge, 2013) or in neighborhoods of more or less natural beauty (Kuo, 2001; Taylor et al., 2001; Wells & Evans, 2003). We believe the results of the present studies set the stage for several hypotheses pertaining to the effects of nature in neighborhoods, classrooms, hospitals, personal living spaces, and contexts where charity is sought. For instance, based on the present investigation's findings, one might set up donation stands (e.g., soliciting donations to charities like the Red Cross) near more and less beautiful natural environments to examine if participants walking near more beautiful nature donate more. Similarly, researchers can investigate if environments that possess more versus less beautiful nature influence how often automobiles yield for pedestrians—a form of prosocial behavior (e.g., Piff, Stancato, Cote, Mendoza-Denton, & Keltner, 2012; Piff, Stancato, Martinez, Kraus, & Keltner, 2012). We also believe that it will be important to extend the present research to the study of other positive outcomes, such as overall well-being, cognitive function, and memory (e.g., see Park & Mattson, 2008, 2009). Such studies would provide intriguing contributions to the empirical study of nature.

Although the samples used in the current research were relatively diverse, it will be important for future investigations to extend our findings to more representative samples and different cultures, where different values may be placed upon the judgment of beauty. For instance, future investigations could examine whether the effects of beautiful nature vary as a function of individual difference in openness towards participating in nature activities (e.g., hiking; Atchley et al., 2012) or cultural backgrounds that are more likely to value and cherish the existence of nature (Hartig et al., 2010).

12. Conclusion

Human civilization has had a profound and ancient relationship with the natural world. In this research, we asked the question, does nature help promote the greater good? Our studies reveal that it does. Specifically, we found that nature promotes prosocial tendencies when it is subjectively beautiful, especially for individuals who are more sensitive to nature's beauty. 30 years after Edward Wilson proposed the Biophilia hypothesis, psychological research has revealed a great deal of positive benefits associated with connecting to nature. The current studies add to this knowledge by demonstrating the prosocial benefits that may be experienced as a result of beautiful nature and by alluding to the social costs that may be incurred by its demise.

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