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Why Is Nature Beneficial?

The Role of Connectedness to Nature

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Three studies examine the effects of exposure to nature on positive affect and ability to reflect on a life problem. Participants spent 15 min walking in a natural setting (Studies 1, 2, & 3), an urban setting (Study 1), or watching videos of natural and urban settings (Studies 2 & 3). In all three studies, exposure to nature increased connectedness to nature, attentional capacity, positive emotions, and ability to reflect on a life problem; these effects are more dramatic for actual nature than for virtual nature. Mediational analyses indicate that the positive effects of exposure to nature are partially mediated by increases in connectedness to nature and are not mediated by increases in attentional capacity. The discussion focuses on the mechanisms that underlie the exposure to nature/well-being effects.

Keywords: *connectedness to nature; attentional capacity; positive affect; ability to reflect*

Environmentalists (e.g., Berry, 1997; Leopold, 1949; Orr, 1994) and nature writers (e.g., Louv, 2005; Muir, 1894; Thoreau, 1854) have long maintained that humans derive physical and psychological benefits from spending

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time in the natural world. The past two decades of research in environmental psychology have supported this contention. Using a variety of methodologies and measures, researchers have shown that exposure to the natural world decreases negative behaviors and states (e.g., aggression, anxiety, depression, illness) and increases positive ones (e.g., affect, health, cognitive capacity). The big picture is clear: Exposure to nature leads to many desirable outcomes (see Health Council of the Netherlands and Dutch Council for Research on Spatial Planning, 2004; van den Berg, 2005; Frumkin, 2001).

The details of this relationship, however, are not clear. For instance, how does exposure to nature influence more complex cognitive-emotional processes such as reflecting on a life problem? Is virtual nature as effective as the real thing? Most important, through what mechanisms does nature have its positive benefits (see report from the Health Council of the Netherlands, 2004; Maas, Verheij, Groenewegen, de Vries, & Spreeuwenberg, 2006)?

This article aims to address these questions. The main goal of our research is to investigate a potential mediator of the nature/well-being connection. Specifically, the well-being effects we focus on are measures related to positive mood. Although exposure to nature has consistently been shown to affect positive mood, to our knowledge there has not been a single experimental study that has conducted a full mediational analysis addressing the question of why nature produces beneficial effects. In particular, in the present work we investigate whether increases in individuals' experiential sense of connection to the natural world, as measured by our Connectedness to Nature Scale (Mayer & Frantz, 2004), mediates nature's effect on positive mood. In conducting this research, we also had two secondary goals: (a) to determine whether exposure to nature aids in the more complex socioemotional process of reflecting on a life problem and (b) to examine the difference between real and virtual nature for accruing benefits. With respect to these goals, the aims of our work are more exploratory. To address these questions, in the three studies we contrasted people who had spent time in an actual natural setting to those who had been exposed to either an urban setting (Study 1), virtual nature (Studies 2 and 3), or a virtual urban scene (Study 2).

Causal Mechanisms Underlying the Beneficial Aspects of Nature

Understanding the causal mechanisms through which nature has its beneficial effects is important not only for theory development but also for aiding practitioners in more effective applications. To date, five potential

mediators of nature's benefits have been proposed (see report from the Health Council of the Netherlands, 2004): recovery from stress and attention fatigue, encouragement to exercise, facilitating social contact, encouraging optimal development in children, and providing opportunities for personal development and a sense of purpose. Although these five mediators have been identified, only recovery from stress and attention fatigue have been extensively researched (see Kaplan & Kaplan, 1989, 2003; Kaplan, 1992, 1993, 2001; Kaplan, 1995; Hartig, Böök, Garvil, Olsson, & Gärling, 1996; Hartig, Evans, Jamner, Davis, & Gärling, 2003). In fact, when reading the exposure to nature/well-being literature, there is often at least the implicit sense that nature is beneficial because it is restoring, without the acknowledgement that nature may be beneficial for many reasons.

If theory guides application, then it is important for practitioners to be aware that the benefits of nature may extend beyond helping people to recover from stress and attention fatigue. However, before theory guides application, stringent tests of these potential mediators need to be conducted. Specifically, to establish mediation, the independent variable (IV) must significantly influence the dependent variable (DV), the IV must significantly affect the potential mediator, the mediator must have a significant relationship with the DV, and the relationship between the IV and DV should be eliminated (full mediation) or weakened (partial mediation) when the mediator is controlled for (Baron & Kenny, 1986; Preacher & Hayes, 2004). To examine the last criterion, a statistical test, such as the Sobel test, needs to be conducted to see whether the IV/DV correlation has been significantly reduced when the mediator is controlled for.

Experiments examining the potential mediator of recovery from stress and attention fatigue typically fulfill the requirements for Step 1. That is, they investigate the impact that exposure to nature (the IV) has on overall happiness and mood (the DVs). They typically also investigate the relationship between exposure to nature (the IV) and a potential mediator, such as directed attention (measured by errors on a proofreading task) or stress reduction (measured by decreases in heart rate), fulfilling Step 2. However, no published study we are aware of explicitly tests for the relationship between the potential mediator to the DV (Step 3) or for the relationship between the IV (exposure to nature) and DV (positive mood or happiness) when controlling for the potential mediator (Step 4). It has been assumed that the observed differences in the positive outcome between the nature and urban environments must be due to their mediator of interest.

This area of research can move in new directions by conducting stringent tests of what mediates the exposure to nature/well-being effects. Of the

five potential mediators that have been identified, our work highlights the possibility that people gain purpose and meaning in life by feeling an experiential sense of belonging to the natural world. In mainstream social psychology, the need to belong to human groups, that is, to feel connected to others and to feel like a valued member of a community, has been highlighted as a basic human need (see Baumeister & Leary, 1995; Fiske, 2004; Myers, 2000). Extending this need to nature, the biophilia hypothesis (see Wilson, 1984; Kellert & Wilson, 1993; Kellert, 1997) argues that people have a biologically based need to affiliate with and feel connected to the broader natural world. From an ecopsychological perspective, Roszak (1995) also argued that this sense of belonging extends beyond our city limits and includes a sense of belonging to the natural world. This argument suggests that when people are in nature and meet this need to belong, they will experience psychological benefits.

We have developed an operationalization of connectedness to the natural world that builds on the work of Aldo Leopold (1949). Leopold argued that in order for people to feel responsible for nature and to engage in eco-friendly acts, they need to feel connected to nature as a plain and simple member. Initially, our work was primarily interested in establishing the reliability and validity of a scale and testing Leopold's notion that increases in connectedness predict eco-friendly behavior. For this purpose, we have created the Connectedness to Nature Scale (CNS; Mayer & Frantz, 2004), a 14-item scale intended to tap into individuals' sense of relatedness to nature.

The scale has been shown to have only one factor, to possess high internal consistency ($\alpha = .84$), test-retest reliability ($r = .79$), and has also been demonstrated to correlate with biospheric values ($r = .49$; Schultz, 2000) and the New Environmental Paradigm (NEP; Stern & Dietz, 1994; $r = .35$), a scale that measures attitudes about environmental protection. Mayer and Frantz (2004) also demonstrated that the scale significantly predicts eco-friendly behavior, providing an important empirical test of Leopold's argument that connectedness to nature does, in fact, promote proenvironmental actions.

In addition, six data sets (Frantz & Mayer, 2005, 2006; Mayer & Frantz, 2004, 2005) now demonstrate that the CNS significantly predicts participants' degree of life satisfaction and overall happiness, in both community and student samples. Furthermore, seven data sets (Frantz & Mayer, 2005, 2006, 2007; Mayer & Frantz, 2004) find CNS to be significantly related to perspective-taking ability, an ability that has been shown to enable people to be better able to resolve interpersonal problems (Arriaga & Rusbult, 1998) and moral dilemmas (Mason & Gibbs, 1993). Thus, connectedness to nature is a measurable construct that is likely to have ramifications for

people's experience of positive affect and sense of belonging. In the present studies, we test to see whether exposure to nature increases individuals' sense of feeling connected to nature and positive affect. Moreover, we test to see whether connectedness to nature mediates the relationship between the exposure to nature and positive affect.

Ability to Reflect as a Potential Benefit of Exposure to Nature

Because exposure to nature influences mood and cognitive processing in such positive ways, one might expect it to affect more complex socioemotional processes, such as the process of reflecting on a life problem. This benefit of being able to think through and gain perspective on personal problems, a benefit termed *reflection* (Herzog, Black, Fountaine, & Knotts, 1997), has important implications for psychological health. Although such an effect has been hypothesized (Kaplan & Kaplan, 1989), a direct experimental test has not been conducted. Although research has shown that people would prefer to be in a more natural setting to engage in reflection (Herzog et al., 1997; Koole & Van den Berg, 2005, Study 1; Korpela, 1992) or has examined the effects of nearby nature on life-management issues (Kuo, 2001), no experiment has actually placed people in a natural setting and measured whether they felt better able to resolve a life issue.

Given that the CNS has been found to be significantly related to perspective-taking ability, in the present studies we are also interested in testing to see whether exposure to nature increases individuals' sense of feeling connectedness to nature and ability to reflect. Moreover, we test to see whether CNS scores mediate the relationship between the exposure to nature and the ability to reflect. Although this aspect of the present studies is more exploratory, we nevertheless argue that findings related to the ability to reflect have important implications.

Study 1

The main purpose of Study 1 was to examine a potential mediator of the exposure to nature/well-being effects. In particular, we were interested in whether connectedness to nature mediates the relationship between exposure to nature and the outcome variables of positive affect and ability to reflect.

In this study and the subsequent studies we also controlled for a potential alternative explanation for the benefits of exposure to nature. Attention Restoration Theory (ART; Kaplan & Kaplan, 1989) argues that the benefits of nature are largely due to its ability to restore cognitive resources. The capacity for focusing our attention on relevant stimuli is limited, and when this mental resource is depleted, people then experience mental fatigue. Kaplan and Kaplan (1989) argued that many natural settings possess features that make it ideal for reducing mental fatigue and restoring attentional capacity. In line with other work in this area (Hartig et al., 1996), we employed an objective measure of cognitive performance as the mediating variable used to test whether attentional capacity can account for the observed findings.

One line of research on ART (Berto, 2005; Hartig et al., 1996, Experiment 1; Hartig et al., 2003; Laumann, Garling, & Stormark, 2003; Staats & Hartig, 2004) has manipulated mental fatigue, to ensure that all participants were depleted in their attentional capacity at the start of the study. Because of limited resources, and because ART was not the primary focus of our work, we did not induce mental fatigue in our participants. In addition, it is important to note that the strongest support for ART actually occurs under the relatively low mental fatigue conditions (Hartig et al., 1996, Experiment 1; Hartig et al., 2003). For instance, after manipulating mental fatigue in their first experiment and finding more support for ART in the low mental fatigue condition, Hartig et al. (1996) decided not to manipulate attention fatigue in their second experiment. Instead, it was assumed that participants entered the study with some degree of mental fatigue. Similarly, we also assume that our participants, who were predominantly first year college students, entered the study with some degree of mental fatigue, for they were not only dealing with the stresses associated with transitioning to college but also with the stresses of coursework associated with being at a highly selective and demanding college setting.

We also controlled for the potential alternative explanation that the positive moods that people experience in nature are simply due to reduced private and/or public self-awareness. *Private self-awareness* can be defined as a self-focus in which the "individual evaluates (his/her) actions without reference to others" and "reflects on private, autonomous, egocentric goals," whereas *public self-awareness* "pertains to aspects of behavior in which the needs, desires, or reactions of others . . . are taken into account" and to a state where people "consider the impact that an action may have on others' impressions of (them)selves" (Mor & Winquest, 2002). One of the central theoretical points within objective self-awareness theory is that reduction of self-awareness, both private and public, can be experienced as a positive state (see Duval &

Wicklund, 1972; Wicklund, 1975; Carver & Scheirer, 1981; Gibbons, 1990; Duval, Silvia, & Lalwani, 2001). From this theoretical perspective, taking people into a natural setting may very well lead these individuals to be less self-focused. Our work (Frantz, Mayer, Norton, & Rock, 2005) also documents how simply being less privately self-aware results in higher CNS scores. Consequently, obtaining and controlling for these measures seemed critical.

In this study and the subsequent studies, we also wished to control for the impact that positive affect may have on the ability to reflect. Fredrickson's (1998; Fredrickson & Losada, 2005) broaden-and-build theory of positive emotions had found that positive emotions facilitate the broadening of people's mindsets (Fredrickson & Joiner, 2002) and enhance their psychological resources and coping strategies (Fredrickson, Brown, Cohn, Conway, & Mikels, 2005). Consequently, in our analyses, we not only examined whether connection to nature mediated the exposure to nature/ability to reflect relationship but also whether CNS remained as a significant predictor even when positive affect was controlled for.

Method

Participants

Seventy-six introductory psychology students (51 females, 22 males, 3 unidentified) participated in a two-celled study (nature vs. urban) in return for partial course credit.

Materials

Attentional capacity measure. Participants completed a 10 min timed memory loaded search task, adapted from Hartig, et al. (1996). This task was designed to measure how the participants' experimental environment influenced their attentional capacities. Participants were given five target letters to memorize and instructed to search lines of letters for these targets. They were told to search each line of letters only once, and to cross off any target letters found. Each line contained 59 letters, 0 to 8 of which were targets. Lines were arranged in sets of six, with 18–27 target letters distributed throughout each set. Four sets of lines were arranged on a sheet, and a total of 95 targets were located throughout the entire task. The number of target letters missed plus the number of nontargets incorrectly crossed off indicated accuracy in the search.

Positive and negative affect. We used the positive and negative affect schedule (PANAS; Watson, Clark, & Tellegen, 1988) to assess participants' state

affect. This 20-item scale is divided into 2 separable 10-item positive and negative affect scales. Positive affect is characterized by feelings of enthusiasm, engagement, and alertness, whereas negative affect is characterized by various types of distress, including anger, contempt, disgust, guilt, fear, and nervousness. Participants rated the degree to which they were presently experiencing each mood state using a modified Likert-type scale (1 = *very slightly or not at all*, 5 = *extremely*). The positive and negative affect scales were both reliable (alpha of negative affect = .87, alpha of positive affect = .88).

Connectedness to nature. The Connectedness to Nature Scale (CNS) measures participants' sense of oneness with the natural world, sense of kinship with animals and plants, and sense of equality between the self and nature (Mayer & Frantz, 2004). Participants completed the trait version of this scale as part of a prescreening procedure at the beginning of the semester. They completed the state version of this scale while in a natural or urban environment. To create the state CNS, trait items were reworded to tap their present feelings of connectedness to the natural world (one item could not be reworded and was dropped, resulting in 13 items; see Appendix). This scale correlates well with the trait CNS (r's > .6) and has been used successfully in previous research to measure differences in connection to nature due to experimental manipulation (Frantz et al., 2005). Both scales used a modified Likert-type scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). A reliability analysis run on the 13-item state CNS scale proved this scale to be reliable ($\alpha = .91$). The trait scale was also reliable, $\alpha = .82$.

Self-awareness measures. The Situational Self-Awareness Scale (SSAS) was employed to measure various dimensions of self-awareness. This scale consists of nine items, with three items assessing levels of private self-awareness, three measuring public self-awareness, and three gauging awareness of one's immediate surroundings (Govern & Marsch, 2001). Participants reported their level of agreement with a series of statements concerning their present state, such as, (a) right now, I am conscious of my inner feelings (private self-awareness), (b) right now, I am concerned about the way I present myself (public self-awareness), and (c) right now, I am keenly aware of everything in my environment (awareness of immediate surroundings). This scale used a modified Likert-type scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). All three scales were reliable, private self-awareness alpha = .81, public self-awareness alpha = .83, and environmental awareness alpha = .81.

Procedure

All participants completed the trait CNS as part of a longer questionnaire administered to introductory psychology students during an in-class mass-testing session. The rest of the data were collected on two consecutive days in April that had identical, sunny weather. After giving informed consent, participants were randomly assigned to board one of two buses. Approximately 15-20 people were on each bus for each experimental session. Two experimenters also boarded each bus. Both buses drove 20 min to a nearby town. One bus went to an urban downtown area, whereas the other went to a nature preserve. Toward the end of the bus ride, an experimenter asked participants to silently reflect on a loose end in their life that needs tying. Participants were informed that this loose end could be anything related to schoolwork, relationships, or any other subject, but it must be an issue that is easily resolvable. The researcher cited finding time to study for a test as a good example of something to reflect on because it is easily resolvable. They described keeping your parents from getting divorced as a bad example because it is too difficult an issue to resolve during a 10-15 min time period. The researchers also requested that participants not talk with one another while walking to their destination, so they could give their full attention to the landscape before them.

On arrival at their destination, participants were divided into smaller groups of 8-10 and led by an experimenter on a 10 min walk. The participants at the nature preserve walked to one of two locations that overlooked a bend in a small river, approximately 20 feet wide. They were led to an open area with woods immediately around them, and they had an open view of the bend in the creek, with woods framing the far side of the creek. The participants in the urban condition ended up in a concrete area near a building with an adjacent parking lot. Their location was at the back of the building, a relatively quiet area, set back from a street that was approximately 20 yards away.

To further insure the independence of the participants' experiences, after the walk, participants were told to spread out from one another. They then sat for 5 min, having been instructed to take in the scene. Following this, they completed the questionnaires described above and rated their ability to reflect by reacting to the statement, "I feel more prepared to 'tie up my loose end' than I did before I began this study". They responded to this statement using a modified Likert-type scale, ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Participants were also asked to indicate the amount of time they spend outdoors on a typical day. Last, all participants performed the memory loaded search task. Participants were fully debriefed on the bus ride back to campus.

Table 1
Pearson Product Moment Correlations
Between Dependent Variables in Study 1

	1	2	3	4	5	6	7	8
1. Trait CNS	—							
2. State CNS	.36***	—						
3. Attentional capacity	–.22*	–.24**	—					
4. Negative affect	.00	–.05	–.02	—				
5. Positive affect	.20*	.54***	–.10	–.13	—			
6. Ability to reflect	–.10	.44***	–.24**	–.03	.36***	—		
7. Private self-awareness	.13	.34***	–.11	.15	.11	.17	—	
8. Public self-awareness	–.13	–.40***	.37***	.12	–.32***	–.25**	.00	—
9. Environmental self-awareness	.14	.55***	–.06	–.10	.38***	.27**	.40***	–.08

Note: CNS = Connectedness to Nature Scale.
*$p < .10$. **$p < .05$. ***$p < .01$.

Results

There were no preexisting differences between the two conditions on trait connectedness to nature, $F(1, 69) = .13$, $p = .72$. The correlations between the main dependent measures appear in Table 1. To test the effects of condition on our DVs, we ran a series of 2 (condition: urban vs. natural) × 2 (gender: male vs. female) analyses of variance.[1]

Outcome Variables

As in past research, spending time in nature led to a number of psychological benefits. Condition influenced positive affect, $F(1, 69) = 5.04$, $p < .05$, as measured by the PANAS. Those in the nature condition reported significantly more positive emotions ($M = 2.55$, $SD = 0.80$) than those in the urban condition ($M = 2.06$, $SD = 0.70$). The effects of gender and the gender × condition interaction on positive affect were not significant, p's $> .5$. Participants in the urban condition also did not experience greater negative emotions than did the participants in the nature condition, $F(1, 68) = .27$, $p > .6$. Both those in the nature and those in the urban condition reported equal (and relatively low) levels of negative emotion (nature $M = 1.50$, $SD = 0.62$; urban $M = 1.42$, $SD = 0.47$).

Those in the nature condition also reported a significantly greater ability to reflect on their loose end ($M = 4.33$, $SD = 1.55$) than those in the urban

condition (M = 3.00, SD = 1.84). The effects of gender and the gender × condition interaction on the ability to reflect were not significant, p's > .13.

We next tested to see whether condition influenced our two potential mediators, CNS and attentional capacity. We ran a 2 (condition) × 2 (gender) analysis of covariance (ANCOVA) with trait CNS as a covariate and state CNS as the DV. Thus, all results show differences in connectedness to nature scores controlling for initial level of connection. Trait CNS scores significantly predicted state CNS scores, $F(1, 67) = 16.27$, $r = .36$, $p < .01$. Those initially high on the CNS tended to remain so. Condition also influenced CNS state scores, $F(1, 67) = 11.63$, $p < .001$. Those who spent time in nature had significantly higher CNS scores ($M = 4.69$, $SD = 1.12$) than those in the urban setting ($M = 3.73$, $SD = 1.06$). The effects of gender and the gender × condition interaction on state CNS were not significant, p's > .15.

Condition also significantly influenced attentional capacity, as measured by the number of errors per line completed (higher numbers reflect more errors and thus less attentional capacity), $F(1, 67) = 8.49$, $p < .01$. Those in the nature condition made significantly fewer errors ($M = 1.18$, $SD = 0.47$) than those in the urban condition (M = 1.60, SD = 0.74). The effects of gender and the gender × condition interaction on number of errors were not significant, p's > .3.

Finally, we tested to see whether exposure to nature influenced self-awareness. There were no significant differences due to gender or condition on environmental awareness (F's < 1) or on private self-awareness (F's < 1.2). However, public self-awareness was significantly higher in the urban condition (M = 11.44, SD = 3.8) than in the nature condition (M = 8.22, SD = 3.79), $F(1, 68) = 12.80$, $p < .001$.

Mediational Analyses

The major goal of this study was to determine what mediates the positive effects of exposure to nature. We used Baron and Kenny's (1986) procedure for establishing whether mediation has occurred. To show mediation, the IV must significantly influence the potential mediator, the mediator must have a significant relationship with the DV, and the relationship between the IV and DV should be eliminated (full mediation) or weakened (partial mediation) when the mediator is controlled for. We used a series of regression equations and the Sobel test (Preacher & Hayes, 2004) to test for mediation.

Our primary interest was in connectedness to nature as a potential mediator (see Table 2). As established above, condition was found to significantly affect positive mood. Condition also significantly influenced state CNS scores. Moreover, state CNS scores were found to be significantly

Table 2
Test of Attentional Capacity and Connection to Nature as Mediators of Condition Effects in Study 1

	Positive Affect					
Mediator	Connectedness to Nature			Attentional Capacity		
Equation	*b*	*t*	Sobel[2]	*b*	*t*	Sobel
Condition[1] predicting mediator	1.01	4.30****		–.43	3.01**	
Predictors of positive affect						
1. Mediator	0.343	5.45**		–.12	0.81	
2. Condition	0.48	2.83**		.48	2.83**	
3. Mediator Condition	0.32	4.49****	3.11**	.01	0.06	.07
	0.16	0.93		.48	2.56**	
	Ability to Reflect					
Mediator	Connectedness to Nature			Attentional Capacity		
Equation	*b*	*t*	Sobel	*b*	*t*	Sobel
Condition[1] predicting mediator	1.01	4.30****		–.43	3.01**	
Predictors of ability to reflect						
1. Mediator	0.67	4.21****		–.68	2.06**	
2. Condition	1.39	3.47****		1.39	3.47****	
3. Mediator condition	0.52	2.94**	2.43**	–0.34	1.03	.97
	0.82	1.92*		1.30	3.02**	

Note: 1. When predicting state CNS, trait CNS was controlled for. 2. The Sobel test indicates whether including the mediator (Equation 3) significantly reduces the condition regression weight (Equation 2 vs. Equation 3).
*$p < .10$. **$p < .05$. ****$p < .001$.

related to positive affect. When condition and state CNS scores were both used to predict positive affect, the relationship between condition and positive affect was significantly weakened. These analyses provide support for the role of connection to nature as at least a partial mediator of condition's effect on the positive affect scores measured here.

To eliminate the alternative explanation that ART could account for our findings, we repeated the same analyses with attentional capacity as the potential mediator (see Table 2). First, as established above, condition influenced the DV of interest. In addition, the IV (condition) was observed to significantly influence the potential mediator (attentional capacity).

However, attentional capacity did not predict positive affect, arguing against its role as a mediator. Thus, the criteria for mediation were not met by attentional capacity.

We also tested to see if the increase in positive affect could be explained by a reduction in private and/or public self-awareness. To test this, public and private self-awareness were added to the regression equation predicting positive affect, along with condition, trait, and state CNS scores. Neither public nor private self-awareness was a significant predictor of positive affect (b's < .02, t's < .8); state CNS remained significant, $b = 0.33$, $t(65) = 3.64$, $p < .001$.

A secondary goal of this study was to determine what mediates the exposure to nature/ability to reflect relationship. We repeated the same analyses that we performed on the exposure to nature/positive mood relationship (see Table 2). Once again, condition was observed to be significantly related to participants' ability to reflect. As established above, condition also significantly influenced state CNS scores. Consistent with the mood findings, state CNS scores were also found to significantly predict the ability to reflect. When condition and state CNS scores were used to predict the ability to reflect, the relationship between condition and ability to reflect was significantly weakened. Once again, these analyses provide support for the role of connection to nature as at least a partial mediator of condition's effect on the positive outcomes measured here.

We then tested attentional capacity as a potential mediator. As established above, the IV (condition) did significantly influence the potential mediator (attentional capacity). In this instance, attentional capacity was also found to predict the ability to reflect. However, when both attentional capacity and condition were included in the same regression equation, the effect of condition was not weakened. Thus, once again the criteria for mediation were not met by attentional capacity.

Finally, because state CNS and positive affect were so highly correlated with each other ($r = .54$, $p < .001$) we tested to see whether the effect of connection to nature contributed to the ability to reflect independently of positive affect.[2] Both positive affect and state CNS were included in a regression equation predicting the ability to reflect. Controlling for state CNS, positive affect was not a significant predictor of the ability to reflect, $b = 0.39$, $t = 1.30$, *ns*. State CNS scores did significantly predict the ability to reflect, $b = 0.53$, $t = 2.77$, $p < .01$, above and beyond the effects of positive affect.

Discussion

Study 1 provides strong support for state CNS as a mediator of nature's effects on well-being. As such, this study constitutes the first time that a full

mediational analysis has been performed on the exposure to nature/positive mood relationship. In addition, although exposure to nature was shown to significantly affect attentional capacity, attentional capacity did not predict positive affect. That attentional capacity was demonstrated not to mediate this relationship also highlights the importance of full mediational analyses for controlling for alternative explanations. Thus, this study also pushes this research in new directions, for it illustrates how another category of potential mediators besides stress and attentional restoration can affect well-being.

Study 1 is also important because in this literature few studies have taken people into actual nature or urban environments to test their hypotheses. Given the logistics involved, especially in more northern climates, it is understandable why these types of studies are rare. Nevertheless, experiments of this type are important not just to investigate causal mechanisms but also to increase the external validity of the work.

The self-awareness findings are also of theoretical interest. The fact that private self-awareness did not significantly decrease in nature versus the urban setting clearly argues against the explanation that increases in positive emotions in nature were due to a reduction in private self-awareness. In addition, controlling for public and private self-awareness did not reduce the significant effect of connectedness to nature on positive affect. Self-awareness is thus not a viable mediator for nature's beneficial effects.

Study 1 also provides support for the benefits of nature on increasing the ability to reflect. Although we view this aspect of the study as being more exploratory, Study 1 does provide the first experimental support for the hypothesis that actually being in nature helps people to reflect on a life issue. Moreover, it is important to note that this effect emerged even though our participants had no special connection to the natural area, and spent a relatively short time there. Thus, the nature/reflection benefit effect is not limited to some place of special meaning to a person but can even occur in a natural setting that is unfamiliar to a person.

In addition, it is important to note that the state CNS/ability to reflect relationship remained significant even when controlling for positive affect, which strongly argues that this relationship cannot be accounted for by Fredrickson's (1998) broaden-and-build theory of positive emotions. Moreover, although attentional capacity did predict individuals' ability to reflect, it was clearly shown not to mediate the effect between condition and ability to reflect. Thus, attention restoration also is not a plausible explanation for our effects.

Given that participants were actually in nature, however, may raise the possibility that demand characteristics could account for the findings. That is, perhaps participants in the nature condition expected that the experimenter

intended for them to experience more positive emotions and be better able to reflect on a life issue. Although on the face of it demand does seem plausible, a closer look brings this alternative explanation into question. Participants in the nature condition felt significantly less publicly self-aware; reduced public self-awareness should make the participants in the nature condition care less about wanting to please the experimenter and confirm the expected hypotheses.

Study 2

Besides addressing the research goals identified in Study 1, Study 2 also addresses the question of whether real nature provides substantially more psychological benefits than virtual nature. As noted above, most research on the restorative aspects of nature has been done using virtual nature: nature viewed through a window or on a screen. This research consistently suggests that benefits can be accrued from indirect experiences of nature. However, are they equivalent to direct experiences? Although it may seem self-evident that merely viewing nature could not provide the same benefits as being immersed in nature, Levi and Kocher (1999) had called this assumption into question. They argued that natural simulations can serve as psychologically satisfying substitutes for the real thing. Levi and Kocher supported this contention by citing previous studies that demonstrated high correlations between on-site and photographic/audiovisual ratings of landscape preferences and scenic quality (beauty) judgments (Anderson, Mulligan, Goodman, & Regen, 1983; Daniel, 1990; Shuttleworth, 1980; Zube, Pitt, & Anderson, 1975).

Based on these findings, it is possible that virtual nature can substitute for actual nature. However, that is not the only interpretation. It may be that landscape preference and scenic beauty assessments are based heavily on visual input from the environment, whereas psychological benefits of nature derive from other senses as well. Natural environments tend to engage a broader range of senses than do photographs and videos. Although videos are composed of visual and auditory components, and photographs only contain a visual dimension, real environments are much more complex, involving the sense of sight, sound, touch, and smell. The eye is also capable of taking in a larger field of vision at any one moment than many cameras (Shuttleworth, 1980).

Thus, the issue raised by Levi and Kocher remains unanswered: Is virtual nature equivalent to the real thing? Study 2 addresses this question by contrasting individuals who have had an actual experience in nature with

those having a virtual experience. Specifically, this study is designed to address whether an individual can obtain the same psychological benefits from viewing audiovisual images of nature as they can from walking in a natural area. In addition, similar to Study 1, Study 2 addresses our research goals concerning reflection and the mediators of the nature/well-being benefits. These goals are addressed by examining whether an actual experience in nature has a greater impact on reflection than a virtual experience and by examining whether connectedness to nature mediates the relationship between exposure to nature and the psychological benefits of positive affect and reflection.

Method

Participants

Participants consisted of 92 male and female undergraduates (28 male, 61 female, and 3 unidentified) enrolled in introductory psychology at Oberlin College. They received course credit for participating in this three-celled study (actual nature vs. virtual nature vs. virtual urban).

Materials

Videotapes. The experimental procedure made use of three videotapes filmed by the research team using a handheld digital camera. Two of these videos were nature videos taken in the local arboretum, which replicated the path and duration of the outdoor group's walk. The nature videos were identical, except one was filmed on a sunny day and the other on a cloudy day. The nature video shown during a given experimental session was yoked to the weather conditions outdoors. In addition, there was one urban video containing footage of a busy metropolitan street on a partially cloudy day. The urban video was approximately equivalent in length to the nature videos.

Additional measures. Participants completed the same memory loaded search task used in the Study 1. They also completed the PANAS (alpha of negative affect = .83, alpha of positive affect = .89, the trait CNS ($\alpha = .84$), and the state CNS ($\alpha = .82$). In addition, they completed measures of environmental awareness ($\alpha = .79$), private self-awareness ($\alpha = .79$), and public self-awareness ($\alpha = .89$).

Procedure

Once again, all participants completed the trait CNS as part of a longer questionnaire administered to introductory psychology during an in-class

mass-testing session. All subsequent data collection took place between mid-October through late November. Each experimental session was randomly preassigned to either the nature condition or the video conditions; all conditions were run on a given day, within 15–30 min of each other, to control for weather effects. However, the outdoor condition was not run in the rain.

All participants met in a building on campus that was equidistant to the psychology department and the arboretum used in the outdoor condition. Participants gave informed consent before departing for their respective destinations. The outdoor group walked to the arboretum accompanied by a researcher. Those in the video conditions were lead by a second researcher to the psychology building.

The researchers explained the purpose of the experiment in transit to their destinations. All participants were informed that they were taking part in a study designed to assess the effects of walking on environmental perceptions. The researchers requested that participants should not talk with one another while at the arboretum or while watching the videos, so they could give their full attention to the landscape/video before them. Also in transit, the researchers asked participants to silently reflect on a loose end in their life that needs tying, using the same instructions from Study 1.

On arrival at the psychology building, those in the video conditions were randomly assigned to either a nature or an urban video group. The researcher explained that they would be viewing identical videos but that this division allowed them to administer the questionnaires in a more time-efficient manner. Participants then watched a 10 min video of a walk in their assigned environment. Participants in the actual nature condition walked for 10 min through a wooded area. Afterwards, all participants completed the PANAS, the self-awareness measures, and the CNS. After finishing these questionnaires, participants rated their ability to reflect by reacting to the statement, "I feel more prepared to 'tie up my loose end' than I did before I began this study." Last, all participants performed the memory loaded search task.

After participants completed the questionnaire and concentration task, they were debriefed by the on-site researcher and thanked for their participation.

Results

There were no preexisting differences between the three conditions on trait connectedness to nature, $F(2, 75) = .73$, $p = .48$. The correlations between the main dependent measures appear in Table 3. To test the effects of condition on our DVs, we ran a series of 3 (condition: nature vs. virtual

Table 3
Pearson Product Moment Correlations Between Dependent Variables in Study 2

	1	2	3	4	5	6	7	8
1. Trait CNS	—							
2. State CNS	.36***	—						
3. Attentional capacity	–.08	–.24*	—					
4. Negative affect	.10	–.26**	.01	—				
5. Positive affect	.09	.46***	–.20	–.21**	—			
6. Ability to reflect	–.03	.36***	–.12	–.32***	.37***	—		
7. Private self-awareness	.14	.39***	–.38***	.00	.44***	.46***	—	
8. Public self-awareness	–.03	–.20*	.13	.25**	–.21**	–.09	.09	—
9. Environmental self-awareness	.05	.39***	–.26**	–.23**	.39***	.35***	.36***	–.11

*$p < .10$. **$p < .05$. ***$p < .01$.

nature vs. virtual urban) × 2 (gender: male vs. female) analyses of variance.[3] Planned comparisons between virtual nature and virtual urban and between virtual nature and nature were run on all variables.

Outcome Variables

Consistent with Study 1, condition significantly influenced positive affect, $F(2, 83) = 21.56$, $p < .001$. Those in the nature condition reported significantly more positive emotions than those in the other two conditions (see Table 4 for means and standard deviations of this and subsequent variables, by condition). The effects of gender and the gender × condition interaction on positive affect were not significant, p's $> .6$. Unlike Study 1, condition had a marginal main effect on negative affect, $F(2, 83) = 2.52$, $p = .09$. The virtual urban condition reported significantly more negative affect than the other two conditions. The effects of gender and the gender × condition interaction on negative affect were not significant, p's $> .15$. Thus, similar to Study 1, exposure to nature once again was shown to lead to more positive emotions, although in this instance exposure to urban scenes led to a marginally significant increase in more negative emotions.

Replicating Study 1, condition also affected participants' ability to reflect, $F(2, 83) = 6.61$, $p < .01$. The urban video condition was significantly less able to reflect than the other two conditions; the actual nature condition was not significantly better able to reflect than the video nature condition. There was also a main effect of gender, $F(1, 83) = 4.42$, $p < .05$.

Table 4
Study 2: Means and Standard Deviations of Mediating and Dependent Variables, by Condition

	Nature		Virtual Nature		Virtual Urban	
DV	*M*	*SD*	*M*	*SD*	*M*	*SD*
CNS	3.60[a]	.64	3.28[b]	.54	2.80[c]	.68
Errors on task	1.00[a]	.47	1.15[a]	.59	1.41[a]	.49
Positive affect	3.15[a]	.72	2.33[b]	.56	2.00[b]	.48
Negative affect	1.35[a]	.50	1.39[a]	.38	1.66[b]	.59
Ability to reflect	3.88[a]	.78	3.69[a]	.84	3.09[b]	1.19
Private self-awareness	3.91[a]	.77	3.60[b]	.64	3.50[b]	1.00
Public self-awareness	2.19[a]	.96	2.65[b]	.92	3.08[b]	1.03
Environmental self-awareness	3.74[a]	.63	3.10[b]	.68	3.21[b]	.82

Note: For each DV, means with different superscripts are significantly different at the $p = .05$ level.
DV = dependent variable.

Women reported a greater ability to reflect ($M = 3.75$, $SD = 0.94$) than men ($M = 3.36$, $SD = 0.95$). The gender × condition interaction was not significant, $p > .25$.

We also examine whether condition influenced our two potential mediators, connectedness to nature and attentional capacity. We once again included trait CNS as a covariate; thus, all results show changes in connectedness to nature scores. Trait CNS scores significantly predicted state CNS scores, $F(1, 74) = 9.35$, $r = .36$, $p < .01$. Those initially high on the CNS tended to remain so. Condition significantly affected state CNS scores, $F(2, 74) = 8.66$, $p < .001$. All three groups differed significantly from each other, with those in the nature conditions feeling most connected and those in the urban video condition feeling least connected. There was a marginal main effect of gender, $F(1, 74) = 3.42$, $p = .07$. Women were marginally higher on the CNS ($M = 3.40$, $SD = 0.70$) than males ($M = 3.11$, $SD = 0.63$). The gender × condition interaction was not significant, $p > .6$.

On examining the scores on the cognitive task, we discovered that one participant in the virtual nature condition had an accuracy score 6 *SD*'s below the mean; this participant was not included in the following analyses. Condition did not have a significant effect on attentional capacity, as measured by the number of errors per line completed, $F(1, 56) = 1.31$, $p = .28$. However, the means were in the predicted direction (see Table 4).

Finally, we tested to see whether condition affected participants' levels of self-awareness. As in Study 1, there was a significant effect of condition on public self-awareness, $F(2, 83) = 4.57$, $p < .05$. The nature condition ($M = 2.2$, $SD = 0.96$) was less publicly self-aware than the two virtual groups ($M = 3.07$, $SD = 1.03$). There was also a marginal condition × gender interaction, $F(2, 83) = 2.63$, $p = .08$. Women in the urban video condition reported feeling particularly publicly self-aware, $M = 3.36$, $SD = 0.98$. The main effect of gender was not significant.

In addition, there was a main effect of condition on environmental awareness, $F(2, 83) = 6.22$, $p < .01$. Participants in the nature condition experienced more awareness of the environment ($M = 3.74$, $SD = 0.63$) than did the two virtual groups ($M = 3.21$, $SD = 0.82$), $t(62) = 2.91$, $p < .01$. No other effects were significant, F's < 1.4. There was also a marginal effect of condition on private self-awareness, $F(2, 83) = 2.58$, $p = .08$. Those in nature were significantly more self-aware ($M = 3.91$, $SD = 0.76$) than those in the virtual conditions ($M = 3.55$, $SD = 0.82$), $t(90) = 2.17$, $p < .05$. Finally, women ($M = 3.89$, $SD = 0.66$) reported feeling more privately self-aware then men ($M = 3.36$, $SD = 0.98$), $F(1, 83) = 9.29$, $p < .01$.

Mediational Analyses

Using the procedures employed in the previous study, we tested to see whether connectedness to nature and attention restoration explained the positive outcomes due to condition (see Table 5). To maximize power, the two most contrasting conditions (nature vs. virtual urban) were used in the analyses. Condition did significantly influence the DVs of interest (positive affect and ability to reflect). As established above, condition significantly influenced state CNS scores. State CNS scores also significantly predicted positive affect and ability to reflect. When condition and state CNS scores were both used to predict positive affect, the relationship between condition and positive affect was significantly weakened. When condition and state CNS scores were used to predict the ability to reflect, the relationship between condition and ability reflect was significantly weakened. These analyses provide support for the role of connection to nature as at least a partial mediator of condition's effect on the positive outcomes measured here.

We also tested to see if the increase in positive affect could be explained by a reduction in private and/or public self-awareness. To test this, public and private self-awareness were added to the regression equation predicting positive affect, along with condition, trait, and state CNS scores. Neither public

Table 5
Test of Attentional Capacity and Connection to Nature as Mediators of Condition Effects in Study 2

	Positive Affect					
Mediator	Connectedness to Nature			Attentional Capacity		
Equation	*b*	*t*	Sobel[2]	*b*	*t*	Sobel
Condition[1] predicting mediator	.36	3.99****		–.42	2.50**	
Predictors of positive affect						
1. Mediator	.62	5.20****		–.17	1.46	
2. Condition	.59	6.87****		.59	6.87****	
3. Mediator condition	.38	3.51****	2.64**	.02	0.17	–.21
	.46	5.39****		.58	5.12****	
	Ability to Reflect					
Mediator	Connectedness to Nature			Attentional Capacity		
Equation	*b*	*t*	Sobel	*b*	*t*	Sobel
Condition[1] predicting mediator	.36	3.99****		–.42	2.50**	
Predictors of ability to reflect						
1. Mediator	.61	4.13****		–.12	1.0	
2. Condition	.40	3.21**		.40	3.21**	
3. Mediator condition	.49	3.07**	2.44**	–.03	0.25	.24
	.24	1.86*		.28	1.91*	

Note: 1. When predicting state CNS, trait CNS was controlled for. 2. The Sobel test indicates whether including the mediator (Equation 3) significantly reduces the condition regression weight (Equation 2 vs. Equation 3).
*$p < .10$. **$p < .05$. ****$p < .001$.

nor private self-awareness was a significant predictor of positive affect (b's < .12, t's < 1.1); state CNS remained significant, $b = 0.33$, $t(51) = 2.36$, $p < .05$.

We also conducted mediational analyses with attentional capacity as the potential mediator. Condition did significantly predict attentional capacity. However, attentional capacity only marginally predicted positive affect ($r = .23$, $p = .07$) and the ability to reflect ($r = .22$, $p = .08$). When both attentional capacity and condition were included in the same regression equation, attentional capacity failed to remain even marginally significant. Condition remained significant. Thus, the conditions for mediation were not met by attentional capacity.

Finally, because state CNS and positive affect were so highly correlated with each other ($r = .46$, $p < .001$) we tested to see whether the effect of connection to nature contributed to the ability to reflect independently of positive affect. Both positive affect and state CNS were included in a regression equation predicting the ability to reflect. Controlling for state CNS, positive affect marginally predicted the ability to reflect, $b = 0.30$, $t = 1.93$, $p < .06$. State connectedness to nature significantly predicted the ability to reflect, $b = 0.44$, $t = 2.54$, $p < .05$, above and beyond the effects of positive affect.

Discussion

Study 2 largely replicated the effects of Study 1: Exposure to nature led to increases in connectedness to nature, positive affect, ability to reflect, and a decrease in public self-awareness. The results also provide strong support for state CNS as a mediator of the exposure to nature/well-being effects; these effects could not be accounted for by attentional capacity or changes in private or public self-awareness. In addition, the state CNS/ability to reflect relationship remained even when controlling positive affect.

Unlike Study 1, Study 2 demonstrated that in contrast to those in virtual environments, participants in the nature condition experienced both higher levels of private self-awareness and awareness of their immediate environment. Although demand characteristics could potentially explain the increases in self-reported positive affect and ability to reflect, a demand explanation is not consistent with this pattern of results on the self-awareness measures. In addition, given the added findings from the virtual nature condition, a demand explanation would assume that somehow people in the actual nature condition knew to feel very positive, in the virtual nature condition only somewhat positive, and in the virtual urban to feel the worse off. This seems implausible. Moreover, lessened public self-awareness in the nature condition should decrease the likelihood that these individuals would engage in behavior to please the experimenter.

The unique findings from Study 2 primarily concern whether virtual nature produces psychological effects similar to actual nature. Although the group means of all variables showed a trend for the virtual nature condition to have less impact than the actual nature condition, the two groups were significantly different only in their effect on connectedness to nature and on positive affect.

Study 3

In Study 2, it was observed that although participants in the real nature condition felt more positive than did the participants in either the virtual nature or virtual urban conditions, this effect did not extend to the ability to reflect measure. Specifically, although participants in the real nature condition were observed to have higher reflection scores than participants in the virtual urban condition, the real nature/virtual nature contrast was not significant. Several factors could account for this finding. On the one hand, it may be the case that real nature and virtual nature do not differ from one another in terms of affecting participants' ability to reflect. On the other hand, it may be that in this more subtle contrast, we simply did not have enough statistical power to ascertain whether a difference was present. To address this question, in this study we only created a two group comparison (i.e., between real nature vs. virtual nature). Otherwise, Study 3 was identical to Study 2 in terms of its goals and procedures, although different nature videos were employed in this study than in Study 2.

Method

Participants

Sixty-four introductory psychology students (33 females, 29 males, 2 unidentified) participated in a two-cell study (actual nature vs. virtual nature) in return for partial course credit.

Materials

Videotape. In this study, a professional-looking video was shot by a cinema studies student with extensive filming experience just a few days before participants were run (to match the amount of foliage as closely as possible). The video replicated the path and duration of the outdoor group's walk.

Additional measures. As in the previous studies, participants completed the memory loaded search task. They also completed the PANAS (alpha of negative affect = .85, alpha of positive affect = .93), the state CNS (α = .91), trait CNS (α = .82), and the three self-awareness measures (environmental awareness alpha = .66, private self-awareness alpha = .76, and public self-awareness alpha = .83).

Procedure

All participants completed a CNS premeasure as part of a longer questionnaire administered to introductory psychology during an in-class mass-testing session.

All subsequent data collection took place between mid-April and mid-May. Each experimental session was randomly preassigned to one of the two conditions; both conditions were run on a given day, within 15–30 min of each other (to control for weather effects.) All participants met in a building on campus that was equidistant to the psychology department and a local arboretum used in the outdoor condition. Participants gave informed consent before departing for their respective destinations. The outdoor group walked to the arboretum accompanied by a researcher. Those in the video condition were led by a second researcher to the psychology building.

The researchers explained the purpose of the experiment in transit to their destinations. All participants were informed that they were taking part in a study designed to assess the effects of walking on environmental perceptions. The researchers requested that participants should not talk with one another while at the arboretum or while watching the video, so they could give their full attention to the landscape/video before them. As in the previous study, the researchers asked participants to silently reflect on a loose end in their life that needs tying.

Participants then walked for 10 min through the arboretum or watched a 10-min video of the same walk through the arboretum. Afterwards, all participants completed the measures described above. Those in the arboretum condition entered a nearby building and completed the questionnaires in a lounge area. Those in the video condition remained in their seats. After finishing these questionnaires, participants rated their ability to reflect by responding to the same question used in the previous studies. Last, all participants performed the memory loaded search task.

After participants completed the questionnaire and concentration task, they were debriefed by the on-site researcher and thanked for their participation.

Results

There were no preexisting differences between the two conditions on trait connectedness to nature, $F(1, 58) = 1.61$, $p = .21$. The correlations between the main dependent measures appear in Table 6. To test the effects of condition on our DVs, we ran a series of 2 (condition: virtual nature vs. actual nature) × 2 (gender: male vs. female) analyses of variance.[4]

Table 6
Pearson Product Moment Correlations Between Dependent Variables in Study 3

	1	2	3	4	5	6	7	8
1. Trait CNS	—							
2. State CNS	.47***	—						
3. Attentional capacity	.04	.05	—					
4. Negative affect	–.18	–.07	.10	—				
5. Positive affect	.08	.41***	–.13	.01	—			
6. Ability to reflect	.04	.40***	.08	.05	.44***	—		
7. Private self-awareness	.14	.26**	–.08	–.24*	.33***	.31**	—	
8. Public self-awareness	–.002	–.15	.14	–.25*	–.09	–.20	.05	—
9. Environmental self-awareness	.03	.41***	–.12	–.03	.49***	.23*	.17	.21

*$p < .10$. **$p < .05$. ***$p < .01$.

Outcome Variables

As in the previous studies, condition influenced positive affect, $F(1, 57) = 12.67$, $p < .001$. Those in the nature condition reported significantly more positive emotions ($M = 5.28$, $SD = 1.74$) than those in the virtual nature condition ($M = 3.83$, $SD = 1.33$). The effects of gender and the gender × condition interaction on positive affect were not significant, p's > .4. In addition, similar to Study 1, the effect of condition on negative affect was not significant, $F(1, 57) = .30$, $p = .59$, nor were other effects, p's > .2.

Of particular interest, by increasing the statistical power in the present study it was now observed that condition significantly affected the ability to reflect, $F(1, 58) = 12.24$, $p < .001$. Those in the nature condition reported a significantly greater ability to reflect on their loose end ($M = 4.52$, $SD = 1.66$) than those in the virtual nature condition ($M = 3.10$, $SD = 1.68$). The effects of gender and the gender × condition interaction on the ability to reflect were not significant, p's > .10.

We once again ran a 2 (condition) × 2 (gender) ANCOVA with trait CNS as a covariate and state CNS as the DV. Thus, as in the previous studies, all results show group differences in connectedness to nature scores that control for initial level of connection. Trait CNS scores significantly predicted state CNS scores, $F(1, 57) = 10.59$, $r = .47$, $p < .01$. Those initially high on the CNS tended to remain so. Condition also influenced state CNS scores, $F(1, 57) = 5.79$, $p < .05$. Those who spent time in actual nature had significantly higher state CNS scores ($M = 3.00$, $SD = 0.70$) than those in

the virtual nature condition ($M = 2.59$, $SD = 0.44$). The effects of gender and the gender × condition interaction on state CNS were not significant, p's > .4.

Condition did not have a significant effect on attentional capacity, as measured by the number of errors per line completed (higher numbers reflect more errors, and thus less attentional capacity), $F(1, 54) = 2.38$, $p = .13$. However, the means were in the predicted direction. The nature condition committed an average of 1.07 errors/line ($SD = 0.54$), whereas the virtual condition committed an average of 1.39 errors/line ($SD = 0.87$).

Finally, we tested to see whether condition affected participants' levels of self-awareness. Unlike the previous studies, there was no effect of condition on public self-awareness, F's < .5. There was a main effect of condition on environmental awareness, $F(1, 60) = 6.83$, $p < .01$. Participants in the nature condition experienced more awareness of the environment ($M = 3.45$, $SD = 0.64$) than the virtual nature condition ($M = 3.06$, $SD = 0.59$). No other effects were significant, F's < 1. There was also a significant effect of condition on private self-awareness, $F(1, 60) = 4.07$, $p < .05$. Once again, those in nature were significantly more self-aware ($M = 3.87$, $SD = 0.78$) than those in the virtual conditions ($M = 3.49$, $SD = 0.77$). No other effects were significant, F's < 1.

Mediational Analyses

We followed the same procedures used in the previous studies for testing whether connectedness to nature scores mediated the effects of condition on positive outcomes (see Table 7). Connectedness to nature received some support as a mediator. As established above, condition significantly influenced the DVs of interest (positive affect and ability to reflect). In addition, condition was observed to significantly influence the state CNS scores. State CNS scores also significantly predicted positive affect and ability to reflect. When condition and state CNS scores were both used to predict positive affect and ability to reflect, the condition effect was weakened for both outcome variables. However, the Sobel test was only marginally significant in both analyses. Thus, although consistent with the findings from the previous studies, there is less compelling evidence for state CNS as a mediator in this study. However, given the subtlety of the comparison (real nature vs. virtual nature), it is not surprising that these effects are weaker than the previously reported effects.

We also tested to see if the increase in positive affect could be explained by a reduction in private and/or public self-awareness. To test this, public

Table 7
Test of Attentional Capacity and Connection to Nature as Mediators of Condition Effects in Study 3

	Positive Affect					
Mediator	Connectedness to Nature			Attentional Capacity		
Equation	*b*	*t*	Sobel[2]	*b*	*t*	Sobel
Condition[1] predicting mediator	0.33	2.35**		–0.33	1.81*	
Predictors of Positive Affect						
1. Mediator	0.56	3.50****		–0.16	0.99	
2. Condition	0.65	3.18**		0.65	3.18**	
3. Mediator Condition	0.44	2.69**	1.77*	–0.07	0.42	0.43
	0.47	2.29**		0.58	2.61	
	Ability to Reflect					
Mediator	Connectedness to Nature			Attentional Capacity		
Equation	*b*	*t*	Sobel	*b*	*t*	Sobel
Condition[1] predicting mediator	0.33	2.35**		–0.33	1.81*	
Predictors of ability to reflect						
1. Mediator	1.12	3.42****		0.21	0.64	
2. Condition	1.43	3.44****		1.43	3.44****	
3. Mediator Condition	0.84	2.51**	1.75*	0.46	1.55	–1.18
	1.07	2.54**		1.56	3.69****	

Note: 1. When predicting state CNS, trait CNS was controlled for. 2. The Sobel test indicates whether including the mediator (Equation 3) significantly reduces the condition regression weight (Equation 2 vs. Equation 3).
*$p < .10$. **$p < .05$. ****$p < .001$.

and private self-awareness were added to the regression equation predicting a positive affect, along with condition, trait, and state CNS scores. Public self-awareness did not predict positive affect, $b = –0.16$, $t(56) = .49$, *ns*. Private self-awareness marginally predicted positive affect ($b = 0.76$, $t(56) = 1.77$, $p = .08$). However, state CNS remained significant, $b = 4.84$, $t(56) = 2.60$, $p < .05$.

Attentional capacity was only observed to be marginally influenced by exposure to nature (see Table 7). Primarily, however, given that attentional capacity did not predict positive affect or ability to reflect, it cannot be considered as a possible mediator of the condition/nature benefit effects.

Finally, because state CNS and positive affect were so highly correlated with each other ($r = .41$, $p < .001$) we tested to see whether the effect of connection to nature contributes to the ability to reflect independently of positive affect. Both positive affect and state CNS were included in a regression equation predicting the ability to reflect. Controlling for state CNS, positive affect significantly predicted the ability to reflect, $b = 0.69$, $t = 2.72$, $p < .01$. However, state CNS also significantly predicted the ability to reflect, $b = 0.70$, $t = 2.03$, $p < .05$, above and beyond the effects of positive affect.

Discussion

Besides addressing the first two goals of our research, Study 3 was also designed to follow up on Study 2's ambiguous results on whether exposure to real nature provides substantially more psychological benefits than exposure to virtual nature. The answer from this study is clearly yes: people in the actual nature condition did reap greater psychological benefits than did the individuals in the virtual nature condition. In addition, as in Study 1, we found that people actually in nature were better able to reflect than people not actually in nature.

Although public self-awareness did not vary by condition in this study, participants in the nature condition did feel significantly more privately self-aware, and they were also significantly more aware of their immediate environment than were the participants in the virtual-nature condition. The increase in private self-awareness in the real-nature condition argues against a demand alternative explanation, because heightened self-awareness is associated with individuals acting in a manner more reflective of their self-and with less concern for meeting the expectations of others.

The tests of mediation in this study were decidedly more equivocal than in the previous studies. Connectedness to nature was found to only marginally reduce the relationship between exposure to nature and the positive outcomes. However, this is not surprising given that the contrast between conditions in Study 3 (virtual vs. actual nature) is much less dramatic than the contrast in Study 1 (actual nature vs. actual urban) and Study 2 (actual nature vs. virtual urban). The test of attentional capacity was unequivocal: It did not mediate the benefits of exposure to nature. Furthermore, as in Studies 1 and 2, the state CNS/ability to reflect relationship remained significant even when controlling for positive affect. Once again, these findings strongly argue that the impact that CNS has on ability to reflect cannot be accounted for by Fredrickson's (1998) broaden-and-build theory of positive emotions or by ART.

General Discussion

The present set of studies attempted to address three questions: (a) to investigate connectedness to nature as a potential mediator of the nature/well-being (i.e., positive mood) effect, (b) to determine whether exposure to nature aids in the more complex socioemotional process of reflecting on a life problem, and (c) to determine the difference between real and virtual nature for accruing these benefits. Overall, the results were consistent across three independent samples, despite differences in season and in both the actual and virtual nature experiences. The consistency of findings across these variations of time, place, method, and participants argues for the internal validity of these effects. The fact that we actually took our participants into the field to test our hypotheses argues for the external validity of the work.

In particular, these studies highlight another potential mediator other than stress reduction and attention restoration that contributes to the exposure to nature/well-being effects. In addition, for the first time these studies also examine a potential mediator of the exposure to nature/well-being effect through a full mediational analysis. These effects held even when controlling for alternative explanations (the broaden and build theory of positive emotions, self-awareness theory, ART). Further, the pattern of findings is inconsistent with a demand explanation for nature's positive benefits.

In other words, researchers need to consider more than hectic lifestyles and the associated stress when thinking of the exposure to nature/well-being effects. Humans have lived the vast majority of their lives embedded in nature, belonging to the natural world in very real ways. In geological time, it is only a tick of the clock that we have spent in highly urban settings, working in concrete buildings, driving in climate controlled cars, and living in relatively densely populated areas, shut off from nature. As Pretty (2002) estimated, for 350,000 generations humans have lived close to the land as hunter-gatherers; a sense of belonging, place, and feeling embedded within the broader natural world characterized these cultures. In some ways, then, it would be surprising if the modern life of being divorced from nature did not have some negative consequences associated with it and that being in nature had positive benefits.

When practitioners think of how to create settings to help clients feel better, they may want to think of more than simply how nature can restore depleted attentional capacity and reduce stress. They may also want to think of how people need to feel a sense of belonging to something larger than themselves and that this need may be fulfilled through a sense of belonging or connectedness to the natural world.

Although we have noted the differences between ART and our approach, the two approaches in all likelihood share some very strong relationships. For instance, the factors that lead to attention restoration (being away, extent, fascination, and compatibility) probably also increase a person's experiential sense of feeling connected to nature. This poses both problems and opportunities for both approaches. Particularly, it will be important for researchers not to assume that simply because they vary these factors that they are necessarily affecting attention restoration, or that they are only affecting attention restoration. Intuitively, it makes sense that exposure to nature helps restore energy drained by our hectic modern lifestyle. Yet our work highlights that, in fact, connectedness to nature may be playing a more important role in some of the well-being effects.

We also want to highlight that we are not arguing that attentional capacity cannot mediate the exposure to nature/well-being relation or that connectedness to nature is the better mediator. As stated in the introduction, five potential mediators have been proposed, and the purpose of our work has been to highlight a mediator other than attentional capacity. To more fully contrast connectedness to nature with attentional capacity, we would have had to manipulate attentional fatigue. Because of limited resources and because ART was not the primary focus of our work, we did not manipulate mental fatigue in our participants but simply tried to control for attentional capacity as an alternative explanation for our findings.

It could be argued that attentional capacity was not found to be a mediator in the present studies due to the fact that perhaps we used an insensitive measure of attentional capacity. Future research should indeed use different measures of attentional capacity (e.g., the Necker Cube Pattern Control Test, as used by Hartig et al., 2003). It should be noted, however, that in our clearest and strongest contrast of nature with urban settings (Study 1), the condition manipulation had a very strong effect on attentional capacity but was still not found to be a mediator. Thus although preliminary, these results do suggest that restored attentional capacity is not a requirement for nature to have beneficial effects.

It is also interesting to contrast our work with the work of Kuo (2001; Kuo & Sullivan, 2001). In her quasi-experimental work, Kuo has found that attentional capacity mediates the relationship between exposure to nature and what we construe as more negative aspects of thought, mood, and behavior (i.e., the ability to cope with major life problems and aggression). Given that attentional fatigue is typically associated with increases in irritability, we wonder whether attentional capacity may play a greater role in relieving people from negative affective states whereas connectedness to

nature may play a greater role in enhancing feelings of positive affect. Future research might explore these possibilities.

This work also constitutes the first time that a true experimental test and a full mediational analysis of the reflection hypothesis has been conducted with people actually present in a natural environment. In each of the three studies, we found that our participants in the actual nature condition reported being better able to tie up a loose end than were the participants in either the actual urban, virtual nature, or virtual urban conditions. This speaks to the importance that actually being in nature has for the more complex socioemotional process of dealing with a life problem. Moreover, although previous researchers (e.g., Korpela, 1992; Korpela, Hartig, Kaiser, & Fuhrer, 2001) have suggested that reflection may occur primarily in places that hold special significance to individuals, our studies suggest that the special significance of a place is not a necessary condition for reflection to occur. Our participants reaped the benefit of reflection even though they had never been to this place before. Thus, although a place that holds a special significance to a person may create more powerful effects, practitioners who wish to help someone reflect on an issue need not limit their thinking to only such places.

One weakness of this research is that the measure of ability to reflect was a single item self-report measure. As such, it is open to the criticism of being unreliable. However, given that in three studies we observed similar results with this measure, the issue of reliability seems to be minimized to some extent. Although future research should employ multi-item scales or perhaps behavioral measures of ability to reflect, we nonetheless think that the present studies provide researchers with a good starting point to jump off from in their future inquiries.

The fact that exposure to nature affects one's ability to reflect has important implications. When confronted with hassles and loose ends, our work argues for the benefits of getting outside and walking in nature. However, our results may not generalize to more major life problems. Our participants were instructed to not think of a major issue, such as resolving the conflict between their parents that might lead to their divorce, because 10 min in nature was not thought to be enough time to reflect on this problem. Future research should explore the severity of the issues that can be resolved in nature and whether length of exposure to nature is linked with the magnitude of the problem that a person can gain insight into. At this point, we only know that brief exposures can help with relatively minor issues.

In addition, in two of our three studies, positive affect predicted the ability to reflect, above and beyond the variance explained by connectedness to nature. These findings point to another possible mechanism to consider in

future research when addressing why exposure to nature leads to enhanced reflection. Fredrickson's (1998) broaden-and-build theory of positive emotions may prove to be helpful in guiding this research.

Our third goal, to determine the difference between real and virtual nature for accruing these benefits, also resulted in interesting findings. Generally, exposure to real nature was associated with greater psychological benefits than with virtual nature. Thus, taking a walk in the woods is not equivalent to watching a nature film if one is interested in accruing the greatest psychological benefit for either oneself or another. Nevertheless, not everyone has this opportunity. Shut-ins, people with busy lives, and others living in certain urban areas may not have the luxury of having an arboretum nearby. Consistent with previous research, our research also speaks of the positive aspects of exposure to nature in the media.

It is also possible that more elaborate simulation technology could approximate actual nature fairly closely. For instance, although we used videos, there are more sophisticated virtual headsets that could make the visual experience even more real. In addition, other sensory inputs could be employed to even further enhance the realism of the presentation and, possibly, the psychological benefits that would result. Staff at hospitals, nursing homes, hospice workers, and so on could potentially provide benefit to their clients through such technology.

The current findings also point out several other potential directions for future research. In addition to exploring the complimentary roles of attention restoration and connection to nature, future research should look for other factors that explain nature's beneficial effects. Self-transcendence, awe, and flow are all states of mind that are often associated with the time spent in nature and, as such, are likely candidates.

Last, when environmentalists exhort modern humans to change their ways, they often rely on fear communications: Unless we change our lifestyles, societal collapse is right around the corner. Although fear communications can produce attitude change (Leventhal, Watts, & Pagano, 1967), they can also lead to denial and accusations that the communicator is an alarmist. A more positive approach would be to highlight the benefits associated with being connected to nature. Besides the psychological benefits demonstrated in this article, our previous work also indicates that people who feel more connected to nature are more likely to engage in ecofriendly acts (Mayer & Frantz, 2004). Perhaps, offering people a different psychological orientation toward the world—that of being a plain and simple member of a natural community—to achieve health benefits might prove to be a message that people will be more willing to hear and act on.

Appendix
Connectedness to Nature Scale (State)

Please answer each of these questions in terms of the way you feel at the present moment. There are no right or wrong answers. Using the following scale, in the space provided next to each question simply state as honestly and candidly as you can what you are presently experiencing.

1	2	3	4	5	6	7
Strongly Disagree			*Neutral*			*Strongly Agree*

____ 1. Right now I'm feeling a sense of oneness with the natural world around me.
____ 2. At the moment, I'm feeling that the natural world is a community to which I belong.
____ 3. I presently recognize and appreciate the intelligence of other living organisms.
____ 4. At the present moment, I don't feel connected to nature.
____ 5. At the moment, I can imagine myself as part of the larger cyclical process of living.
____ 6. At this moment, I'm feeling a kinship with animals and plants.
____ 7. Right now, I feel as though I belong to the earth just as much as it belongs to me.
____ 8. Right now, I am feeling deeply aware of how my actions affect the natural world.
____ 9. Presently, I feel like I am part of the web of life.
____10. Right now, I feel that all inhabitants of earth, human and nonhuman, share a common life force.
____11. At the moment, I am feeling embedded within the broader natural world, like a tree in a forest.
____12. When I think of humans' place on earth right now, I consider them to be the most valuable species in nature.
____13. At this moment, I am feeling like I am only a part of the natural world around me, and that I am no more important than the grass on the ground or the birds in the trees.

Notes

1. Because it is possible that participants' trait level of connection to nature could influence their reaction to the condition, trait CNS was initially included as a covariate in all analyses, and the interaction between trait CNS and condition was tested. The interaction term was not significant for any of the DVs.

2. In this study and in Studies 2 and 3, we also tested to see if positive affect mediated the relationship between CNS and ability to reflect. It did not meet the criteria of mediation in any of the three studies.

3. As in Study 1, trait CNS was initially included as a covariate in all analyses, and the interaction between trait CNS and condition was tested. The interaction term was not significant for any of the DVs.

4. Once again, trait CNS was initially included as a covariate in all analyses, and the interaction between trait CNS and condition was tested. The interaction between trait CNS and condition was significant only for state CNS, $F(1, 56) = 4.17$, $p < .05$. Those in the actual nature condition showed a stronger relationship between state and trait CNS ($r = .57$) than those in the virtual nature condition ($r = .23$). This interaction did not qualify the main effect, however.

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