

RESEARCH ARTICLE

WILEY

The affective benefits of nature exposure

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Funding information

JPB Environmental Health Fellowship

Abstract

Mounting evidence demonstrates that nature exposure can have affective benefits. These include behavioral and psychophysiological responses consistent with (a) decreases in stress and negative affect; and (b) increases in subjective well-being and positive affect. What is less clear, however, is what mechanisms are responsible for these effects. In this article, we examine the evidence for affective impacts of nature exposure, consider underlying mechanisms (with a focus on affect regulation), and discuss what might moderate these effects at the individual and population level. We end by pointing to future research directions and practical applications. This includes investigations into the range of effects and duration of their impact, harnessing knowledge about temporal dynamics for insights into causal mechanisms, broadening the discussions around moderators and effect modifications to include diverse perspectives on the relationship between nature exposure and psychological well-being, and integrating findings into existing frameworks from public health.

1 | INTRODUCTION

Affective science involves the examination of emotions, moods, and stress responses, all of which provide information about whether something is beneficial or harmful (Gross, 2015). Affective responses arise in many ways, including thoughts about the past or future, and perceptions of current states of the body, social interactions, or the environment. It is this last category of environmental factors that we consider here. Previous work in psychology

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supports this consideration, with an emphasis on responses to the ways in which the environment aligns with well-being and survival (Frijda, 1986; Lazarus, 1991; Schwarz & Clore, 1983), and the degree to which the processing of this information is “inextricably linked” to emotions (Kaplan & Kaplan, 2009).

Our particular focus is a specific set of environments: natural ones. We define nature as “encompassing elements and phenomena of Earth's lands, waters, and biodiversity, across spatial scales and degrees of human influence, from a potted plant or a small urban creek or park to expansive, ‘pristine’ wilderness with its dynamics of fire, weather, geology, and other forces” (Bratman et al., 2019, p. 2). Here, we review the affective benefits of exposure to nature, describe the evidence for a variety of potential mechanisms (with a focus on affect regulation), and consider moderators and effect modifiers on the individual and population levels. We conclude by considering future research directions, and addressing the importance of integrating these results into broader public health frameworks centered on social and environmental determinants of health.

2 | OVERVIEW

Mounting evidence from a variety of disciplines suggests that exposure to natural environments is associated with affective benefits (Bowler et al., 2010; Bragg & Atkins, 2016; Bratman et al., 2012, 2019; Britton et al., 2020; Frumkin et al., 2017; Hartig & Kahn, 2016; Keniger et al., 2013; Kondo, Fluehr, et al., 2018; White et al., 2017). Documented effects of nature exposure include a reduction of negative outcomes (a “buffering against harm pathway”) and contributions to resilience and positive psychological functioning (a “promotion of positive pathway”) (Bratman et al., 2019; Cleary et al., 2017; Dzhambov et al., 2019; Markevych et al., 2017; McMahan & Estes, 2015). The first pathway includes lower levels of stress and negative affect (Bratman, Daily, et al., 2015; Hartig et al., 2003; Ulrich et al., 1991), and a decrease in the risk of mental health disorders and depressive symptoms (Bezold et al., 2018; for reviews see: Gascon et al., 2015; Kondo, Fluehr, et al., 2018; Roe, 2016; van den Berg et al., 2015). The second pathway includes higher levels of subjective well-being and positive affect (Berman et al., 2012; Hartig et al., 2003; Park et al., 2008; Passmore & Holder, 2017; White et al., 2013, 2021).

These results have been demonstrated using a wide range of study designs, from cross-sectional and longitudinal cohort approaches (Mitchell et al., 2015; van den Berg et al., 2016; Wheeler et al., 2015; White et al., 2013), to natural experiments (Kondo, MacDonald, et al., 2018) and controlled field and laboratory experiments (Aspinall et al., 2015; Berman et al., 2008; Hartig et al., 2003; Ulrich et al., 1991). Benefits have been tied to different forms of nature exposure, including viewing nature images (Ulrich et al., 1991), immersion in virtual reality (Browning et al., 2020; McMahan & Estes, 2015), or being physically present within a range of natural versus urban environments (Berman et al., 2008, 2012; Bratman, Daily, et al., 2015; Hartig et al., 2003; Roe & Aspinall, 2011). The benefits have been assessed through self-report as well as psychophysiological measures (Annerstedt et al., 2013; Brown et al., 2013; Gladwell et al., 2012; Kasetani et al., 2009; Shuda et al., 2020), biomarkers of stress and inflammation, and brain responses (Bratman, Hamilton, et al., 2015; Chang et al., 2020; Cho et al., 2017; Hunter et al., 2019; Roe et al., 2013).

The affective impacts of nature exposure vary in terms of magnitude as well as duration. They range from short, state-level changes in emotion, to longer-lasting shifts in patterns of mood and thought, to changes in prevalence of mental health disorders (Bratman et al., 2019). Evidence increasingly supports the notion that affective impacts of nature exposure also vary by characteristics of the exposure, including duration and frequency of visits (Shanahan et al., 2016; White et al., 2017, 2019) and patterns of human-nature interaction (Kahn et al., 2010; Kahn et al., 2018), as well as the characteristics of the environments, including biodiversity (Cameron et al., 2020; Marselle et al., 2021), landscape type (Wheeler et al., 2015), tree canopy density (Jiang et al., 2014), quality and location (Wyles et al., 2019), and other factors (Barnes et al., 2019).

3 | MECHANISMS

A variety of posited pathways from nature exposure to affective responses have motivated the experimental designs and cross-sectional analytic approaches of studies in the field. Here, we discuss how these pathways relate to outcomes most relevant to (a) buffering against harm, or (b) promotion of well-being. It is important to note that these categorizations are not definitive or mutually exclusive. For example, as we describe below, stress reduction does not exclude increased positive affect, and in fact may rely on this response as an initial factor in a posited mechanistic pathway.

3.1 | Decreased stress and negative affect

Stress Reduction Theory is grounded in the psycho-evolutionary notion that human beings share an innate affinity for nature (the “biophilia hypothesis”) (Kellert & Wilson, 1995; Ulrich, 1977, 1979, 1983, 1993). The primary outcomes predicted by this theory often center on the reduction of stress and negative affect. However, two points are key to note: (a) the affective processes underlying these effects are posited to involve initial, pre-cognitive, positive reactions to natural environments that are tied to corresponding autonomic nervous system responses and stress reduction; and (b) this reduction of stress and negative affect is based upon “antecedent states” in which respondents enter into an exposure with a baseline level of heightened stress and anxiety that is subsequently reduced.

Green, savanna-like environments are postulated to be the most impactful on this front, due to the fact that these environments have been most advantageous to human survival through evolutionary history (Orians & Heerwagen, 1992) via the provision of prospect and refuge (e.g., large, climbable canopy) (Lohr & Pearson-Mims, 2006), views of water sources and green natural elements (Appleton, 1984; Dosen & Ostwald, 2016; Falk & Balling, 2010; Herzog, 1992; Lohr, 2007; Myers, 1996), and the cues for safety and sustenance that they contain. The theory identifies related aesthetic factors of natural environments that are typically preferred by humans, including: coherence, unity, surface texture, depth, mystery, and complexity (Falk & Balling, 2010; Ulrich, 1977) or ideal levels of density (Jiang et al., 2014, 2015). These primarily visual aesthetic characteristics are inherent in habitats that are most suitable for human survival and ideal levels of arousal—and this is the foundation upon which they are restorative, preferred, and rated as less stressful than other environments (Grahn & Stigsdotter, 2010).

As in Zajonc's work on the “minimal mental work” necessary for appraisal of safety, the initial affective responses to natural stimuli may bypass conscious recognition (Kaplan, 1987; Zajonc, 1968, 1984). These responses may be followed by more explicit and conscious appraisals of safety and preference, which in turn lead to further affective responses, including stress reduction (Ratcliffe & Korpela, 2016; Ulrich, 1983). In this way, responses to nature may involve more than just a biophilic, evolutionary-programmed affinity—they may also be learned through experience, associations, and increased familiarity with specific natural environments over time (Ulrich, 1983). This learning may be “biologically prepared” through genetic predisposition or based predominantly on lived experiences. For example, a recent study found that children preferred urban environments over natural ones (in contrast to adults), but that they demonstrated greater preference for nature scenes with older age, supporting the notion that this preference was learned over time (Meidenbauer et al., 2019). Balling and Falk (1982) support this possibility, with their finding that increasing age predicted a preference shift from savanna to hardwood forest in young participants whose living location resulted in them being more familiar with the latter environment through experience. And other research has found that biome preference was predicted by familiarity, as determined by social and demographic characteristics of respondents instead of psycho-evolutionary factors (Hartmann & Apaolaza-Ibanez, 2010; Lyons, 1983).

Stress Reduction Theory posits that a change in affective and cognitive state occurs via nature exposure. Relatedly, the Generalized Unsafety Theory of Stress posits that by default people consider environments to be unsafe unless and until cues of safety are recognized (Brosschot et al., 2018). With this perspective, green environments may provide contexts in which the default state of scanning for threats can be eased via a “letting down of one’s guard” due to our increased capacity to assess cues of safety in these environments (Browning & Olvera-Alvarez, 2020). As with aesthetic preference, this reaction could be tied to genetic predisposition, or to lived experiences and conscious preferences for natural environments based on experiences of safety—independent of whether they fit the archetypical, biophilic landscape of the green savanna.

3.2 | Increased subjective well-being and positive affect

Studies using measures such as the Perceived Restorativeness Scale (Berto, 2005; Hartig et al., 1997; Korpela & Hartig, 1996) posit that natural environments are explicitly preferred due to an acknowledgment of their restorative qualities (Hartig & Staats, 2006; Schebella et al., 2017), and research has found significant correlations between this stated preference and positive affect (van den Berg et al., 2003; White et al., 2010). Over time, a formation of pleasant and restorative memories within specific natural spaces can evolve to a connection to these places that is over and above familiarity. This attachment and identification includes cultural and traditional connections with these environments that can lead to psychological well-being through inspiration, spiritual experiences, positive memories, and an emotional bond with and sense of attachment to a specific place (Díaz et al., 2018; Halpenny, 2010; Lewicka, 2014; Scannell & Gifford, 2017).

In addition to familiarity and attachment to specific places, some researchers have posited that feelings of connectedness and relatedness to the natural world may fulfill primary psychological needs of inclusion and belongingness (Baxter & Pelletier, 2019; Perrin & Benassi, 2009). In support of this, increased levels of psychological connectedness to nature have been shown to predict increased subjective well-being in general (Capaldi et al., 2014; Capaldi et al., 2015; White et al., 2021; Zelenski & Nisbet, 2014), or immediately after nature exposure (Mayer et al., 2009). Increased eudaimonic (and to a lesser extent, hedonic) well-being has been found to be associated with connectedness to nature in a recent meta-analysis (Pritchard et al., 2020), as well as cross-sectional studies with adults (Martin et al., 2020) and children (Barrera-Hernández et al., 2020). This connectedness can extend to posited pathways from nature contact to subjective well-being through feelings of awe or savoring that accompanies nature experiences, which in turn increases positive affect and prosocial tendencies (Anderson et al., 2018; Kahn & Hasbach, 2012; Richardson & Sheffield, 2017; Sato et al., 2018).

3.3 | Regulating affect

Thus far, we have considered nature exposure either as leading to decreased stress and negative affect or increased subjective well-being and positive affect. These impacts suggest the possibility that individuals might seek out natural environments in order to regulate their affective states. This brings us to a discussion of the process model of emotion regulation and its relevance to nature exposure (Bratman, Daily, et al., 2015; Bratman et al., 2012; Korpela et al., 2020; Richardson, 2019). Here, we refer to the ways in which individuals change the timing, duration and nature of their affective responses (Gross, 1998b, 2015). This includes conscious and unconscious processes and strategies that up- or down-regulate momentary emotions, short-lived environmental reactions, and general levels of mood (Braunstein et al., 2017; Gross, 1998b; Koole et al., 2015; McRae & Gross, 2020; Quoidbach et al., 2015). Natural environments may aid or hinder affect regulation processes through an increase in adaptive processes or a decrease in maladaptive ones (Bratman, Daily, et al., 2015; Johnsen & Rydstedt, 2013; Korpela et al., 2018; Mueller & Flouri, 2020; Richardson, 2019; Tost et al., 2019; Weeland et al., 2019).

The process model of emotion regulation (Gross, 2015) provides one helpful way to understand the ways in which natural environments play a relevant role in encouraging or discouraging some of these regulation strategies (see Figure 1). Although the focus of this model has historically been on emotions, it is as applicable to other affective states (Gross et al., 2019). This framework describes five families of emotion regulation processes, each of which we briefly describe as relevant to understanding the affective impacts of nature exposure.

Situation selection describes a circumstance in which an individual chooses a situation based upon a consideration of its emotional impact (Gross, 2015). It typically occurs either through the avoidance of settings in which undesirable emotions arise, or through choosing situations in which desirable ones are typically experienced—including natural environments (Johnsen & Rydstedt, 2013; Korpela et al., 2001, 2018). Korpela et al. (2018) note that individuals may seek out and select natural environments that are favorite places as a form of situation selection, and that they prefer to visit natural areas because they acknowledge that these are places that help them to “self regulate” (Hartig et al., 2007; Korpela et al., 2018; Korpela et al., 2001; Korpela, 2009; Roe et al., 2017). *Situation modification* refers to an alteration of a situation that changes its emotional impact (Gross, 2015). This family of strategies is relevant to nature exposure insofar as people often choose to move to nearby nature or seek to bring natural elements such as indoor plants into office buildings through biophilic design (Kellert, 2018).

Attentional deployment refers to the processes underlying allocation of an individual's attention and the repercussions that this has for emotions. It includes both distraction and rumination strategies (McRae & Gross, 2020). Emerging research has posited that some aspects of natural environments provide greater affordances for “positive distraction” away from the self, due to pleasant, novel, or other preferred characteristics they contain (Jiang et al., 2019; Nolen-Hoeksema et al., 2008; Roelofs et al., 2009). This distraction may provide affective benefits due to a shift in focus to positive, external elements of the environment and away from repetitive and negative self-referential thought, known as rumination (Aldao & Nolen-Hoeksema, 2010; Genet & Siemer, 2012;

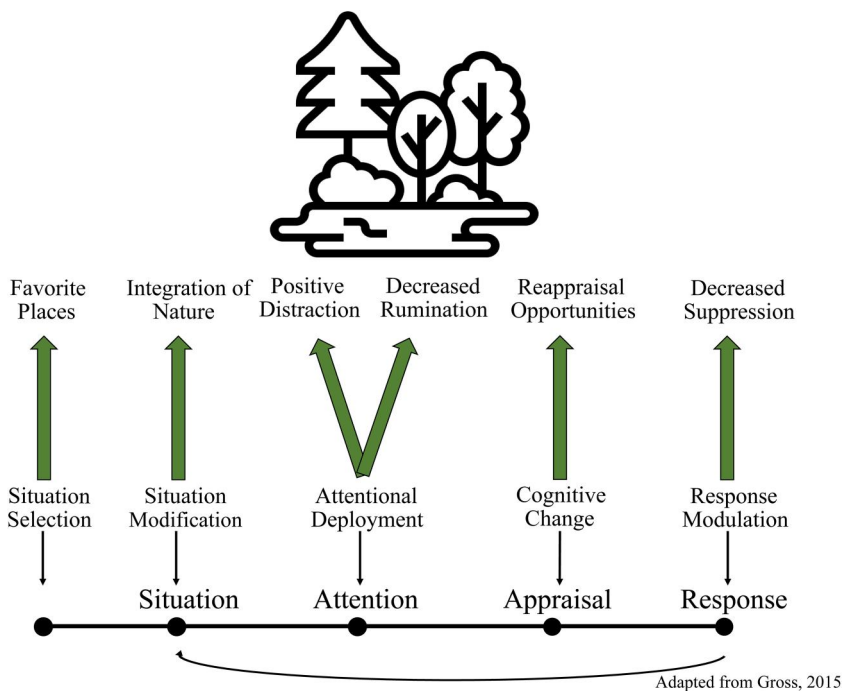


FIGURE 1 Nature contact and the process model of emotion regulation. We describe the ways in which these five family of strategies may be influenced by natural environmental factors, which in turn leads to affective benefits. Figure icon made by eucalypt from www.flaticon.com

Joormann & Gotlib, 2010; Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). In support of this, recent research has found that nature exposure may reduce a tendency to engage in this maladaptive form of attention allocation (Bratman, Daily, et al., 2015; Bratman, Hamilton, et al., 2015; Bratman et al., 2021; Lopes et al., 2020).

Cognitive change is a family of strategies that can up- or down-regulate emotions through the interpretation and framing of stimuli within a situation. It includes reappraisal through a reinterpretation of circumstances, or reevaluation of goals (McRae & Gross, 2020; Uusberg et al., 2019) and is typically considered an adaptive family of strategies insofar as it often results in positive emotional and affective outcomes (Gross, 1998a, 2015; Gross & John, 2003). Previous work in emotion regulation supports the notion that reappraisal is impacted by the environment (McRae et al., 2017). The potential for engagement in cognitive reappraisal can be influenced by the characteristics of a stimulus (Suri et al., 2018; Young & Suri, 2020), as well as the concurrent affective experiences and underlying levels of stress that are occurring at the time (Colombo et al., 2020; Raio et al., 2013)—factors that are relevant to specific stimuli or emotional states that accompany nature exposure. Specifically, affordances for reappraisal may be influenced through different associations one might have with people or objects one encounters in given environmental settings. For example, a person who seems upset as he approaches on a path might at first seem threatening, but in natural settings it may be easier to reappraise this stimulus, given the affordances and associations one has to people in nature (e.g., the person could be stressed by work and seeking relief in nature). Additionally, lowered tension or stress levels that occur with nature exposure can also allow for more successful reappraisal capability (Sheppes et al., 2011). And in support of the repeated use of nature exposure for reappraisal, environmental cues may influence “action readiness”—a tendency to engage in behavior that is primed or influenced by having previously engaged in it in similar contexts (Ghafur et al., 2018).

Last, *response modulation* refers to directly modifying aspects of an emotional response after it has begun (Gross, 2015). This family of strategies includes expressive suppression (i.e., the obstruction of noticeable signs of emotion; Richards & Gross, 2006). Individuals may choose natural environments as spaces in which they feel more able to express these previously inhibited responses, thereby decreasing chronic levels of suppression. For example, nature exposure can alter affordances for suppression through decreasing the probability of needing to suppress for social reasons (e.g., one can cry freely while in nature in a way one may not in a city). Additionally, the physiological relaxation that has been demonstrated to result from nature exposure is in line with effects from decreased suppression (Butler et al., 2003; Gross, 1998a).

3.4 | Other pathways

Attention Restoration Theory (Kaplan & Kaplan, 1989) rests upon an understanding of directed attention as a resource that can be depleted, and then replenished, through the engagement of “soft fascination” during nature contact (Basu et al., 2019; Berto, 2005; Kaplan, 1995; Ohly et al., 2016; Schertz & Berman, 2019). A separate but related notion, known as the Perceptual Fluency Account (Joye et al., 2016; Joye & van den Berg, 2011), posits a bottom-up pathway—one in which the perceptual properties of components within natural environments are more easily processed by the human visual system. The results of these restorative processes on cognitive functioning are beyond the scope of this paper, but it is important to note that these theories do posit that affective consequences may stem from directed attention replenishment or a decrease in cognitive load that results from low-level feature processing (Kardan, Demiralp, et al., 2015; Schertz et al., 2018; Ulrich et al., 1991). Some have found support that mid- to high-spatial frequencies of nature scenes may be tied specifically to affective responses (Valtchanov & Ellard, 2015), while others have found that low-level properties alone are less consistently associated with mood (Menzel & Reese, 2021).

Many of the causal mechanisms and associated affective outcomes described above focus predominantly on the visual pathway. However, it is important to consider other sensory stimuli as well, including the benefits of multi-modal experiences (Annerstedt et al., 2013; Franco et al., 2017; Hedblom et al., 2019). Natural sounds have

been shown to be preferred over urban sounds (De Coensel et al., 2011; Irvine et al., 2009), contribute to mood recovery after a stressor (Benfield et al., 2014), and reduce anxiety and stress (Aghaie et al., 2014; Buxton et al., 2021; Jo et al., 2019), sometimes even independent of the visual pathway (Hedblom et al., 2019). The affective impacts of sounds and smells may operate through psychophysiological pathways that involve stress reduction (Alvarsson et al., 2010; Francis et al., 2017; Weber & Heuberger, 2008) or the triggering of memories or attachment to place that can have affective consequences (Ehrlichman & Halpern, 1988; Franco et al., 2017; Ratcliffe et al., 2013, 2016; Schloss et al., 2015).

There are other potential affective mechanisms specific to these sensory modalities as well, including potential bottom-up pathways that bypass awareness. In support of this, research in *shinrin-yoku* (known in North America as “forest bathing”) from East Asia has demonstrated the ways in which inhalation of a specific class of volatile organic compounds (i.e., terpenes) from forest species may act directly on our limbic and inflammatory systems in ways that have affective consequences (Cho et al., 2017; Li et al., 2016; Rufino et al., 2014; Wen et al., 2019).

4 | MODERATORS AND EFFECT MODIFIERS

It is crucial to consider the ways in which nature exposure impacts different people differently (Bratman et al., 2019). Effect modifiers exist at the individual level (e.g., how a person reacts to and interacts with an environment) (Kahn et al., 2010; Kahn & Weiss, 2017; White et al., 2020), and sociocultural factors can impact the characteristics of nature experience as well (e.g., experiencing discrimination within urban greenspace) (Roberts, 2021). We have described above the manner in which lived experience, memory, and familiarity interacts with preference, perceived restorativeness, sense of place and connection to nature at the individual level in ways that may moderate the affective impacts of nature exposure. Personality, age, gender, race/ethnicity, and other additional, relevant factors are important to consider here as well—both with respect to the moderation of affective effects themselves, as well as the way in which these factors are associated with access to nature and the amount of exposure (and subsequent familiarity) that is available.

Emerging work supports the notion that personality may moderate the effects of nature contact (Astell-Burt & Feng, 2020). In cross-sectional work, Ambrey & Cartlidge (2017) found evidence that lower levels of neuroticism were associated with increased psychological well-being when living in proximity to greenspace. These approaches are not able to measure actual nature exposure, however (Ekkel & de Vries, 2017; Jarvis, Gergel, et al., 2020), and differences in association could be due to a relatively greater tendency for individuals with lower levels of neuroticism or other personality characteristics to venture outside and come into more frequent contact with nearby greenspace (Ambrey & Cartlidge, 2017; Matz & Harari, 2020), instead of an effect modification of nature contact that is tied to this facet of personality. In innovative neuroimaging work, Tost et al. (2019) found that the individuals who benefited most from greenspace contact had reduced prefrontal regulatory capacity, a characteristic that correlates with trait anxiety (Pezawas et al., 2005). These findings support the notion that nature contact addressed the disadvantage that was most pronounced for these highly anxious individuals, acting as an additional “external” emotion regulation resource for the people who needed it most.

Age and gender have been found to moderate associations of well-being with residential proximity to nature at the city and regional level (Astell-Burt, Mitchell, & Hartig, 2014; Jarvis, Koehoorn, et al., 2020; Lee & Lee, 2019). These differences may be due to differences in individual-level physiological and affective reactivity to the natural environments that covary with age and gender (Bangasser et al., 2019; Beil & Hanes, 2013), or they may be due to differences in access and feelings of safety that influence total amount of exposure to this nearby nature (Richardson & Mitchell, 2010; Roe et al., 2017; Wright Wendel et al., 2012). Race/ethnicity and socioeconomic status are also critical factors to consider—effects of which may vary depending on specific sociocultural and demographic contexts—as they may be associated with preference for varying types of nature and recreation activities (Buijs et al., 2009; Gentin, 2011). With respect to amount of nature exposure, substantial inequities in

nature access exist for under-resourced and socially disadvantaged communities (Astell-Burt, Feng, et al., 2014; Dahmann et al., 2010; Jarvis, Gergel, et al., 2020; Li et al., 2016; Rigolon, 2016; Rigolon et al., 2018; Schwarz et al., 2015; Wüstemann et al., 2017). Some cross-sectional work suggests that nature exposure may result in greater mental health benefits for lower-income versus higher-income populations (Garrett et al., 2019; McEachan et al., 2016; Mitchell et al., 2015). Questions about psychological mechanism remain here as well, however, as most of these findings are confined to cross-sectional studies of regional and population-level effect modifications (Browning & Rigolon, 2018), and may be due to different amounts of nature exposure versus moderation of affective effects on the individual level.

5 | FUTURE DIRECTIONS

A great deal of research on the relationship between nature exposure and affect remains to be done. This includes future investigations into affective impacts and causal mechanisms, moderators and effect modifiers, and practical applications. We broadly lay out proposed approaches for these directions below.

5.1 | Clarifying affective impacts and causal mechanisms

Detailed knowledge is needed on the temporal characteristics of the affective impacts of nature exposure, and the dynamic ways in which multiple mechanisms interact through time. This spatio-temporal understanding will provide insight into the inter-related affective, regulatory, and relevant cognitive processes that take place in response to nature contact. For example, future investigations can determine whether pre-cognitive, positive affective responses precede subsequent processes related to stress reduction. They could also illuminate the interplay between affective states and regulation, capturing the feedback loops and continuous cycles between momentary emotion and regulation strategy (Colombo et al., 2020).

Progress on this front hinges on the increased utilization of methodologies that capture real-time reactions to the environment, as well as detailed information on the characteristics of the environment itself. This will allow for researchers to assess detailed, momentary changes in affect that come from exposure to specific environmental factors. To measure individuals' reactions in real-time, ecological momentary assessment surveys can be administered via smartphones, along with mobile psychophysiology, electroencephalography (mobile EEG) (Chen et al., 2020; Neale et al., 2017, 2020), and functional near-infrared spectroscopy (fNIRS) equipment to monitor real-time changes in body and brain activity as they relate to changes in environmental exposure. To more specifically measure the characteristics of the environment, utilization of tools such as Street View software (Liu et al., 2020) and sophisticated satellite data can provide high-resolution imagery of natural structure. All of these approaches can then be integrated together, along with global positioning systems (GPS), to provide granular information about affective processes as they change in conjunction with exposure to specific environmental factors (Cameron et al., 2020; Kondo et al., 2020; Reichert et al., 2020; Tost et al., 2019).

With respect to affect regulation, utilizing these approaches will allow for future experimental designs that provide ecologically valid insight into specific reasons and motivations for situation selection, aspects of the environment that capture attention (e.g., through use of mobile eye-tracking technology), and components of reappraisal and reevaluation that occur more significantly in certain environmental contexts. In addition to outdoor environments, real-time assessments can take place in laboratory settings, using virtual reality or indoor natural elements as an exposure, and continuous psychophysiological, neuroimaging, and self-report measures (e.g., affect rating dials). These conditions allow for controlled experiments that tease apart the "active ingredients" of sensory stimuli. Moving forward, there is great promise for insights that can come from closely coordinating different types of lab and field studies for these purposes (Reichert et al., 2020), as well as expanding to include qualitative and

ethnographic work to better understand perspectives outside of those typically captured within Western psychology.

5.2 | Elucidating moderators and effect modifiers

Future work should also seek to further understand moderators and effect modifications at the individual and population level. This includes investigations into the relevance of individual differences such as connectedness to nature, familiarity with environments, personality, and other characteristics. It also includes factors affecting nature experiences among marginalized populations due to exclusionary histories and practices in these spaces (Finney, 2014). It is critical to document and address the racism, discrimination, and lack of safety that individuals experience within urban greenspace and natural areas (Byrne, 2012; Hoover & Lim, 2020; Roberts, 2021), and the negative associations with these spaces that exist for some Black Americans due to collective memories of traumatic events and acts of violence against past generations that have occurred in similar environments (Johnson & Bowker, 2004; Johnson et al., 1997). Also crucially important for this field will be an integration of the deep understandings that come from the interactions and relationships of Indigenous peoples with nature (Díaz et al., 2015; Hatala et al., 2019; Hill et al., 2020). These traditional and cultural practices embody fundamentally different ways of knowing and relating with the natural world than the more use-based perspective embodied in most of the research contained in this paper (Chan et al., 2012; Díaz et al., 2018; Gould et al., 2015; Hill et al., 2020; Ives et al., 2017; Sangha et al., 2018; Varanasi, 2020).

5.3 | Practical applications

Effective interventions at the individual and population levels are most informed when they account for the multiple environmental exposures that interact in direct and indirect ways to impact psychological well-being (Kabisch et al., 2017; Olvera-Alvarez, Appleton, et al., 2018; van den Bosch & Ode, 2017; van den Bosch & Meyer-Lindenberg, 2019). At the individual level, knowledge about the affective benefits of nature exposure can inform complementary strategies that accompany clinical therapies for conditions such as depression or PTSD (Gelkopf et al., 2013; Gonzalez et al., 2010; Poulsen et al., 2015; Roberts et al., 2019), individuals with limited mobility (e.g., nursing home residents) (Dahlkvist et al., 2016), or others who experience high levels of stress and risk in their daily lives and occupations. A “dose-response” perspective in these contexts will be most effective if it incorporates important details about the individuals (Hunter et al., 2019; Neill et al., 2018; Shanahan et al., 2016). For example, recent work has shown that explicit instructions given through “green prescriptions” and other avenues of social pressure to visit greenspace may be counterproductive for those with anxiety or depressive disorders, if they perceive their time in nature as being due to social pressure (Tester-Jones et al., 2020).

At the population level, urban planning and decision-making can take green infrastructure and natural elements into account when considering the equitable impacts of the built environment on health (Hendricks & Van Zandt, 2021; Jennings et al., 2017; Kardan, Gozdyra, et al., 2015), and the barriers that exist for nature access. Attention should be paid to local contexts with these considerations, including the lower quality of the natural spaces that can occur in underprivileged neighborhoods (Wolch et al., 2014) and the fewer benefits that therefore may be experienced in them (Wyles et al., 2019). This knowledge can inform policy-level interventions through urban planning that focuses on provision and access to urban greenspaces as critical infrastructure (Hendricks & Van Zandt, 2021), and include community input on the planning level as well (Carmichael & McDonough, 2019).

In these and other ways, public health efforts can be informed by knowledge of the ways in which nature exposure within urban environments helps to counteract the negative impacts of other environmental exposures, such as air pollution (Olvera-Alvarez, Kubzansky, et al., 2018). As the body of empirical evidence grows, it can be

integrated into predictive models of psychological well-being that account for the repercussions of landscape change on affect, and consider how these impacts differ across populations and environmental contexts.

6 | CONCLUDING REMARKS

Mechanisms underlying affective benefits from nature experience occur through unconscious and lower-level, bottom-up processes; top-down emotion regulation pathways; and conscious and deliberate appraisals of preference and attachment. Impacts range from the direct, pre-cognitive effects of the environment on affect, to the ways in which thoughts and emotions are experienced and regulated differently, depending on cues and characteristics of environmental context. Integrating the use of multiple methods to measure change in real time—from qualitative interviews to self-report measures to psychophysiological and neuroimmunological assessments—will provide much-needed understanding across all of these domains as the research continues to evolve. This includes increased comprehension of specific affective benefits, the extent to which experiences and preferences for nature differ across the lifespan, and how different people experience different types of nature differently. This knowledge can be employed in practical ways to contribute to the psychological well-being and mental health of people around the globe, as many aspects of their environments rapidly change around them.

ACKNOWLEDGMENTS

Gregory N. Bratman appreciates support from the Doug Walker Endowed Professorship, Craig McKibben and Sarah Merner, John Miller, and discussions with members of the UW Nature and Health group, as well as the Environment and Well-Being Lab. Preparation of this manuscript was supported by grants from the JPB Environmental Health Fellowship (to Gregory N. Bratman and Hector A. Olvera-Alvarez).

CONFLICT OF INTEREST

None.

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How to cite this article: Bratman, G. N., Olvera-Alvarez, H. A., & Gross, J. J. (2021). The affective benefits of nature exposure. *Social and Personality Psychology Compass*, 15(8), e12630. <https://doi.org/10.1111/spc3.12630>