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Nature Nurtures Authenticity: Mechanisms and Consequences

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Contact with nature may benefit, not only the bodily organism, but also the psychological self. We proposed that, assuming humans' innate affinity for nature (the biophilia hypothesis), nature would be conducive to a sense of environment-self fit, which would be experienced as authenticity (being aligned with one's true self). We formulated several hypotheses: (a) nature fosters authenticity, and it does so through at least four plausible mechanisms: self-esteem, basic needs satisfaction (autonomy, competence, relatedness), mindfulness, and positive affect; (b) self-esteem is the strongest mechanism overall, and autonomy is the strongest mechanism of the three basic needs; (c) self-esteem and authenticity mediate sequentially the positive impact of nature on current psychological well-being (higher life satisfaction and meaning in life); and (d) authenticity mediates the positive influence of nature on longer term psychological well-being (higher life satisfaction and meaning in life, lower depression, anxiety, and stress). We obtained support for these hypotheses across 12 studies ($N = 5,512$). These were diverse in terms of setting (field, laboratory), design (cross-sectional, experimental, longitudinal), methodology (varying manipulations of nature and assessment of mediators and/or dependent measures), and sampling (university/community, East Asian/Western). The findings establish nature as a correlate and determinant of authenticity, chiefly via the mechanism of self-esteem, and further establish authenticity (preceded by self-esteem) as a mediator of the positive influence of nature on psychological well-being. The findings are also generative and have policy implications.

Keywords: nature, authenticity, autonomy need satisfaction, self-esteem, psychological well-being

The moon is bright and quiet flows the creek,
The rain stopped and the bamboos look fresh.
Whereby I feel like my true self,
Sitting peacefully and relaxingly.

—Yuyi Chen, Chinese poet (1090–1138)

We often forget that we are nature. Nature is not something separate from us. So when we say that we have lost our connection to nature, we've lost our connection to ourselves.

—Andy Goldsworthy (b 1956), English sculptor,
photographer, and environmentalist

Nature, as Yuyi Chen and Andy Goldsworthy contended, fosters a sense of connection with one's true self, namely, authenticity. Here, we tested this contention. We also asked how nature might increase authenticity and what the downstream consequences of this effect are.

Nature and Authenticity

Definition of Nature

Nature encompasses:

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)

For the purposes of our research, we further qualify this definition as follows. Nature primarily refers to nonthreatening natural settings subject to human management (e.g., urban parks; Baxter & Pelletier, 2019; Maller et al., 2008), immersion in or exposure to such settings, and activities such as plant cultivation (Tam, 2013; Zylstra et al., 2014).

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Ying Yang played a lead role in methodology, investigation, formal analysis, and writing—original draft and an equal role in conceptualization,

data curation, project administration, and resources. Constantine Sedikides played a lead role in writing—review and editing and an equal role in conceptualization and methodology. Yuqi Wang played an equal role in formal analysis and methodology. Huajian Cai played a lead role in conceptualization, data curation, project administration, funding acquisition, and supervision, an equal role in methodology, formal analysis, and writing—original draft, and a supporting role in writing—review and editing.

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Definition of Authenticity

A humanistic tradition, capitalizing on such constructs as self-actualization (Maslow, 1971) and the fully functioning person (Rogers, 1961), considers authenticity a disposition toward behavior congruent with the self or as "... the reduction of phoniness toward the zero point" (Maslow, 1971, p. 183). In particular, authenticity has been defined as "the unobstructed operation of one's true self in one's daily enterprise" (Goldman & Kernis, 2002, p. 293). It is thought to comprise four facets (Kernis & Goldman, 2006): (a) awareness of one's motives, feelings, and beliefs, even if contradictory; (b) unbiased processing of unfavorable information about the self; (c) behavior in accord with one's values, preferences, and needs rather than others' expectations; and (d) relational orientation toward openness and trustfulness. These facets are assessed by the Authenticity Inventory (Kernis & Goldman, 2006).

The authentic personality model condenses the above four facets into three, emphasizing the first and third facets (A. M. Wood et al., 2008). In particular, the model conceptualizes authenticity in terms of (a) authentic living (acting in alignment with one's beliefs, preferences, values, or goals), (b) low acceptance of external influence (resisting conformity to others' expectations), and (c) low self-alienation (maintaining one's true self in part by rejecting external influence). These three facets are assessed by the Authenticity Scale (A. M. Wood et al., 2008).

The above two definitions were born out of a personality trait tradition. Authenticity, though, can also be conceived at the state level, defined as a sense of alignment with one's true self or as feeling that one is currently their real, essential self (Lenton, Bruder, et al., 2013). The emphasis on felt authenticity reflects recent empirical advances (S. Chen, 2019; Landa & English, 2022; Rivera et al., 2019; Schmader & Sedikides, 2018; Sedikides et al., 2017; Vess et al., 2019). For example, authenticity is frequent in daily life, and more frequent than inauthenticity (Huber et al., 2022).

On the Relation Between Nature and Authenticity

Goffman (1949) distinguished between the front-stage and the back-stage self. The front-stage self is aware of being perceived and evaluated by others. As such, it is often constrained or inhibited, and can be performative or chameleon like. In contrast, the back-stage self is away from the public eye, is relatively free of obligation, and is unencumbered or unfiltered. The front-stage versus back-stage self-metaphor has been used in descriptions of inauthenticity and authenticity, respectively (Lehman et al., 2019; Schlegel et al., 2011).

We propose that nature reinforces the back-stage self. According to the state authenticity as fit to environment model (Schmader & Sedikides, 2018), people are attracted to and remain in spaces where they experience fit between the environment and the self. Fit is felt as authenticity. In all, nature affords satisfactory fit. But why would nature do so? According to the biophilia hypothesis, humans share an innate affinity with nature (Kellert & Wilson, 1995; Ulrich, 1993; Ulrich et al., 1991; Wilson, 1984). This affinity is due to the evolutionary adaptation to green, savanna-like environments that provided refuge, water resources, and cues for sustenance and safety (Falk & Balling, 2010; Lohr, 2007; Orians & Heerwagen, 1992). Natural environments contain esthetic characteristics (e.g., coherence, surface texture, depth, density) that are preferred by humans

both psychologically (entailing optimal arousal) and functionally (being suitable for survival; Falk & Balling, 2010; Grahn & Stigsdotter, 2010; B. Jiang et al., 2015; Ulrich, 1977). People even have anthropocentric biases in their nature-related teleological thinking, endorsing such statements as "Trees produce oxygen so that humans can breathe" (Preston & Shin, 2021). Of course, socialization is also relevant, as preference for nature is modulated by familiarity with natural environments (Hartmann & Apaolaza-Ibanez, 2010; Meidenbauer et al., 2019).

Suggestive evidence for nature-person fit is provided by qualitative research. For example, individuals exposed to nature (e.g., through walks in the woods) report that nature brought them closer to their inner world, emotions, or essence, and enabled them to be themselves (Meuwese et al., 2021; Revell & McCloud, 2017; Sonntag-Öström et al., 2015). Consequently, we hypothesize that nature is associated with, or fosters, authenticity.

How Is Nature Related to Authenticity?

But how might nature foster authenticity? We discuss four plausible mechanisms: basic psychological needs, positive affect, self-esteem, and mindfulness. We also adopt a regulatory perspective on nature exposure (Bratman, Daily, et al., 2015; Korpela et al., 2020; Richardson, 2019). In particular, we argue that nature influences authenticity by regulating basic psychological needs, positive affect, self-esteem, and mindfulness. The mechanisms are congruent with three theoretical formulations derived from the biophilia hypothesis. First, according to attention restoration theory (R. Kaplan & Kaplan, 1989), the brain's capacity to focus on a specific task or stimulus is limited, resulting in concentration fatigue; nature (vs. urban) exposure restores concentration. Second, according to stress recovery theory (Ulrich et al., 1991), nature (vs. urban) exposure alleviates stress. Third, according to the perceptual fluency account (Joye & van den Berg, 2011), attention restoration and stress reduction are by-products of the ease of processing of natural stimuli. Taken together, these formulations posit that nonthreatening natural environments can repair or invigorate cognitive and psychological functioning.

Benefits of Nature

Exposure to nature or involvement with nature is likely associated with a perceptually conveyed and assimilated sense of freedom. Natural (compared to urban) environments have more degrees of freedom or Gibsonian affordances of possible avenues of movement (Gibson, 1979). In feeling freer, one feels more self-determined. Indeed, exposure to nature or involvement with nature facilitates the basic psychological needs postulated by self-determination theory (R. M. Ryan & Deci, 2017). These needs are autonomy (i.e., self-determined action), competence (i.e., effectiveness and mastery), and relatedness (i.e., social connection; Landon et al., 2021; Quested et al., 2018; Yang et al., 2022). For example, in a series of experiments, participants recalled an experience of ostracism (vs. inclusion) or experienced ostracism (vs. inclusion). Subsequently, they were presented with photographs of natural versus urban landscapes. Participants who viewed nature scenes reported greater need satisfaction than those who viewed urban scenes (Yang et al., 2021). Stated otherwise, exposure to nature safeguarded need satisfaction (cf. S. Kaplan, 1995).

Exposure to nature or involvement with it may also be linked to, or raise, positive affect. As mentioned above (i.e., biophilia hypothesis; Ulrich et al., 1991; Wilson, 1984), the evolutionarily derived affinity with nature conduces to safety (Lohr, 2007; Orians & Heerwagen, 1992) and esthetic pleasantness (Falk & Balling, 2010; Ulrich, 1977). Further, fluent processing of natural stimuli is likely to engender positive affect, as per the perceptual fluency account (Joye & van den Berg, 2011). Indeed, exposure to nature increases positive affect (and decreases negative affect) compared to control conditions (for a meta-analysis, see McMahan & Estes, 2015). Also, exposure to nature restores positive affect: Ostracized participants reported higher positive affect than nonostracized participants after nature exposure (Yang et al., 2021; cf. S. Kaplan, 1995). In addition, nature connectedness, a trait-like construct capturing individual differences in the sense of being bonded with nature, is associated with positive affect (Capaldi et al., 2014).

Moreover, exposure to nature or involvement with it may be related to, or increase, self-esteem. Nature is nonjudgmental and nonevaluative; indeed, spending time in nature is associated with a reduction in public self-awareness (Mayer et al., 2009). As such, exposure to nature may allow the individual to bring to the fore positive aspects of the self or feel good about themselves. Qualitative work has indeed linked nature involvement to higher self-esteem (Oh et al., 2020), and nature connectedness is positively related to self-esteem (Di Fabio et al., 2019). Also, engagement with nature (i.e., allotment gardening) is associated with higher body esteem (Swami et al., 2019, 2020), an effect mediated by nature connectedness (Swami et al., 2016, 2020). Moreover, exposure to nature contributes to self-esteem restoration following ostracism (Yang et al., 2021; cf. S. Kaplan, 1995).

A fourth benefit is mindfulness, the intentional and nonjudgmental awareness of the present (Kabat-Zinn, 2003). Natural environments, by being calming and varied, may invite full absorption and engagement. Qualitative work has associated nature with higher mindfulness (Brymer et al., 2021; Macaulay et al., 2022), and correlational research has demonstrated a positive link between nature connectedness and mindfulness (Schutte & Malouff, 2018; Tohme & Joseph, 2020). Further, engagement with nature increases mindfulness. For example, participants who spent at least 30 min a day in nature for 30 days reported greater mindfulness compared to those who were on a waiting list (Hamann & Ivztan, 2016; see also Bratman, Hamilton, et al., 2015; Lopes et al., 2020). Last, a qualitative investigation suggested that nature might contribute to healing from a traumatic experience through mindfulness (Moore & Van Vliet, 2022; cf. S. Kaplan, 1995).

Correlates of Authenticity

The benefits of nature involvement are also correlates of authenticity. To begin, basic need satisfaction is associated with authenticity (Lenton, Bruder, et al., 2013; Thomaes et al., 2017; Wickham et al., 2018) across cultures (i.e., China, India, Singapore, United States; Slabu et al., 2014) and in daily reports (Heppner et al., 2008). Satisfaction of all three needs facilitates goal internalization, which is presumably a precondition for authenticity (Sheldon & Elliot, 1998).

Moreover, increased positive affect or decreased negative effect is linked with authenticity (Goldman & Kernis, 2002; Lenton, Bruder, et al., 2013; Lenton et al., 2016; Rivera et al., 2019; Stephan et al., 2012; A. M. Wood et al., 2008) across cultures (i.e., China, India,

Singapore, United States; Slabu et al., 2014) and in daily life (Heppner et al., 2008). In an experience sampling study, participants completed eight surveys per day for 1 week. Positive affect predicted authenticity, and participants felt more authentic in situations that they characterized as more pleasant (Cooper et al., 2018). In other experience sampling studies, higher positive (and lower negative) affect predicted authenticity (Fleeson & Wilt, 2010). Finally, in experiments, positive (vs. negative or neutral) affect increased authenticity (Lenton, Slabu, et al., 2013). True-self (compared to false-self) situations entail a more positive emotional atmosphere (Rice & Pasupathi, 2010; Turner & Billings, 1991).

Self-esteem is associated with higher authenticity (Goldman & Kernis, 2002; Lenton, Bruder, et al., 2013; Lenton et al., 2016; Rivera et al., 2019; A. M. Wood et al., 2008) across cultures (i.e., China, India, Japan, Singapore, United States; Ito & Kodama, 2007; Slabu et al., 2014). In addition, self-esteem is positively related to authenticity in daily reports (Heppner et al., 2008). Last, various proxies for self-esteem are positively linked to authenticity. For example, behavioral positivity (Jongman-Sereno & Leary, 2016; Smallenbroek et al., 2017) and self-appraisals on positive or socially desirable traits (i.e., agreeable, conscientious, emotionally stable, extraverted, open; Fleeson & Wilt, 2010; Sheldon et al., 1997) predict authenticity. Acceptance and approval are characteristics of authentic-self situations (Turner & Billings, 1991).

Relaxation and flow (Lenton, Bruder, et al., 2013; Lenton et al., 2016) have been linked with authenticity, whereas daydreaming and mind-wandering have been lined with inauthenticity (Vess et al., 2016, 2019; H. Williams & Vess, 2016). More directly relevant, mindfulness is positively related to authenticity (Allan et al., 2015; Bayır-Toper et al., 2022; Kernis & Goldman, 2006; Lakey et al., 2008; Leroy et al., 2013; Tsur et al., 2016) and practicing mindfulness raises authenticity (Leroy et al., 2013; Nübold et al., 2020; Ye et al., 2019). Low evaluation apprehension or anxiety is considered characteristics of real-self situations (Harter, 2002).

Hypotheses

We discussed nature-derived benefits, and showed that these benefits also reflect correlates of authenticity. On the basis of the literature, we inferred that basic psychological needs, positive affect, self-esteem, and mindfulness are plausible mechanisms through which nature influences authenticity. We hypothesized that these four variables will mediate the effect (correlational or causal) of nature on authenticity.

We derived two more nuanced hypotheses. The first one concerned the relative strength of the three basic needs to act as mediators of the relation between nature and authenticity. We hypothesized that autonomy would be the most potent mediator. As stated previously, natural environments often entail a sense of freedom, which is key constituent of autonomy. In addition, literature links autonomy (more strongly than relatedness or competence) to authenticity. In fact, classic treatises of authenticity deemphasize the role of relatedness and are even adversarial to it (Kernis & Goldman, 2006; Maslow, 1968; Rogers, 1961), arguing that the authentic person resists social influence and has the courage to stand against others or societal institutions (Kierkegaard, 1844/2014; May, 1953; Sartre, 1946/1989). According to cognitive evaluation theory (R. M. Ryan & Deci, 2000), satisfaction of the needs for autonomy and competence, but not relatedness, should predict authenticity. Also, despite correlational evidence of an association between relatedness need

satisfaction and authenticity (Lenton, Bruder, et al., 2013), evidence for a causal effect of relatedness need satisfaction on authenticity is lacking (Thomaes et al., 2017, Study 3), as is evidence for a causal effect of competence need satisfaction on authenticity (Thomaes et al., 2017, Study 3). Further, recent theorizing and findings point to the role of autonomy need satisfaction in authenticity (W. S. Ryan & Ryan, 2019). As a case in point, promotion focus is positively associated with authenticity (Kim et al., 2019). Promotion focus is a self-regulatory orientation that fulfills the need for growth (Higgins, 1998), and is closely linked to autonomy (Komissarouk & Nadler, 2014). Importantly, experimentally satisfying the need for autonomy increases authenticity (Thomaes et al., 2017, Study 3).

The second hypothesis concerned the relative strength of the four putative mediators (i.e., self-esteem, autonomy need satisfaction, mindfulness, positive affect). We hypothesized that self-esteem would be the most potent mediator. Self-esteem is consequential in many domains of life (e.g., personal goals, school work, mental and physical health, antisocial behavior; Gebauer et al., 2015; Heimpel et al., 2006; Orth & Robins, 2022; Sedikides & Gregg, 2003; Swann et al., 2007). As argued in a prior section, the nonjudgmental or nonevaluative character of nature likely conduces to or increases self-esteem. To the contrary, the demands of urban environments, labeled “technique” (i.e., focusing on efficiency, pressure, and deindividuation; Ellul, 1964) or “self-alienation” (e.g., lacking ownership of valued goods and services produced by the self; Marx, 1964), are likely associated with lower self-esteem or decrease self-esteem. Indeed, self-esteem has emerged as an influential antecedent of authenticity (Goldman & Kernis, 2002; Ito & Kodama, 2007; Sedikides et al., 2017, 2019). Adults construe the good and moral self as authentic (Newman et al., 2014; Schlegel et al., 2009; Strohminger et al., 2017), and children believe that their positive traits reflect their authentic selves more so than their negative traits (Harter, 2002). Also, self-positivity, in the form of being self-compassionate (H. Zhang et al., 2019), upholding personal values (Smallenbroek et al., 2017), or behaving morally (Christy et al., 2016) raises authenticity. Similarly, self-enhancement, that is, receiving favorable (vs. unfavorable) feedback on personally important attributes, or imagining a future occasion in which one would manifest much higher (vs. much lower) caring, understanding, or kindness than they had now, raises authenticity (Guenther et al., 2023).

Nature, Authenticity, and Psychological Well-Being

We wondered additionally about the downstream consequences of nature-related or nature-induced authenticity. According to several theoretical formulations, nature involvement is related to, or increases, psychological well-being (PWB). These formulations, derived from the biophilia hypothesis, emphasize effective coping or decreased stress (Bratman et al., 2012; Evans & Cohen, 1987; Korpela et al., 2018). In line with this theorizing, we defined PWB both as advancing positive outcomes (operationalized in terms of life satisfaction and meaning in life) and buffering against harm (operationalized in terms of depression, anxiety, and stress). Nature involvement is indeed related to PWB, including higher life satisfaction (Capaldi et al., 2014; Mayer & Frantz, 2004; Tam, 2013; Yang et al., 2022) and meaning in life (Di Fabio et al., 2019; Nisbet & Zelenski, 2013; Passmore & Holder, 2017; Pensini et al., 2016; Yang et al., 2022), as well as lower depression (Beute & de Kort, 2018; Jakstis & Fischer, 2021; Tran et al., 2022; Turunen et al.,

2023), anxiety (Braçe et al., 2020; Farrow & Washburn, 2019; Gascon et al., 2018; Turunen et al., 2023), and stress (Bakir-Demir et al., 2021; Cindrich et al., 2021; Mintz et al., 2021). We expected to replicate these findings.

The literature has established that authenticity is also related to PWB, including higher life satisfaction (Chew & Ang, 2023; Goldman & Kernis, 2002; Kifer et al., 2013; Riggle et al., 2017; Thomaes et al., 2017) and meaning in life (Rivera et al., 2019; Schlegel et al., 2009, 2011), as well as lower depression (Bryan et al., 2017; Riggle et al., 2017; Thomaes et al., 2017), anxiety (Asher & Aderka, 2021; Bryan et al., 2017; Thomaes et al., 2017), and stress (Grieve & Watkinson, 2016; Riggle et al., 2017; A. M. Wood et al., 2008). We expected to replicate these findings. More important, we hypothesized that authenticity—preceded by self-esteem or alone—would transmit the (correlational or causal) effect of nature on PWB.

Overview

We hypothesized that nature involvement fosters authenticity, and plausibly does so through at least four independent mechanisms: basic psychological needs, positive affect, self-esteem, and mindfulness. We further hypothesized that autonomy is the most impactful mechanism among basic psychological needs, and that self-esteem is the most impactful mechanism among them all. Finally, we hypothesized that authenticity mediates the relation between nature and PWB.

We tested these hypotheses in 12 studies. They were diverse in terms of methodology (e.g., differing manipulations of nature and assessment of putative mediators or dependent measures), participants (mostly university students but also community members), and cultures (mostly East Asian [i.e., Chinese] but also Western). In Studies 1–2, we examined the cross-sectional link between nature involvement and authenticity. In Studies 3–6, we tested experimentally whether nature involvement augments authenticity via, respectively, basic need (especially autonomy) satisfaction, positive affect, self-esteem, and mindfulness. In Study 7, we tested: whether nature connectedness positively predicts autonomy satisfaction, positive affect, mindfulness, self-esteem, and authenticity; whether the association between nature connectedness and authenticity is independently mediated by those four variables; and whether self-esteem is the most powerful mediator. In Studies 8–9, we examined whether the Study 7 findings were replicated experimentally. In Study 10, we tested directly the mediational character of self-esteem. Following the logic of the experimental-causal-chain approach (Spencer et al., 2005), we manipulated self-esteem and measured authenticity. In Study 11, we examined the impact of nature, via self-esteem and authenticity, on current PWB (life satisfaction, meaning in life). Finally, in Study 12, we examined the downstream consequences of nature-induced authenticity for PWB (life satisfaction, meaning in life, depression, anxiety, stress).

We tested community members in Studies 1–2, and 9–11, and undergraduate students in the rest of them. Further, we tested Chinese participants in all studies but Study 9, where we tested Western participants. Across studies, participants learned that they were taking part in research on “environmental perception.” When a scale was unavailable in Chinese, we first translated it by committee (Brislin, 1980), and then followed translation and back-translation procedures.

All studies were approved by the institutional review board of the first author’s institution. We report how we determined our sample size, all manipulations, and all measures (no data exclusions), and we follow

Journal Article Reporting Standards (Kazak, 2018). Supplemental materials, data, and analysis code for all studies are available on the Open Science Framework (<https://osf.io/2wnfx/>), and the research protocol in supplemental materials. We preregistered four of the 12 studies: Study 3 (<https://osf.io/wvk4a/>), Study 9 (<https://osf.io/2gbd6/>), Study 10 (<https://osf.io/wtgk7/>), and Study 11 (<https://osf.io/4b687/>).

Study 1: Correlational Evidence for the Relation Between Nature and Authenticity

In online cross-sectional Study 1, we conducted a preliminary test of the hypothesis that nature is beneficial for authenticity. The hypothesis anticipates that greater nature involvement is associated with higher trait authenticity. We operationalized nature involvement as both nature connectedness and engagement in nature-related activity (i.e., cultivating indoor plants).

Participants

We opportunistically recruited 1,179 participants (694 women, 485 men) from Wenjuanxing, a popular Chinese online platform similar to Qualtrics.¹ Their ages ranged from 18 to 66 years ($M = 33.96$, $SD = 9.20$; 22 participants did not report age). We remunerated each with 2 Yuan ($\approx \$0.30$).

Measures

We assessed nature connectedness with the 14-item Connectedness to Nature Scale (Mayer & Frantz, 2004; for the Chinese version, see Geng et al., 2015). A sample item is “I often feel a sense of oneness with the natural world around me” (1 = *strongly disagree*, 7 = *strongly agree*; $M = 4.77$, $SD = .85$, $\alpha = .82$). We assessed engagement in nature-related activity by asking participants whether they cultivated indoor plants (yes vs. no). Next, we assessed authenticity with the 12-item Authenticity Scale (A. M. Wood et al., 2008; for the Chinese version, see Slabu et al., 2014). A sample item is “I am true to myself in most situations” (1 = *does not describe me at all*, 7 = *describes me very well*; $M = 4.43$, $SD = .91$, $\alpha = .84$). Finally (here and in all studies), participants responded to demographic questions.²

Results and Discussion

Nature connectedness was positively related to authenticity, $r(1179) = .32$, $p < .001$. Similarly, participants high on engagement in nature-related activity (i.e., those who cultivated indoor plants; $M = 4.48$, $SD = .89$) reported feeling more authentic than participants low on engagement in nature-related activity (i.e., those who did not cultivate indoor plants; $M = 4.29$, $SD = .95$), $t(1177) = 3.07$, $p = .002$, Cohen’s $d = .21$, 95% CI [.08, .35].³ As hypothesized, nature involvement was related to higher trait authenticity.

Study 2: A Field Quasi-Experiment on the Role of Nature in Authenticity

In Study 2, a field quasi-experiment, we again evaluated the hypothesis that nature is beneficial to authenticity. We surveyed individuals either at natural environments (i.e., parks) or urban settings (i.e., plazas). We expected for participants in natural environments to report higher state authenticity than those in urban settings.

Participants

Study 2 allows the ecological assessment of the association between natural (vs. urban) environments and authenticity. We determined the sample size after Schönbrodt and Perugini (2013), who found that at least 250 participants are needed to obtain a stable correlation (we conservatively treated this quasi-experiment as a cross-sectional study). We surveyed 270 Chinese participants, compensating them with 5 Yuan ($\approx \$0.80$). The sample included 135 women and 135 men, who ranged in age from 13 to 68 years ($M = 27.57$, $SD = 11.00$). We conducted the survey in two parks (nature condition; $n = 133$) and two plazas (urban condition; $n = 137$), sample photographs of which we display in Figure 1.

Procedure

Four female research assistants (unaware of hypotheses) carried out the survey on the same day in the month of April, two in each site (determined by random assignment). The research assistants approached 221 individuals in the nature condition, 88 (39.82%) of whom declined, and 234 individuals in the urban condition, 97 (41.45%) of whom declined. The attrition rate did not differ significantly across conditions, $\chi^2(1, 455) = .126$, $p = .775$. We assessed authenticity with the state version of the Authenticity Scale (Lenton, Slabu, et al., 2013; for the Chinese version, see Slabu et al., 2014). A sample item is “Right now, I am true to myself” (1 = *strongly disagree*, 7 = *strongly agree*; $M = 4.41$, $SD = .82$, $\alpha = .75$).

Results and Discussion

Participants in the nature condition ($M = 4.54$, $SD = .82$) reported being more authentic than those in the urban condition ($M = 4.28$, $SD = .81$), $t(268) = 2.69$, $p = .008$, Cohen’s $d = .33$, 95% CI [.09, .57]. As hypothesized, presence in a natural (than urban) environment was linked to higher state authenticity. Given the quasi-experimental character of this study, though, causality is ambiguous: it is likely that individuals higher in authenticity gravitate toward parks than malls. We addressed the issue of causality in the next study.

Study 3: Experimental Evidence for the Nature–Authenticity Link and Its Mediation by Basic Psychological Needs (Especially Autonomy Satisfaction)

In preregistered field experimental Study 3, we tested directly the hypothesis that nature is beneficial for (state) authenticity. Also, we tested the hypothesis that nature would increase satisfaction of all three basic psychological needs (autonomy, competence, relatedness), although, in a recent laboratory experiment, Yang et al. (2022,

¹ In this, all other studies conducted on an online platform (i.e., Wenjuanxing, Credamo, Prolific; Studies 1, 7, 8, 9, 10, 11, 12), participants responded to an attention check (“This is an attention check question. Please select 7 = *strongly agree*”). If participants failed the attention check, they were automatically excluded by the platform.

² Demographic questions in all studies included age and gender. They also included monthly income in Study 1. Controlling for demographic attributes did not alter the results.

³ Participants high on engagement with nature-related activities ($M = 4.86$, $SD = .79$) reported stronger nature connectedness than their low counterparts ($M = 4.47$, $SD = .95$), $t(1177) = 6.93$, $p < .001$, Cohen’s $d = .48$, 95% CI [.34, .61].

Figure 1

Sample Photographs of Testing Sites (i.e., Park and Plaza) in Study 2



Note. See the online article for the color version of this figure.

Study 2a) reported a null effect of nature on relatedness. More important, we examined the mediational role of need satisfaction. We evaluated the hypothesis that, although nature's effect on state authenticity would be independently mediated by satisfaction of all three basic needs, autonomy satisfaction would emerge as the stronger mediator in a parallel mediation analysis.

Participants

We used the Monte Carlo power analysis for indirect effects application (Schoemann et al., 2017) to determine the sample size for the proposed mediation model with three parallel mediators (i.e., satisfaction of autonomy, competence, relatedness). As the nature effect on state authenticity is medium (based on Study 2), we assumed medium intercorrelations among the manipulation (nature vs. urban condition), mediator, and dependent variable (authenticity) of $r = .30$ ($SD = .10$). Accordingly, we needed at least 291 participants to reach power .80 at $\alpha = .05$. We tested 322 Chinese undergraduate students (204 women, 118 men) at Zhejiang Ocean University in exchange for course credit. They ranged in age from 18 to 24 years ($M = 18.74$, $SD = .90$).

Procedure

First, we randomly allocated participants to the nature ($n = 160$) or urban ($n = 162$) condition. Then, we sent them a text message inviting them to report (at an appointed time) to a park or a plaza for the study, run in the months of April and May. Participants were met at the testing site by one of four female research assistants, the same as in Study 2. The research assistants were unaware of hypotheses and randomly allocated to testing sites. Participants were requested to take a rest and observe their surroundings for 5 min. Then, they were instructed to describe in writing, in at least five lines, "their environment and their feelings evoked by the environment." No time limit was set, although all participants completed the task in under 10 min and proceeded to fill out the measures described below.

Basic Psychological Needs Scale

This scale (Sheldon et al., 2001) comprises six items, preceded by the stem "Right now, I feel" Two items refer to autonomy (e.g., "free to do things my own way"; $M = 5.25$, $SD = 1.04$, $\alpha = .82$), two

to competence (e.g., "very capable in what I did"; $M = 4.96$, $SD = 1.16$, $\alpha = .81$), and two to relatedness (e.g., "close and connected with other people who are important to me"; $M = 4.93$, $SD = 1.15$, $\alpha = .82$). Response options range from 1 (*strongly disagree*) to 7 (*strongly agree*). We presented the items in a fixed random order.

State Authenticity Scale

Participants completed the state version of the Authenticity Scale (Lenton, Slabu, et al., 2013), as in Study 2 ($M = 4.42$, $SD = .80$, $\alpha = .81$).

Results and Discussion

Basic Psychological Needs

Participants in the nature condition ($M = 5.46$, $SD = 1.05$) reported higher autonomy satisfaction than those in the urban condition ($M = 5.06$, $SD = .99$), $t(320) = 3.53$, $p < .001$, Cohen's $d = .39$, 95% CI [.17, .61]. Further, participants in the nature condition ($M = 5.10$, $SD = 1.09$) reported higher competence satisfaction compared to those in the urban condition ($M = 4.83$, $SD = 1.22$), $t(320) = 2.15$, $p = .033$, Cohen's $d = .24$, 95% CI [.02, .46]. However, participants in the nature ($M = 5.03$, $SD = 1.17$) and urban ($M = 4.84$, $SD = 1.12$) conditions did not differ significantly on relatedness satisfaction, $t(320) = 1.43$, $p = .154$, Cohen's $d = .16$, 95% CI [-0.06, .38], as in Yang et al. (2022, Study 2a).

State Authenticity

Participants in the nature condition ($M = 4.54$, $SD = .75$) reported higher authenticity than those in the urban condition ($M = 4.30$, $SD = .67$), $t(320) = 2.98$, $p = .003$, Cohen's $d = 0.33$, 95% CI [.11, .55].

Mediation Analysis

In a mediation analysis (Hayes, 2018; 1 = *nature condition*, 0 = *urban condition*), we entered the dummy-coded condition as independent variable, the three needs as mediators, and authenticity as dependent variable. First, we tested for the independent mediational role of autonomy, competence, and relatedness satisfaction. The results of bias-corrected bootstrapping with 5,000 resamples indicated that the indirect effects via autonomy and competence

excluded zero: satisfaction of these two needs independently mediated nature's effect on authenticity (Supplemental Table 1S).⁴ Relatedness was not a significant mediator.

We then tested for parallel mediation of the three needs by entering them simultaneously in the model. The result of bias-corrected bootstrapping with 5,000 resamples (Hayes, 2018) indicated that the total mediation effect was significant, $F(4, 317) = 10.64$, $R^2 = .12$, $p < .001$, $SE = .03$, indirect effect = .08, 95% CI [.03, .16]. Only autonomy satisfaction significantly mediated the effect of nature on authenticity (Figure 2).

Summary

Nature increased need satisfaction and (in conceptual replication of Study 2 findings) state authenticity. Also, autonomy and competence (but not relatedness) independently mediated nature's effect on state authenticity. Yet, in a parallel mediation analysis, only autonomy emerged as a significant mediator of this effect. The results were consistent with the hypotheses.

Study 4: On the Causal Relation Between Nature and Authenticity, and Its Mediation by Positive Affect

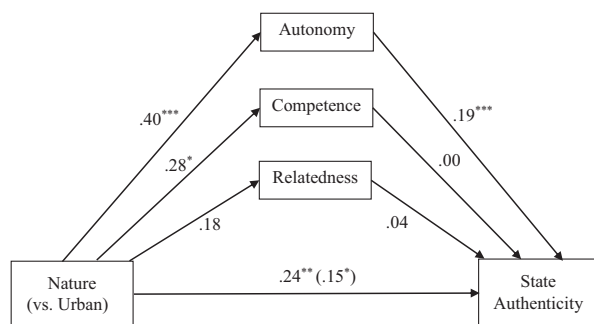
In experimental Study 4, we retested, in a laboratory context this time, the hypothesis that exposure to nature augments state authenticity. Additionally, we evaluated the hypothesis that positive affect mediates the effect of nature on state authenticity.

Participants

We used the Monte Carlo power analysis for indirect effects application to arrive at the sample size for the proposed mediation model (i.e., single mediator). As in Study 3, we assumed medium intercorrelations among the manipulation (nature vs. urban condition), mediator, and dependent variable (i.e., authenticity) of $r = .30$ ($SD = .10$). At least 160 participants were needed to reach power .80 at $\alpha = .05$. We tested 171 Chinese undergraduate students (139 women, 32 men) at Zhejiang Ocean University in exchange for course credit. They ranged in age from 17 to 23 years ($M = 19.94$, $SD = 1.19$). We randomly assigned them to the nature ($n = 85$) or urban ($n = 86$) condition.

Figure 2

Autonomy Need Satisfaction Mediates the Effect of Nature on State Authenticity in Parallel Mediation Analysis in Study 3



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

Procedure

Participants viewed 14 photographs of nature or urban scenes immersing themselves into the scenes at their own pace. The stimuli and procedure have been validated by prior research (in China) on whether nature buffers the consequences of ostracism (Yang et al., 2021). Next, participants completed the Chinese version (Qiu et al., 2008) of the Positive and Negative Affect Scale (Watson et al., 1988) indicating how they currently felt on each of nine positive (e.g., happy, active, enthusiastic) and nine negative (e.g., sad, nervous, afraid) adjectives (1 = *very slightly or not at all*, 5 = *extremely*). We reverse-scored responses on the negative adjectives and combined them with those on the positive adjectives to form a positive affect score ($M = 3.59$, $SD = .61$, $\alpha = .91$). Afterward, participants completed the state version of the Authenticity Scale (Lenton, Slabu, et al., 2013), as in Studies 2–3 ($M = 4.69$, $SD = .84$, $\alpha = .82$).

Results and Discussion

Participants in the nature condition ($M = 3.76$, $SD = .54$) reported more positive affect than those in the urban condition ($M = 3.44$, $SD = .62$), $t(169) = 3.57$, $p < .001$, Cohen's $d = .55$, 95% CI [.25, .85]. Also, participants in the nature condition ($M = 4.73$, $SD = .84$) reported higher authenticity than their urban condition counterparts ($M = 4.44$, $SD = .92$), $t(169) = 2.17$, $p = .032$, Cohen's $d = .33$, 95% CI [.03, .63].

We used the same procedure as in Study 3 to test whether positive affect mediated the effect of nature on authenticity. The results of bias-corrected bootstrapping with 5,000 resamples revealed significant mediation, $F(2, 168) = 11.54$, $R^2 = .12$, $p < .001$, $SE = .05$, indirect effect = .15, 95% CI [.06, .28] (Figure 3).⁵ Taken together, exposure to natural (vs. urban) environments led to increases in state authenticity, and these increases were transmitted by positive affect.

Study 5: On the Causal Relation Between Nature and Authenticity, and Its Mediation by Self-Esteem

In experimental Study 5, conducted in the laboratory, we again tested the hypothesis that nature augments authenticity using a new experimental procedure (i.e., video presentation). Moreover, we evaluated the hypothesis that self-esteem mediates the effect of nature on authenticity.

Participants

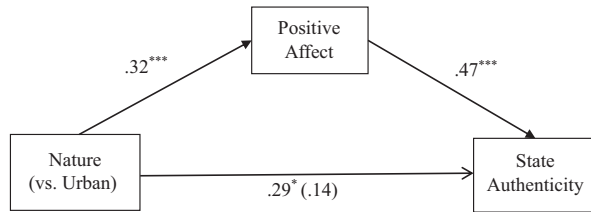
We conducted power analysis as in Study 4 to determine our sample size (minimum needed = 160). We tested 165 Chinese undergraduate students (97 women, 68 men) at Zhejiang Ocean University, aged between 17 and 22 years ($M = 19.51$, $SD = 1.03$). We remunerated each with 10 Yuan ($\approx \$1.50$).

⁴ We also tested an alternative model, whether nature fulfilled basic psychological needs (i.e., autonomy and competence) through higher authenticity. The fitness of this alternative model was similar to the hypothesized one (Supplemental Table 1S).

⁵ We also tested an alternative model, whether nature increased positive affect by elevating authenticity. This alternative model yielded worse fit than the hypothesized one (Supplemental Table 2S).

Figure 3

Positive Affect Mediates the Effect of Nature on State Authenticity in Study 4



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

Procedure

We randomly assigned participants to the nature ($n = 82$) or urban ($n = 83$) condition. In the nature condition, they watched a 5-min video depicting natural environments (i.e., forests, rivers, beaches, meadows, mountains), whereas in the urban condition, they watched a similar-length video depicting urban environments (i.e., streets, roads, cars, buildings, plazas). The videos, downloaded from the internet and edited by the first author, were played mutely so as to control for the possible confounding effect of voice.⁶ We asked participants to immerse themselves into their respective environment and be aware of “their feelings evoked by the environment.”

Subsequently, participants completed measures of the putative mediator (self-esteem) and the dependent variable (state authenticity). We assessed self-esteem with a state version of the 10-item Rosenberg (1965) Self-Esteem Scale (for the Chinese version, see Ji & Yu, 1999), with each item being preceded by the stem “Right now” (1 = *strongly disagree*, 4 = *strongly agree*; $M = 2.98$, $SD = .46$, $\alpha = .84$). We assessed authenticity with the state version of the Authenticity Scale (Lenton, Slabu, et al., 2013), as in Studies 2–4 ($M = 4.75$, $SD = .50$, $\alpha = .66$).

Results and Discussion

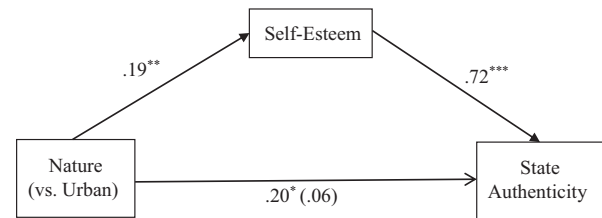
Participants in the nature condition ($M = 3.08$, $SD = .49$) reported higher self-esteem than those in the urban condition ($M = 2.89$, $SD = .41$), $t(163) = 2.67$, $p = .008$, Cohen’s $d = .42$, 95% CI [.11, .72]. Also, participants in the nature condition ($M = 4.85$, $SD = .47$) reported higher authenticity than those in the urban condition ($M = 4.66$, $SD = .51$), $t(163) = 2.57$, $p = .011$, Cohen’s $d = .40$, 95% CI [.09, .71]. Further, self-esteem mediated the effect of nature on authenticity,⁷ $F(2, 162) = 70.67$, $R^2 = .47$, $p < .001$, $SE = .05$, indirect effect = .14, 95% CI [.04, .25] (Figure 4). In summary, watching videos of natural (vs. urban) environments elevated state authenticity, an effect mediated by state self-esteem.

Study 6: On the Causal Relation Between Nature and Authenticity, and Its Mediation by Mindfulness

In experimental Study 6, carried out in the laboratory, we retested the hypothesis that nature raises authenticity with a novel procedure (i.e., engaging in a nature-based vs. control activity). More important,

Figure 4

Self-Esteem Mediates the Effect of Nature on State Authenticity in Study 5



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

we tested the hypothesis that mindfulness mediates the effect of nature on authenticity.

Participants

We implemented the same power analysis as in Studies 4 and 5 to determine our sample size (minimum needed = 160). We tested 161 Chinese undergraduate students (137 women, 24 men) at Zhejiang Ocean University, aged 17–23 years ($M = 19.30$, $SD = 1.01$). We paid each 15 Yuan ($\approx \$2.25$).

Procedure

We randomly assigned participants to the nature ($n = 81$) or control ($n = 80$) condition. We adopted a manipulation introduced by Berger (2020). In the nature condition, we instructed participants to create a natural poster using nature-related materials (i.e., fallen leaves, branches, petals, weeds), whereas in the control condition, we instructed them to create a geometric poster using artificial materials (i.e., triangles, circles, rectangles, polygons; Figure 5). The relevant materials were provided by the experimenter (along with a piece of A4 article, a box of crayons, and a bottle of glue). We gave participants 10 min to complete the task.

Afterward, participants filled out a 13-item Mindfulness Scale developed by Lau et al. (2006). It consists of two subscales, curiosity (reflecting awareness of the present-moment experience; six items) and decentering (reflecting acceptance of the present-moment experience; seven items). Given that we intended to capture the transient character of mindfulness in our experimental context, we opted to shorten the scale. Our primary item selection criterion was high factor loadings, and our secondary criterion was high face validity (see Sibley et al., 2005, for a similar practice). We arrived at three curiosity and three decentering items, which we administered to participants after we thematically blocked them. A sample curiosity item is “I was curious about each of the thoughts and feelings that I was having,” and a sample decentering item is “I was more invested in just watching my experiences as they arose, than in figuring out what they could mean.” Response options ranged from 1 (*strongly disagree*) to 7 (*strongly agree*; $M = 5.18$, $SD = .72$, $\alpha = .68$). We assessed authenticity with the state version of the

⁶ The videos are available upon request.

⁷ We also tested an alternative model, whether nature increased self-esteem through authenticity. This alternative model yielded a similar fit to the hypothesized model (Supplemental Table 3S).

Figure 5
Sample Paintings Created by two participants in Study 6: Natural (Left) Versus Geometric (Right)



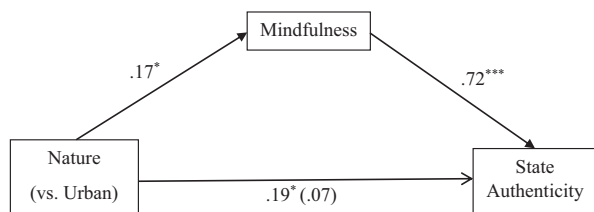
Note. We acknowledge the two participants for their permissions for us to use the posters. See the online article for the color version of this figure.

Authenticity Scale (Lenton, Slabu, et al., 2013), as in Studies 2–5 ($M = 4.90$, $SD = .64$, $\alpha = .62$).

Results and Discussion

Participants in the nature condition ($M = 5.30$, $SD = .70$) reported higher mindfulness than those in the control condition ($M = 5.05$, $SD = .73$), $t(159) = 2.28$, $p = .024$, Cohen's $d = 0.36$, 95% CI [.05, .67]. Also, participants in the nature condition ($M = 5.03$, $SD = .64$) reported greater authenticity than controls ($M = 4.76$, $SD = .62$), $t(159) = 2.69$, $p = .008$, Cohen's $d = 0.42$, 95% CI [.11, .73]. In turn, mindfulness mediated nature's effect on authenticity,⁸ $F(2, 158) = 22.85$, $R^2 = .22$, $p < .001$, $SE = .05$, indirect effect = .10, 95% CI [.02, .21] (Figure 6). Together, creating a natural (vs. geometric) poster increased state authenticity, and this effect was transmitted by state mindfulness.

Figure 6
Mindfulness Mediates the Effect of Nature on State Authenticity in Study 6



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

Study 7: The Nature–Authenticity Link and the Role of Self-Esteem

So far, we have found that exposure to nature is either linked with authenticity or increases authenticity. We have also found that the effect of nature on authenticity is independently mediated by satisfaction of the need for autonomy, positive affect, self-esteem, and mindfulness. In Study 7, we questioned the relative potency of these four mediators. Which one accounts best for nature's effect on authenticity? To answer this question, we tested the strength of these mediators both independently and in parallel in a cross-sectional design. Participants completed measures of nature connectedness, autonomy satisfaction, positive affect, mindfulness, self-esteem, and authenticity (measured with an alternative scale, the Authenticity Inventory, Kernis & Goldman, 2006). We tested the following hypotheses: (a) nature connectedness is positively related to autonomy satisfaction, positive affect, mindfulness, self-esteem, and authenticity; (b) the relation between nature connectedness and authenticity is independently mediated by autonomy satisfaction, positive affect, mindfulness, and self-esteem; and (c) self-esteem is the most potent mediator.

Participants

We relied on an opportunistic sample of 1,753 Chinese undergraduate students (881 men, 872 women) at Zhejiang Ocean University aged 17–24 years ($M = 19.56$, $SD = .83$; 131 unreported).

⁸ We tested an alternative model, whether nature enhanced mindfulness through authenticity. The alternative model yielded slightly worse fit than the hypothesized one (Supplemental Table 4S).

We administered the measures in person, as part of the first-year battery of psychological tests.

Measures

We measured the relevant constructs at the trait level. We assessed the predictor, nature connectedness, with the Connectedness to Nature Scale (Geng et al., 2015; Mayer & Frantz, 2004; $M = 5.09$, $SD = .86$, $\alpha = .91$). We proceeded with the assessment of the putative mediators in a fixed random order. First, we assessed autonomy need satisfaction (Sheldon et al., 2001; $M = 4.81$, $SD = 1.22$, $\alpha = .91$) and self-esteem (Ji & Yu, 1999; Rosenberg, 1965; $M = 2.91$, $SD = .50$, $\alpha = .77$). Then, we assessed positive affect using four positive (e.g., pleasant, happy) and four negative (e.g., sad, afraid) adjectives from the Scale of Positive and Negative Experience (Diener et al., 2010; for the Chinese version, see Tong & Wang, 2017; 1 = *not at all*, 7 = *very strong*). After reverse-scoring responses to the negative adjectives, we computed a composite ($M = 4.88$, $SD = 1.03$, $\alpha = .92$). Subsequently, we assessed mindfulness with the 15-item Chinese version (S. Chen et al., 2012) of the Mindful Attention Awareness Scale; original scale: K. W. Brown and Ryan (2003). A sample item is “I could be experiencing some emotion and not be conscious of it until sometime later” (1 = *strongly disagree*, 7 = *strongly agree*; $M = 4.14$, $SD = .98$, $\alpha = .94$). Finally, we assessed authenticity with the 45-item Authenticity Inventory (Kernis & Goldman, 2006). It captures four proposed components of authenticity: awareness (e.g., “For better or for worse I am aware of who I truly am”), unbiased processing (e.g., “I am very uncomfortable objectively considering my limitations and shortcomings”), behavioral consistency (e.g., “I am willing to change myself for others if the reward is desirable enough”), and relational orientation (e.g., “If asked, people I am close to can accurately describe what kind of person I am”). Response options range from 1 (*strongly disagree*) to 7 (*strongly agree*). We computed a composite ($M = 4.42$, $SD = .54$, $\alpha = .89$).

Results and Discussion

The six variables exhibited a positive manifold (Table 1). In particular, nature connectedness was related to authenticity. Also, nature connectedness was related to autonomy need satisfaction, self-esteem, positive affect, and mindfulness. Last, autonomy need satisfaction, self-esteem, positive affect, and mindfulness were related to authenticity.

Next, we conducted independent mediation analyses. As hypothesized, autonomy satisfaction, positive affect, self-esteem, and

Table 1
Intercorrelations of Variables in Study 7 (n = 1573)

| Variable | 1 | 2 | 3 | 4 | 5 | 6 |
|--------------------------|--------|--------|--------|--------|--------|---|
| 1. Nature connectedness | — | | | | | |
| 2. Autonomy satisfaction | .42*** | — | | | | |
| 3. Positive affect | .46*** | .50*** | — | | | |
| 4. Self-esteem | .47*** | .50*** | .65*** | — | | |
| 5. Mindfulness | .25*** | .17*** | .37*** | .40*** | — | |
| 6. Authenticity | .58*** | .43*** | .56*** | .60*** | .57*** | — |

*** $p < .001$.

Table 2
Parallel Mediation Analysis in Study 7

| Mediator | <i>a</i> path | <i>b</i> path | <i>c</i> path | <i>c'</i> path | <i>SE</i> | <i>ab</i> 95% CI |
|--|---------------|---------------|---------------|----------------|-----------|---------------------|
| Autonomy satisfaction | .59*** | .04*** | .36*** | .19*** | .006 | .024 [.01, .04] |
| Positive affect | .56*** | .05*** | | | .007 | .030 [.02, .04] |
| Self-esteem | .27*** | .22*** | | | .008 | .061 [.05, .08] |
| Mindfulness | .29*** | .20*** | | | .007 | .057 [.04, .07] |
| Model summary: $F(5, 1747) = 514.07$, $R^2 = .60$, $p < .0001$, $SE = .011$, indirect effect = .17, 95% CI [.15, .19]. | | | | | | |

Note. *a* = simple path coefficient from nature connectedness to mediators; *b* = simple path coefficient from mediators to authenticity; *c* = simple path coefficient from nature connectedness to authenticity; *c'* = path coefficient from nature connectedness to authenticity, adjusting for mediators; *SE* = standard error; CI = confidence interval.
*** $p < .001$.

mindfulness independently mediated the effect of nature on state authenticity (For detailed statistics, see Supplemental Table 5S). Last, we carried out a parallel mediation analysis. The result of bias-corrected bootstrapping with 5,000 resamples (Hayes, 2018) indicated that the total mediation effect was significant, $F(5, 1747) = 514.07$, $R^2 = .60$, $p < .001$, $SE = .011$, indirect effect = .17, 95% CI [.15, .19]. As hypothesized, self-esteem emerged as the strongest mediator of nature's effect on authenticity, followed closely by mindfulness (Table 2, Figure 7).⁹

Study 8: The Effect of Nature on Authenticity and the Role of Self-Esteem

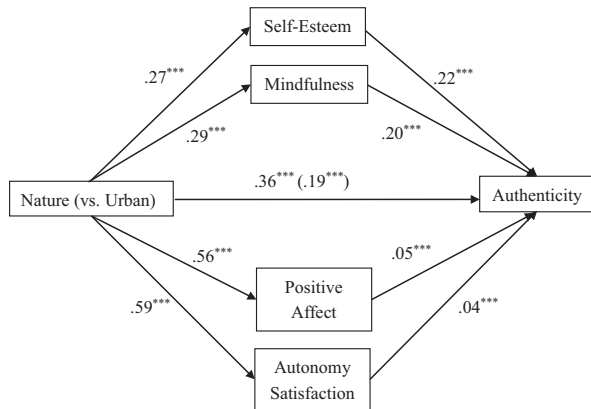
In Study 7, we gauged the relative potency of the four mediators in a correlational design. In online Study 8, we attempted to do so in an experimental design. Participants viewed a 5-min video depicting nature (vs. urban) scenes and filled out scales assessing the four plausible mediators, as well as the dependent variable (i.e., authenticity) at the state level. We hypothesized that: (a) participants in the nature (vs. urban) condition would report higher autonomy need satisfaction, positive affect, self-esteem, mindfulness, and authenticity; (b) nature's effect on authenticity would be independently mediated by autonomy need satisfaction, positive affect, mindfulness, and self-esteem; and (c) self-esteem would emerge as the most potent mediator in a parallel mediation analysis.

Participants

As before, we used the Monte Carlo power analysis for indirect effects application to determine the sample size for the proposed mediation model with four parallel mediators (i.e., autonomy need satisfaction, positive affect, mindfulness, self-esteem). Given that nature's effect is medium (based on our prior studies), we assumed medium intercorrelations among the manipulation (nature vs.

⁹ We also tested alternative models, whether nature connectedness predicted autonomy need satisfaction and self-esteem through authenticity, respectively. These alternative models yielded slightly better fit than the hypothesized ones (Supplemental Table 6S).

Figure 7
Parallel Mediation Analysis of the Effect of Nature on Authenticity in Study 7



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

urban), putative mediators, and dependent variable (i.e., authenticity) of $r = .30$ ($SD = .10$). Accordingly, we needed at least 400 participants to reach power .80 at $\alpha = .05$. We recruited 416 Chinese undergraduate students (262 women, 154 men) at Zhejiang Ocean University compensating them with 10 Yuan ($\approx \$1.50$). Their ages ranged from 17 to 27 years ($M = 19.79$, $SD = 1.38$).

Procedure

We randomly assigned participants to the nature ($n = 207$) or urban ($n = 209$) condition, in which they watched the same videos as in Study 5. Next, they completed the relevant measures. We presented the four plausible mediators in one fixed random order (as below), followed by the dependent variables.

All measures were preceded by the stem "Right now." We measured mindfulness with the six-item Mindfulness Scale (adapted from Lau et al., 2006; $M = 5.12$, $SD = .93$, $\alpha = .76$). We measured positive affect with the Chinese version of Positive and Negative Affect Scale (Qiu et al., 2008; $M = 3.59$, $SD = .54$, $\alpha = .86$). We measured autonomy need satisfaction with the two relevant items of the Basic Psychological Needs Scale (Sheldon et al., 2001; $M = 4.96$, $SD = 1.43$, $\alpha = .83$). We measured self-esteem with the Rosenberg (1965) Self-Esteem Scale (Ji & Yu, 1999; $M = 2.99$, $SD = .43$, $\alpha = .82$). Finally, we measured authenticity with the state version of the Authenticity Scale (Lenton, Slabu, et al., 2013), as before ($M = 4.65$, $SD = .79$, $\alpha = .78$).

Results and Discussion

Participants in the nature condition reported higher autonomy need satisfaction, positive affect, self-esteem, mindfulness, and authenticity than those in the urban condition (Table 3). Next, we carried out mediation analyses testing independently for each potential mediator. Autonomy need satisfaction, positive affect, self-esteem, and mindfulness independently mediated the effect of nature on state authenticity¹⁰ (Supplemental Table 7S).

Finally, we conducted a parallel mediation analysis. The total effect was significant, $F(5, 410) = 56.71$, $R^2 = .41$, $p < .001$,

$SE = .05$, indirect effect $ab = .25$, 95% CI [.15, .36]. However, only self-esteem and mindfulness significantly mediated the effect of nature on authenticity (Figure 8). Furthermore, the indirect effect of nature (vs. urban) on authenticity through self-esteem (.16) was larger than through mindfulness (.05). Self-esteem emerged as the most potent mediator of nature's effect on state authenticity. In all, the results were consistent with hypotheses.

Study 9: The Effect of Nature on Authenticity and the Role of Self-Esteem in Western Cultural Context

In Study 8, and all preceding studies, participants were Chinese. We conducted preregistered Study 9—an exact replication of Study 8—for two reasons. First, we aimed to examine the reproducibility of Study 8; this study is crucial, as it established experimentally the role of self-esteem in transmitting the effect of nature on authenticity. Second, we aimed to expand the generalizability of our findings by targeting a Western sample.

Participants

We determined the sample size as in Study 8. We needed at least 400 participants to reach power .80 at $\alpha = .05$. We recruited 442 participants via Prolific Academic in exchange of £2 (\$2.46). This online platform automatically excluded 15 participants, because they completed the study in less than 7 min (as a reminder, the study consisted of a 5-min video and a 51-question survey). We also excluded 14 participants, as they were from non-Western countries. The final sample comprised 413 participants (236 women, 172 men, five other) ranging in age from 19 to 75 years ($M = 37.42$, $SD = 12.77$). They were from the United Kingdom (288), Canada (83), United States (35), Sweden (3), Australia (1), Ireland (1), Spain (1), or Switzerland (1).

Procedure

We randomly assigned participants to the nature ($n = 204$) or urban ($n = 209$) condition. The procedure was identical to that of Study 8 (and Study 5). After watching the relevant video, participants completed state measures of: mindfulness (Mindfulness Scale—Lau et al., 2006; $M = 4.68$, $SD = .90$, $\alpha = .75$), positive affect (Positive and Negative Affect Scale—Watson et al., 1988; $M = 3.59$, $SD = .53$, $\alpha = .86$), autonomy (Basic Psychological Need of Autonomy subscale—Sheldon et al., 2001; $M = 5.52$, $SD = 1.17$, $\alpha = .88$), self-esteem (the Self-Esteem Scale—Rosenberg, 1965; $M = 2.99$, $SD = .65$, $\alpha = .94$), and authenticity (Authenticity Scale—Lenton, Slabu, et al., 2013; $M = 5.11$, $SD = .94$, $\alpha = .87$).

Results and Discussion

Participants in the nature condition reported significantly higher autonomy need satisfaction, positive affect, self-esteem, and authenticity (as well as directionally higher mindfulness) than those in the urban condition (Table 4). Next, we carried out mediational analyses testing independent mediation by autonomy need

¹⁰ We also tested the alternative model for each mediator, as we did in Studies 3–7 (Supplemental Table 7S). All hypothesized models yielded better fitness than the alternative ones, except for condition \rightarrow autonomy \rightarrow authenticity.

Table 3
The Effect of Condition (Nature vs. Urban) on Variables Assessed in Study 8

| Variable | <i>M (SD)</i> | | <i>t</i> (414) | <i>p</i> | Cohen's <i>d</i> 95% CI |
|-----------------------|--------------------------|-------------------------|----------------|----------|----------------------------|
| | Nature (<i>n</i> = 207) | Urban (<i>n</i> = 209) | | | |
| Autonomy satisfaction | 5.24 (1.31) | 4.68 (1.48) | 4.13 | <.001 | .41 [.21, .60] |
| Positive affect | 3.78 (.54) | 3.41 (.62) | 6.50 | <.001 | .64 [.44, .83] |
| Self-esteem | 3.07 (.39) | 2.91 (.45) | 3.98 | <.001 | .39 [.20, .58] |
| Mindfulness | 5.33 (.88) | 4.91 (.94) | 4.74 | <.001 | .47 [.27, .66] |
| Authenticity | 4.76 (.75) | 4.54 (.82) | 2.91 | .004 | .29 [.09, .48] |

Note. CI = confidence interval.

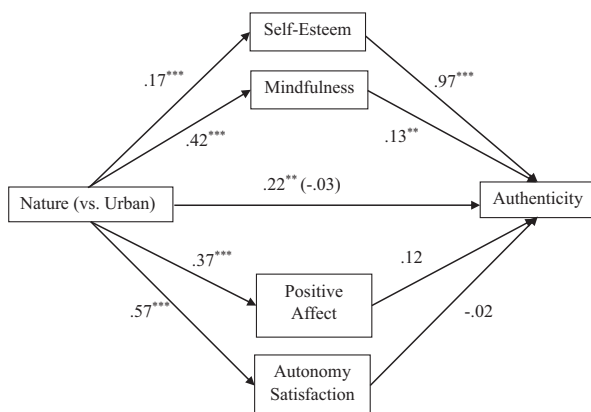
satisfaction, positive affect, and self-esteem. Each mediated nature's effect on authenticity¹¹ (Supplemental Table 8S).

Finally, we carried out a parallel mediation analysis involving autonomy need satisfaction, positive affect, and self-esteem. The total effect was significant, $F(4, 408) = 102.45$, $R^2 = .50$, $p < .001$, $SE = .07$, indirect effect = .20, 95% CI [.07, .34]. However, only self-esteem (indirect effect = .17, 95% CI [.05, .29]) significantly mediated nature's effect on authenticity. The indirect effects of positive affect (.02, 95% CI [-.02, .06]) and autonomy need satisfaction (.01, 95% CI [-.001, .04]) were not significant (Figure 9). Self-esteem emerged as the most powerful mediator of nature's effect on authenticity, replicating the Study 8 results.

Study 10: The Causal Influence of Self-Esteem on Authenticity

We have shown that self-esteem is the strongest mediator of nature's effect on authenticity. However, the logic of the experimental-causal-chain approach (Spencer et al., 2005) would require that we manipulate the mediator (i.e., self-esteem) and assess

Figure 8
Parallel Mediation Analysis of the Effect of Nature on Authenticity in Study 8



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

its impact on the dependent measure (i.e., authenticity). This is what we did in preregistered Study 10. We hypothesized that that high self-esteem participants would report greater authenticity than their low self-esteem counterparts.

Participants

We calculated the sample size using G*Power 3.1 (Faul et al., 2009). To ensure 90% statistical power at $\alpha = .05$, at least 172 participants were needed. We recruited 229 Chinese participants (130 women, 99 men) via Credamo, a Chinese online platform similar to Qualtrics, remunerating them with 10 Yuan (\approx \$1.50). Their age ranged from 18 to 67 years ($M = 33.14$, $SD = 9.12$).

Procedure

We randomly assigned participants to the high ($n = 114$) or low ($n = 115$) self-esteem condition. We induced self-esteem with a procedure validated by Mahadevan et al. (2023). In the high self-esteem condition, participants thought about ways in which they felt like they were a person of worth, had a number of good qualities, and were satisfied with themselves. In the low self-esteem condition, participants thought about ways in which they did not have much to be proud of, felt like a bit of a failure, and felt a bit useless. Next, participants listed three relevant keywords and wrote about the pertinent ways for at least 3 min. Finally, they completed the manipulation check and a state authenticity measure.

Manipulation Check

We used the Rosenberg (1965) Self-Esteem Scale as a manipulation check. We converted the scale to state format by adding the stem "right now" before each item. A sample item is "Right now, I feel that I am a person of worth, at least on an equal plane with others" (1 = *strongly disagree*, 7 = *strongly agree*). We averaged the ratings, after reverse-scoring the ratings for the negatively worded items, to form an index ($M = 4.60$, $SD = 1.56$, $\alpha = .94$).

¹¹ Additionally, we tested the alternative model for each mediator. All hypothesized models yielded better fit than the alternative ones (Supplemental Table 8S).

Table 4
The Effect of Condition (Nature vs. Urban) on Variables Assessed in Study 9

| Variable | <i>M (SD)</i> | | <i>t</i> (411) | <i>p</i> | Cohen's <i>d</i> 95% CI |
|-----------------------|--------------------------|-------------------------|----------------|----------|----------------------------|
| | Nature (<i>n</i> = 204) | Urban (<i>n</i> = 209) | | | |
| Autonomy satisfaction | 5.63 (1.13) | 5.38 (1.26) | 2.08 | .038 | .21 [.01, .40] |
| Positive affect | 3.71 (.52) | 3.46 (.52) | 4.90 | <.001 | .48 [.29, .68] |
| Self-esteem | 3.08 (.62) | 2.90 (.67) | 2.74 | .006 | .27 [.08, .46] |
| Mindfulness | 4.74 (.94) | 4.60 (.90) | 1.60 | .110 | .16 [−.04, .35] |
| Authenticity | 5.23 (.99) | 4.98 (.91) | 2.71 | .007 | .27 [.07, .46] |

Note. CI = confidence interval.

Authenticity

For cross-validated purposes, we assessed authenticity with two scales administered in counterbalanced order. The first one was the state version of the Authenticity Scale (Lenton, Slabu, et al., 2013; $M = 4.77$, $SD = 1.26$, $\alpha = .92$), as before. The second one was the state Southampton Authenticity Scale (Kelley et al., 2022). Its four items, followed by the stem “Right now,” are “I feel true to myself,” “I am feeling authentic,” “I feel like the real me,” and “I feel genuine” (1 = *strongly disagree*, 7 = *strongly agree*; $M = 5.18$, $SD = 1.52$, $\alpha = .95$). We calculated indices for each scale by averaging the ratings (following score-reversals in the case of the Rosenberg Self-Esteem Scale).

Results and Discussion

Manipulation Check

Participants in the high self-esteem condition ($M = 5.84$, $SD = .53$) reported higher levels of self-esteem than those in the low self-esteem

condition ($M = 3.38$, $SD = 1.25$), $t(227) = 19.40$, $p < .001$, Cohen's $d = 2.56$, 95% CI [2.30, 2.82]. The manipulation was effective.

Authenticity

The two authenticity scales were highly and positively related, $r(229) = .91$, $p < .001$. With regard to the Authenticity Scale, participants in the high self-esteem condition ($M = 5.52$, $SD = .65$) reported higher levels of authenticity than those in the low self-esteem condition ($M = 4.03$, $SD = 1.28$), $t(227) = 11.13$, $p < .001$, Cohen's $d = 1.47$, 95% CI [1.21, 1.73]. With regard to the Southampton Authenticity Scale, participants in the high self-esteem condition ($M = 6.00$, $SD = .64$) also reported higher levels of authenticity than those in the low self-esteem condition ($M = 4.38$, $SD = 1.69$), $t(227) = 9.59$, $p < .001$, Cohen's $d = 1.27$, 95% CI [1.01, 1.53]. The results were consistent with the hypothesis. The study is also the first to document the causal relation between self-esteem and authenticity.

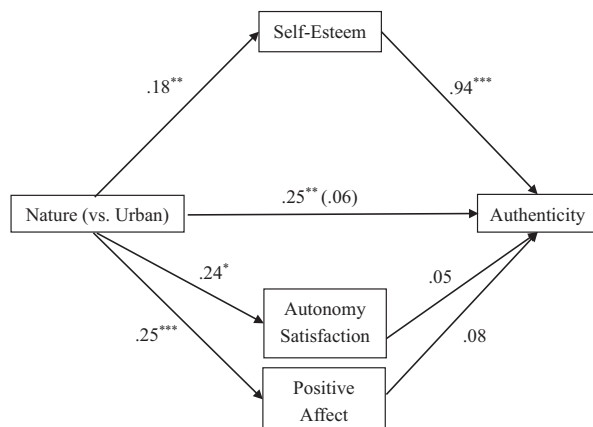
Study 11: The Impact of Nature, as Mediated Serially by Self-Esteem and Authenticity, on Psychological Well-Being

In Studies 7–10, self-esteem emerged as the strongest mediator of the effect of nature on authenticity. In preregistered Study 11, we focused on nature and PWB. How does nature momentarily enhance PWB? We were concerned with serial mediation. In particular, we hypothesized that nature would increase self-esteem, which would be linked to higher authenticity and, in turn, greater PWB.

Participants

We determined the sample size for the proposed serial mediation model based on the Monte Carlo power analysis for indirect effects application (Schoemann et al., 2017). Given that the effect of nature is generally medium (based on our prior studies), we assumed medium intercorrelations among the manipulation (nature vs. urban), mediators, and PWB of $r = .30$ ($SD = .10$). As such, at least 271 participants were required to reach power .80 at $\alpha = .05$. We recruited 300 Chinese participants (158 women, 142 men) via Credamo, compensating them with 10 Yuan ($\approx \$1.50$). Their ages ranged from 18 to 59 years ($M = 30.05$, $SD = 8.16$).

Figure 9
Parallel Mediation Analysis of the Effect of Nature on Authenticity in Study 9



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

Procedure

We used the same manipulation (i.e., videos of nature or urban scenes) as in Studies 5, 8, and 9. Following random assignment to conditions (nature condition $n = 147$, urban condition $n = 153$), participants completed state measures of the putative mediators (self-esteem, authenticity) and the dependent variable (PWB).

Self-Esteem

We assessed this construct with the Rosenberg (1965) Self-Esteem Scale, as in Studies 7–8 ($M = 3.26$, $SD = .38$, $\alpha = .83$).

Authenticity

We assessed this construct with the state version of the Authenticity Scale (Lenton, Slabu, et al., 2013), as in Studies 2–6, and 8 ($M = 5.30$, $SD = .80$, $\alpha = .86$).

Psychological Well-Being

Aiming for brevity (due to the expected short duration of experimental effects), we opted to operationalize PWB in terms of life satisfaction and meaning in life. We assessed life satisfaction with the five-item Satisfaction with Life Scale (Diener et al., 1985; for the Chinese version, see Xiong & Xu, 2009). A sample item is “In most ways, my life is close to my ideal” (1 = *strongly disagree*, 7 = *strongly agree*; $M = 5.11$, $SD = 1.10$, $\alpha = .87$). We assessed meaning with the five-item Presence of Meaning Subscale of the Meaning in Life Questionnaire (Steger et al., 2006; for the Chinese version, see Y. Jiang et al., 2016). A sample item is “My life has a clear sense of purpose” (1 = *strongly disagree*, 7 = *strongly agree* $M = 5.70$, $SD = 1.04$, $\alpha = .88$). In both cases, the items were preceded by the stem “Right now.”

Results and Discussion

Participants in the nature (vs. urban) condition reported higher self-esteem, authenticity, life satisfaction, and meaning in life (Table 5). Next, we carried out two serial mediation analyses (Model 6, 5,000 bootstraps; Hayes, 2018) with life satisfaction and meaning in life as dependent variables. In both cases, condition (1 = *nature condition*, 0 = *urban condition*) was the independent variable, whereas self-esteem and authenticity were the serial mediators.¹²

As shown in Figure 10, the indirect effect of condition on life satisfaction through self-esteem and authenticity (.06) was significant, 95% CI [.02, .13]. In addition, the indirect effect of condition on life satisfaction through self-esteem alone (.16) was significant, 95% CI [.04, .29], as was the indirect effect of condition on life satisfaction through authenticity (.07), 95% CI [.02, .17].

As displayed in Figure 11, the indirect effect of condition on meaning in life through self-esteem and authenticity (.11) was significant, 95% CI [.03, .22]. The indirect effect of condition on meaning in life through self-esteem (.09) was also significant, 95% CI [.03, .20], as was the indirect effect of condition on meaning in life through authenticity (.14), 95% CI [.04, .28]. Taken together, nature increased PWB by raising sequentially self-esteem and authenticity.

Study 12: The Long-Term Influence of Nature on Psychological Well-Being as Mediated by Authenticity

Study 12 was interventional and longitudinal. We fostered nature involvement by asking participants to engage in a nature-related activity (vs. control) for a month. We assessed authenticity and PWB (indicated by life satisfaction, meaning in life, depression, anxiety, and stress) at the beginning (Time 1), and twice later (Time 2 and Time 3) with a 2-week interval. Compared with the control group, we expected that nature involvement would be linked to increases in authenticity and PWB. We further hypothesized that authenticity change would mediate the relation between nature involvement and PWB.

Method

Participants

In Studies 1–9 and Study 11, nature’s effect on authenticity was small to medium. We anticipated a similarly sized effect in Study 12. Given that our primary analyses would be regression-based, we referred to Cohen’s (1988) indications of effect sizes (i.e., small = .14, medium = .39, large = .59). We expected a standardized β of .26, the average value of small and medium effects (Fritz & Mackinnon, 2007).

We conducted a power analysis in G*Power 3.1 (F test—linear multiple regression: fixed model, R^2 increase option; Faul et al., 2009). We set Cohen’s f^2 to .0725 ($f^2 = R^2/[1 - R^2]$; $.26^2/[1 - .26^2]$) to determine the sample size for obtaining 80% power to detect a small-to-medium effect of nature on authenticity and PWB. At least 111 participants were required.

We conducted an additional power analysis pertaining to the mediation by authenticity of the nature–PWB link (Fritz & Mackinnon, 2007). Given the small-to-medium effect of nature on authenticity and the medium effect of authenticity on PWB (for a meta-analysis, see Sutton, 2020), we would need a minimum sample size of 126 to achieve 80% power using a percentile bootstrap approach (Hayes, 2018; Kenny & Judd, 2014).

We recruited 152 Chinese undergraduate students from Zhejiang Ocean University for a three-wave study remunerating each with 15 Yuan ($\approx \$2.40$). All students lived in dormitories. Of them, 19 did not complete measures pertinent to the second and/or third wave, and so we excluded them from data analysis. The resulting 133 participants (78 women, 55 men) ranged in age from 17 to 24 years ($M = 18.63$, $SD = 1.07$; seven participants did not report their age).

Procedure

Participants learned that they would complete measures of a psychological survey 3 times in the coming weeks. At Time 1, they filled out the authenticity and PWB measures. Afterward, they

¹² We compared the fitness of the first hypothesized serial mediation model (condition \rightarrow self-esteem \rightarrow authenticity \rightarrow life satisfaction) with an alternative mediation model (condition \rightarrow authenticity \rightarrow self-esteem \rightarrow life satisfaction). The fitness of hypothesized serial mediation model was better than that of the alternative model (Supplemental Table 9S). We also compared the fitness of the second hypothesized serial mediation model (condition \rightarrow self-esteem \rightarrow authenticity \rightarrow meaning in life) with an alternative mediation model (condition \rightarrow authenticity \rightarrow self-esteem \rightarrow meaning in life). The fitness of hypothesized serial mediation model was better than that of the alternative’s (Supplemental Table 9S).

Table 5
The Effect of Condition (Nature vs. Urban) on Variables Assessed in Study 11

| Variable | <i>M (SD)</i> | | <i>t</i> (298) | <i>p</i> | Cohen's <i>d</i> 95% CI |
|-------------------|--------------------------|-------------------------|----------------|----------|----------------------------|
| | Nature (<i>n</i> = 147) | Urban (<i>n</i> = 153) | | | |
| Self-esteem | 3.32 (.28) | 3.21 (.46) | 2.55 | .011 | .30 [.07, .52] |
| Authenticity | 5.47 (.62) | 5.15 (.92) | 3.54 | <.001 | .41 [.18, .64] |
| Life satisfaction | 5.30 (.96) | 4.93 (1.20) | 2.96 | .003 | .34 [.11, .57] |
| Meaning in life | 5.82 (.81) | 5.57 (1.21) | 2.12 | .035 | .24 [.02, .47] |

Note. CI = confidence interval.

were randomly assigned to the nature involvement ($n = 61$) versus control ($n = 72$) condition. In the nature involvement condition, they received a flowerpot with daffodil bulbs as a token of our appreciation for their involvement in the study; they were instructed to water the plant and photograph it every second day. In the control condition, participants received a notebook (of equal value with the flowerpot) as a token of our appreciation for their involvement; they were instructed to carry on with their daily schedules, as usual.

Two weeks later, participants were contacted via a text message and invited to fill out again the measures using an online link (Time 2). Those in the nature involvement condition were reminded to look after the plant and photograph it every second day. Finally, 2 weeks later (i.e., 4 weeks after Time 1), all of the participants were recontacted via text messaging and requested to fill out the measure once again using an online link (Time 3). At exit interviews, all participants in the nature condition indicated that they watered and photographed their plants regularly, as instructed. Only five of the 61 participants in that condition reported that the plants had started to bloom at Time 3.

Measures

Authenticity. Participants completed the Authenticity Scale (A. M. Wood et al., 2008) 3 times: $M_s = 4.42, 4.48, 4.53$; $SD_s = .84, .84, .87$; $\alpha_s = .84, .86, .89$.

Psychological Well-Being. Participants completed three PWB measures. One, assessing *life satisfaction*, was the five-item Satisfaction with Life Scale (Diener et al., 1985; Xiong & Xu,

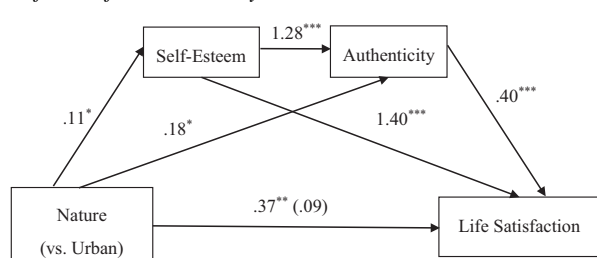
2009; 1 = *strongly disagree*, 7 = *strongly agree*). They filled it out 3 times: $M_s = 4.44, 4.52, 4.62$; $SD_s = 1.05, 1.13, 1.16$; $\alpha_s = .82, .87, .88$. The second scale, assessing *meaning in life*, was the five-item Presence of Meaning Subscale of the Meaning in Life Questionnaire (Passmore et al., 2022; Steger et al., 2006; 1 = *strongly disagree*, 7 = *strongly agree*). Participants completed it 3 times: $M_s = 5.08, 5.10, 5.11$; $SD_s = 1.11, 1.10, 1.02$; $\alpha_s = .89, .90, .87$. The third scale was the Depression Anxiety Stress Scale (Lovibond & Lovibond, 1995). It comprises 21 items, seven of which pertain to depression (e.g., "I found it difficult to work up the initiative to do things"), seven to anxiety (e.g., "I felt I was close to panic"), and seven to stress (e.g., "I found myself getting agitated"). Response options ranged from 1 (*did not apply to me at all*) to 4 (*applied to me very much or most of the time*). Participants completed the same 3 times: $M_s = 1.67, 1.62, 1.59$; $SD_s = .38, .43, .44$; $\alpha_s = .89, .92, .94$.

Results and Discussion

Authenticity

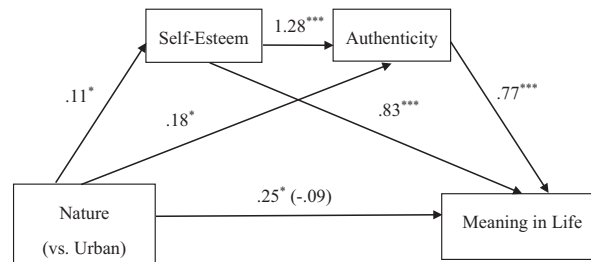
The results are displayed in Table 7. At Time 1 (baseline), there was no significant difference between participants in the nature involvement and control conditions on authenticity. Our random assignment was effective. At Time 2, there was still no significant difference on authenticity between the two conditions. However, at Time 3, participants in the nature involvement condition reported higher authenticity than controls. A repeated measures multivariate analysis of variance showed that the Condition \times Time interaction was significant, $F(2, 262) = 6.38, p = .002, \eta_p^2 = .046, 90\% \text{ CI } [.01, .09]$.

Figure 10
Self-Esteem and Authenticity Serially Mediate the Effect of Nature on Life Satisfaction in Study 11



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

Figure 11
Self-Esteem and Authenticity Serially Mediate the Effect of Nature on Meaning in Life in Study 11



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

Table 6

Effect of Nature (vs. Control) on Change in Authenticity and Psychological Well-Being (Life Satisfaction, Meaning in Life, Depression/Anxiety/Stress) in Study 12

| Predictor | Authenticity | | Life satisfaction | | Meaning in life | | DASS | |
|------------------|--------------|-----------|-------------------|-----------|-----------------|-----------|----------|-----------|
| | <i>b</i> | <i>SE</i> | <i>b</i> | <i>SE</i> | <i>b</i> | <i>SE</i> | <i>b</i> | <i>SE</i> |
| Intercept | 4.42*** | .10 | 4.38*** | .12 | 4.97*** | .13 | 1.67*** | .04 |
| Condition | .02 | .14 | .09 | .18 | .07 | .20 | -.01 | .07 |
| Time | -.01 | .02 | .00 | .03 | -.02 | .02 | .00 | .01 |
| Condition × Time | .08** | .02 | .10** | .04 | .11** | .04 | -.05*** | .01 |

Note. DASS = Depression Anxiety Stress Scale; *SE* = standard error.

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

We applied longitudinal multilevel analysis to model the effect of nature involvement (vs. control) on authenticity. Level 1 consisted of assessments at repeated time points nested within each participant, whereas Level 2 unit consisted of each participant. We allowed both the intercept and linear slope of authenticity to differ randomly across participants. We coded condition (1 = *nature involvement*, 0 = *control*) as a time-invariance covariant. To examine how authenticity changed over time across conditions, we added condition, time, and their interaction in the regression model, with the Condition × Time interaction characterizing the nature (vs. control) effect on authenticity over time. Consistent with the abovementioned analysis, the results (presented in Table 6) showed that the starting level of authenticity did not differ between conditions ($\gamma_{\text{Condition}} = .02$, $SE = .14$, $p = .901$). More important, although authenticity for control participants did not change over time ($\gamma_{\text{time}} = -.01$, $SE = .02$, $p = .503$), authenticity manifested increasing higher level over time among nature participants compared to control participants ($\gamma_{\text{Condition} \times \text{Time}} = .08$, $SE = .02$, $p = .001$). Plant cultivation for a month (vs. control) was accompanied by rises in authenticity.

Psychological Well-Being

There was no difference on life satisfaction, meaning in life, and depression/anxiety/stress between participants in the nature involvement versus control condition at Time 1 or Time 2 (Table 7). Differences, though, emerged at Time 3. Participants in the nature involvement condition reported higher life satisfaction than controls. Likewise, participants in the nature involvement condition reported higher meaning in life than controls. Similarly, participants in the nature involvement condition reported lower depression, anxiety, and stress than controls. A repeated measures multivariate analysis of variance yielded a significant Condition × Time interactions on: satisfaction with life: $F(2, 262) = 3.71$, $p = .027$, $\eta_p^2 = .028$, 90% CI [.00, .07]; meaning in life: $F(2, 262) = 5.05$, $p = .007$, $\eta_p^2 = .037$, 90% CI [.00, .09]; and depression/anxiety/stress, $F(2, 262) = 6.66$, $p = .002$, $\eta_p^2 = .048$, 90% CI [.01, .10]. Stated otherwise, nature involvement significantly increased life satisfaction and meaning in life, and significantly decreased depression, anxiety, and stress over time compared to control (Table 7). Finally, we conducted a longitudinal multilevel analysis followed the same procedure as we did for authenticity. We found a consistent pattern of results: nature involvement significantly increased all indicators of PWB over time compared to control (Table 6).

Mediation Analysis

Next, we examined whether the effect of nature involvement (vs. control) on PWB was mediated by change in authenticity (see Figure 12, for the relevant theoretical model). Specifically, we tested two effects of authenticity under the framework of longitudinal multilevel analysis: (a) the initial level of authenticity, which is a Level 2, between-person effect by grand mean centering the baseline level of authenticity, and (b) change in authenticity, which is a Level 1, within-person effect by subtracting the baseline score from authenticity score at each time point. Thus, we added in the model the initial level of authenticity, its interaction with time, and change in authenticity from baseline to predict PWB. As hypothesized, for all the outcomes, the Condition × Time interaction decreased. Furthermore, we used mediation package (Tofiqhi & MacKinnon, 2011) in R to test the indirect effect. We found significant indirect effect of nature involvement (vs. control) on PWB through increasing authenticity (Table 8).

Internal Meta-Analyses

We carried out a series of internal meta-analyses in an effort to consolidate the findings. We first conducted a meta-analysis estimating the size of nature's effect on authenticity across all quasi-experimental and experimental studies (Studies 2–6, 8–9, and 11) via the metafor package in R (Viechtbauer, 2010). We obtained a significant and medium-size effect ($d = .33$, $p < .001$, 95% CI [.25, .41]). We also estimated the size of nature's effect on authenticity separately for each factor of the Authenticity Scale (Lenton, Slabu, et al., 2013; A. M. Wood et al., 2008). We observed significant and medium-to-small effects sizes for all three factors: for authentic living, $d = .33$, $p < .001$, 95% CI [.25, .42]; for acceptance of external influence, $d = -.22$, $p = .007$, 95% CI [-.38, -.06]; and for acceptance of self-alienation, $d = -.19$, $p < .001$, 95% CI [-.28, -.11].

In the next meta-analysis, we tested whether nature's effect on authenticity varies as a function of type of exposure (i.e., real nature vs. digital nature).¹³ We obtained null findings ($d = .03$, $p = .728$, 95% CI [-.15, .21]): nature's influence on authenticity was independent of exposure type. In addition, the effects of nature on the three factors of authenticity did not vary across different nature exposure types ($p > .458$): for authentic living, $d = -.02$, $p = .868$, 95% CI [-.19, .16]; for low acceptance of external influence,

¹³ We coded Studies 2–3 and 6 as 1, representing real nature. We coded Studies 4–5 and 8–10 as 0, representing digital nature.

Table 7
Effect of Nature (vs. Control) on Authenticity and Psychological Well-Being in Study 12

| Variable | <i>M (SD)</i> | | <i>t</i> (131) | <i>p</i> | Cohen's <i>d</i> 95% CI |
|--------------------------|-------------------------|--------------------------|----------------|----------|----------------------------|
| | Nature (<i>n</i> = 61) | Control (<i>n</i> = 72) | | | |
| Authenticity | | | | | |
| Time 1 | 4.45 (.78) | 4.41 (.89) | .32 | .749 | .06 [−.29, .40] |
| Time 2 | 4.55 (.85) | 4.42 (.83) | .83 | .396 | .15 [−.20, .49] |
| Time 3 | 4.74 (.87) | 4.36 (.83) | 2.56 | .011 | .45 [.10, .79] |
| Life Satisfaction | | | | | |
| Time 1 | 4.49 (1.08) | 4.42 (1.05) | .36 | .723 | .06 [−.28, .41] |
| Time 2 | 4.64 (1.18) | 4.30 (1.07) | 1.74 | .084 | .30 [−.04, .65] |
| Time 3 | 4.90 (1.17) | 4.43 (1.13) | 2.33 | .021 | .41 [.06, .75] |
| Meaning in Life | | | | | |
| Time 1 | 5.03 (1.18) | 4.99 (1.09) | .21 | .835 | .04 [−.31, .38] |
| Time 2 | 5.23 (1.14) | 4.89 (1.06) | 1.78 | .078 | .31 [−.04, .65] |
| Time 3 | 5.38 (1.03) | 4.91 (.97) | 2.68 | .008 | .47 [.12, .81] |
| DASS | | | | | |
| Time 1 | 1.65 (.39) | 1.68 (.39) | −.34 | .736 | −.06 [−.40, .29] |
| Time 2 | 1.58 (.42) | 1.66 (.44) | −1.16 | .249 | −.20 [−.55, .14] |
| Time 3 | 1.46 (.41) | 1.69 (.44) | −3.09 | .002 | −.54 [−.88, −.19] |

Note. DASS = Depression Anxiety Stress Scale; CI = confidence interval.

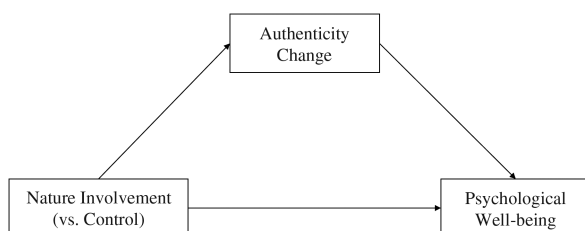
$d = -.13, p = .458, 95\% \text{ CI } [-.47, .21]$; and for low self-alienation, $d = .04, p = .624, 95\% \text{ CI } [-.13, .22]$.

Finally, in an attempt to quantify fit discrepancies between the hypothesized and alternative model, we conducted a meta-analysis of experimental studies that assessed self-esteem as a mediator (Studies 5, 8, 9, and 11). The results indicated that the hypothesized model (indirect effect = .15, $SE = .03, 95\% \text{ CI } [.10, .20]$) fits better than the alternative model (indirect effect = .09, $SE = .02, 95\% \text{ CI } [.06, .12]$). Also, we performed a meta-analysis comparing the mediational strength of self-esteem (nature → self-esteem → authenticity; Studies 5, 8, 9, and 11) with that of mindfulness (nature → mindfulness → authenticity; Studies 6, 8, and 9; Viechtbauer, 2010). The mediational effect of self-esteem was significant (indirect effect = .15, $SE = .03, 95\% \text{ CI } [.10, .20]$), whereas the mediational effect of mindfulness was not significant (indirect effect = .08, $SE = .05, 95\% \text{ CI } [-.01, .18]$).

General Discussion

The human mind evolved in a natural environment (Barkow et al., 1992; Buss, 2000; Sedikides et al., 2006). According to the biophilia hypothesis (Kellert & Wilson, 1995), humans have an inborn proclivity to affiliate with nature. This is a distal influence. The said proclivity is expressed proximally in preferences for engagement

Figure 12
Effect of Nature Involvement (vs. Control) on Psychological Well-Being as Mediated by Authenticity Change in Study 12



with a natural environment rather than a built environment (Mangone et al., 2017; Ulrich, 1981; Zhu & Xu, 2021), and in spending time in nature (M. Chen et al., 2018; Kellert et al., 2017).

What might account for people's attraction to nature? We postulated that nonthreatening environments constitute optimal fit for humans (Schmader & Sedikides, 2018). As such, people would feel more authentic when in a natural environment.

Summary of Findings

We obtained consistent support for this proposal (i.e., nature has a positive influence on authenticity) across 12 studies characterized by setting (field, laboratory), design (cross-sectional, experimental, longitudinal), methodology (different manipulations of nature and assessment of mediators and/or dependent measures), and cultural (university/community, East Asian/Western) diversity. In addition, we obtained a significant and medium-size effect of nature on authenticity via an internal meta-analysis of all quasi-experimental and experimental studies (Studies 2–6, 8–9, and 11).

Moreover, we specified plausible mechanisms through which nature is associated with, or fosters, authenticity. These were basic need satisfaction (Study 3), positive affect (Studies 4 and 7), self-esteem (Studies 5, 7–9, and 11), and mindfulness (Studies 6 and 7–9). Satisfaction of autonomy proved to be more potent than satisfaction of competence or relatedness (Study 3), and self-esteem emerged as the most powerful overall mechanism linking nature to authenticity (Studies 7–9). Finally, we observed that exposure to nature (vs. control) improves PWB, contributing to increases in life satisfaction and meaning in life via self-esteem and authenticity (Studies 11 and 12), and both to increases in life satisfaction and meaning in life, as well as decreases in depression, anxiety, and stress via authenticity (Study 12). The findings generalized across age and gender (Studies 1–12): We report reanalyses that include gender and age as control variables in Supplemental Tables 20S–29S. Also, the findings generalized across an index of socioeconomic status (i.e., monthly income; Study 1).

Table 8

Effects of Initial Authenticity and Change in Authenticity on Psychological Well-Being (Life Satisfaction, Meaning in Life, Depression/Anxiety/Stress) Over Time in Study 12

| Predictor | Life satisfaction | | Meaning in life | | DASS | |
|---|-------------------|------------|-----------------|------------|----------|--------------|
| | <i>b</i> | <i>SE</i> | <i>b</i> | <i>SE</i> | <i>b</i> | <i>SE</i> |
| Intercept | 4.70*** | .12 | 5.40*** | .13 | 1.52*** | .04 |
| Condition | .08 | .16 | .05 | .16 | -.00 | .06 |
| Time | .01 | .03 | -.03 | .03 | -.00 | .01 |
| Condition × Time | .07 | .04 | .08 | .04 | -.04* | .01 |
| Initial authenticity | .55*** | .10 | .72*** | .10 | -.26*** | .03 |
| Initial Authenticity × Time | .01 | .02 | -.02 | .02 | -.01 | .01 |
| Authenticity change | .41*** | .09 | .35*** | .08 | -.19*** | .03 |
| Indirect effect | | | | | | |
| Condition → authenticity change → psychological well-being | .03 | [.02, .05] | .03 | [.01, .05] | -.01 | [-.02, -.01] |

Note. DASS = Depression Anxiety Stress Scale; *SE* = standard error.

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

We approach the issue of mediation cautiously. Our mediational hypotheses were informed by our theoretical framework. Although the mediational tests placed the theory at risk (Anderson & Bushman, 1997; Fiedler et al., 2011), we interpret the findings as plausible rather than definitive (Maxwell & Cole, 2007; O’Laughlin et al., 2018). In particular, we tested alternative models, where applicable (see Footnotes and Supplemental Materials). In most cases (Studies 4–6, Studies 8–9, Study 11), the tested model had better fit than the alternative model(s), but in one case (Study 3) it did not do so, and in another case, it had worse fit (Study 7). Furthermore, we found that self-esteem emerged as the strongest mediator of nature’s effect on authenticity, through an internal meta-analysis across experimental studies that included self-esteem as a mediator (Studies 5, 8, 9, and 11).

Finally, in an attempt to test directly its mediational status, we manipulated self-esteem and examined its causal impact on authenticity (Study 10). Self-esteem increased authenticity, thus reinforcing its conceptualization as mediator. Regardless, we acknowledge that the ordering of our variables (i.e., putative mediators) can be approached from alternative theoretical perspectives, and we hope that future research takes that extra step.

Implications

There is no consensus in the literature regarding the precursors of authenticity. However, we derived, theoretically and empirically, four likely candidates of the relation between nature and authenticity—basic need satisfaction, positive affect, self-esteem, mindfulness—and secured independent support for each.

Autonomy emerged as the most influential of the basic needs. This finding is consistent with the self-determination theory literature highlighting the relevance of autonomy (Lee et al., 2022; Weinstein et al., 2009) and with the attention restoration theory literature indicating that nature enables people to behave autonomously (S. Kaplan, 1995; Passmore & Howell, 2014). The finding is also consistent with literature characterizing the sense of power, a correlate of autonomy (Lammers et al., 2016), as a precursor of authenticity (Kifer et al., 2013; Kraus et al., 2011).

Self-esteem was the most potent of the mediators that we examined (followed by mindfulness). Overall, nature relates to

authenticity through high self-esteem or impacts on authenticity by raising one’s self-esteem. Self-esteem is a key ingredient of the self-concept (Alicke & Sedikides, 2009; Greenwald et al., 1988; M. Wood, 1991). As such, nature has implications for one’s self-concept, and in particular for self-concept positivity. Interestingly, authenticity is also enveloped in self-concept positivity. For example, authenticity is associated with positive or socially desirable characteristics (Fleeson & Wilt, 2010; Sheldon et al., 1997), and people regard their morally superior hypothetical behaviors (i.e., solutions to moral dilemmas) as more authentic. In addition, they construe their authentic self as good and moral (Christy et al., 2016; Newman et al., 2014) and as a guide to their moral behavior (Newman et al., 2015). Last, people believe that their authentic self is more positive and moral than others’ authentic selves (Y. Zhang & Alicke, 2021), and their authenticity is raised when they receive positive feedback or visualizing a highly positive future self (Guenther et al., 2023). Self-esteem, then, and perhaps self-concept positivity, are particularly influential in connecting nature to authenticity.

We treated authenticity as a unitary construct and measured it in most studies (at the trait or state level) with the Authenticity Scale (Lenton, Slabu, et al., 2013; A. M. Wood et al., 2008). This scale, though, consists of three factors: authentic living, low acceptance of external influence, and low self-alienation. In our analyses, we collapsed across these three factors. Study 10 reinforced our decision, showing that the Authenticity Scale produced converging results with the Southampton Authenticity Scale (Kelley et al., 2022). Nevertheless, we proceeded to reanalyzed data from all studies that had used the Authenticity Scale (Studies 1–6, 8–9, 11) separately for each factor. The results generally converged across factors (Supplemental Tables 10S–19S). Second, we obtained significant and medium-to-small effects sizes of nature on all of the three factors of authenticity through meta-analyses across the quasi-experimental and experimental studies (Studies 2–6, 8–9, and 11).

The findings have applicability. For example, nature engagement might elevate authenticity and consequently improve PWB among those with limited mobility (nursing home residents), persons who experience higher levels of stress or daily risk, and individuals in clinical therapy (Bratman et al., 2021; Grassini, 2022; Owens & Bunce, 2022) or living with psychopathology (Tran et al., 2022).

More generally, the findings could inform policymaking and urban planning, with an emphasis on improving the quality of greenspace infrastructure in underprivileged areas (Wolch et al., 2014; Wyles et al., 2019).

Directions for Future Research

We examined, in part, effects of nature on PWB as mediated by authenticity. Future research might address whether authenticity transmits the influence on nature upon other domains such as physical health (Jimenez et al., 2021; Turunen et al., 2023), prosociality (Castelo et al., 2021; J. W. Zhang et al., 2014), education (Kuo et al., 2021; Mann et al., 2022), or leadership effectiveness (Van Droffelaar & Jacobs, 2017, 2018). Alternatively, or in addition, future research could examine whether authenticity carries the influence of nature on morality or ethical behavior (Kim et al., 2019; H. Zhang et al., 2019), reduced aggression (McCormick et al., 2015; Pinto et al., 2012), or work satisfaction and performance (Cable et al., 2013; Nübold et al., 2020).

Some authors suggested that nature's PWB benefits might vary depending on type of exposure (i.e., real nature vs. digital nature; White et al., 2017). We could not address this question, but addressed a similar one, namely, whether nature's effect on authenticity varies as a function of type of exposure (i.e., real nature vs. digital nature). We found through internal meta-analyses that nature's effects on authenticity, as well as the three factors of authenticity, did not vary across different nature exposure types.

The literature has also suggested that nature's PWB benefits can vary depending on exposure frequency or length (Shanahan et al., 2016), patterns of contact with nature (Kahn et al., 2010), as well as environmental attributes such as landscape type (Wheeler et al., 2015), tree canopy density (B. Jiang et al., 2014), and biodiversity (Marselle et al., 2021). In Study 12, nature involvement (vs. control) manifested its influence on authenticity and PWB with some delay, that is, 4 weeks from onset. Future research may examine whether the abovementioned variables moderate the influence of nature on authenticity, especially via the currently identified mediators. There are other promising moderators, such as personality characteristics. For example, the nature-instigated, and authenticity-mediated, effects that we observed might be stronger for individuals high on anxiety (Tost et al., 2019) or loneliness (Vitalia, 2020), and low on narcissism (Womick et al., 2019).

Moreover, a focus on the restorative qualities of nature is promising (Menardo et al., 2021). For example, cyberostracism (i.e., experimental manipulations of exclusion via the cyberball paradigm; K. D. Williams & Jarvis, 2006) decreases authenticity (Borawski, 2022) and so does objectification (i.e., being treated as an object for the attainment of others' goals; Cheng et al., 2022). Nature may counter the influence of cyberostracism and objectification, thus restoring authenticity.

Limitations

We conducted both cross-sectional Study 2 and quasi-experimental Study 3 in the field, and particularly in a park or a plaza. We collected data across conditions on the same days and times, and we employed the same randomly assigned research assistants. The parks and plazas appeared to be equally crowded, although we did not record the number of people present in each site. Generally, people in the parks

were involved in leisure activities (e.g., walking, sitting), whereas people in the plazas were involved in shopping or walking. We cannot rule out the possibility of confounds pertinent to the testing sites. We addressed this possibility, however, in Study 3, an experiment in which we randomly assigned participants to the nature versus urban condition. Here, we replicated the findings of Studies 1–2 (as we did in Studies 4–6, 8–9, and 11).

In exit interviews (Study 12), participants in the nature condition remarked that they had watered their plant (without specifying how frequently) and had photographed it every second day. Participants in the control condition did not engage in an equivalent activity. However, we doubt that the results can be accounted for solely by this difference in conditions. Participants were students, living in dormitories, and leading busy lives. We surmise that control condition participants would have found another, non-nature-related activity (e.g., social media engagement) to fill up a time equivalent to occasional plant-watering and photographing a plant.

We conceptualized, operationalized, and focused on nonthreatening nature. Of course, natural environments can also be threatening. For example, wilderness evokes more death-related cognitions compared to cultivated nature (Koole & Van den Berg, 2005), and exposure to untamed nature may have unfavorable well-being or health consequences (e.g., being poisoned by plants, stung by insects, or attacked by large mammals; Soga & Gaston, 2022). Threatening environments, then, place boundaries on our findings.

Researchers on the link between nature and PWB have raised the alarm, pointing out that most of the studies have included Western samples (Gallegos-Riofrío et al., 2022). We took steps at addressing this issue by testing mostly Chinese samples. Yet, the next empirical wave would need to sample from a broader pool of cultures.

We used cross-sectional, experimental, and longitudinal designs. Future research might add experience sample methodology (Huber et al., 2022) allowing the assessment of momentary variation of the influence of nature on authenticity and downstream consequences, and virtual reality (Chan et al., 2021), which may maximize the effects of nature. Also, we relied exclusively on self-report. Follow-up investigations could supplement self-report with neuropsychological, biomarkers of inflammation and stress, and physiological measures (D. K. Brown et al., 2013; Chang et al., 2021; Hunter et al., 2019; Shuda et al., 2020; Tost et al., 2019).

Concluding Remarks

Individuals report feeling authentic in familiar places (Lenton, Bruder, et al., 2013), harmonious work environments or when led by authentic managers (Cha et al., 2019; Grandey et al., 2012), close relationships (Kraus & Chen, 2014; Wickham et al., 2018), online contexts (Hance et al., 2018), and while they are having fun (Lenton, Bruder, et al., 2013). Here, we identified another source of authenticity: nature. It is linked to, or fosters, authenticity predominantly via self-esteem, and it has implications for PWB.

Nature, then, is important to the sense of feeling aligned with one's real self and to wellness. These findings raise questions for the increasing trend toward urbanization and the accompanying environmental or mental health deterioration (Blue & Harpham, 1996; Kesebir, & Kesebir, 2017). Reconnecting with nature promises benefits for the self (i.e., higher authenticity) and wellness (i.e., PWB).

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