ORIGINAL RESEARCH



Creating Kinship with Nature and Boosting Well-Being: Testing Two Novel Character Strengths-Based Nature Connectedness Interventions

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Abstract

We tested the efficacy of engaging in two novel randomized interventions based on character strengths and engaging with nature on boosting nature connectedness and well-being. In Study 1 (N = 134, international community adults) and Study 2 (N = 106, Canadian university students), participants were tasked with noticing how their character strengths were displayed in nature (CinN intervention). In Study 3 (N=99, Canadian university students), participants were tasked with using their highest character strength in a new way each day to connect with nature (CSwithN intervention). A no treatment control condition was used for comparison. Both interventions significantly boosted nature connectedness (ds = 0.48, 0.66, 0.67). With respect to well-being, the CSinN intervention significantly boosted transcendent connectedness (ds = 053, 0.57), elevation (d = 0.40), and harmony in life (d = 0.48). The CSwithN intervention also significantly boosted transcendent connectedness (d=0.43), elevation (d=0.48), and harmony in life (d=0.50), along with satisfaction of basic need of relatedness (d=0.58), flourishing (d=0.57), satisfaction with life (d=0.44), and positive affect (d=0.43). Beneficial effects on nature connectedness and well-being were evident despite there being no significant difference in time spent in nature compared to controls. These findings present a unique contribution to the current literature. To our knowledge, the CSinN and CSwithN interventions are the first interventions developed and tested that incorporate character strengths and engagement with nature with the dual goal of boosting nature connectedness and individual well-being.

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"Nature and I are Closer Intertwined than I Initially Understood." [Participant 2266598].

Amidst increasingly technological, urbanized societies (Mamichev & Dergacheva, 2021; Silva et al., 2018), a general trend of decreased connection with the natural world appears to be present (Beery et al., 2023). The presence of this growing disconnect is noticeable, for example, in language trends from the mid-nineteenth century to present exhibiting a steady decrease in references to nature in literature and popular cultural products such as movies and song lyrics (Kesebir & Kesebir, 2017; Langer et al., 2021; Prévot-Julliard et al., 2015). This growing nature-disconnect is substantiated by longitudinal survey data. Over time, individuals in post-industrial nations have reported feeling increasingly less connected to nature (Soga & Gaston, 2023), with young people in particular reporting greater feelings of disconnect with nature (Schönbach et al., 2022). Such a prevalent detachment from the natural world poses a potential threat to well-being, given evidence of positive associations between feeling connected to nature and several well-being outcomes, and a negative association between feeling connected to nature and mental distress (Barrable & Booth, 2022; Capaldi et al., 2014, Pritchard et al., 2020; White et al., 2021; Wu & Jones, 2022).

An *anthropocentric* view, characterized by valuing nature for its tangible advantages (Thompson & Barton, 1994) and a perception of dominance over ecosystems (Olivos & Clayton, 2017), is prevalent in Western cultures (Speed, 2006). This pervasive assumption of 'human exceptionalism', "the idea that humans occupy a separate and privileged place among other beings" (Anderson & Perrin, 2018, p. 448), has fed a growing detachment from nature (Kellert et al., 2017; Kim et al., 2023), a detachment that appears to have deepened with urban population growth (Bashan et al., 2021; Richardson et al., 2022b).

The effect of urbanization on nature connectedness may in part be explained by an *extinction of experience* of interacting with nature (Cazalis et al., 2023; Colléony et al., 2020; Gaston & Soga, 2020; Soga & Gaston, 2016). Diminished interaction with nature may reduce perceived benefits and even precipitate an aversion (Zhang et al., 2014), perpetuating a cycle of disconnect. The rapid proliferation of screen-based pastimes appears to have further exacerbated this extinction of experience of engaging with nature (Michaelson et al., 2020; Pergams & Zeredic, 2006; Richardson et al., 2018). It is important to recognize, however, that many cultures have maintained worldviews and identities closely connected to the natural world (Lomas, 2019; Marczak & Sorokowski, 2018; Oh et al., 2020). Nonetheless, consistent patterns of disconnect from nature appear present among many nations sharing a "Western" mindset and cultural values (Richardson et al., 2022a, 2022b).

As humans, we have a fundamental need to feel connected and to belong to a community (Deci & Ryan, 2000; Vansteenkiste et al., 2020). While these needs are, of course, importantly met by connecting with our fellow humans, another fundamental pathway for satisfying these needs extends beyond our relationships with other people. Across the globe, people also relate to and form connections with deceased ancestors, deities, abstract entities such as countries and organizations, as well as with non-human animals and the living environment (the greater-than-human natural world) to meet their social-relational needs (Fiske, 2004; Keaulana et al., 2021; Lengieza et al., 2023). Thus, a disconnect from the other-than-human natural world thwarts this additional pathway to satisfying our fundamental need to relate and belong. Despite a growing disconnect, the desire to be connected to nature remains adapting to changing cultural contexts (Colding et al., 2020; Gaekwad et al., 2022). Nature connectedness, a sense of belonging to and identifying with nature (Lengieza & Swim, 2021; Mayer & Frantz, 2009; Schultz, 2002), could offer a path back to harmonizing our intrinsic need for connection with the ecological systems we inhabit, thereby improving well-being, given consistent links of nature connectedness to outcomes such as happiness and meaning in life (Pritchard et al., 2020).

1 Nature Connectedness

A wealth of empirical literature evidences that nature connectedness is linked with both hedonic and eudaimonic well-being (see meta-analyses: Capaldi et al., 2014, Pritchard et al., 2020; Wu & Jones, 2022). While research is somewhat limited directly examining the mechanisms by which connecting with nature leads to well-being, various researchers have proposed and/or provided evidence that nature provides for meaning in life (Passmore & Krause, 2023), helps to assuage our existential anxieties including those relating to identity, death, and freedom (Passmore & Howell, 2014), nurtures our self-authenticity (Yang et al., 2023a, 2023b), and helps to meet our basic psychological needs of autonomy, competence, and relatedness (Yang et al., 2022).

Relatedness may be a particularly strong mechanism by which nature connection is linked to well-being. As a hyper-social species (Wilson, 2012) we are biologically and psychologically predisposed to want to affiliate with *all* of life, including the beyond-human natural world ("biophilia hypothesis": Kellert & Wilson, 1993; Schiebel et al., 2022; Wilson, 1984). In their Eco-Existential Positive Psychology framework, Passmore and Howell (2014) proposed, and provided evidence, that the cultivation of our innate biophilic tendencies plays a fundamentally important role in assuaging our existential anxieties relating to isolation, harkening back to Nelson's (1993) writing on how disconnection from the natural community creates for us a "profound and imperiling loneliness" (p. 221; see also Passmore et al., 2023). Several researchers have reviewed evidence of how an enhanced sense of nature connectedness is linked to greater feelings of social and general connectedness (Clayton, 2003; Cleary et al., 2017; Mayer et al., 2009).

A bond with nature seems to represent a unique type of connectedness, one that predicts personal well-being over and above the sense of connection people experience in various areas of life, such as with friends, family, and home environments (Passmore et al., 2023; Richardson et al., 2021; Zelenski & Nisbet, 2014). Thus, connecting with nature has been put forth as a basic human need in and of itself (Baxter & Pelletier, 2019; Hurly & Walker, 2019)., which can be facilitated by reconnecting to nature through the Pathways Framework (i.e., activities highlighting the senses, emotions, meaning, beauty, and compassion; Lumber et al., 2017).

Self-transcendence, particularly salient when connecting with nature (Castelo et al., 2021; Isham et al., 2022; Jacobs & McConnell, 2022; Mei et al., 2024; Sanyer, 2023), involves expanded feelings of connection (what we term "transcendent connectedness"; i.e., feeling connected to everyone and everything;see Yaden et al., 2017). This is often accompanied by a cognitively expanded sense of self wherein the natural world is incorporated into one's self-construal (DeCicco & Stroink, 2007). Recent evidence suggests that self-transcendence fosters pro-social behaviour (Castelo et al.; Stellar et al., 2017) including pro-environmental behaviour (Isham et al., 2022; Jacobs & McConnell, 2022;

Moreton et al., 2019). Consistent evidence has also emerged linking nature connectedness to greater pro-environmental behaviour (Barragan-Jason et al., 2023; Dunne et al., 2024; Mackay & Schmitt, 2019; Richardson et al., 2020; Whitburn et al., 2019; Zylstra et al., 2014). Moreover, several researchers have argued that nature connectedness is the primary driver and a necessary pre-requisite for engagement in pro-environmental behaviour (Frantz & Mayer, 2014; Roczen et al., 2014), actions which themselves have been, across cultures, related to improved well-being (Capstick et al., 2022). Thus, nature connectedness is beneficial for both people's and nature's well-being and appear to be interlinked.

2 Nature Connectedness Interventions

A variety of interventions have been utilized to foster nature connectedness, yielding positive results in enhancing nature connectedness and well-being (or reducing ill-being in some studies) across different age groups (McEwan et al., 2022; see also reviews: Barrable & Booth, 2020; Moula et al., 2022; Sheffield et al., 2022). Research evidences that immersion in nature yields increases in cognitive, affective, and physiological benefits (Capaldi et al., 2015; Jimenez et al., 2021; McMahan & Estes, 2015; Ohly et al., 2016; Rojas-Rueda et al., 2019), in addition to increases in nature connectedness (Lengieza & Swim, 2021; Silva et al., 2023). Thus, most nature connectedness interventions emphasize nature immersion (e.g., McEwan et al., 2022; Pirchio et al., 2021; Schmäing & Grotjohann, 2024).

However, it appears as though the quality of engagement with nature is more important than mere exposure to or time spent in nature in the promotion of nature connectedness and well-being (Richardson et al.,). Interventions in which the primary activity is actively paying attention to everyday nature have evidenced increases in well-being (Passmore & Holder, 2017; Passmore et al., 2022a, 2022b) and nature connectedness (Passmore et al., 2022a, 2022b; see also Nisbet et al., 2019), despite participants not spending more time in nature than control counterparts. Interventions which are integrated into daily routines hold advantages over interventions focusing on immersion in nature. In addition to the obvious appeal of not having to devote additional time in one's day, interventions that occur in the same context as one's day-to-day life are accessible, particularly for individuals residing in urban environments (van Heel et al., 2024).

One route to deepening the quality of one's engagement with nature is to recognize characteristics shared with nature. The important role that a perception of similarity-to-oneself plays in attraction (and consequently, connection) is well evidenced (Byrne, 1997). We tend to exhibit greater positive feelings towards others whom we perceive as being similar to ourselves (Launay & Dunbar, 2015; Sprecher, 2019; Sprecher et al., 2008). This similarity effect also holds true for our attraction towards non-human animals, an effect which appears to be enhanced by anthropomorphization, the attribution of human qualities to non-human entities (Amiot & Bastion, 2017). Extending beyond animals, ascribing human qualities such as personality traits and character strengths to the natural world can facilitate a sense of similarity, and subsequently a greater sense of nature connectedness (Clayton et al., 2011; Lumber et al., 2023; Yang et al., 2023a, 2023b) and/or greater intentions to engage in pro-environmental behaviours (Chan, 2021; Liu et al., 2019; Tam, 2019; Tam et al., 2013).

3 Character Strengths

One of the foundations upon which the science of well-being/positive psychology is grounded is the study of character strengths (Littman-Ovadia et al., 2021; see also Horowitz, 2018). Character strengths, defined as "personality traits that reflect our basic identity, produce positive outcomes for ourselves and others, and contribute to the collective good" (Niemiec & Pearce, 2021, p. 2; Niemiec, 2018), are most commonly assessed using the VIA taxonomy (see VIA Inventory of Strengths, Kretzschmar et al., 2023; McGrath, 2019; McGrath et al., 2022; McGrath & Wallace, 2021),¹ which are 24 universal strengths in the VIA Classification framework (Peterson & Seligman, 2004). Findings from several studies utilizing character strengths interventions provide support for their utility in promoting well-being in various contexts (see reviews by: Littman-Ovadia et al., 2021; Niemiec & Pearce, 2021; Schutte & Malouff, 2019). Signature strengths are those character strengths most essential to one's identity and that are energizing and effortless to use (Niemiec & McGrath, 2019). Engaging personal signature strengths (particularly engaging signature strengths in new ways) within interventions provides a means of individualizing interventions, benefiting well-being (Gander et al., 2024; Ghielen et al., 2017; Heintzelman et al., 2023; Proyer et al., 2015; Schutte & Malouf, 2019). A greater degree of individualization in positive psychology interventions may also enhance intervention adherence (Sheldon & Lyubomirsky, 2006; Uliaszek et al., 2022), albeit, evidence is limited for this supposition.

The practice of intentionally looking for character strengths displayed by others (a practice known as 'strengths spotting'; Niemiec, 2019) has also demonstrated beneficial effects for well-being, including enhanced feelings of belonging (Kashdan et al., 2018), satisfaction of basic need of relatedness (Quinlan et al., 2015, 2019) and supportive behaviours towards the other (Tobias et al., 2024).

Although limited, some research has been conducted examining the relationship between character strengths and nature connectedness (Merino et al., 2020) as well as intentions to engage in pro-environmental behaviour (Corral-Verdugo et al., 2015; Diessner & Niemiec, 2023). Interestingly, one strengths-spotting exercise that Quinlan et al. (2015) included in their intervention was identifying strengths in videos of lion cubs, thus extending the 'other' to include beyond-human natural word. Together, these findings offer initial evidence for the utility of targeting character strengths in nature-focused interventions.

4 The Current Research

Collectively, extant literature exhibits the present widespread disconnect with the natural world (Soga & Gaston, 2023), and the need to promote the inclusion of nature in the sense of self in order to foster nature connectedness, pro-environmental behaviour, and well-being (Lumber et al., 2017; Pritchard et al., 2020; Whitburn et al., 2019). In the current three studies we aimed to address this by testing two week-long character strengthsbased interventions designed to boost nature connectedness and individual well-being. As noted above, identifying commonalities between the self and the natural world plays an important role in fostering nature connectedness (Clayton et al., 2011), while the practice

¹ See Najderska & Cieciuch, 2018; Partsch et al., 2022 for additional assessments. See Snow, 2019 for critiques.

of strengths-spotting (Niemiec, 2019) has been demonstrated to enhance feelings of relatedness. Further, literature suggests that anthropomorphism can offer a means of facilitating identification and connection with non-human entities in a meaningful way (Tam et al., 2013; Yang et al., 2023a, 2023b). Taking all of this into account, we surmised that anthropomorphization might be enhanced by recognizing one's own character strengths and then identifying them being displayed by the natural world. Such an approach may bolster the similarity effect, thus strengthening the degree to which the natural world is included in individuals' sense of self and eliciting a deeper a sense of nature connectedness.

Thus, our intervention in Studies 1 and 2 involved observing and identifying how nature displays one's own character strengths. (See Lumber et al., 2023 for an in-depth exploration of the qualitative responses from Study 1.) Building on findings from Studies 1 and 2, and from literature demonstrating the impact of using one's signature strength(s) in new ways (Schutte & Malouff, 2019), the intervention utilized in Study 3 involved using one's top strength in a new way each day to connect more with nature.

Across these three studies, we hypothesized that compared to a no treatment control condition, participants who engaged in the character strengths interventions would report significantly higher levels of nature connectedness (H1) and well-being (H2). Given that Passmore and colleagues (2022a) previously evidenced that participants who engaged in the Noticing Nature Intervention (i.e., noticing how the everyday nature encountered in their daily routine made them feel) reported significant boosts to well-being despite not spending more time in nature than control participants, we further hypothesized that time spent in nature over the course of the current study would not significantly impact differential levels of nature connectedness and well-being across the CSiN and control conditions (H3). Lastly, we hypothesized that, compared to participants in the no treatment condition, participants engaged in the character strengths-based interventions would report significantly higher levels of intentions to engage in pro-environmental behaviour (H4).

We report how we determined our sample size, data exclusions, all manipulations, and all measures in the study. We also note measures that were completed at the same time as the current study but which are not reported herein as this data was collected for the purpose of a separate exploratory study.

5 Study 1

5.1 Method

5.1.1 Recruitment and Participants

We partnered with the VIA Institute on Character to recruit participants.² Every third visitor to the VIA site who had completed the VIA Inventory of Strengths was forwarded to an ad on an external site (not associated with the VIA Institute). The study ad invited people to "participate in a scientific study examining variations of a new strengths-based wellbeing intervention", at the end of which they could enter themselves into a draw to win

² This was an arms-length collaboration between our study and the VIA Institute; no participant responses were shared with the authors about participants' VIA responses and vice versa.

one of two \$50 CAD Amazon e-vouchers. No mention was made of 'nature' so as to avoid initial self-selection bias. All participants were fluent in written and spoken English.

We strove to recruit as large a sample size as we could over the course of timeframe we were able to collect data. A total of 373 participants were initially recruited. Of these, data from 213 participants were dropped for not completing the post-questionnaires; data from an additional 26 participants were dropped for either not engaging in their randomly assigned intervention task for a minimum of five days with at least one entry per day or not following directions with respect to the intervention. Thus, our final sample size consisted of 134 participants (see Table 1). Of those who reported their age, mean age of participants was 41.71 years (SD=14.31); Median=44; range: 20–69. The majority of participants gender-identified as female (n=104); the majority of participants (n=92) were currently residing in the United States, the United Kingdom, Australia, and Canada. (See Table 2 for complete demographics on gender identity and country.)

5.2 Measures

Beyond the measures noted below, a few additional measures were utilized for use in separate studies; manuscripts for these studies are in preparation. Please see our OSF supplementary material for a listing of these and for all items of all questionnaires used in the current studies: https://osf.io/q4axh/?view_only=424d9f77543d4e9e99888c6c8520e43c.

Nature Connectedness. Given nuanced aspects comprising nature connectedness, we created a composite measure by standardizing scores on three scales and calculating a mean.

Inclusion of Nature in Self. The Inclusion of Nature in Self Scale (INS; Schultz, 2002) is a single-item measure in which participants choose one of seven diagrams depicting increasing degrees of overlap between a circle labeled "Self" and one labeled "Nature", rated on a scale from 1 (the furthest apart) to 7 (completely overlapping).

Condition		Completed part 1	Completed part 3	(% dropped out of study)	Engaged in task correctly*	(% Dropped off-the- mark)
Study 1:						
	Control	186	103	44.62%	103	0%
	CSinNature	187	57	69.52%	31	45.61%
	Total	373	160	-	134	-
Study 2:						
	Control	61	61	0%	61	0%
	CSinNature	53	53	0%	45	15.09%
	Total	114	114	_	106	_
Study 3:						
	Control	61	61	0%	61	0%
	CSwithNature	50	50	0%	38	24.00%
	Total	111	111	-	99	-

Table 1 Study 1, 2, and 3: participant numbers

For a minimum of 5 days with a minimum of 5 entries (i.e., minimum one correct entry per day)

Table 2	Study 1, 2, 3: participant gender identity and cou	ntry				
Demo- graphic	Study 1		Study 2		Study 3	
	N		Ν		N	
Gender ic	dentity:					
	Male	22	Male	17	Male	14
	Female	104	Female	88	Female	82
	Transgender	7	Non-binary	1	Non-binary	1
	None above	1		I		I
	Prefer not say	1		I		I
	Missing Info	4		I		2
Country:	*					
	United States	58	Canada	LT L	Canada	72
	United Kingdom	13	India	4	India	5
	Australia	11	Philippines	3	Colombia	3
	Canada	10	Colombia, Lebanon, Mexico, Nigeria,	2 each	Nigeria, Philippines, Portugal	2 each
	Spain	3	Pakistan,		Cameroon, Croatia, England, Eritrea,	1 each
	Brazil, Finland, Germany, Greece, Malaysia, Mexico	2 each	Afghanistan, Cameroon, Croatia, Eritrea, France, Jamaica, Norway, Portugal, Sri	1 each	Lebanon, Mexico, Norway, Pakistan, Sri Lanka, Yemen	
	Argentina, Belarus, Belgium, Bugaria, Estonia, France, Hungary, India, Israel, Italy, Jamaica, Japan, Kenya, Palau, Peru, Philippines, Poland, Russia, South Africa, Sweden, Turkey, United Arab Emirates	1 each	Lanka, Ukraine, Yemen			
	Missing Info	5	Missing Info	1	Missing Info	3
* Study 1	: Country currently residing in. Study 2, 3: Coun	ttry you e	consider home			

Connectedness to Nature. The Connectedness to Nature Scale (CNS; Mayer and Frantz, 2004) is composed of 14 items which assess a sense of oneness with the natural world (e.g., "I often feel a sense of oneness with the natural world around me", "I often feel a kinship with animals and plants"). Items are rated on a 5-point scale with endpoints 1 (*Strongly Disagree*) and 5 (*Strongly Agree*).

Nature connection index. The Nature Connection Index (NCI; Richardson et al., 2019) is a 6-item scale (e.g., "I find being in nature really amazing."); items are rated on a 7-point scale with endpoints 1 (*Completely disagree*) and 7 (*Completely agree*).

Well-Being. We chose a variety of measures utilized in previous research examining nature-based interventions, to capture a broad and nuanced range of aspects of well-being.

Transcendent Connectedness. Transcendent connectedness (TC) is the extent to which an individual feels connected to wider aspects of humankind and life in general; that is, "feeling connected to everything and everyone" (Yaden et al., 2017, p. 143). To assess TC, six items were selected from the Metapersonal Self (MPS) Scale (DeCicco & Stroink, 2007; see also Passmore et al., 2022a, 2022b). Items (e.g., "My sense of identity is based on something that unites me with all other people" and "I see myself as being extended into everything else") are rated on a 7-point scale with end points of 1 = Strongly Disagree and 7 = Strongly Agree.

Satisfaction of basic need of relatedness. We utilized the 4-item relatedness subscale of Chen et al's (2015) Satisfaction of Basic Psychological Needs Scale (item example: "I feel connected with people who care for me, and for whom I care."), on which items are rated on a 5-point scale ranging from 1 =Completely Disagree to 5 =Completely Agree).

Elevation. The composite emotional experience of elevation was assessed with Huta and Ryan's (2010) Elevating Experience Scale (EES), a 13-item scale which assesses a variety of emotions comprising elevation (e.g., inspired, elevated, deeply appreciative, profoundly touched, emotionally moved). Items are rated using a 7-point scale with endpoints 1 (*Not At All*) and 7 (*Extremely*), according to the degree to which each item describes how the respondent typically feels.

Flourishing. Overall flourishing was measured with Diener et al.'s (2010) Flourishing Scale, a 7-item scale (e.g., "I lead a purposeful and meaningful life", "I am engaged and interested in my daily activities."); items are rated on a 7-point scale from 1 = Strongly Disagree to 7 = Strongly Agree.

Harmony in Life. Kjell et al.'s (2015) Harmony in Life five-item scale was used. Items (e.g., "I accept the various conditions of my life.") are rated on a 7-point scale ranging from 1=Strongly Disagree to 7=Strongly Agree.

Satisfaction with Life. Diener et al.'s (1985) Satisfaction with Life Scale was used; respondents rate five items (e.g., "The conditions of my life are excellent.") on a 7-point scale ranging from 1 (*Strongly Disagree*) to 7 (*Strongly Agree*).

Positive and Negative Emotions. Lastly, the 12-item Scale of Positive and Negative Experiences (Diener et al., 2010) was used; respondents rate six words pertaining to positive emotions (e.g., good, joyful) and six words illustrating negative emotions (e.g., bad, sad) on a 5-point scale from 1 (Very Rarely or Never) to 5 (Very Often or Always) to indicate the extent to which they experience each of the listed emotions.

Pro-environmental Behaviour. Two scales were used to assess the degree to which participants engage in pro-environmental behaviours; items in both scales were reframed to assess the degree to which participants intended to engage in the behaviours in the future.

Pro-environmental Activism. The Pro-Environmental Activist Behavior Scale (Schmitt et al., 2019) lists ten pro-nature activism actions (e.g., "I will get involved with a group

Dependent variables	Study 1	Study 2	Study 3
	ωt	ωt	ωt
Nature connectedness (composite)	0.88	0.90	0.87
Transcendent connectedness	0.88	0.81	0.80
Satisfaction of basic needs-relatedness	0.86	0.79	0.82
Elevation	0.95	0.93	0.93
Flourishing	0.90	0.90	0.85
Harmony in life	0.90	0.89	0.85
Satisfaction with life	0.90	0.89	0.87
Positive affect	0.90	0.88	0.86
Negative affect	0.87	0.83	0.81
Pro-nature activist behaviours (intentions)	0.92	0.93	92
Pro-environmental consumer behaviours (intentions)	0.90	0.91	0.90
Time in nature (hours) over past week of study	_	_	_

Table 3 Study 1, 2, 3: dependent variable reliability statistics and sample sizes

whose main aim is to preserve or protect the environment.", "I will sign a petition in support of protecting the environment."

Pro-environmental Consumerism. The Pro-Environmental Consumer Behaviors Scale (Schmitt et al., 2019) is a 16-item scale focusing on pro-nature consumer behaviors; for example; "I will eat more plants (such as vegetables, fruits, legumes, and grains) and less meat.", "I will reduce my consumption overall (having fewer material goods)." Items in both scales are rated on a 7-point scale from l = Strongly Disagree to 7 = Strongly Agree.

(See Table 3 for McDonald's ωt for all measures.)

Time in Nature. At the end of the study, participants were asked to estimate (in hours) how much time they had spent in nature over the past week. The question noted that 'nature' was defined as "any area that is predominantly not human-built. This could be a back yard or front yard garden, an urban green-space park, sitting by a river even if in an urban built area. etc." All participants were also asked to comment on what they learned or gained from participating in the study.

5.3 Procedure

After reading the ad and consenting, participants completed our dependent variable measures on nature connectedness, well-being, and intentions to engage in pro-environmental behaviour. Participants were then randomly assigned by the online system to the Character Strengths in Nature (CS*in*N) intervention condition or a no treatment control condition.³ Participants assigned to the CS*in*N condition were asked to, "*Each day, for the next 7 days, look for examples of your top 5 signature strengths in the nature that you encounter in your daily routine. Take notice of these examples and write them down.*" An example was

³ For efficiency, we concurrently ran a separate intervention study which utilized Study 1's control condition. Thus, participants could have also been randomly assigned to a people-based character-strengths-based well-being intervention condition. Results of this study are being written up separately; manuscript is in preparation.

provided. For the next seven days, these participants received a daily email which contained a reminder of the intervention instructions, and a link to the study website to log their daily observations of nature displaying their own personal character strengths. Participants in the control condition were instructed that "We are also testing the effects of engaging in variations of the new strengths-based well-being intervention at different times of the month. You will receive your strengths-based intervention in 8 days! We appreciate your patience while waiting to receive your instructions." At the end of the week, all participants received an email with a link to the post-study questionnaires; these consisted of the same measures asked at pre-study, with the addition of the time-in-nature question and the open-ended question regarding any insights gained from participating in the study. All participants were then presented with debriefing information which included instructions for the CS*in*N intervention. Participants then clicked "next" to continue to a page separate from their responses to enter their name and contact information into the draw for one of two \$50 CAD Amazon e-vouchers.

6 Quantitative Results–Hypothesis Tests

Hypotheses regarding differences at post-intervention in nature connectedness, well-being, and intentions to engage in pro-environmental behaviour between the CSinN (n=31) and the no treatment control (n=103) conditions were tested via conducting a series of ANCOVAs using pre-measure scores as a covariate in each analysis. To test our hypothesis regarding time spent in nature, a t-test was conducted to assess if a significant difference between the conditions was evident. Analyses were performed using *jamovi* (v. 2.3.28 for Linux). (See Table 4 for detailed statistics of analyses.)

H1 on nature connectedness: Post-intervention levels of nature connectedness were, as hypothesized, significantly higher in the CS*in*N condition (d=0.48).

H2 on well-being: Post-intervention levels of transcendent connectedness were significantly higher in the CS*in*N condition (d=0.53), partially supporting our hypothesis with respect to well-being. However, no significant difference emerged between the conditions for any of the other well-being measures or for negative affect.

H3 on time in nature: Results of a t-test did not indicate a significant difference between conditions for the amount of time participants had spent in nature over the course of the study period, supporting our hypothesis. Further, the addition of time spent in nature as covariate did not significantly change outcomes of ANCOVAs for nature connectedness or any of the well-being variables.

H4 on intentions to engage in pro-environmental behaviour. This hypothesis was not supported as no significant difference emerged between the conditions for either measure of pro-environmental behaviour.

7 Qualitative Findings

With the exception of spirituality, each of the "core" 24 character strengths identified by Peterson and Seligman (2004) were mentioned by participants as being displayed by nature. The character strengths participants most commonly observed nature displaying included honesty, creativity, curiosity, love of learning, and love. (See Table 5 for complete breakdown.) Although the character strength of spirituality was mentioned, rather than noting how nature

					i
Dependent variables	F/t	d	d (95% CI)	CSinN Maroinal M (SF)	Control Maroinal <i>M</i> (<i>SE</i>)
*Nature Connectedness (composite)	F(1,125) = 5.07	0.026	$0.48\ (0.06,\ 0.90)$	00.07 (0.06)	-00.09 (0.03)
*Transcendent Connectedness	F(1,127) = 6.12	0.015	$0.53\ (0.10,0.96)$	30.58 (0.79)	28.38 (0.41)
Satisfaction of Basic Needs-Relatedness	F(1,128) = 0.02	0.881	0.03 (-0.45, 0.39)	16.58 (0.31)	16.63(0.16)
Elevation	F(1,125) = 0.09	0.760	0.07 (-0.36, 0.50)	64.37 (1.31)	63.92 (0.68)
Flourishing	F(1,128) = 3.18	0.078	0.38 (-0.04, 0.81)	45.54 (0.67)	44.19 (0.35)
Harmony in Life	F(1,125) = 0.32	0.571	0.12 (-0.31, 0.56)	24.41 (0.63)	24.01 (0.33)
Satisfaction With Life	F(1, 128) = 1.83	0.179	0.29 (-0.14, 0.72)	24.83 (0.58)	23.94 (0.30)
Positive Affect	F(1,127) = 0.84	0.362	0.20 (-0.23, 0.63)	23.22 (0.35)	22.86 (0.18)
Negative Affect	F(1,127) = 1.25	0.265	0.24 (-0.68, 0.19)	16.71 (0.43)	17.25 (0.22)
Pro-Nature Activist Behaviours (Intentions)	F(1,126) = 0.54	0.465	0.16 (-0.27, 0.59)	39.35 (1.36)	38.23 (0.70)
Pro-Environmental Consumer Behaviours (Intentions)	F(1,125) = 0.23	0.631	0.10 (-0.53, 0.33)	84.92 (1.45)	85.71 (0.75)
Time In Nature (hours) over past week of study	t(128) = 1.43	0.154	0.31 (-0.12, .73)	M = 9.86 (2.40)	$M = 6.81 \ (0.90)$

time point
d effect sizes are for difference between respective conditions See OSF supplementary material for tables of all M(SD) of all dependent variables for each condition at
*Denotes significant difference between conditions; bold denotes significant difference between conditions Marginal M are estimated marginal means corrected for pre-sc d effect sizes are for difference between respective conditions See OSF supplementary material for tables of all M(SD) of all dependent variables for each condition at

	Study 1 CSinNature		Study 2 CSinNature		Study 3 CSwithNature	
Virtues	Wisdom	33.28%	Courage	30.51%	Transcendence	49.50%
	Courage	19.63%	Humanity	16.16%	Wisdom	19.80%
	Humanity	16.10%	Wisdom	15.76%	hUmanity	19.14%
	Transcendence	12.27%	Justice	15.35%	Justice	4.62%
	Temperance	11.81%	Transcendence	12.93%	Temperance	3.63%
	Justice	6.90%	Temperance	9.29%	Courage	3.30%
Character						
Strengths	Honesty	10.89%	Perseverance	16.16%	Beauty & excellence	20.79%
	Creativity	9.36%	Bravery	7.68%	Gratitude	16.83%
	Curiosity	8.59%	Teamwork	6.87%	Love	10.23%
	Love of learning	7.36%	Kindness	6.87%	Kindness	8.91%
	Love	7.21%	Curiosity	6.67%	Curiosity	8.25%
	Kindness	5.83%	Love	6.06%	Humour	5.61%
	Judgment	5.67%	Creativity	5.05%	Love of learning	4.95%
	Forgiveness	5.67%	Zest	4.65%	Spirituality	3.96%
	Fairness	4.60%	Fairness	4.44%	Teamwork	3.63%
	Humour	4.14%	Gratitude	4.24%	Creativity	3.63%
	Perseverance	3.37%	Leadership	4.04%	Perseverance	2.31%
	Gratitude	3.37%	Humour	3.43%	Норе	2.31%
	Zest	3.07%	Social intelligence	3.23%	Judgment	1.98%
	Social intelligence	3.07%	forgiveness	3.23%	Self-regulation	1.98%
	Prudence	3.07%	Prudence	2.63%	Leadership	0.99%
	Humility	2.61%	Beauty & excellence	2.63%	Perspective	0.99%
	Норе	2.61%	Perspective	2.42%	Forgiveness	0.99%
	Perspective	2.30%	Self-regulation	2.22%	Bravery	0.66%
	Bravery	2.30%	Honesty	2.02%	Prudence	0.66%
	Beauty & excellence	2.15%	Hope	1.82%	Zest	0.33%
	Leadership	1.99%	Love of learning	1.21%	Fairness	0.00%
	Self-regulation	0.46%	Humility	1.21%	Honesty	0.00%
	Teamwork	0.31%	Spirituality	0.81%	Social intelligence	0.00%
	Spirituality	0.00%	Judgment	0.40%	Humility	0.00%

Table 5 Summary table of virtues and character strengths from "on-the-mark" entries in study 1, 2, 3

itself displayed this character strength, participants reflected on how nature inspired a sense of spirituality in themselves. Similarly, as Lumber et al. (2023) noted in their in-depth exploration of the qualitative findings from this study, some participants misunderstood the task and used their character strengths to connect *with* nature. Nonetheless, for those who did engage successfully and were 'on-the-mark' with the task, the intervention appeared to provide solid benefits, as reflected in the end-of-study comments. For example, "*More kinship with nature and awareness*" [Participant 5110872].

8 Discussion

In Study 1, we tested a new intervention which combined character strengths and noticing nature. The CS*in*N intervention involves spotting your character strengths in nature, that is, noting how nature displays your personal character strengths. Compared to the control condition, engaging in this intervention, for a minimum of five days over the course of a week, significantly boosted nature connectedness and transcendent connectedness with effect sizes being on the high end (ds = 0.48, 0.53) of the average effect size of positive psychology interventions (ds from 0.20 to 0.61) reported in meta-analyses from non-clinical populations (Bolier et al., 2013; Sin & Lyubomirksy 2009; Weiss et al., 2016; White et al., 2019; see also Carr et al., 2023 for mega-analysis of meta-analyses). Qualitative findings supported the quantitative results, particularly with respect to individuals feeling a greater connection to nature.

It is important to note that a relatively large number of participants assigned to the CS*in*N condition dropped out of the study before completing Part 3 (69.52%), compared to the Control condition (44.62%), and of participants in the CS*in*N who completed Part 3, just under half (45.61%) either did not engage in the intervention for a minimum of five days, or were off-the-mark with respect to the intervention. Of the total 1,328 daily entries logged by participants in the CS*in*N condition, only 678 entries (51.05%) were on-the-mark, that is, were observations of how nature displayed individual's personal character strengths.

Given the promising indications for boosts in nature connectedness and transcendent connectedness by participants who fully engaged in the intervention, we decided to adjust the instructions to be more clear and to re-run the study with a new group of participants (Study 2).

9 Study 2

9.1 Method

9.1.1 Recruitment and Participants

The study ad was the same as in Study 1, except that compensation was 1.5% course credit. We strove to recruit as large a sample size as we could over the course of the semester. A total of 114 undergraduate participants were recruited from the participant pool at a Canadian university. All participants completed all parts of the study; however, data from 8 participants were dropped for either not engaging in their randomly assigned intervention task a minimum of five days with at least one entry per day, or not following directions with respect to the intervention. Thus, our final sample size was 106 participants (see Table 1). Mean age of participants was 21.82 years (SD = 5.39); Median = 20; range: 17–51. The majority of participants gender-identified as female (n = 88); the majority of participants considered Canada their home country (n = 77). (See Table 2 for complete demographics on gender identity and country.)

9.2 Measures and Procedure

All measures were identical to Study 1. (See Table 3 for McDonald's ωt for all measures.) The overall procedure was the same as in Study 1 (ad, consent, pre-questionnaires, random assignment, emails, daily logs for the intervention condition, post-questionnaires, debriefing); however, we made some adjustments to improve clarity and understanding. For the CSinN condition, a chart of the standard 24 character strengths was displayed with examples of each strength. We asked participants to carefully read this over and to think about which of the strengths they most identified with and how they displayed those strengths. A notice informed participants that "The 'next' button will appear in 3 min so you have time to contemplate these character strengths." The next page then provided the instructions as in Study 1, with the addition of an extra example and some clarifying statements emphasizing that the task was to notice what character strengths nature was exhibiting (i.e., "Note: We are not asking you to use your character strengths in nature. We are asking you to observe how NATURE displays character strengths, in particular, how does NATURE display character strengths you identify with."). Participants were then presented with a 2-min video of the lead author reiterating the instructions; the "next" button did not appear until the video was over to help ensure participants did not click past the video without watching/listening to it. Instructions for the no treatment control condition remained the same as in Study 1, with the addition of an explanatory video.⁴

10 Quantitative Results–Hypothesis Tests

Statistical methodology to test differences between the CS*in*N (n=45) intervention condition and the no treatment control (n=61) condition was the same as in Study 1. (See Table 6 for detailed statistics of analyses.)

H1 on nature connectedness: Post-intervention levels of nature connectedness were, as hypothesized, significantly higher in the CS*in*N condition (d=0.66).

H2 on well-being: Post-intervention levels of three indices of well-being were significantly higher in the CS*in*N condition: transcendent connectedness (d=0.57), the composite emotion of elevation (d=0.57), and harmony in life (d=0.48); positive affect was marginally significantly higher in the CS*in*N condition (d=0.39). Thus, our hypothesis with respect to well-being was largely supported. No significant difference emerged between the conditions for satisfaction of the basic need of relatedness, flourishing, or satisfaction with life, or for negative affect.

H3 on time in nature: Results of a t-test did not indicate a significant difference between conditions in the amount of time participants had spent in nature over the course of the study period. Further, the addition of time spent in nature as covariate did not significantly change outcomes of ANCOVAs for nature connectedness or any of the well-being variables.

H4 intentions to engage in pro-environmental behaviour: No significant difference emerged between the conditions for either measure of pro-environmental behaviour.

⁴ For efficiency, based on insights from Study 1, we concurrently ran a separate intervention study (CS*with*N) which utilized Study 2's control condition. Thus, participants could have also been randomly assigned to the CS*with*N condition. Results of this study are reported below as Study 3.

Dependent variables	F/t	d	d (95% CI)	CSinN Marginal <i>M</i> (<i>SE</i>)	Control Marginal M (SE)
*Nature connectedness (composite)	F(1,95) = 10.22	0.002	0.66 (0.25, 1.06)	0.11 (0.07)	-0.19 (0.06)
*Transcendent connectedness	F(1,103) = 8.46	0.004	$0.57\ (0.17,0.97)$	31.24 (0.53)	29.19 (0.46)
Satisfaction of basic needs-relatedness	F(1,102) = 0.52	0.474	0.14(-0.25,0.54)	17.09 (0.23)	16.87 (0.19)
*Elevation	F(1,102) = 3.98	0.049	$0.40\ (0.00,\ 0.80)$	65.45 (1.17)	62.37 (1.00)
Flourishing	F(1,102) = 0.38	0.54	0.12 (-0.53, 0.28)	44.47 (0.56)	44.93 (0.48)
*Harmony in Life	F(1,102) = 5.79	0.018	$0.48\ (0.08,\ 0.87)$	25.81 (0.50)	24.24 (0.42)
Satisfaction With Life	F(1,102) = 0.10	0.756	0.06(-0.33, 0.45)	24.15 (0.52)	23.94 (0.44)
†Positive Affect	F(1,101) = 3.66	0.058	0.39 (-0.02, 0.80)	23.67 (0.38)	22.71 (0.32)
Negative Affect	F(1,101) = 1.38	0.243	0.24 (-0.63, 0.16)	16.87 (0.30)	17.33 (0.26)
Pro-Nature Activist Behaviours (Intentions)	F(1,102) = 0.20	0.660	0.09(-0.31, 0.48)	40.87 (1.13)	40.21 (0.96)
Pro-Environmental Consumer Behaviours (Intentions)	F(1,101) = 1.44	0.233	0.24 (-0.16, 0.64)	87.59 (1.25)	85.63 (1.05)
Time In Nature (hours) over past week of study	t(104) = 0.02	0.986	0.00(-0.38, 0.38)	10.58 (14.49)	10.53 (15.40)
[*] Denotes significant difference between conditions; bold	denotes significant differ	ence between c	onditions † denotes margi	nally significant difference	between conditions;

italics denotes marginally significant differences between conditions | Marginal M are estimated marginal means corrected for pre-scores | d effect sizes are for difference between respective conditions | See OSF supplementary material for tables of all M(SD) of all dependent variables for each condition at each time point

Table 6 Study 2: ANCOVAs / t-test

11 Qualitative Findings

Overall, log entries were similar to those in Study 1, with each of the "core" 24 character strengths represented (see Table 5 for complete breakdown). This included spirituality being noted as nature itself displaying the transcendent or sacred aspect of spirituality (rather than inspiring a sense of spirituality as in Study 1). See Fig. 1 for a chart of examples of the VIA Character Strengths displayed in nature.

At the end of the study, virtually every person in the CSinN condition commented that engaging in the intervention helped them appreciate nature more and that it deepened their connection to nature. For example, "I learned a deeper sense of appreciation for nature" [Participant 1892710]; "I feel that I improved my connection with nature and my environment." [Participant 3138487]. Several participants also commented on the positive impact the intervention had on their well-being. For example, "Being in natures is really great on my well-being." [Participant 4727696]; "I learned that paying attention to nature made me feel calm." [Participant 2895766]; "I learned that ... it does bring me joy." [Participant 5505040].



The VIA Classification of character strengths on this graphic is © 2004-2025, VIA Institute on Character. Used with permission. All rights reserved. www.viacharacter.org

Fig. 1 Matrix chart of examples of the VIA character strengths displayed in nature – Study 2

12 Discussion

In Study 2, we again tested the new intervention of spotting one's personal character strengths in nature, but this time with enhanced instructions. Compared to the control condition, engaging in the CS*in*N for a minimum of five days over the course of a week significantly boosted nature connectedness and three indices of well-being: transcendent connectedness, the composite emotion of elevation, and harmony in life (ds = 0.40-0.66]. Additionally, positive affect was marginally significantly higher (d=0.39). As in Study 1, effect sizes were at the high end of the average effect size of other positive psychology interventions reported in meta-analyses (e.g., Carr et al., 2023). Qualitative findings supported the quantitative results with respect to the intervention enhancing individual's connection to nature and their well-being.

All participants in Study 2 completed all parts of the study, in contrast to Study 1 where 57.10% of participants dropped out before completing the post-questionnaires. Compared to the community adult sample in Study 1 for whom compensation was not guaranteed (i.e., a prize draw entry), the student sample recruited in Study 2 may have been more motivated to complete the study for their course credits. Nonetheless, of particular note is that, compared to Study 1 wherein nearly 46% of data in the CSiN condition was dropped due to participants not fully engaging in the task or logging off-the-mark entries, in Study 2 only 15% of the data needed to be dropped for these reasons. Indeed, of the 628 daily entries logged, 552 entries (87.89%) were on-the-mark; that is, entries were observations of how nature displayed the individual's personal character strengths. Clearly the enhanced instructions in combination with the explanatory video helped to ensure that the bulk of participants successfully engaged in the intervention as per instructions.

13 Study 3

The intervention tested in Study 3 was grounded in meta-analytic findings evidencing the efficacy of signature strengths interventions (Schutte & Malouff, 2019). We also drew inspiration from the many log entries in Study 1 by participants who had misconstrued the CS*in*N instructions and had, instead, used their character strengths to engage *with* nature. Thus, the intervention tested in Study 3 involved participants using their top character strength to connect more with nature (Character Strengths with Nature Intervention [CS*with*N]).

14 Method

14.1 Recruitment and Participants

The study ad and compensation were the same as for Study 2, and the same undergraduate participant pool was utilized. We strove to recruit as large a sample size as we could over the course of the semester. A total of 111 participants were recruited for Study 3. All participants completed all parts of the study; however, data from 12 participants were dropped for either not engaging in their randomly assigned intervention task a minimum of five days with at least one entry per day, or not following directions with respect to the intervention.

Thus, our final sample size was 99 participants (see Table 1). Mean age of participants was 21.38 years (SD=3.96); *Median*=20; range: 17–40. The majority of participants genderidentified as female (n=83); the majority of participants considered Canada their home country (n=72). (See Table 2 for complete demographics on gender identity and country.)

14.2 Measures and Procedure

All measures were identical to Study 1 and 2 (See Table 3 for McDonald's *wt* for all measures) The overall procedure was the same as in Study 2 (ad, consent, pre-questionnaires, random assignment, emails, daily logs for the intervention condition, post-questionnaires, debriefing); however, the intervention was different. In this study we were testing the CSwithN intervention. A chart of the standard 24 character strengths was displayed with examples of each strength. We asked participants to carefully read this over and to think about the which of these strengths they most identified with and how they displayed those strengths. A notice informed participants that "The "next" button will appear in 3 min so you have time to contemplate these character strengths." The next page then displayed a summary chart listing the 24 character strengths and provided the instructions as follows: "Referring back to the chart, choose the Character Strength on the list of 24 that is most energizing, easy to use, and most core/essential to who you are. Please use that (signature) strength in one new way each day to connect more with nature." As in Study 2, participants were then presented with a 2-min video of the lead author reiterating the instructions; the "next" button did not appear until the video was over to help ensure participants did not click past the video without watching/listening to it. Instructions for the no treatment control condition remained the same as in Study 2.⁵

15 Quantitative Results–Hypothesis Tests

Statistical methodology to test differences between the CSwithN (n=38) and the no treatment control (n=61) conditions was the same as in Study 2. (See Table 7 for detailed statistics of analyses.)

H1 on nature connectedness: Post-intervention levels of nature connectedness were, as hypothesized, significantly higher in the CSwithN condition (d=0.67).

H2 on well-being: Post-intervention levels of all indices of well-being (excepting flourishing) were significantly higher in the CS*with*N condition: transcendent connectedness (d=0.43), satisfaction of the basic need for relatedness (d=0.58), the composite emotion of elevation (d=0.48), harmony in life (d=0.50), satisfaction with life (d=0.44), and positive affect (d=0.43). Negative affect was not significantly different between conditions. Thus, our hypothesis was supported with respect to well-being.

H3 on time in nature: As in Study 1 and 2, t-test results did not indicate a significant difference between conditions in the amount of time participants had spent in nature over the course of the study period. Further, the addition of time spent in nature as a covariate

⁵ As noted previously, for efficiency, we concurrently ran Study 2 and Study 3 in order to utilize Study 2's control condition. Thus, participants could have also been randomly assigned to the CS*in*N, which have reported above for Study 2.

Dependent variables	F/t	d	d (95% CI)	CSwithN Marginal <i>M</i> (<i>SE</i>)	Control Marginal M (SE)
*Nature connectedness (composite)	F(1,85) = 9.26	0.003	0.67 (0.23, 1.12)	00.08 (0.07)	-00.19 (0.05)
*Transcendent connectedness	F(1,96) = 4.36	0.039	0.43 (0.02, 0.85)	30.79 (0.64)	29.10 (0.50)
*Satisfaction of basic needs-relatedness	F(1,96) = 7.63	0.007	$0.58\ (0.16,\ 1.00)$	17.85 (0.25)	16.95 (0.20)
*Elevation	F(1,96) = 5.31	0.023	$0.48\ (0.06,\ 0.90)$	66.36(1.35)	62.40 (1.06)
Flourishing	F(1,95) = 2.97	0.09	0.37 (-0.06, 0.80)	46.16(0.55)	44.94 (0.43)
*Harmony in life	F(1,95) = 5.77	0.018	$0.50\ (0.08,\ 0.93)$	2.13 (0.47)	24.69 (0.37)
*Satisfaction with life	F(1,95) = 4.19	0.043	$0.44\ (0.01,\ 0.87)$	26.43 (0.59)	24.87 (0.46)
*Positive affect	F(1,95) = 4.10	0.046	$0.43\ (0.01,\ 0.85)$	23.52 (0.39)	22.52 (0.30)
Negative affect	F(1,94) = 2.78	0.099	0.35 (-0.77, 0.07)	16.42 (0.37)	17.21 (0.29)
Pro-nature activist behaviours (intentions)	F(1,95) = 2.93	060.0	0.36 (-0.06, 0.81)	39.92 (1.27)	37.12 (0.98)
Pro-environmental consumer behaviours (intentions)	F(1,95) = 0.10	0.926	0.02 (-0.44, 0.40)	83.33 (1.42)	83.50 (1.10)
Time in nature (hours) over past week of study	t(96) = 0.75	0.454	0.15 (-0.57, 0.25)	8.54 (0.94)	10.53 (1.97)

1 d effect sizes are for difference between respective conditions I See OSF supplementary material for tables of all M(SD) of all dependent variables for each condition at each time point

Table 7 Study 3: ANCOVAs / t-test

did not significantly change outcomes of ANCOVAs for nature connectedness or any of the well-being variables.

H4 on intentions to engage in pro-environmental behaviour: No significant difference emerged between the conditions for either measure of pro-environmental behaviour.

16 Qualitative Findings

All but four (fairness, honesty, humility, social intelligence) of the "core" 24 character strengths were represented in the log entries, with the character strengths of appreciation of beauty and excellence, gratitude, love, kindness, and curiosity being the most common. (See Table 5 for complete breakdown.) Participants used their character strengths to connect with nature in a variety of ways (e.g., feeding birds, photographing or writing about nature, sensory awareness of nature, learning more about nature). See Fig. 2 for a world cloud of these activities.)

As in Study 2, participants commented that the intervention facilitated their connection to nature. For example, "I already knew I had a major connection with Nature, but participating in this study and recording it everyday has inspired a deeper connection when I see it written out. Writing everyday has inspired more emotional connections for when I am out in nature." [Participant 5203813]. Several participants also commented on the positive impact the intervention had on their well-being. For example, "[I learned] how much nature can affect our well-being (socially, emotionally, etc.)" [Participant 3348787]; "Being in nature is extremely helpful when feeling anxious or when you just need a boost in your day." [3263933]; "That being in nature is important and there are so many strengths that come along and things to look for it in for both well-being and enjoyment." [Participant 1917531].

A notable number of daily entries communicated a sense of experiential appreciation during the intervention. For example, "Today I went on another beautiful walk to connect more with nature. While I was walking I recognized the smallest details around me, This only made me appreciate it more." [Participant 5203813]; "I decided to use my strength of kindness to connect more with nature by reducing carbon waste from my car. I had a great

Fig. 2 Wordcloud of activities engaged in to connect more with nature – Study 3



morning riding my bike and I really got to appreciate my surroundings which led myself to enjoying my commute to school." [Participant 4016001].

All but five participants in the CSwithN condition commented that they had learned something. For example, "I learned how to be more aware of my surroundings and to reflect on my day and the positives that I saw" [Participant 3823698]; "I learned that I enjoy and appreciate nature more than I thought" [Participant 1928937]. A number of participants also commented about an enhanced sense of experiential appreciation: e.g., "I learned that I need to appreciate nature more and even stopping doing something for a second to enjoy nature is worth it." [Participant 2429881]; "[I learned] to take a moment and pause, look around at the world around me and appreciate the beauty in the little things." [Participant 5519611].

17 Discussion

In Study 3, we tested a second intervention involving using one's top character strength to connect more with nature. Compared to the control condition, engaging in the CS*with*N intervention for a minimum of five days over the course of a week significantly boosted nature connectedness and six indices of well-being: transcendent connectedness, satisfaction of the basic need for relatedness, the composite emotion of elevation, flourishing, harmony in life, satisfaction with life, and positive affect (ds = 0.43-0.67]. As in Study 1 and 2, effect sizes were at the high end of the average effect size of other positive psychology interventions reported in meta-analyses (e.g., Carr et al., 2023). Qualitative results were in line with quantitative findings with respect to the intervention improving well-being and strengthening individuals' connection to nature.

As in Study 2, all participants in Study 3 completed all parts of the study. The percentage of data that needed to be dropped due to participants not fully engaging in the task or logging off-the-mark entries (22%) was roughly similar to Study 2 (15%). Of the 392 daily entries logged, 303 entries (77.30%) were on-the-mark; that is, entries were observations of how the participant used their top character strengths to connect more with nature. Of entries that were off-the-mark, a majority engaged their top character strength but they did not use it to connect with nature, or they discussed well-being but did not mention a character strength or nature, or simply recapped activities the participant had engaged in that day.

18 General Discussion

The present research investigated two novel character strengths-based interventions geared to promote nature connectedness and well-being. Informed by research and literature on character strengths (Littman-Ovadia et al., 2021; Niemiec & Pearce, 2021; Schutte & Malouff, 2019), the similarity effect (Byrne, 1997; Launay & Dunbar, 2015; Sprecher et al., 2008), and anthropomorphism (Tam et al., 2013; Yang et al., 2023a, 2023b), in Study 1 and 2 participants were randomly assigned to either proceed with their usual activities (no treatment control) or to engage in the Character Strengths In Nature (CS*in*N) intervention, a twist on the practice of strengths-spotting. The CS*in*N intervention entails observing daily, for one week, how nature displays one's own personal top five signature character strengths. Participants in Study 2 received slightly modified, and clearer, instructions

due to a large proportion of off-the-mark entries in Study 1. Informed by the off-the-mark qualitative comments and literature evidencing benefits of using signature strengths in new ways, Study 3 introduced another character strengths-based intervention, the Character Strengths with Nature intervention (CS*with*N) wherein participants applied their foremost character strength in new ways to connect with nature daily for one week. (See Table 8 for summary of effect sizes and significance for all three studies.)

19 Nature Connectedness

Consistent with hypotheses, compared to participants randomly assigned to the control condition, participants randomly assigned to the character strengths interventions, reported significantly higher levels of nature connectedness (ds = 0.48, 0.66, 0.67). Qualitative comments from all three studies corroborated these findings, with most participants' comments implying a deep, meaningful degree of engagement with nature during, and at the end of,

Dependent Variable	Study $n = \text{pre}, n = \text{post}$		
	Study 1: CSiN $n = 31, 103$	Study 2: CSiN <i>n</i> =45, 61	Study 3: CSwN n=38, 61
Nature Connectedness (composite)	d = 0.48	d = 0.66	d = 0.67
	p = .026	p = .002	p = .003
Transcendent Connectedness	d = 0.53	d = 0.57	d = 0.43
	p = .015	p = .004	p = .039
Satisfaction of Basic Needs-Relatedness	d = 0.03	d = 0.14	d = 0.58
	p = .881	p = .474	p = .007
Elevation	d = 0.07	d = 0.40	d = 0.48
	p = .760	p = .049	p = .023
Flourishing	d = 0.38	d = 0.25	d = 0.37
	p = .078	p = .210	p = .088
Harmony in Life	d = 0.12	d = 0.48	d = 0.50
	p = .571	p = .018	p = .018
Satisfaction With Life	d = 0.29	d = 0.06	d = 0.44
	p = .179	p = .756	p = .043
Positive Affect	d = 0.20	d = 0.39	d = 0.43
	p = .362	p = .058	p = .046
Negative Affect	d = 0.24	d = 0.24	d = 0.35
	p = .265	p = .243	p = .099
Pro-Nature Activist Behaviours (Intentions)	d = 0.16	d = 0.09	d = 0.36
	p = .465	p = .660	p = .090
Pro-Environmental Consumer Behaviours (Intentions)	d = 0.10	d = 0.24	d = 0.02
	p = .631	p = .233	p = .926
Time In Nature (hours) over past week of study	d = 0.31	d = 0.00	d = 0.15
	p = .154	p = .986	p = .454

 Table 8
 Summary table of effect sizes and significance study 1, 2, 3

Bold denotes significant difference between conditions | italics denotes marginally significant differences between conditions | d effect sizes are for difference between respective conditions

the intervention. These results and findings, thus, provide strong initial support for the efficacy of both the CW*in*N and CS*with*N interventions to enhance nature connectedness.

These findings also provide insight into the mechanisms by which nature connectedness may have been enhanced. Participants in the intervention conditions of all three studies reported significantly higher levels of transcendent connectedness compared to control conditions, substantiating prior research implicating the association between transcendent connectedness and nature connectedness (Jacobs & McConnell, 2022; Sanyer, 2023). Although some evidence indicates that transcendent connection plays a mechanistic role in facilitating nature connectedness (Lumber et al., 2017), future research could explore this further, examining the potential mediating role of transcendent connectedness in the nature connectedness-promoting effects of the CS*in*N and CS*with*N interventions. Qualitative results provide further evidence for the role of transcendent connectedness, with numerous entries referencing a sense of connectedness, expanded sense of self, and spirituality as they engaged in the intervention.

Overall, results from Study 1 and 2, wherein the CS*in*N intervention was tested, support previous literature in evidencing that nthropomorphization can be an effective means of facilitating connection with non-human entities (Clayton et al., 2011; Yang et al., 2023a, 2023b) and that a sense of similarity helps foster nature connectedness (Lumber et al., 2018). At the same time, it is important to note that some participants had difficulty anthropomorphizing or finding similarity with nature via attributing their own human character strengths to nature. For example, "*Hard to ascribe many of my character strengths to nature*." [Participant 3751119]; "*my top strengths do not translate to nature too well*", [Participant 5550544]; "*I also think that Hope/Optimism is a uniquely human strength, so I will never see that one in nature*" [Participant 5479718]. Further research is warranted to adjust this intervention to further enhance its efficacy at fostering nature connectedness.

Qualitative responses in the current studies touched on each of the five pathways to nature connectedness proposed by Lumber and colleagues (2017). Findings thus support and help to solidify the importance of these pathways in facilitating nature connectedness.

20 Well-Being

Combined, results from all three studies largely supported the efficacy of CS*in*N intervention (with enhanced instructions) and particularly the CS*with*N intervention to boost well-being. Compared to participants randomly assigned to the control condition, participants randomly assigned to the character strengths interventions reported significantly higher levels of transcendent connectedness, elevation, and harmony in life (CS*in*N Study 2, CS*with*N; *ds*=0.40 to 0.57), in addition to significantly higher levels of satisfaction of based need of relatedness, satisfaction with life, and positive affect (Study 3, CS*with*N; *ds*=0.43 to 0.58). Further research is warranted to better understand differences in the well-being promoting effects of both the CS*in*N and CS*with*N interventions.

It is important to note that for the CS*in*N intervention (wherein participants spotted their own character strengths in nature), although nature connectedness was significantly higher than in the control condition for both Study 1 and 2, well-being was not as widely impacted as in Study 3 wherein participants used their top signature strengths in a new way each day to connect with nature (CS*with*N). Person-activity fit is important when considering all interventions (Heintzelman et al., 2023; Lyubomirsky & Layous, 2013); this includes factors such as personal characteristics and situational circumstances. These considerations

may be especially important with respect to the CS*in*N intervention which combined character strengths and anthropomorphism. It may be that anthropomorphizing nature was challenging for some participants due to being asked to limit observations to their top five character strengths or to individual differences in openness. Ease of identification of character strengths in nature could also vary depending on location, diversity of nature, and what is occurring in nature in any given moment (e.g., the presence of certain species, the behavior of wildlife, weather; see also Furness, 2021). It may be that such factors, while not seemingly impacting the efficacy of the CS*in*N intervention to boost nature connectedness and some aspects of well-being, did reduce impact the efficacy of the intervention to boost other aspects of well-being. More research is needed to elucidate the utility of the CS*in*N intervention and how to best fit this to individuals.

The broader impact on well-being of the CSwithN intervention could also be due to a difference in the type of engagement with nature inherent in this activity compared to the CSinN intervention. Spotting one's character strengths in nature (CSinN) is perhaps a more cognitive, and in some respects, passive activity which emphasizes observing nature, while using one's character strengths to connect with nature (CSwithN) emphasizes a more interactive engagement with nature. These differences could be drivers of the differential impact on various facets of well-being observed across the two interventions.

Both quantitative and qualitative findings from the current research are consistent with previous research demonstrating a link between nature connectedness and meaning in life (Aruta, 2023; Cervinka et al., 2012; Howell et al., 2013; Pritchard et al., 2020). Given that the essence of meaning in life is feeling connected to something larger than oneself (Baumeister & Vohs, 2002; Martela, 2020), it is possible that the impact of the interventions on feelings of transcendent connectedness (i.e., a grand feeling of being connected to all of life) benefited well-being by enhancing overall meaning in life.

For those individuals whose top character strengths included spirituality, spotting how nature displays spirituality (CSinN) or using one's strength of spirituality to connect more with nature (CSwithN) may have also boosted the significance/mattering facet of meaning in life (see review of links between nature experiences, nature connectedness, and meaning in life by Passmore & Krause, 2023). Further, some participants commented how engaging in their respective intervention boosted a greater appreciation for all of their experiences. For example, "[I learned] to look around at the world around me and appreciate the beauty in the little things" [Participant 551911]; "I feel more appreciative of the little things in my life" [Participant 2561698]. Experiential appreciation is another recently proposed facet of meaning in life (Kim et al., 2022).

Further research could explicitly assess how the CSinN and CSwithN intervetions impact overall meaning in life and its component facets. Future research examining mechanisms by which character strengths promote well-being in the CSinN and CSwithN interventions may prove fruitful in determining how character strengths can best be leveraged in conjunction with engagement with nature to enhance both nature connectedness and various aspects of well-being.

21 Pro-environmental Behaviour

Contrary to our hypothesis, surprisingly, intentions to engage in pro-environmental behaviour were not significantly different in the intervention condition compared to the control condition. These results are inconsistent with previous findings indicating

Power to detect	Study 1 $N - 134$	Study 2 $N = 106$	Study 3 $N = 00$
	5000 1, 17 - 154	Study 2, W = 100	Study 5, 14 = 77
≤50%	$0 < d \le 0.309$	$0 < d \le 0.349$	$0 < d \le 0.362$
50% - 80%	$0.309 < d \le 0.447$	$0.349 < d < \le 0.507$	$0.362 < d \le 0.526$
80% - 95%	$0.447 < d \le 0.585$	$0.507 < d \le 0.666$	$0.562 < d \le 0.693$
≥95%	d>0.585	d>0.666	<i>d</i> >0.693

Table 9 Summary table of sensitivity analyses for study 1, 2, 3

a strong and robust association between nature connectedness and pro-environmental behaviour (Mackay & Schmitt, 2019; Whitburn et al., 2019). It may be that the interventions in the present study were too short to effect a significant change in behavioural intentions. Nonetheless, approximately 19% of participants who engaged in the CSwithN and used their top character strength in new ways to connect more with nature (Study 3), chose to engage in activities that cared for nature. Moreover, several participants commented at the end of the study that the intervention did motivate them to care more for nature. For example "I definitely care a little more about the environment." [Participant 3717242]. As a whole, these responses suggest that the CSwithN intervention led to enhanced pro-environmental behavioural intentions for some, but not consistently for all participants. Future studies testing the CSwithN intervention could extend the duration of the intervention to two weeks, and include a follow-up assessment to examine any carry-over impacts. Development and testing of character strengths-based interventions specifically targeting pro-environmental behaviours through established approaches such as the Pathways Framework (Lumber et al., 2017) would likely prove fruitful.

22 Time in Nature

Consistent with our hypothesis, the beneficial effects of the CSinN and CSwithN interventions on nature connectedness and well-being were not a result of these participants spending significantly more time in nature than participants in the control condition. In fact, in Study 2 (CSinN), time in nature was nearly identical between the intervention and control conditions, and in Study 3 (CSwithN) participants in the control condition actually spent more time in nature on average than those in the intervention condition (though this difference was not significant). These results add to a growing body of research indicating that attending to and meaningfully engaging in nature is central to fostering nature connectedness (Richardson et al., 2022a, 2022b) and well-being (Passmore et al., 2017; Passmore et al., 2022a, 2022b; Passmore et al., 2022a, 2022b; Richardson et al., 2021), regardless of time spent in nature. These results have notable implications for future interventions aimed at enhancing nature connectedness and well-being: intervention development should emphasize meaningfully engaging with nature, over and above merely increasing time spent in nature. Results from the current studies also indicate the utility and efficacy of accessible nature connectedness interventions. Clearly, even for individuals facing barriers to spending time in nature and/or those in urban environments, enhancements to nature connectedness and well-being can be achieved through meaningful engagement with nature in everyday life.

23 Limitations

As with all studies, the current research had limitations which should be taken into consideration. Sample sizes in all three studies were relatively small (Ns = 134, 106, 99); thus power to detect effect sizes of note was somewhat limited. (See Table 9 for sensitivity analyses.) Participants in Study 1 were a general population sample from several countries, while participant samples in Study 2 and 3 were undergraduate students attending a Canadian university. It is possible that cultural differences influenced our findings. As is often the case in intervention studies, females were over-represented. Selection bias was, however, mitigated in that the advertisements for participants made no mention of nature. Pre-post measurements were taken to control for possible differences between conditions before random assignment, but no follow-up assessments were made; thus, we cannot determine the duration of the beneficial impacts the interventions had on nature connectedness and various indices of well-being which future work in the area could address.

One major limitation of our study designs is that they did not allow for disentangling the effects of the nature component from the general effects of using signature strengths in a new way, especially with respect to enhanced well-being. Future studies could address this by comparing the impact on well-being of engaging in the current studies' combined character strengths- nature-based interventions to engaging in a broader, more generic "use your signature strengths in a new way" intervention. (We would not expect that using one's signature strengths in a new way in general would boost nature connectedness.) It is also possible that the boosts to well-being and nature connectedness evidenced in the interventions (compared to the no treatment condition) were influenced by greater mindfulness. Future studies could measure and control for mindfulness to help assess this.

24 Future Research Directions

Replications of the present study are, of course, needed with larger and more varied samples. Future research should also continue to refine instructions to mitigate participants being off-the-mark in their engagement with the activities. While the efficacy of using signature strengths in well-being interventions is well supported (Schutte & Malouff, 2019) and presents a means of individualization, it is possible that certain character strengths are better suited for use in conjunction with nature engagement. Ruch and colleagues (2020) noted in their review that larger benefits might be expected if interventions target specific character strengths most strongly correlated with the desired outcome. In previous research two character strengths—1) appreciation of beauty and excellence and 2) love of learning—have consistently emerged as being particularly important to nature connectedness and pro-environmental behaviour (Corral-Verdugo et al., 2015; Diessner & Niemiec, 2023; Merino et al., 2020). Development of nature-based interventions targeting these specific character strengths is warranted to examine the most effective methods of boosting nature connectedness, well-being, and pro-environmental behaviours. Intervention studies integrating the nature connection pathways of contact/senses, beauty, emotions, meaning, and compassion (Lumber et al., 2017) in conjunction with character strengths is warranted.

Regardless of the intervention being tested, examination of long-term effects of character strengths-based nature connectedness interventions is needed. Studies conducted over multiple weeks or months (initial practice combined with follow-up assessments) would help discern trends in adherence and the degree to which beneficial effects observed in the current study persist. Such studies would also allow for detecting effects which may take time to emerge, such as pro-environmental behaviours.

25 Conclusion

A growing body of evidence indicates that feeling a connection to nature is important for individual well-being and for the well-being of the planet (Dunne et al., 2024; Lambert et al., 2020; Lengieza et al., 2023; Martin et al., 2020; Richardson et al., 2022a, 2022b; Zelenski et al., 2023). In an age characterized by growing feelings of disconnect from nature among industrialized Western nations (Schönbach et al., 2022; Soga & Gaston, 2023), the current research presents preliminary evidence for two effective, accessible approaches to boosting nature connectedness and nurturing well-being. These findings are of practical importance as the CS*in*N and CS*with*N interventions are simple activities for individuals to engage in (or for practitioners to suggest to their clients) that can easily be incorporated in one's daily routine.

Although informative, these results should be considered with some caution, as further empirical testing needs to be conducted. In particular, future testing should include active control conditions, such as traditional versions of strengths spotting, using one's signature strengths in new ways, and/or a non-character strength variant of the intervention. This would help to isolate the impact of adding a character strengths aspect to nature-based interventions, and assess any possible influence that enhanced mindfulness may have had on the well-being and nature connectedness outcomes.

Nonetheless, these results lay the groundwork for continued development, implementation, and testing of combined nature-strengths based interventions to boost both nature connectedness and well-being. Mayerson (2020) noted how deliberate use of character strengths is one way "for humanity to advance toward its positive potential" (p. 6). We suggest extending this to the beyond-human natural world. For as one participant noted, "I learned that nature is full of a bunch of small aspects that you typically by pass without realizing. I never knew how many ways I could personally relate to nature and found so much motivation and inspiration within nature that I didn't acknowledge prior to the study." [Participant 1387080].

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Declarations

Conflict of interest Not applicable.

Consent to publication All participants signed consent forms prior to beginning each of the studies.

Ethics approval These studies were approved by Concordia University of Edmonton's Research Ethics Board.

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References

- Amiot, C. E., & Bastian, B. (2017). Solidarity with animals: Assessing a relevant dimension of social identification with animals. *PLoS ONE*, 12(1), Article e0168184. https://doi.org/10.1371/journal.pone. 0168184
- Anderson, K., & Perrin, C. (2018). "Removed from nature": the modern idea of human exceptionality. Environmental Humanities, 10(2), 447–472. https://doi.org/10.1215/22011919-7156827
- Aruta, J. J. B. R. (2023). The quest to mental well-being: Nature connectedness, materialism and the mediating role of meaning in life in the Philippine context. *Current Psychology*, 42(2), 1058–1069. https:// doi.org/10.1007/s12144-021-01523-y
- Barrable, A., & Booth, D. (2020). Increasing nature Connection in children: A mini review of interventions. Frontiers in Psychology, 11, 492. https://doi.org/10.3389/fpsyg.2020.00492
- Barrable, A., & Booth, D. (2022). Disconnected: what can we learn from individuals with very low nature connection? *International Journal of Environmental Research and Public Health*, 19(13), 8021. https://doi.org/10.3390/ijerph19138021
- Barragan-Jason, G., Loreau, M., de Mazancourt, C., Singer, M. C., & Parmesan, C. (2023). Psychological and physical connections with nature improve both human well-being and nature conservation: A systematic review of meta-analyses. *Biological Conservation*, 277, Article 109842. https://doi.org/10. 1016/j.biocon.2022.109842
- Bashan, D., Colléony, A., & Shwartz, A. (2021). Urban versus rural? The effects of residential status on species identification skills and connection to nature. *People and Nature*, 3(2), 347–358. https://doi.org/ 10.1002/pan3.10176
- Baumeister, R. F., & Vohs, K. D. (2002). The pursuit of meaningfulness in life. In C. R. Snyder & S. J. Lopex (Eds.), *Handbook of positive psychology* (pp. 608–616). Oxford: Oxford University Press.
- Baxter, D. E., & Pelletier, L. G. (2019). Is nature relatedness a basic human psychological need? A critical examination of the extant literature. *Canadian Psychology / Psychologie Canadienne*, 60(1), 21–34. https://doi.org/10.1037/cap0000145
- Beery, T., Stahl Olafsson, A., Gentin, S., Maurer, M., Stålhammar, S., Albert, C., Bieling, C., Buijs, A., Fagerholm, N., Garcia-Martin, M., & Plieninger, T. (2023). Disconnection from nature: Expanding our understanding of human–nature relations. *People and Nature.*, 5(2), 470–488. https://doi.org/10. 1002/pan3.10451
- Bolier, L., Haverman, M., Westerhof, G. J., Riper, H., Smit, F., & Bohlmeijer, E. (2013). Positive psychology interventions: A meta-analysis of randomized controlled studies. *BMC Public Health*, 13(1), 119. https://doi.org/10.1186/1471-2458-13-119
- Byrne, D. (1997). An overview (and underview) of research and theory within the attraction paradigm. Journal of Social and Personal Relationships, 14(3), 417–431. https://doi.org/10.1177/0265407597 1430
- Capaldi, C., Dopko, R., & Zelenski, J. (2014). The relationship between nature connectedness and happiness: a meta-analysis. *Frontiers in Psychology*. https://doi.org/510.3389/fpsyg.2014.00976
- Capaldi, C., Passmore, H.-A., Nisbet, E., Zelenski, J., & Dopko, R. (2015). Flourishing in nature: A review of the benefits of connecting with nature and its application as a wellbeing intervention. *International Journal of Wellbeing*, 5(4), 1–16. https://doi.org/10.5502/ijw.v5i4.449
- Capstick, S., Nash, N., Whitmarsh, L., Poortinga, W., Haggar, P., & Brügger, A. (2022). The connection between subjective wellbeing and pro-environmental behaviour: Individual and cross-national characteristics in a seven-country study. *Environmental Science & Policy*, 133, 63–73. https://doi.org/10. 1016/j.envsci.2022.02.025
- Carr, A., Finneran, L., Boyd, C., Shirey, C., Canning, C., Stafford, O., Lyons, J., Cullen, K., Prendergast, C., Corbett, C., Drumm, C., & Burke, T. (2023). The evidence-base for positive psychology

interventions: A mega-analysis of meta-analyses. *The Journal of Positive Psychology*, 19(2), 1–15. https://doi.org/10.1080/17439760.2023.2168564

- Castelo, N., White, K., & Goode, M. R. (2021). Nature promotes self-transcendence and prosocial behavior. *Journal of Environmental Psychology*, 76, Article 101639. https://doi.org/10.1016/j.jenvp.2021. 101639
- Catton, W. R., & Dunlap, R. E. (1978). Environmental sociology: A new paradigm. American Sociologist, 13(1), 41–49.
- Cazalis, V., Loreau, M., & Barragan-Jason, G. (2023). A global synthesis of trends in human experience of nature. *Frontiers in Ecology and the Environment*, 21(2), 85–93. https://doi.org/10.1002/fee.2540
- Cervinka, R., Röderer, K., & Hefler, E. (2012). Are nature lovers happy? On various indicators of wellbeing and connectedness with nature. *Journal of Health Psychology*, 17(3), 379–388. https://doi.org/ 10.1177/1359105311416873
- Chan, E. Y. (2021). Saving Mr. Water: Anthropomorphizing water promotes water conservation. *Resources*, *Conservation and Recycling*, 174, 105814.
- Chen, B., Vansteenkiste, M., Beyers, W., Boone, L., Deci, E. L., Van Der Kaap-Deeder, J., Duriez, B., Lens, W., Matos, L., Mouratidis, A., Ryan, R. M., Sheldon, K. M., Soenens, B., Van Petegem, S., & Verstuyf, J. (2015). Basic psychological need satisfaction, need frustration, and need strength across four cultures. *Motivation and Emotion*, 39(2), 216–236. https://doi.org/10.1007/s11031-014-9450-1
- Clayton, S. (2003). Environmental identity: A conceptual and an operational definition. In S. Clayton & S. Opotow (Eds.), *Identity and the natural environment: The psychological significance of nature* (pp. 45–65). MIT Press.
- Clayton, S., Fraser, J., & Burgess, C. (2011). The role of zoos in fostering environmental identity. *Ecopsy-chology*, 3(2), 87–96. https://doi.org/10.1089/eco.2010.0079
- Cleary, A., Fielding, K. S., Bell, S. L., Murray, Z., & Roiko, A. (2017). Exploring potential mechanisms involved in the relationship between eudaimonic wellbeing and nature connection. *Landscape and Urban Planning*, 158, 119–128. https://doi.org/10.1016/j.landurbplan.2016.10.003
- Colding, J., Giusti, M., Haga, A., Wallhagen, M., & Barthel, S. (2020). Enabling relationships with nature in cities. *Sustainability*, 12(11), 4394. https://doi.org/10.3390/su12114394
- Colléony, A., Cohen-Seffer, R., & Shwartz, A. (2020). Unpacking the causes and consequences of the extinction of experience. *Biological Conservation*, 251, Article 108788. https://doi.org/10.1016/j.biocon.2020.108788
- Corral-Verdugo, V., Tapia-Fonllem, C., & Ortiz-Valdez, A. (2015). On the relationship between character strengths and sustainable behavior. *Environment and Behavior*, 47(8), 877–901. https://doi.org/10. 1177/0013916514530718
- Deci, E. L., & Ryan, R. M. (2000). The "what" and the "why" of goal pursuits: Human needs and the selfdetermination of behavior. *Psychological Inquiry*, 11, 227–268. https://doi.org/10.1207/S15327965P LI1104_01
- DeCicco, T. L., & Stroink, M. L. (2007). A third model of self-construal: The metapersonal self. International Journal of Transpersonal Studies, 26(1), 82–104. https://doi.org/10.24972/ijts.2007.26.1.82
- Diessner, R., & Niemiec, R. M. (2023). Can beauty save the world? Appreciation of beauty predicts proenvironmental behavior and moral elevation better than 23 other character strengths. *Ecopsychology*, 15(2), 93–109. https://doi.org/10.1089/eco.2022.0047
- Dunne, H., Lionetti, F., Pluess, M., & Setti, A. (2024). Individual traits are associated with pro-environmental behaviour: Environmental sensitivity, nature connectedness and consideration for future consequences. *People and Nature*, 6(2), 586–597. https://doi.org/10.1002/pan3.10581
- Fiske, A. P. (2004). Four modes of constituting relationships: Consubstantial assimilation; space, magnitude, time, and force; concrete procedures; abstract symbolism. In N. Haslam (Ed.), *Relational models theory: A contemporary overview* (pp. 61–146). Lawrence Erlbaum Associates Inc.
- Frantz, C.M.P., Mayer, F.S. (2014). The importance of connection to nature in assessing environmental education programs. *Studies in Educational Evaluation*, 4185-89. https://doi.org/10.1016/j.stueduc. 2013.10.001
- Furness, E. (2021). Understanding the lived experience of connection to nature. *Conservation Science and Practice*, 3(7), Article e440. https://doi.org/10.1111/csp2.440
- Gaekwad, J. S., Sal Moslehian, A., Roös, P. B., & Walker, A. (2022). A meta-analysis of emotional evidence for the biophilia hypothesis and implications for biophilic design. *Frontiers in Psychology*, 13, Article 750245. https://doi.org/10.3389/fpsyg.2022.750245
- Gander, F., Wagner, L., & Niemiec, R. M. (2024). Do character strengths-based interventions change character strengths? Two randomized controlled intervention studies. *Collabra Psychology*, 10(1), Article 108604. https://doi.org/10.1525/collabra.108604

- Gaston, K. J., & Soga, M. (2020). Extinction of experience: The need to be more specific. *People and Nature*, 2(3), 575–581. https://doi.org/10.1002/pan3.10118
- Ghielen, S. T. S., Van Woerkom, M., & Christina Meyers, M. (2017). Promoting positive outcomes through strengths interventions: A literature review. *The Journal of Positive Psychology*, 13(6), 1–13. https:// doi.org/10.1080/17439760.2017.1365164
- Heintzelman, S. J., Kushlev, K., & Diener, E. (2023). Personalizing a positive psychology intervention improves well-being. *Applied Psychology: Health and Well-Being*, 15(4), 1271–1292. https://doi.org/ 10.1111/aphw.12436
- Horowitz, D. (2018). Happier? Oxford: Oxford University Press.
- Howell, A. J., Passmore, H.-A., & Buro, K. (2013). Meaning in nature: Meaning in life as a mediator of the relationship between nature connectedness and well-being. *Journal of Happiness Studies*, 14(6), 1681–1696. https://doi.org/10.1007/s10902-012-9403-x
- Hurly, J., & Walker, G. J. (2019). Nature in our lives: Examining the human need for nature relatedness as a basic psychological need. *Journal of Leisure Research*, 50(4), 290–310. https://doi.org/10.1080/ 00222216.2019.1578939
- Isham, A., Elf, P., & Jackson, T. (2022). Self-transcendent experiences as promoters of ecological wellbeing? Exploration of the evidence and hypotheses to be tested. *Frontiers in Psychology*, 13, 1051478. https://doi.org/10.3389/fpsyg.2022.1051478
- Jacobs, T. P., & McConnell, A. R. (2022). Self-transcendent emotion dispositions: Greater connections with nature and more sustainable behavior. *Journal of Environmental Psychology*, 81, Article 101797. https://doi.org/10.1016/j.jenvp.2022.101797
- Jimenez, M. P., DeVille, N. V., Elliott, E. G., Schiff, J. E., Wilt, G. E., Hart, J. E., & James, P. (2021). Associations between nature exposure and health: A review of the evidence. *International Journal of Environmental Research and Public Health*, 18(9), 4790. https://doi.org/10.3390/ijerph1809 4790
- Jones, C. (2022). The relationship between connectedness to nature and wellbeing: A meta-analysis. Current Research in Psychology and Behavioral Science (CRPBS), 3(6), 1–8. https://doi.org/10. 54026/CRPBS/1064
- Kashdan, T. B., Blalock, D. V., Young, K. C., Machell, K. A., Monfort, S. S., McKnight, P. E., & Ferssizidis, P. (2018). Personality strengths in romantic relationships: Measuring perceptions of benefits and costs and their impact on personal and relational well-being. *Psychological Assessment*, 30(2), 241–258. https://doi.org/10.1037/pas0000464
- Keaulana, S., Kahili-Heede, M., Riley, L., Park, M. L. N., Makua, K. L., Vegas, J. K., & Antonio, M. C. K. (2021). A scoping review of nature, land, and environmental connectedness and relatedness. *International Journal of Environmental Research and Public Health*, 18(11), 5897. https://doi.org/ 10.3390/ijerph18115897
- Kellert, S. R., Case, D. J., Escher, D., Witter, D. J., Mikels-Carrasco, J., Seng, P.T. (2017). The nature of Americans national report: Disconnection and recommendations for reconnection. NatureOfAmericans.org.
- Kellert, S. R. (1993). The biological basis for human values of nature. In S. R. Kellert & E. O. Wilson (Eds.), *The biophilia hypothesis* (pp. 42–69). Island Press.
- Kellert, S. R., & Wilson, E. O. (1993). The biophilia hypothesis. Island Press.
- Kesebir, S., & Kesebir, P. (2017). A growing disconnection from nature is evident in cultural products. *Perspectives on Psychological Science*, 12(2), 258–269. https://doi.org/10.1177/1745691616 662473
- Kim, J. J. H., Betz, N., Helmuth, B., & Coley, J. D. (2023). Conceptualizing human-nature relationships: Implications of human exceptionalist thinking for sustainability and conservation. *Topics in Cognitive Science*, 15(3), 357–387. https://doi.org/10.1111/tops.12653
- Kim, J., Holte, P., Martela, F., Shanahan, C., Li, Z., Zhang, H., Eisenbeck, N., Carreno, D. F., Schlegel, R. J., & Hicks, J. A. (2022). Experiential appreciation as a pathway to meaning in life. *Nature Human Behaviour*, 6(5), 677–690. https://doi.org/10.1038/s41562-021-01283-6
- Kretzschmar, A., Harzer, C., & Ruch, W. (2023). Character strengths in adults and adolescents: Their measurement and association with well-being. *Journal of Personality Assessment*, 105(1), 34–47. https://doi.org/10.1080/00223891.2022.2043879
- Lambert, L., Warren, M. A., Brule, G., O'Brien, C., Murray, S., Mulay-Shah, A., Passmore, H.-A., Zelenski, J. M., Asfour, M., & Alsubaiei, S. (2020). Perspectives: using positive psychology and the United Nations' sustainable development goals to build a better world. *Middle East Journal of Positive Psychology*, 6, 1–28.
- Langer, L., Burghardt, M., Borgards, R., Böhning-Gaese, K., Seppelt, R., & Wirth, C. (2021). The rise and fall of biodiversity in literature: A comprehensive quantification of historical changes in the

use of vernacular labels for biological taxa in Western creative literature. *People and Nature*, 3(5), 1093–1109. https://doi.org/10.1002/pan3.10256

- Launay, J., & Dunbar, R. I. M. (2015). Playing with strangers: Which shared traits attract us most to new people? PLoS ONE, 10(6), Article e0129688. https://doi.org/10.1371/journal.pone.0129688
- Lengieza, M. L., Aviste, R., & Richardson, M. (2023). The human-nature relationship as a tangible target for pro-environmental behaviour—Guidance from interpersonal relationships. *Sustainability*, 15(16), 12175. https://doi.org/10.3390/su151612175
- Lengieza, M. L., & Swim, J. K. (2021). The paths to connectedness: A review of the antecedents of connectedness to nature. *Frontiers in Psychology*, 12, Article 763231. https://doi.org/10.3389/fpsyg. 2021.763231
- Littman-Ovadia, H., Dubreuil, P., Meyers, M. C., & Freidlin, P. (2021). Editorial: VIA character strengths: Theory, research and practice. *Frontiers in Psychology*, 12, Article 653941. https://doi. org/10.3389/fpsyg.2021.653941
- Liu, T., Geng, L., Ye, L., & Zhou, K. (2019). "Mother Nature" enhances connectedness to nature and pro-environmental behavior. *Journal of Environmental Psychology*, 61, 37–45. https://doi.org/10. 1016/j.jenvp.2018.12.003
- Lomas, T. (2019). The elements of eco-connection: A cross-cultural lexical enquiry. International Journal of Environmental Research and Public Health, 16(24), 5120. https://doi.org/10.3390/ijerph16245120
- Lumber, R., Passmore, H.-A., & Niemiec, R. (2023). Trees are honest, bugs are creative, sunsets are hopeful - Identifying character strengths in nature: A structured tabular thematic analysis. *Current Research in Ecological and Social Psychology*, 4, Article 100092. https://doi.org/10.1016/j.cresp. 2023.100092
- Lumber, R., Richardson, M., & Sheffield, D. (2017). Beyond knowing nature: Contact, emotion, compassion, meaning, and beauty are pathways to nature connection. *PLoS ONE*, 12(5), Article e0177186. https://doi.org/10.1371/journal.pone.0177186
- Lumber, R., Richardson, M., & Sheffield, D. (2018). The pathways to nature connectedness: A focus group exploration. *European Journal of Ecopsychology*, 6, 47–68.
- Lyubomirsky, S., & Layous, K. (2013). How do simple positive activities increase well-being? Current Directions in Psychological Science, 22(1), 57–62. https://doi.org/10.1177/0963721412469809
- Mackay, C. M. L., & Schmitt, M. T. (2019). Do people who feel connected to nature do more to protect it? A Meta-Analysis. Journal of Environmental Psychology, 65, Article 101323. https://doi.org/10. 1016/j.jenvp.2019.101323
- Mamichev, M., & Dergacheva, E. (2021). Technosphere—urban society and its problems. SHS Web of Conferences, 93, 01011. https://doi.org/10.1051/shsconf/20219301011
- Marczak, M., & Sorokowski, P. (2018). Emotional connectedness to nature is meaningfully related to modernization. Evidence from the Meru of Kenya. *Frontiers in Psychology*, 9, 1789. https://doi. org/10.3389/fpsyg.2018.01789
- Martela, F. (2020). A wonderful life: Insights on finding a meaningful existence. HarperCollins.
- Martin, L., White, M. P., Hunt, A., Richardson, M., Pahl, S., & Burt, J. (2020). Nature contact, nature connectedness and associations with health, wellbeing and pro-environmental behaviours. *Journal* of Environmental Psychology, 68, Article 101389. https://doi.org/10.1016/j.jenvp.2020.101389
- Matthew, J. Z., Andrew T. K., Karen, J. E., Lesley L. L. Le Grange. (2014) Connectedness as a Core Conservation Concern: An Interdisciplinary Review of Theory and a Call for Practice. *Springer Science Reviews*, 2(1–2), 119–143. https://doi.org/10.1007/s40362-014-0021-3
- Mayer, F. S., Frantz, C. M., Bruehlman-Senecal, E., & Dolliver, K. (2009). Why is nature beneficial?: The Role of connectedness to nature. *Environment and Behavior*, 41(5), 607–643. https://doi.org/ 10.1177/0013916508319745
- Mayerson, N. H. (2020). The character strengths response: An urgent call to action. Frontiers in Psychology, 11, 2106. https://doi.org/10.3389/fpsyg.2020.02106
- McEwan, K., Potter, V., Kotera, Y., Jackson, J. E., & Greaves, S. (2022). 'This is what the colour green smells like!': Urban forest bathing improved adolescent nature connection and wellbeing. *International Journal of Environmental Research and Public Health*, 19(23), 15594. https://doi.org/10. 3390/ijerph192315594
- McGrath, R. E. (2019). Technical report: The VIA assessment suite for adults: Development and initial evaluation revised edition. VIA Institute on Character www.viacharacter.org
- McGrath, R. E., Brown, M., Westrich, B., & Han, H. (2022). Representative sampling of the VIA assessment suite for adults. *Journal of Personality Assessment*, 104(3), 380–394. https://doi.org/10. 1080/00223891.2021.1955692

- McGrath, R. E., & Wallace, N. (2021). Cross-validation of the VIA inventory of strengths-revised and its short forms. *Journal of Personality Assessment*, 103(1), 120–131. https://doi.org/10.1080/ 00223891.2019.1705465
- McMahan, E. A., & Estes, D. (2015). The effect of contact with natural environments on positive and negative affect: A meta-analysis. *The Journal of Positive Psychology*, 10(6), 507–519. https://doi. org/10.1080/17439760.2014.994224
- Mei, D., Yang, D., Li, T., Zhang, X., Rao, K., & Li, L. M. W. (2024). Nature contact promotes prosociality: The mediating roles of self-transcendence, nature connectedness, and materialism. *Journal of Environmental Psychology*, 96, Article 102324. https://doi.org/10.1016/j.jenvp.2024.102324
- Merino, A., Valor, C., & Redondo, R. (2020). Connectedness is in my character: The relationship between nature relatedness and character strengths. *Environmental Education Research*, 26(12), 1707–1728. https://doi.org/10.1080/13504622.2020.1825630
- Michaelson, V., King, N., Janssen, I., Lawal, S., & Pickett, W. (2020). Electronic screen technology use and connection to nature in Canadian adolescents: A mixed methods study. *Canadian Journal of Public Health*, 111(4), 502–514. https://doi.org/10.17269/s41997-019-00289-y
- Moreton, S. G., Arena, A., Hornsey, M. J., Crimston, C. R., & Tiliopoulos, N. (2019). Elevating nature: Moral elevation increases feelings of connectedness to nature. *Journal of Environmental Psychology*, 65, Article 101332. https://doi.org/10.1016/j.jenvp.2019.101332
- Moula, Z., Palmer, K., & Walshe, N. (2022). A systematic review of arts-based interventions delivered to children and young people in nature or outdoor spaces: Impact on nature connectedness, health and wellbeing. *Frontiers in Psychology*, 13, Article 858781. https://doi.org/10.3389/fpsyg.2022.858781
- Najderska, M., & Cieciuch, J. (2018). The structure of character strengths: Variable- and person-centered approaches. *Frontiers in Psychology*, 9, 153. https://doi.org/10.3389/fpsyg.2018.00153
- Nelson, R. (1993). Searching for the lost arrow: Physical and spiritual ecology in the hunter's world. In S. R. Kellert & E. O. Wilson (Eds.), *The biophilia hypothesis* (pp. 201–228). Washington: Island Press.
- Niemiec, R. M., and McGrath, R. E. (2019). *The power of character strengths: Appreciate and ignite your positive personality*. VIA Institute on Character.
- Niemiec, R. M. (2018). *Character strengths interventions: A field guide for practitioners*. Boston: Hogrefe Publishing.
- Niemiec, R. M. (2019). Finding the golden mean: The overuse, underuse, and optimal use of character strengths. *Counselling Psychology Quarterly*, 32(3–4), 453–471. https://doi.org/10.1080/09515 070.2019.1617674
- Niemiec, R. M., & Pearce, R. (2021). The practice of character strengths: Unifying definitions, principles, and exploration of what's soaring, emerging, and ripe with potential in science and in practice. *Frontiers in Psychology*, 11, Article 590220. https://doi.org/10.3389/fpsyg.2020.590220
- Nisbet, E. K., Zelenski, J. M., & Grandpierre, Z. (2019). Mindfulness in nature enhances connectedness and mood. *Ecopsychology*, 11(2), 81–91. https://doi.org/10.1089/eco.2018.0061
- Oh, R. R. Y., Fielding, K. S., Carrasco, R. L., & Fuller, R. A. (2020). No evidence of an extinction of experience or emotional disconnect from nature in urban Singapore. *People and Nature*, 2(4), 1196–1209. https://doi.org/10.1002/pan3.10148
- Ohly, H., White, M. P., Wheeler, B. W., Bethel, A., Ukoumunne, O. C., Nikolaou, V., & Garside, R. (2016). Attention restoration theory: A systematic review of the attention restoration potential of exposure to natural environments. *Journal of Toxicology and Environmental Health, Part B, 19*(7), 305–343. https://doi.org/10.1080/10937404.2016.1196155
- Olivos, P., & Clayton, S. (2017). Self, nature and well-being: Sense of connectedness and environmental identity for quality of life. In G. Fleury-Bahi, E. Pol, & O. Navarro (Eds.), *Handbook of Environmental Psychology and Quality of Life Research* (pp. 107–126). Berlin Heidelberg: Springer International Publishing. https://doi.org/10.1007/978-3-319-31416-7_6
- Partsch, M. V., Bluemke, M., & Lechner, C. M. (2022). Revisiting the hierarchical structure of the 24 VIA character strengths: Three global dimensions may suffice to capture their essence. *European Journal of Personality*, 36(5), 825–845. https://doi.org/10.1177/08902070211017760
- Passmore, H.-A., Zelenski, J. M., & Steger, M. F. (2023, July 22) An emotional connection to nature: A global perspective [Conference session]. International Positive Psychology Association (IPPA) 2023 World Congress on Positive Psychology, Vancouver, BC. Canada.
- Passmore, H.-A., & Holder, M. D. (2017). Noticing nature: Individual and social benefits of a two-week intervention. *The Journal of Positive Psychology*, 12(6), 537–546. https://doi.org/10.1080/17439 760.2016.1221126

- Passmore, H.-A., & Howell, A. J. (2014). Eco-Existential positive psychology: Experiences in nature, existential anxieties, and well-being. *The Humanistic Psychologist*, 42(4), 370–388. https://doi. org/10.1080/08873267.2014.920335
- Passmore, H.-A., & Krause, A. N. (2023). The beyond-human natural world: Providing meaning and making meaning. *International Journal of Environmental Research and Public Health*, 20(12), 6170. https://doi.org/10.3390/ijerph20126170
- Passmore, H.-A., Lutz, P. K., & Howell, A. J. (2023). Eco-anxiety: A cascade of fundamental existential anxieties. Journal of Constructivist Psychology, 36(2), 138–153. https://doi.org/10.1080/10720 537.2022.2068706
- Passmore, H.-A., Yang, Y., & Sabine, S. (2022a). An extended replication study of the well-being intervention, the Noticing Nature Intervention (NNI). *Journal of Happiness Studies*, 23(6), 2663–2683. https://doi.org/10.1007/s10902-022-00516-3
- Passmore, H.-A., Yargeau, A., & Blench, J. (2022b). Wellbeing in winter: Testing the noticing nature intervention during winter months. *Frontiers in Psychology*, 13, Article 840273. https://doi.org/ 10.3389/fpsyg.2022.840273
- Pergams, O. R. W., & Zaradic, P. A. (2006). Is love of nature in the US becoming love of electronic media? 16-year downtrend in national park visits explained by watching movies, playing video games, internet use, and oil prices. *Journal of Environmental Management*, 80(4), 387–393. https://doi.org/10.1016/j.jenvman.2006.02.001
- Peterson, C., & Seligman, M. E. P. (2004). Character strengths and virtues: A handbook and classification. Oxford University Press and the American Psychological Association.
- Pirchio, S., Passiatore, Y., Panno, A., Cipparone, M., & Carrus, G. (2021). The effects of contact with nature during outdoor environmental education on students' wellbeing, connectedness to nature and pro-sociality. *Frontiers in Psychology*, 12, Article 648458. https://doi.org/10.3389/fpsyg.2021. 648458
- Prévot-Julliard, A.-C., Julliard, R., & Clayton, S. (2015). Historical evidence for nature disconnection in a 70 year time series of Disney animated films. *Public Understanding of Science*, 24(6), 672–680. https://doi.org/10.1177/0963662513519042
- Pritchard, A., Richardson, M., Sheffield, D., & McEwan, K. (2020). The relationship between nature connectedness and eudaimonic well-being: A Meta-analysis. *Journal of Happiness Studies*, 21(3), 1145– 1167. https://doi.org/10.1007/s10902-019-00118-6
- Proyer, R. T., Gander, F., Wellenzohn, S., & Ruch, W. (2015). Strengths-based positive psychology interventions: A randomized placebo-controlled online trial on long-term effects for a signature strengthsvs. a lesser strengths-intervention. *Frontiers in Psychology*, 06, 456. https://doi.org/10.3389/fpsyg. 2015.00456
- Quinlan, D. M., Swain, N., Cameron, C., & Vella-Brodrick, D. A. (2015). How 'other people matter' in a classroom-based strengths intervention: Exploring interpersonal strategies and classroom outcomes. *The Journal of Positive Psychology*, 10(1), 77–89. https://doi.org/10.1080/17439760.2014.920407
- Quinlan, D., Vella-Brodrick, D. A., Gray, A., & Swain, N. (2019). Teachers matter: Student outcomes following a strengths intervention are mediated by teacher strengths spotting. *Journal of Happiness Studies*, 20(8), 2507–2523. https://doi.org/10.1007/s10902-018-0051-7
- Richardson, M., Hamlin, I., Butler, C. W., Thomas, R., & Hunt, A. (2022a). Actively noticing nature (not just time in nature) helps promote nature connectedness. *Ecopsychology*, 14(1), 8–16. https://doi.org/ 10.1089/eco.2021.0023
- Richardson, M., Hamlin, I., Elliott, L. R., & White, M. P. (2022b). Country-level factors in a failing relationship with nature: Nature connectedness as a key metric for a sustainable future. *Ambio*, 51(11), 2201–2213. https://doi.org/10.1007/s13280-022-01744-w
- Richardson, M., Hussain, Z., & Griffiths, M. D. (2018). Problematic smartphone use, nature connectedness, and anxiety. *Journal of Behavioral Addictions*, 7(1), 109–116. https://doi.org/10.1556/2006.7.2018.10
- Richardson, M., Passmore, H., Barbett, L., Lumber, R., Thomas, R., & Hunt, A. (2020). The green care code: How nature connectedness and simple activities help explain pro-nature conservation behaviours. *People and Nature*, 2(3), 821–839. https://doi.org/10.1002/pan3.10117
- Richardson, M., Passmore, H.-A., Lumber, R., Thomas, R., & Hunt, A. (2021). Moments, not minutes: The nature-wellbeing relationship. *International Journal of Wellbeing*, 11(1), 8–33. https://doi.org/10. 5502/ijw.v11i1.1267
- Roczen, N., Kaiser, F. G., Bogner, F. X., & Wilson, M. (2014). A competence model for environmental education. *Environment and Behavior*, 46(8), 972–992. https://doi.org/10.1177/0013916513492416
- Rojas-Rueda, D., Nieuwenhuijsen, M. J., Gascon, M., Perez-Leon, D., & Mudu, P. (2019). Green spaces and mortality: A systematic review and meta-analysis of cohort studies. *The Lancet Planetary Health*, 3(11), e469–e477. https://doi.org/10.1016/S2542-5196(19)30215-3

- Ruch, W., Niemiec, R. M., McGrath, R. E., Gander, F., & Proyer, R. T. (2020). Character strengths-based interventions: Open questions and ideas for future research. *The Journal of Positive Psychology*, 15(5), 680–684. https://doi.org/10.1080/17439760.2020.1789700
- Sanyer, M. M., Bettmann, J. E., Anstadt, G., Ganesh, K., & Hanley, A. W. (2023). Decenter to reenter nature: Relationships between decentering, self-transcendence, and nature connectedness. *Psychol*ogy of Consciousness: Theory, Research, and Practice, 10(3), 205–212. https://doi.org/10.1037/cns00 00307
- Schiebel, T., Gallinat, J., & Kühn, S. (2022). Testing the Biophilia theory: Automatic approach tendencies towards nature. *Journal of Environmental Psychology*, 79, Article 101725. https://doi.org/10.1016/j. jenvp.2021.101725
- Schmäing, T., & Grotjohann, N. (2024). Exploring the Wadden sea ecosystem through an educational intervention to promote connectedness with nature. *Ecopsychology*, 16(1), 32–40. https://doi.org/10.1089/ eco.2022.0100
- Schönbach, D. M. I., Tiscareno-Osorno, X., MacIntyre, T. E., Smith, S., MacIntyre, D., & Demetriou, Y. (2022). What socio-demographic characteristics of university students in Southern Germany predict their urban nature connectedness? *PLoS ONE*, 17(8), Article e0272344. https://doi.org/10.1371/journ al.pone.0272344
- Schutte, N. S., & Malouff, J. M. (2019). The impact of signature character strengths interventions: A meta-analysis. *Journal of Happiness Studies*, 20(4), 1179–1196. https://doi.org/10.1007/ s10902-018-9990-2
- Sheffield, D., Butler, C. W., & Richardson, M. (2022). Improving nature connectedness in adults: A metaanalysis, review and agenda. *Sustainability*, 14(19), 12494. https://doi.org/10.3390/su141912494
- Sheldon, K. M., & Lyubomirsky, S. (2006). How to increase and sustain positive emotion: The effects of expressing gratitude and visualizing best possible selves. *The Journal of Positive Psychology*, 1, 73–82. https://doi.org/10.1080/17439760500510676
- Silva, A., Matos, M., & Gonçalves, M. (2023). Nature and human well-being: A systematic review of empirical evidence from nature-based interventions. *Journal of Environmental Planning and Management*, 67(14), 1–58. https://doi.org/10.1080/09640568.2023.2227761
- Silva, B. N., Khan, M., & Han, K. (2018). Towards sustainable smart cities: A review of trends, architectures, components, and open challenges in smart cities. *Sustainable Cities and Society*, 38, 697–713. https://doi.org/10.1016/j.scs.2018.01.053
- Sin, N., & Lyubomirsky, S. (2009). Enhancing well-being and alleviating depressive symptoms with positive psychology interventions: A practice-friendly meta-analysis. *Journal of Clinical Psychology*, 65(5), 467–487. https://doi.org/10.1002/jclp.20593
- Snow, N. E. (2019). Positive psychology, the classification of character strengths and virtues, and issues of measurement. *The Journal of Positive Psychology*, 14(1), 20–31. https://doi.org/10.1080/17439760. 2018.1528376
- Soga, M., & Gaston, K. J. (2016). Extinction of experience: The loss of human-nature interactions. Frontiers in Ecology and the Environment, 14(2), 94–101. https://doi.org/10.1002/fee.1225
- Soga, M., & Gaston, K. J. (2023). Global synthesis reveals heterogeneous changes in connection of humans to nature. One Earth, 6(2), 131–138. https://doi.org/10.1016/j.oneear.2023.01.007
- Speed, C. (2006). Anthropocentrism and sustainable development: Oxymoron or symbiosis? The Sustainable City IV: Urban Regeneration and Sustainability, 1, 323–332. https://doi.org/10.2495/SC060311
- Sprecher, S. (2019). Does (dis)similarity information about a new acquaintance lead to liking or repulsion? An experimental test of a classic social psychology issue. *Social Psychology Quarterly*, 82(3), 303– 318. https://doi.org/10.1177/0190272519855954
- Sprecher, S., Wenzel, A., & Harvey, J. (2008). Handbook of relationship initiation. Taylor & Francis.
- Stellar, J. E., Gordon, A. M., Piff, P. K., Cordaro, D., Anderson, C. L., Bai, Y., Maruskin, L. A., & Keltner, D. (2017). Self-transcendent emotions and their social functions: Compassion, gratitude, and awe bind us to others through prosociality. *Emotion Review*, 9(3), 200–207. https://doi.org/10.1177/17540 73916684557
- Tam, K. P. (2019). Anthropomorphism of nature, environmental guilt, and pro-environmental behavior. Sustainability, 11(19), 5430. https://doi.org/10.3390/su11195430
- Tam, K.-P., Lee, S.-L., & Chao, M. M. (2013). Saving Mr Nature: Anthropomorphism enhances connectedness to and protectiveness toward nature. *Journal of Experimental Social Psychology*, 49(3), 514– 521. https://doi.org/10.1016/j.jesp.2013.02.001
- Thompson, S. C. G., & Barton, M. A. (1994). Ecocentric and anthropocentric attitudes toward the environment. Journal of Environmental Psychology, 14(2), 149–157. https://doi.org/10.1016/S0272-4944(05)80168-9

- Tobias, V. Y., Van Woerkom, M., Meyers, M. C., & Bauwens, R. (2024). Coaching based on signature strengths or lesser strengths? The effects of two strengths spotting interventions on managerial coaching behavior. *Journal of Happiness Studies*, 25(5), 54. https://doi.org/10.1007/s10902-024-00756-5
- Uliaszek, A. A., Rashid, T., & Zarowsky, Z. (2022). The role of signature strengths in treatment outcome: Initial results from a large and diverse university sample. *Journal of Contemporary Psychotherapy*, 52(1), 15–21. https://doi.org/10.1007/s10879-021-09523-6
- van Heel, B. F., Van Den Born, R. J. G., & Aarts, N. (2024). A multidimensional approach to strengthening connectedness with nature in everyday life: Evaluating the earthfulness challenge. *Sustainability*, 16(3), 1119. https://doi.org/10.3390/su16031119
- Vansteenkiste, M., Ryan, R. M., & Soenens, B. (2020). Basic psychological need theory: Advancements, critical themes, and future directions. *Motivation and Emotion*, 44(1), 1–31. https://doi.org/10.1007/ s11031-019-09818-1
- Weiss, L. A., Westerhof, G. J., Bohlmeijer, E. T., & Coyne, J. (2016). Can we increase psychological wellbeing? The effects of interventions on psychological well- being: A meta-analysis of randomized controlled trials. *PLoS ONE*, 11(6), Article e0158092. https://doi.org/10.1371/journal.pone.0158092
- Wesley Schultz, P. (2002). Inclusion with nature: the psychology of human-nature relations. In P. Schmuck & W. P. Schultz (Eds.), *Psychology of Sustainable Development* (pp. 61–78). Boston, MA: Springer US. https://doi.org/10.1007/978-1-4615-0995-0_4
- Whitburn, J., Linklater, W., & Abrahamse, W. (2019). Meta-analysis of human connection to nature and proenvironmental behavior. *Conservation Biology*, 34(1), 180–193. https://doi.org/10.1111/cobi. 13381
- White, C. A., Uttl, B., & Holder, M. D. (2019). Meta-analyses of positive psychology interventions: The effects are much smaller than previously reported. *PLoS ONE*, 14(5), Article e0216588. https://doi. org/10.1371/journal.pone.0216588
- White, M. P., Elliott, L. R., Grellier, J., Economou, T., Bell, S., Bratman, G. N., Cirach, M., Gascon, M., Lima, M. L., Löhmus, M., Nieuwenhuijsen, M., Ojala, A., Roiko, A., Schultz, P. W., Van Den Bosch, M., & Fleming, L. E. (2021). Associations between green/blue spaces and mental health across 18 countries. *Scientific Reports*, 11(1), 8903. https://doi.org/10.1038/s41598-021-87675-0
- Wilson, E. O., (2012). The social conquest of the Earth. W. W. Norton & Company.
- Wilson, E. O. (1984). Biophilia. Harvard University Press.
- Yaden, D. B., Haidt, J., Hood, R. W., Vago, D. R., & Newberg, A. B. (2017). The varieties of self-transcendent experience. *Review of General Psychology*, 21(2), 143–160. https://doi.org/10.1037/gpr0000102
- Yang, Y., Cai, H., Yang, Z., Zhao, X., Li, M., Han, R., & Chen, S. X. (2022). Why does nature enhance psychological well-being? A Self-Determination account. *Journal of Environmental Psychology*, 83, Article 101872. https://doi.org/10.1016/j.jenvp.2022.101872
- Yang, Y., Sedikides, C., Wang, Y., & Cai, H. (2023a). Nature nurtures authenticity: Mechanisms and consequences. Journal of Personality and Social Psychology. https://doi.org/10.1037/pspi0000432
- Yang, Y., Sun, L., Han, B., & Liu, P. (2023b). The trajectory of anthropomorphism and pro-environmental behavior: A serial mediation model. *International Journal of Environmental Research and Public Health*, 20(3), 2393. https://doi.org/10.3390/ijerph20032393
- Zelenski, J. M., & Nisbet, E. K. (2014). Happiness and feeling connected: The distinct role of nature relatedness. *Environment and Behavior*, 46(1), 3–23. https://doi.org/10.1177/0013916512451901
- Zelenski, J., Warber, S., Robinson, J. M., Logan, A. C., & Prescott, S. L. (2023). Nature connection: Providing a pathway from personal to planetary health. *Challenges*, 14(1), 16. https://doi.org/10.3390/chall e14010016
- Zhang, W., Goodale, E., & Chen, J. (2014). How contact with nature affects children's biophilia, biophobia and conservation attitude in China. *Biological Conservation*, 177, 109–116. https://doi.org/10.1016/j. biocon.2014.06.011

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