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Why Do Individuals Engage with the Natural World? A Self-Determination Theory Perspective on the Effect of Nature Engagement and Well-Being

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Abstract
There is an apparent contradiction between the general appreciation for nature, the benefits from engaging with it, and the declining rates of engagement with it. We propose that self-determination theory's distinction between autonomous and controlled motivation can explain this contradiction. Using data from multiple samples (total $N = 1755$), we examined how the types of motivation—ranging from autonomous to controlled—can explain why people engage with nature, as well as the benefits of engaging with nature. As expected, relative autonomous motivation to engage with nature was related to engagement with nature. In addition, we found that satisfaction of psychological needs while in nature is positively associated with autonomous motivation and several types of well-being including flourishing, affect, life satisfaction, and eudaimonic well-being.

Keywords Nature · Outdoor recreation · Motivation · Self-determination theory · Well-being

Most people prefer to engage with a natural environment rather than a built environment (Ulrich, 1981; Hartig et al., 1996; Newell, 1997; van den Berg et al., 2003; Mangone et al., 2017). According to the biophilia hypothesis (Wilson, 1984, see also Kellert & Wilson, 1993), this desire to commune with nature is due to an inherent connection between humans and nature. The preference for nature may also be due to the benefits of engaging with it, such as increased quality of life (see Martens & Bauer, 2013 for a review of the benefits). However, not all reasons to engage with nature are equal. Using self-determination theory (SDT; Deci & Ryan, 2000; Ryan & Deci, 2017) as a framework, we propose that engaging with nature for the

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intrinsic pleasure of doing it or because we value it (autonomous motivation) should be distinguished from engaging with nature because of personal obligation, external pressure, or incentives (controlled motivation). SDT's distinction between autonomous and controlled motivation has been well-established in many areas, showing distinct effects on behavioral engagement, affect, and other outcomes (see Sheldon et al., 2017). After reviewing early research on the motivation to engage with nature, we present how SDT can enhance our understanding of nature engagement and its consequences for quality of life. This involves the development of a new self-report measure of autonomous and controlled forms of motivation to engage with nature that we examined in relation with determinants and outcomes.

Early Research on Motivation to Engage With Nature

The initial research into why people engage with nature was largely exploratory and atheoretical. For example, Bultena and Taves (1961) asked vacationers why they were attending a forested area and found that people felt that the forest was fascinating, a sanctuary, part of national heritage, a place for sport and play, and/or a place where they can exercise their full capabilities. Subsequent research added more reasons to this list (see Schreyer, 1986; Tinsley, 1986), which ultimately resulted in the creation of the Recreation Experience Preference (REP) scale (Driver et al., 1991; Manfredo et al., 1996). The REP has 234 items grouped in 15 general categories of reasons for engaging in outdoor recreation including: achievement, autonomy, risk taking, meeting similar people, meeting new people, learning, enjoying nature, introspection, creativity, nostalgia, fitness, social escape, physical escape, teaching, and risk reduction.

The REP has been used in research on a variety of activities, such as general outdoor recreation (Walker et al., 2001; White, 2008), camping (Kyle et al., 2006), birding (Glowinski & Moore, 2014), sea kayaking (O'Connell, 2010), mountain biking (Skår et al., 2008), picnicking, and skiing/snowboarding (Zeidenitz et al., 2007). Despite its widespread use, the REP has marked limitations. First, it has many items which could induce participant fatigue and limits its use in research. Secondly, as Shin et al. (2005) noted, the REP is not applicable to all activities (e.g., engagement with greenspace). Finally, and most importantly, it has no theoretical basis, which limits its predictive power (i.e., whether different reasons lead to different behavioral or affective outcomes).

Autonomous vs. Controlled Motivation: Self-Determination Theory as a Framework

Among the many motivational theories that have been developed in psychology, self-determination theory (SDT; Deci & Ryan, 2000; Ryan & Deci, 2017) is among the most robust theories with strong predictive power. Founded on the early distinction between intrinsic and extrinsic motivation, SDT proposes that behavioral engagement, attitudes, and well-being can be predicted by the distinction between

autonomous and controlled forms of motivation (a.k.a. regulation types), which are organized on a self-determination continuum. The most controlled (or non-self-determined) form of motivation is *external regulation* where a behavior is engaged in to satisfy an external demand or receive an external reward. *Introjected regulation* is another controlled form of motivation and involves engaging in an activity because of internally felt pressures that originate from external sources and is often associated with fear, guilt, or anxiety. More autonomous (and self-determined) forms of motivation include *identified regulation* that reflects a person's engagement in an activity because of the associated value of this engagement, and *integrated regulation* that occurs when behavioral engagement is considered as part of the self and is fully congruent with other aspects of the self. The most self-determined form of motivation is *intrinsic motivation*, which involves engaging in an activity for the pleasure, enjoyment, or interest of doing that activity. While intrinsic motivation is often studied and measured as a single concept, Vallerand and colleagues (1992) proposed a distinction between intrinsic motivation for knowledge and intrinsic motivation for stimulation.[1] *Intrinsic motivation for knowledge* refers to the pleasure of learning, exploring, or seeking understanding in the activity, whereas *intrinsic motivation for stimulation* refers to the person's motivation to engage in an activity for the pleasurable sensations or stimulation that arise from that activity. SDT also proposes on the non-self-determined end of the self-determination continuum *amotivation* that represents a state of non-intentional behavior where the person has no desire, willingness, or understanding of why they engage in a behavior.

These types of motivation (i.e., intrinsic, integrated, identified, introjected, and external regulations) independently predict different outcomes and show functional independence in numerous factor analyses (see Ryan & Deci, 2017 for a review). However, the relative importance of these types of motivation (rather than each of them individually) is sometimes an informative and succinct predictor of behavioral engagement and well-being. Relative autonomous motivation is a function of the difference between autonomous and controlled forms of motivations—level of intrinsic, integrated, and identified regulation relative to introjected and external regulation (Howard et al., 2017; Ryan & Connell, 1989).

The quality of motivation as outlined within SDT has been applied in many domains including education (Vallerand et al., 1992), leisure (Pelletier et al., 1989), health (Ng et al., 2012), and pro-environmental behaviors (Pelletier et al., 1998). We propose that the distinction between autonomous and controlled forms of motivation can shed a light on why people differ in how much they engage with nature and the benefits of nature. However, nature engagement is different from other behaviors that have been examined through the lens of SDT because it is regarded as inherently interesting to humans (Wilson, 1984), there is an innate desire to connect with it (Shepard, 1982; Ulrich, 1983; Wilson, 1984; Baxter & Pelletier, 2019), and people generally prefer it over built environments

[1] Vallerand and colleagues (1992) also propose a third type of intrinsic motivation: intrinsic motivation for achievement. However, this third type of intrinsic motivation is not relevant to the context of nature engagement.

(Hartig et al., 1996; Newell, 1997; Ulrich, 1981; van den Berg et al., 2003; Mangone et al., 2017). We could thus expect that the dominant motivation would be intrinsic motivation. However, many other reasons for nature engagement have been identified (e.g., meeting new people) that could represent controlled motivation. Furthermore, nature engagement is generally declining (Shultis & More, 2011), which may suggest that not all people are intrinsically motivated to engage with nature. Therefore, we can expect the existence of autonomous and controlled forms of motivation to explain various levels of people's engagement with nature.

Determinants and Consequences of Autonomous and Controlled Motivation

SDT proposes that autonomous motivation is supported by the fulfillment of the needs for autonomy (e.g., willfully engaging with nature by one's own volition), competence (e.g., feeling capable of navigating a natural environment), and relatedness (e.g., feeling connected to or accepted by others while in nature) (Deci & Ryan, 2000). Natural environments are proposed to be prime environments for satisfying these needs (Ceylan, 2020; Houge Mackenzie & Hodge, 2020). Therefore, the satisfaction of these psychological needs while in nature is expected to be associated with autonomous motivation to engage with nature.

The distinction between autonomous and controlled forms of motivation is also important to predict behaviors, well-being, and attitudes (Vallerand, 1997). First, relative autonomous motivation is associated with persistence (Blais et al., 1990; Vallerand & Bissonnette, 1992; Vallerand et al., 1993, 1997). This persistence could take the form of continuous engagement with nature despite obstacles (e.g., bad weather) and distractions from other activities (e.g., video games). This is particularly true for outdoor activities that are not necessary for commuting or work. Thus, it is important to differentiate between everyday and non-everyday nature exposure, with the expectation that the autonomous motivation to engage with nature will play a role in non-everyday nature exposure but less of a role in everyday nature exposure. Second, because autonomous motivation and nature engagement both lead to well-being (Vallerand, 1997; Ryan & Deci, 2000b; McMahan & Estes, 2015), going outside for autonomous reasons should guarantee the positive effect of nature on well-being, whereas being forced to engage with nature (i.e., controlled motivation) may thwart well-being effects of being in nature. We were also interested in the role that fear plays in motivation. If someone is afraid of something, they would not want to engage with it and would need an external incentive to motivate them. Fear of nature should thus be associated with controlled motivation. Finally, a free and personal decision to engage with nature (i.e., autonomous motivation) is expected to be associated with positive attitudes towards nature such as wanting to protect it and feeling subjectively connected to it.

Motivation to Engage with Nature and Individuals' Motivation Systems

According to Vallerand's (1997) hierarchical model of intrinsic and extrinsic motivation, individuals' motivations exist in a hierarchical system where global motivation is related to contextual motivations. Both top-down and bottom-up relationships explain why global autonomous motivation is associated with autonomous forms of motivation in various contexts, including engagement with nature. However, individuals can still show different levels of autonomous and controlled motivation in various contexts. While motivation to engage with nature can share some variance with motivation in closely related contexts (e.g., sport, leisure), we can expect less similarity with contexts such as education. Motivation to engage with nature is, thus, expected to be more strongly related to the motivation for pro-environmental behavior, sports, and leisure than motivation for academics, while remaining distinct.

Current Research

The goal of the current research is to examine how the distinction between autonomous and controlled forms of motivation can inform the study of nature engagement and consequences for quality of life. Using SDT as a theoretical framework, we propose that engaging with nature for the intrinsic pleasure or personal valuing (i.e., autonomous motivation) can be distinguished from engaging with nature because of internal or external pressure or incentives (i.e., controlled motivation), which could lead to differential associations with behavioral engagement, well-being, and attitudes.

In a first multi-sample study, we developed a measurement instrument that can capture the distinction between autonomous and controlled forms of motivation to engage with nature. Then, in a second two-sample study, we examined autonomous (vs. controlled) motivation to engage with nature as (1) the result of the fulfillment of the needs for autonomy, competence, and relatedness in nature, and (2) predictor of cognitive, affective, and behavioral engagement with nature and quality of life. These relations are examined in mediation models as proposed by SDT and Vallerand's hierarchical model. We also examined the quality of motivation as moderator of the relation between nature engagement and well-being, testing the hypothesis that the benefits of nature are experienced when individuals are autonomously motivated to engage with nature. Finally, we examined nature engagement motivation within individuals' motivational systems (i.e., in relation to global and contextual motivations).

Study 1

The objective of Study 1 was to identify the different types of motivation to engage with nature, using SDT as a framework. We first developed the Nature Engagement Motivation Scale (NEMS). Three independent samples were recruited to examine the presence, structure, and independence of the proposed motivation types.

Sample 1 completed a preliminary 49-item version of the NEMS that allowed us to select the most representative items. A reduced version was completed by Sample 2, and then a final version was validated with Sample 3.

Methods

Participants and Procedure

Three samples of participants ($n=497$, $n=360$, $n=300$) were recruited across two campuses.[2] Sample sizes were chosen to ensure sufficient degrees of freedom to conduct both exploratory and confirmatory factor analyses (Kline, 2015). Participants were invited to complete a survey about why they go outside to nature in exchange for a small chocolate bar. Participants who indicated that they had completed the survey before[3] were removed from the analyses ($n=23$ in Sample 2 and $n=5$ in Sample 3). Data from participants with more than 10% missing data were also removed ($n=22$ in Sample 1 and $n=1$ in Sample 2). Expectation maximization was used to impute other missing observations for Samples 1 and 2 (mean of 1.8 and 1.2 per item in each sample; Honaker et al., 2011). Then, data from Sample 1 and 2 participants were removed based on visual inspection of Mahalanobis' distance scores ($n=19$ and $n=6$, respectively).[4] For analyses, Sample 1 ($n=456$) included 60% female and age ranged from 17 to 66 years ($M=22$; 85% of participants under the age of 25). Sample 2 ($n=330$) included 60% female and age ranged from 18 to 88 years ($M=21$; 92% of participants under the age of 25). Finally, Sample 3 ($n=295$) included 62% female and age ranged from 13 to 69 years ($M=23$; 75% of participants under the age of 25).[5]

Measures

The initial iteration of the Nature Engagement Motivation Scale (NEMS) consisted of 49 items that were adapted from existing motivation scales including the Sport Motivation Scale-II (Pelletier et al., 2013), Motivation Toward the Environment Scale (Pelletier et al., 1998), Self-Regulation Questionnaire (Ryan & Connell, 1989), and the Academic Motivation Scale (Vallerand et al., 1992). Other items were created based upon theoretical reasoning. Items were designed to assess different types of motivation: *intrinsic motivation for knowledge* (4 items), *intrinsic motivation*

[2] All procedures performed in studies were in accordance with the ethical standards of the institutional review board of the University of Victoria (protocol #16-446). Informed consent was obtained from all individual participants included in the study.

[3] Multiple research assistants recruited participants for nearly a week for each sample. Although participants were asked if they had completed the survey before, there is a possibility that participants completed the survey more than once.

[4] Results do not noticeably change if outliers are removed at the $p<.001$ chi-square cutoff, or if all observations are included in analyses.

[5] All data is available upon request to Frederick Grouzet fgrouzet@uvic.ca.

for stimulation (4 items), *general intrinsic motivation* (4 items), *integrated regulation* (7 items), *identified regulation* (7 items), *introjected regulation* (8 items), and *external regulation* (10 items), as well as *amotivation* (5 items). Items were possible responses to the question "Why do you go outside to nature?". Participants were informed that going outside to nature can include anything from a brief walk to more immersive experiences such as camping, but not commuting or working. Participants responded along a 7-point scale from (1) "Does not correspond at all" to (7) "Corresponds exactly."

Results

The structure of the scale was examined in a two-stage process. First, in order to identify the most representative items of each motivation type while contrasting with the most conceptually proximate type of motivation, four exploratory factor analyses (EFA) were conducted on each of the following groupings: (1) *intrinsic motivation* items, (2) *integrated regulation* and *identified regulation* items, (3) *introjected regulation* and *external regulation* items, and (4) *amotivation* items. A combination of parallel analysis and theoretical reasoning was used to determine the number of extracted factors for each category (package "paran" in R; Dinno, 2015) using maximum likelihood estimation and oblique rotation ("psych" package in R; Revelle, 2018). Item correlations were all below 0.80, indicating a relative absence of multicollinearity (Tabachnick & Fidell, 2007). For each of the four separate EFAs, items with a 0.30 loading for the appropriate factor were retained (see Tables 1 through 5 in *Supplementary Material* for item loadings). As expected, within each EFA, the expected subscales were distinguishable. After this first stage, 15 items were removed: 11 because they cross-loaded too high on other factors, three because they were judged on face validity to be too similar to other items, and one because it did not load onto any factor. For the second stage, an overall EFA was conducted on the retained 34 items. Results showed an 8-factor solution, but the last eigenvalue barely exceeded the randomness threshold, and accounted for less than 1% of the sample variance. Therefore, a 7-factor solution was examined, which accounted for 62% of the sample variance. The factors were *intrinsic motivation for knowledge*, *intrinsic motivation for stimulation*, *integrated regulation*, *identified regulation*, *introjected regulation*, *external regulation*, and *amotivation*.

Sample 2 completed a 33-item version of the scale.[6] The same two-phase procedure (separate EFAs then overall EFA) was used. Item correlations were all below 0.80, indicating relative absence of multicollinearity. Based on low factor loadings and moderately large cross-loadings, 4 items were removed, resulting in a 28-item version of the scale (see Tables 6 through 11 in *Supplementary Material* for item loadings). Parallel analysis of the retained 28 items indicated a 7-factor solution, which accounted for 62% of the sample variance. The resulting factors were identified as *intrinsic motivation for knowledge* (3 items), *intrinsic motivation for*

[6] Due to a clerical error, one *intrinsic motivation for knowledge* item was not included in the survey for Sample 2. It was included in all other versions.

Table 1 Items on the 26-Item and 29-Item versions of nature engagement motivation scale

Why do you go outside to nature?	
Intrinsic motivation—for knowledge	
1	For the pleasure that I experience in broadening my knowledge about nature
2	For the pleasure I experience when I discover new things never seen before
3	Because when I go outside to nature I experience pleasure and satisfaction while learning new things
4	Because going outside to nature allows me to continue to learn about many things that interest me
Intrinsic motivation—for stimulation	
5	For the pleasure that I experience when I go outside to nature
6	For the pleasure that I experience when I feel completely absorbed in nature
7	Because I like the feeling I get when I go outside to nature
8	Because I find pleasure in going outside to nature and being surrounded by nature
Integrated Regulation	
9	Because going outside to nature is part of my identity
10	Because going outside to nature is a fundamental part of who I am
11	Because I identify with nature
12	Because going outside to nature is part of the way I have chosen to live my life
Identified regulation	
13	[a] Because I personally value going outside to nature
14	[b] Because I see many personal advantages of going outside to nature
15	[b] Because I understand the worth of going outside to nature
16	[b] Because I know that going outside to nature is good for me
Introjected Regulation	
17	Because I would feel guilty if I didn't go outside to nature
18	Because I would feel bad if I didn't go outside to nature
19	Because I feel that I must go outside to nature regularly
20	Because I would feel bad if I was not taking time to go outside to nature
External regulation	
21	Because I feel pressured by others or by circumstances to go outside to nature
22	Because my friends or family insist that I go outside to nature
23	Because going outside to nature allows me to be well regarded by people that I know
24	For the recognition I get from others when I go outside to nature
25	Because other people will be upset if I don't go outside to nature
26	Because people around me think it is important to engage with nature

Table 1 (continued)

Why do you go outside to nature?	
Amotivation	
27	I don't know why I go outside to nature, I can't see what I'm getting out of it
28	It's not clear to me why I go outside to nature; I don't think my place is in nature
29	I cannot see why I go outside to nature and frankly, I could not care less

[a]In the 26-item version, this item is combined with the *Integrated Regulation* items to create an *Integrated-Identified Regulation* Factor

[b]These items are removed in the 26-item version of the scale

stimulation (4 items), *integrated regulation* (4 items), *identified regulation* (4 items), *introjected regulation* (4 items), *external regulation* (6 items), and *amotivation* (3 items).

Confirmatory factor analysis (CFA)[7] was conducted on the 29-item version of the scale that was completed by Sample 3 participants. Item correlations did not exceed 0.71, indicating an absence of multicollinearity. The 7-factor CFA showed acceptable fit, $\chi^2(356) = 857.94$, $p < 0.001$, CFI = 0.87, SRMR = 0.091, RMSEA = 0.069, 90% CI [0.064, 0.075]. Item loadings ranged between 0.56 and 0.86 (see Table 12 in *Supplementary Material*). However, we noticed that *intrinsic motivation for stimulation* correlated highly with *identified regulation* ($r = 0.95$) and most items from these factors cross-loaded. When we investigated the face validity of these items, we noticed that three of the *identified regulation* items focused on outcomes. Therefore, these items were removed and the remaining item was combined with the *integrated regulation* factor. We renamed this factor *integrated-identified regulation* (see Table 1 for list of items with notation of items that were removed). Integrated and identified regulation are both autonomous forms of extrinsic motivation (Ryan & Connell, 1989; Ryan & Deci, 2000a) and are not always distinguished in SDT-based motivation scales (Pelletier et al., 1989; Vallerand et al., 1992; Koestner et al., 1996; Losier & Koestner, 1999; Losier et al., 2001). In fact, in a meta-analysis of SDT's continuum structure found that integrated regulation was most correlated with identified and that it need not be included as a separate factor (Howard et al., 2017).

A further CFA was thus conducted on Sample 3 data using this revised, 6-factor (26-item) version of the NEMS. This 6-factor CFA showed adequate fit, $\chi^2(284) = 736.90$, $p < 0.001$, CFI = 0.87, SRMR = 0.100, RMSEA = 0.074, 90% CI [0.067, 0.080]. Item loadings ranged between 0.56 and 0.85. The factor correlations reflected the proposed simplex structure of the SDT continuum (Ryan & Connell, 1989) and the NEMS subscales demonstrated high internal consistency (see Table 2). Exploratory structural equation modelling (ESEM) was also conducted

[7] CFAs were conducted using robust maximum likelihood estimation (Rosseel, 2012). The first item loading for each factor was fixed to 1.0 for identification purposes.

Table 2 Factor correlations, internal subscale reliabilities, means, and standard deviations of the NEMS for Study 1—Sample 3 and Study 2 both samples

	IN-K			IN-S			IG-ID			IJ			EX			AM		
Study -sample	*1–3*	*2–1*	*2–2*	*1–3*	*2–1*	*2–2*	*1–3*	*2–1*	*2–2*	*1–3*	*2–1*	*2–2*	*1–3*	*2–1*	*2–2*	*1–3*	*2–1*	*2–2*
IN-K				0.54	0.58	0.59	0.57	0.73	0.67	0.40	0.32	0.22	0.08	0.10	− 0.06	− 0.29	− 0.34	− 0.42
IN-S	0.71	0.71	0.71				0.51	0.67	0.62	0.30	0.24	0.29	− 0.18	− 0.19	− 0.29	− 0.47	− 0.59	− 0.58
IG-ID	0.83	0.80	0.75	0.83	0.81	0.79				0.44	0.40	0.34	0.03	0.02	− 0.13	− 0.27	− 0.42	− 0.44
IJ	0.54	0.39	0.22	0.43	0.34	0.30	0.65	0.47	0.36				0.31	0.42	0.40	− 0.03	− 0.15	− 0.12
EX	0.02	0.11	− 0.09	− 0.26	− 0.20	− 0.33	− 0.03	0.00	− 0.19	0.28	0.46	0.42				0.36	0.31	0.40
AM	− 0.28	− 0.36	− 0.47	− 0.62	− 0.67	− 0.66	− 0.46	− 0.48	− 0.53	− 0.11	− 0.18	− 0.10	0.63	.35	0.44			
Mean	4.90	4.47	4.57	5.63	5.51	5.62	4.65	4.40	4.39	4.00	3.78	3.67	2.45	2.46	2.43	1.93	1.54	1.48
SD	1.29	1.44	1.27	1.20	1.30	1.09	1.47	1.51	1.37	1.44	1.44	1.30	1.14	1.11	1.03	1.26	0.97	0.76
α	0.82	0.90	0.87	0.86	0.92	0.90	0.89	0.92	0.91	0.80	0.86	0.84	0.82	0.83	0.85	0.81	0.87	0.85

IN-K intrinsic motivation—for Knowledge; *IN-S* intrinsic motivation – for stimulation; *IG-ID* integrated-identified regulation; *IJ* introjected regulation; *EX* external regulation; *AM* amotivation, *SD* standard deviation. Factor correlations from the exploratory structural equation modeling (ESEM) are above the diagonal, and those from the confirmatory factor analysis (CFA) are below the diagonal. Internal subscale reliabilities (Cronbach's α) for each sample are along the bottom

Table 3 Correlations between the NEMS and the REP

REP Subscales	IN-K	IN-S	IG-ID	IJ	EX	AM	RAI
Achievement	0.38***	0.18**	0.31***	0.31***	0.35***	− 0.08	0.00
Autonomy	0.26***	0.19***	0.20***	0.17**	0.15**	0.06	0.06
Risk Taking	0.28***	0.05	0.14*	0.12*	0.13*	− 0.01	0.04
Equipment	0.19***	− 0.01	0.15**	0.09	0.16**	0.06	0.02
Family Togetherness	0.21***	0.13*	0.20***	0.16**	0.22***	− 0.08	0.01
Similar People	0.26***	0.15**	0.24***	0.19***	0.17**	− 0.19***	0.06
New People	0.21***	0.01	0.10	0.19***	0.26***	0.06	− 0.08
Learning	0.71***	0.45***	0.52***	0.19***	0.06	− 0.27***	0.39***
Enjoy Nature	0.54***	0.69***	0.60***	0.22***	− 0.13*	− 0.44***	0.49***
Introspection	0.36***	0.37***	0.38***	0.19***	0.05	− 0.13*	0.25***
Creativity	0.37***	0.29***	0.36***	0.10	0.03	− 0.19***	0.26***
Nostalgia	0.36***	0.31***	0.31***	0.12*	0.05	− 0.15**	0.22***
Physical Fitness	0.24***	0.37***	0.29***	0.28***	0.00	− 0.30***	0.14*
Physical Rest	0.23***	0.18**	0.16**	0.07	− 0.00	− 0.08	0.13*
Esc. Personal-Social Pressures	0.33***	0.43***	0.36***	0.24***	− 0.01	− 0.26***	0.23***
Escape Physical Pressures	0.27***	0.35***	0.30***	0.20***	− 0.00	− 0.13*	0.18***
Social Security	0.28***	0.09	0.23***	0.27***	0.27***	− 0.07	− 0.03
Escape Family Pressures	0.24***	0.05	0.18**	0.16**	0.17**	0.07	0.02
Teaching	0.34***	0.10	0.26***	0.13*	0.19***	− 0.01	0.09
Risk Reduction	0.22***	− 0.02	0.08	0.17**	0.30***	0.09	− 0.10

IN-K intrinsic motivation—for knowledge; *IN-S* intrinsic motivation—for stimulation; *IG-ID* integrated-identified regulation; *IJ* introjected regulation; *EX* external regulation; *AM* amotivation; *RAI* relative autonomy index

*$p < 0.05$

**$p < 0.01$

***$p < 0.001$

to overcome limitations of CFA (i.e., to avoid inflated factor correlations and to examine potential cross-loadings; see Marsh et al., 2014). Results supported the proposed structure of the scale (see Table 2 for ESEM factor correlations and Tables 13 and 16 in *Supplementary Material* for detailed results).

Study 2

Study 1 provides evidence for the distinction between autonomous and controlled motivation to engage with nature. The aim of Study 2 was to validate the importance of this distinction by examining motivational determinants and outcomes as outlined by SDT (Vallerand, 1997; Deci & Ryan, 2000). We first explored how different regulation types capture or relate to reasons for engaging with nature. Next, we examined whether the satisfaction of basic psychological needs when in nature is associated with autonomous (vs. controlled) motivation. We then examined

Table 4 Factor correlations of the NEMS and nature attitudes

Measures & Subscales	IN-K	IN-S	IG-ID	IJ	EX	AM	Aut (β)	Con (β)	RAI
Nature relatedness									
Experience	0.71***	0.77***	0.86***	0.32***	− 0.13	− 0.54***	0.90***	− 0.12**	0.70***
Self	0.71***	0.70***	0.83***	0.33***	− 0.04	− 0.44***	0.85***	− 0.06	0.64***
Perspective	0.23**	0.33***	0.26**	0.15*	− 0.23*	− 0.42**	0.34***	− 0.10	0.31***
Connectedness to nature	0.62***	0.59***	0.69***	0.14*	− 0.16*	− 0.41***	0.73***	− 0.06	0.57***
New ecological paradigm	0.21**	0.34***	0.27***	0.19**	− 0.15	− 0.31***	0.32***	− 0.06	0.25***
Outdoor fears	− 0.15*	− 0.27***	− 0.34***	0.02	0.29***	0.26***	− 0.39***	0.27***	− 0.40***

IN-K intrinsic motivation—for knowledge; *IN-S* intrinsic motivation—for stimulation; *IG-ID* integrated-identified regulation; *IJ* introjected regulation; *EX* external regulation; *AM* amotivation; *Aut* autonomous motivation; *Con* controlled motivation; *RAI* relative autonomy index

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

Table 5 Factor correlations of the NEMS subscales with the corresponding subscales of other motivation scales

	GMS	LMS	AMS	MTES	SMS-II
Intrinsic—Knowledge	0.46***	0.61***	0.42***	0.71***[b]	0.53***[b]
Intrinsic—Stimulation	0.34***	0.49***	0.31***	0.50***[b]	0.31***[b]
Integrated[a]	0.39***	–	–	0.69***	0.41***
Identified[a]	0.22***	0.42***	− 0.01	0.40***	0.38***
Introjected	0.20**	0.31	0.22***	0.49***	0.37***
External	0.50***	0.48***	0.20**	0.60***	0.60***
Amotivation	0.33***	0.57***	0.36***	0.56***	0.45***
RAI	0.49***	0.56***	0.46***	0.61***	0.45***

GMS general motivation scale; *LMS* leisure motivation scale; *AMS* academic motivation scale; *MTES* motivation toward the environment scale; *SMS-II* sport motivation scale; The LMS and AMS scales do not include an Integrated Regulation Factor

[a]NEMS Integrated-Identified factor correlation with separate Integrated and Identified factors of other SDT scales

[b]NEMS Intrinsic-Knowledge and Intrinsic-Stimulation correlations with a general Intrinsic factor

*$p < 0.05$

**$p < 0.01$

***$p < 0.001$

autonomous (vs. controlled) motivation in relation to behavioral engagement with nature (as proposed by Vallerand, 1997). Following Vallerand's (1997) model, we then tested the mediating role of motivation between need satisfaction and behavioral outcomes and well-being. We then investigated whether autonomous motivation to engage with nature makes the relationship between engagement with nature and well-being stronger. We also expected that autonomous motivation to engage with nature would be positively related to positive attitudes towards nature, including greater feelings of connection to nature, a desire to care for nature, and less fear of nature. Conversely, we expected controlled motivation to be unrelated or negatively related with these attitudinal and affective outcomes. Finally, we examined the relationship between motivation to engage with nature and motivation in other contexts.

Materials and Methods

Participants and Procedure

Two independent samples of participants ($n = 358$ and $n = 316$) were recruited from a university undergraduate participant pool. Sample sizes were chosen to ensure sufficient degrees of freedom to conduct analyses using structural equation modelling (Kline, 2015), and to ensure power of at least 0.95 to detect an effect of $r = \pm 0.20$. The samples were mostly female (77% and 84% female) and had mean ages of 23 and 21 years (90% and 89% of participants under the age of 25). Participants were invited to complete a battery of questionnaires in a computer lab in exchange for

course credit. Measures that were deemed central to the purpose of the study were completed by both samples, but other measures were distributed between samples to reduce participant fatigue.

Measures

Motivation to Engage with Nature

Both samples completed the 29-item version of the NEMS that was validated in Study 1. For some analyses, a score for autonomous motivation was computed by combining items from intrinsic motivation, and integrated/identified regulation, whereas introjected and external regulation items were combined into a controlled motivation score. Relative autonomy index (RAI) scores were calculated by subtracting scores of two or three external and introjected regulation items from scores of two or three intrinsic and integrated-identified regulation items. Each of these scores were then used as indicators for a Relative Autonomous Motivation latent variable.

Reasons for Nature Engagement

Sample 2 completed a reduced version of the Recreation Experience Preference scale (REP; Driver, 1983; Driver et al., 1991; Manfredo et al., 1996) containing only the 113 core items. Participants indicated how much each item represented a reason they engage with nature, using a 7-point scale from (1) "Not at all true" to (7) "Very true." Examples of items include "To gain a sense of self-confidence" (*Achievement)* and "To do something with your family" (*Family Togetherness*).[8]

Perceived Satisfaction of Psychological Needs While in Nature

Both samples completed an adapted version of the Balanced Measure of Psychological Needs scale (BMPN; Sheldon & Hilpert, 2012) to assess perceived satisfaction of three psychological needs while outside: *autonomy, competence,* and *relatedness*. The scale contains 21 items for which participants indicate how true each is for them along a 7-point Likert scale from (1) "Not at all true" to (7) "Very true." Examples of items are "I feel like I am free to decide for myself how to live my life" (*autonomy*), "I have been able to learn interesting new skills recently" (*competence*), and "I really like the people I interact with" (*relatedness*). A four-factor structure of the three needs, with a "negative" factor representing reversed coded items, showed good fit in Sample 1, $\chi^2(177) = 397.58$, $p < 0.001$, CFI = 0.90, SRMR = 0.06, RMSEA = 0.059, 90% CI [0.052, 0.066], and Sample 2, $\chi^2(177) = 348.48$, $p < 0.001$, CFI = 0.91, SRMR = 0.06, RMSEA = 0.055, 90% CI [0.047, 0.063]. The scale showed high reliability ($\alpha_{\text{sample 1}} = 0.89$, $\alpha_{\text{sample 2}} = 0.88$). For the analyses, need

[8] No confirmatory factor analysis was conducted on the REP because it contains several single-item factors and there are insufficient degrees of freedom.

satisfaction was, however, treated as a latent variable reflecting three parcels, each containing two autonomy items, two competence items, and three relatedness items.

Nature Exposure

Both samples completed a brief 4-item measure of nature exposure created by Kamitsis and Francis (2013). Participants were asked to rate how often they are exposed to natural environments in (a) everyday life and (b) non-everyday life on a 5-point scale ranging from (1) "Low" to (5) "High", and to indicate how much they take notice of these natural environments in (a) everyday life and (b) non-everyday life on a 5-point scale ranging from (1) "Not much" to (5) "A great deal." Separate indicators for everyday and non-everyday nature exposure were calculated as products of these two items (i.e., frequency × awareness).

Time Spent in Nature

Both samples were asked to recall the amount of time they spent in nature in terms of frequency and duration. They were asked: "On average, in the past 6 months, how many times a week have you gone out into/sought time in nature?" Possible responses ranged from (0) "Less than once per week" to (8) "More than seven times per week." Then, they were asked: "In minutes, how long do you spend in nature per week?" Possible responses ranged from (0) "Less than 5 min per week" to (8) "Five or more hours per week." A single indicator for time spent in nature was calculated as a product of frequency and duration responses.

Well-Being

Sample 2 completed several scales to assess various aspects of well-being. The Scale of Positive and Negative Experience (SPANE; Diener et al., 2010) was used to assess the experience of positive affect (6 items; e.g., "positive", "joyful") and negative affect (6 items; e.g., "negative", "angry") on a 5-point Likert scale from (1) "Very slightly or not at all" to (5) "Very much." The data showed a good fit to a two-factor model, $\chi^2(53) = 94.43$, $p < 0.001$, CFI = 0.97, SRMR = 0.04, RMSEA = 0.050, 90% CI [0.034, 0.065], and the two subscales had good reliability coefficients ($\alpha_{positive} = 0.87$, $\alpha_{negative} = 0.79$). As suggested by Diener and colleagues, a balanced affect score was composed by subtracting an average negative affect score from the average positive affect score.

Life satisfaction was assessed with Life Satisfaction Scale (Diener et al., 1985). It consists of 5 items to which participants responded along a 7-point Likert scale from (1) "Strongly Disagree" to (7) "Strongly Agree". Sample items include, "I am satisfied with my life" and "In most ways my life is close to ideal." The scale showed good reliability ($\alpha = 0.92$).

The 8-item Flourishing Scale (Diener et al., 2010) was used to assess psychological well-being, including positive relationships, competence, and purpose in life. Items were responded to on a 7-point Likert scale ranging from (1) "Strongly Disagree" to (7) "Strongly Agree." Sample items include "I lead a purposeful and

meaningful life" and "I actively contribute to the happiness and well-being of others." The scale showed good reliability ($\alpha = 0.86$).

The 21-item Questionnaire for Eudaimonic Well-Being (QEWB; Waterman et al., 2010) was used to assess eudaimonia, which focuses on "self-discovery, perceived development of one's best potentials, a sense of purpose and meaning in life, intense involvement in activities, investment of significant effort, and enjoyment of activities as personally expressive" (p. 41). Participants responded on a 7-point Likert scale ranging from (1) "Very untrue of me" to (7) "Very true of me." Sample items include "I believe I have discovered who I really am" and "When I engage in activities that involve my best potentials, I have this sense of really being alive." The scale showed good reliability ($\alpha = 0.85$).

Finally, the Subjective Vitality scale (Ryan & Frederick, 1997) was used to assess feelings of aliveness and energy. It consists of 6-items to which participants respond along a 7-point scale from (1) "Not at all true" to (7) "Very true." Sample items include "I feel alive and vital" and "I look forward to each new day." The scale showed high reliability ($\alpha = 0.92$).

Nature Relations

Sample 1 completed the Nature Relatedness scale (NR; Nisbet et al., 2009) which is a 21-item measure of three factors: experiences within the natural world (experience subscale), personal feelings of relationship to nature (self subscale), and perspectives of how nature should be treated (perspective subscale). Participants responded along a 5-point Likert scale from (1) "Strongly disagree" to (5) "Strongly agree" to items such as "My relationship to nature is an important part of who I am." The three-factor structure of the NR scale showed adequate fit, $\chi^2(186) = 486.94$, $p < 0.001$, CFI = 0.84, SRMR = 0.07, RMSEA = 0.067, 90% CI [0.060, 0.074], $\alpha_{self} = 0.83$, $\alpha_{perspective} = 0.57$, $\alpha_{experience} = 0.81$.

Sample 2 completed the Connectedness to Nature Scale (CNS; Mayer & Frantz, 2004) that is a 14-item scale designed to assess subjective feelings of emotional connection to the natural world. Participants were asked to indicate how much each statement is descriptive of themselves along the same 5-point scale as in the NR. A sample item is "I feel as though I belong to the Earth as equally as it belongs to me." The CNS showed good fit to a single-factor model with 3 parcels, $\chi^2(77) = 184.76$, $p < 0.001$, CFI = 0.89, SRMR = 0.06, RMSEA = 0.067, 90% CI [0.055, 0.078], and adequate reliability ($\alpha = 0.83$).

Environmental Concern

Sample 1 completed the New Ecological Paradigm (NEP; Dunlap et al., 2000), a 15-item scale that assesses participants' concerns about the protection and sustainability of the earth with questions such as "The balance of nature is very delicate and easily upset." Participants responded along a 5-point Likert scale from (1) "Strongly agree" to (5) "Strongly disagree." A single-factor model of environmental concern with the inclusion of a "negative" factor of reverse-coded items showed the best

fit, $\chi^2(83) = 153.19$, $p < 0.001$, CFI = 0.93, SRMR = 0.05, RMSEA = 0.049, 90% CI [0.037, 0.060]. The scale as a whole also showed high reliability ($\alpha = 0.87$).

Outdoor Fears

Sample 1 completed the Outdoor Situational Fear Inventory (OSFI; Young et al., 1995) that measures fears in 33 different outdoor-related situations or phenomena such as "getting dirty," "not having enough physical strength," or "unable to control physical environment." Participants responded using a 10-point scale from (1) "Not at all anxious" to (10) "Very anxious." The scale showed high reliability ($\alpha = 0.93$). For the analyses, outdoor fears were treated as a single latent variable reflecting four parcels of items.

Global and Contextual Motivations

Sample 1 completed several motivation scales. The General Motivation Scale (GMS; Guay et al., 2003) assesses global motivation and consists of 24 items spanning 8 factors: *intrinsic motivation for stimulation, intrinsic motivation for accomplishment, intrinsic motivation for knowledge, integrated regulation, identified regulation, introjected regulation, external regulation*, and *amotivation*. In response to the statement, "In general, I do things…" participants were asked to respond along a 7-point Likert scale ranging from (1) "Does not correspond at all" to (7) "Corresponds exactly." The GMS demonstrated good fit to an 8-factor structure, $\chi^2(477) = 749.27$, $p < 0.001$, CFI = 0.93, SRMR = 0.06, RMSEA = 0.040, 90% CI [0.035, 0.045]. Reliability coefficients for the factors ranged from 0.76 to 0.88.

The Leisure Motivation Scale (LMS; Pelletier, Vallerand, Brière, & Blais, 1989) assesses the motivation for leisure activities and consists of 24 items spanning the same factors as in the GMS, but without an *integrated regulation* factor. The LMS showed adequate fit, $\chi^2(337) = 763.00$, $p < 0.001$, CFI = 0.86, SRMR = 0.08, RMSEA = 0.059, 90% CI [0.054, 0.064]. Reliability coefficients ranged from 0.53 to 0.88.

The 28-item Academic Motivation Scale (AMS; Vallerand et al., 1992) was used to assess reasons for pursuing post-secondary education. The AMS assesses the same 7 subtypes of behavior regulation as the LMS. The AMS showed good fit, $\chi^2(337) = 668.16$, $p < 0.001$, CFI = 0.93, SRMR = 0.07, RMSEA = 0.052, 90% CI [0.047, 0.064]. Reliability coefficients ranged from 0.76 to 0.94.

The Sport Motivation Scale II (SMS-II) measured motivation to participate in sports (Pelletier et al., 2013) through 6 factors: *intrinsic motivation, integrated regulation, identified regulation, introjected regulation, external regulation*, and *amotivation*. The SMS-II showed good fit, $\chi^2(120) = 358.52$, $p < 0.001$, CFI = 0.92, SRMR = 0.08, RMSEA = 0.075, 90% CI [0.066, 0.083]. Reliability coefficients ranged from 0.70 to 0.90.

Finally, the 24-item Motivation Toward the Environment Scale (MTES; Pelletier et al., 1998) was employed to assess reasons for engaging in pro-environmental behaviors through the same 6 factors as the SMS-II. The MTES showed good fit,

$\chi^2(237) = 557.94$, $p < 0.001$, CFI = 0.92, SRMR = 0.07, RMSEA = 0.061, 90% CI [0.055, 0.067]. Reliability coefficients ranged from 0.82 to 0.89.

Social Desirability

Sample 1 completed the 40-item Balanced Inventory of Desirable Responding (BIDR; Paulhus, 1991) to assess two aspects of social desirability: *self-deception* and *impression management.* Examples of item are "I am in control of my own fate" (*self-deception*) and "I never take things that don't belong to me" (*impression management*). Participants responded along a 7-point Likert scale from (1) "Not True" to (7) "Very True". The BIDR demonstrated poor fit,[9] $\chi^2(739) = 1611.88$, $p < 0.001$, CFI = 0.57, SRMR = 0.07, RMSEA = 0.057, 90% CI [0.054, 0.061]. The scale showed adequate reliability for self-deception ($\alpha = 0.71$) and impression management ($\alpha = 0.76$).

Results

Factorial Structure of the NEMS

The structure of the different regulation types was evaluated with a CFA and exploratory structural equation modeling (ESEM). Three item correlations reached 0.90, and all others were 0.80 or lower, suggesting a relative absence of multicollinearity. The CFA results for the 6-factor solution indicated acceptable fit for both samples: $\chi^2(284)_{\text{Sample1}} = 724.50$, $p < 0.001$, CFI = 0.92, SRMR = 0.085, RMSEA = 0.066, 90% CI [0.060, 0.071]; $\chi^2(284)_{\text{Sample2}} = 672.39$, $p < 0.001$, CFI = 0.91, SRMR = 0.077, RMSEA = 0.066, 90% CI [0.060, 0.072] (see Table 2 for factor correlations and subscale reliabilities, and Tables 14 through 19 in *Supplementary Material* for detailed results and tests of measurement invariance of the NEMS across gender).

NEMS and Reasons for Nature Engagement

To examine relations between the NEMS and the REP, each motivation type from the NEMS was correlated with each category of reasons for recreation from the REP (see Table 3). The results show that several reasons for engaging with nature were positively correlated with both autonomous and controlled motivation types. For example, wanting to achieve something in nature was positively correlated with intrinsic motivation for knowledge ($r = 0.38$ [0.28, 0.47], $p < 0.001$) and external regulation ($r = 0.35$ [0.25, 0.44], $p < 0.001$).[10] Also, being in nature to be with

[9] The BIDR did not demonstrate an adequate factor structure in our sample, despite testing various formulations of the structural model (e.g., superordinate factor, negative factor, dichotomous scoring). This has occurred in previous research (Gignac, 2013). Nonetheless, we include relations between social desirability and nature engagement motivation as *Supplementary Material* (Table 20), but advise caution in interpretation.

[10] We report 95% confidence intervals for correlations and regression coefficients throughout the results section.

family was positively correlated with both integrated-identified regulation ($r=0.20$ [0.09, 0.30], $p<0.001$) and external regulation ($r=0.22$ [0.12, 0.33], $p<0.001$). Finally, the RAI was positively related to going outside because of the enjoyment of nature ($r=0.49$ [0.41, 0.57], $p<0.001$), the desire to learn ($r=0.39$ [0.30, 0.48], $p<0.001$), the desire to introspect ($r=0.24$ [0.13, 0.34], $p<0.001$), a sense of nostalgia ($r=0.22$ [0.11, 0.32], $p<0.001$), creativity ($r=0.26$ [0.15, 0.36], $p<0.001$), to escape personal pressures ($r=0.23$ [0.12, 0.33], $p<0.001$), and to escape physical pressures ($r=0.18$ [0.07, 0.29], $p=0.001$). Finally, no REP factors were exclusively associated with controlling reasons and, in fact, the RAI was not negatively correlated with any reasons.

Need Satisfaction, Motivation, and Behavior

Because both samples completed the measures of need satisfaction, motivation and behavior, we combined them for the following analyses. We first examined the relation between psychological needs and the autonomous and controlled forms of motivation. Autonomous and controlled motivation were treated as latent variables composed of four parcels each (i.e., average of one or two items from each relevant regulation types). As proposed by SDT, autonomous motivation was positively related to autonomy ($r=0.32$ [0.25, 0.39], $p<0.001$), competence ($r=0.27$ [0.20, 0.34], $p<0.001$), and relatedness ($r=0.27$ [0.19, 0.34], $p<0.001$), whereas controlled motivation was negatively related to autonomy ($r=-0.16$ [-0.24, -0.08], $p<0.001$), and competence ($r=-0.10$ [-0.18, -0.02], $p=0.015$), and unrelated to relatedness ($r=-0.03$ [-0.05, 0.11], $p=0.409$).

Second, we examined the distinction between autonomous and controlled motivation to predict engagement with nature. Results showed that autonomous motivation was significantly related to everyday nature exposure ($\beta=0.40$ [0.33, 0.47], $p<0.001$), non-everyday nature exposure ($\beta=0.54$ [0.49, 0.60], $p<0.001$), and time spent in nature ($\beta=0.35$ [0.28, 0.42], $p<0.001$), whereas controlled motivation was unrelated to everyday nature exposure ($\beta=-0.02$ [-0.09, 0.06], $p=0.707$), non-everyday nature exposure ($\beta=-0.01$ [-0.09, 0.06], $p=0.692$), and time spent in nature ($\beta=0.00$ [-0.08, 0.08], $p=1.000$).[11]

Finally, the relations between psychological needs, motivation, and behavioral engagement were examined in three mediation models (see Fig. 1) using structural equation modeling and bootstrapped confidence intervals (10,000 resamples). For everyday nature exposure, the model fit the data well, $\chi^2(49)=291.63$, $p<0.001$, CFI = 0.96, SRMR = 0.06, RMSEA = 0.090, 90% CI [0.076, 0.095], and showed that autonomous motivation partially mediates the relationship between need satisfaction and everyday nature exposure, $ab=0.13$ [0.09, 0.18], $p<0.001$ (71.0% of the total effect mediated), $c=0.18$ [0.11, 0.26], $p<0.001$. For non-everyday nature exposure, the model also fit the data well, $\chi^2(49)=290.15$, $p<0.001$, CFI = 0.96, SRMR = 0.06, RMSEA = 0.085, 90% CI [0.076, 0.095], and showed that the

[11] See Table 21 in *Supplementary Material* for relations between each motivation type and behavioral engagement with nature.

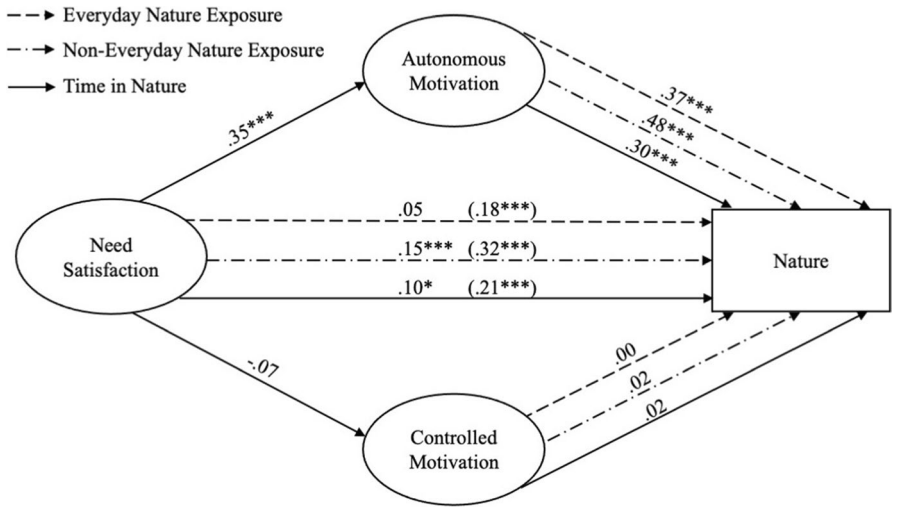

Fig. 1 Mediation results from basic psychological need satisfaction through motivation to three nature behavior outcomes. Each model was tested separately. Both the direct and total effects are presented, respectively. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

relationship between need satisfaction and non-everyday nature exposure was partially mediated by autonomous motivation, $ab = 0.17$ [0.12, 0.22], $p < 0.001$ (50.9% of the total effect mediated), $c = 0.32$ [0.24, 0.39], $p < 0.001$. Finally, for time spent in nature, the model also fit the data well, $\chi^2(49) = 304.24$, $p < 0.001$, CFI = 0.96, SRMR = 0.06, RMSEA = 0.088, 90% CI [0.078, 0.097]. Autonomous motivation partially mediated the relationship between need satisfaction and time spent in nature, $ab = 0.11$ [0.07, 0.15], $p < 0.001$ (50.2% of the total effect mediated), $c = 0.21$ [0.13, 0.29], $p < 0.001$ (see Figs. 1 through 3 in the *Supplementary Material* for measurement models).

Motivation to Engage with Nature and Well-Being

We first examined the relation between motivation to engage with nature and well-being. Intrinsic motivation and integrated-identified regulation were positively associated with most indicators of well-being (rs = 0.10 to 0.25, all ps < 0.05 except for one), whereas external regulation and amotivation were negatively related to some indicators of well-being (rs = -0.80 to -0.22, half with ps < 0.05; see Table 22 in the *Supplementary Material*).

Second, we examined the effect of autonomous versus controlled forms of motivation on well-being. We found that autonomous motivation was positively related to balanced affect ($\beta = 0.17$ [0.06, 0.28], $p = 0.004$), life satisfaction ($\beta = 0.16$ [0.05, 0.27], $p = 0.006$), flourishing ($\beta = 0.19$ [0.08, 0.30], $p = 0.001$), eudaimonic well-being ($\beta = 0.25$ [0.14, 0.36], $p < 0.001$), and vitality ($\beta = 0.27$ [0.16, 0.38], $p < 0.001$), whereas, controlled motivation was unrelated to balanced affect ($\beta = -0.10$ [− 0.21,

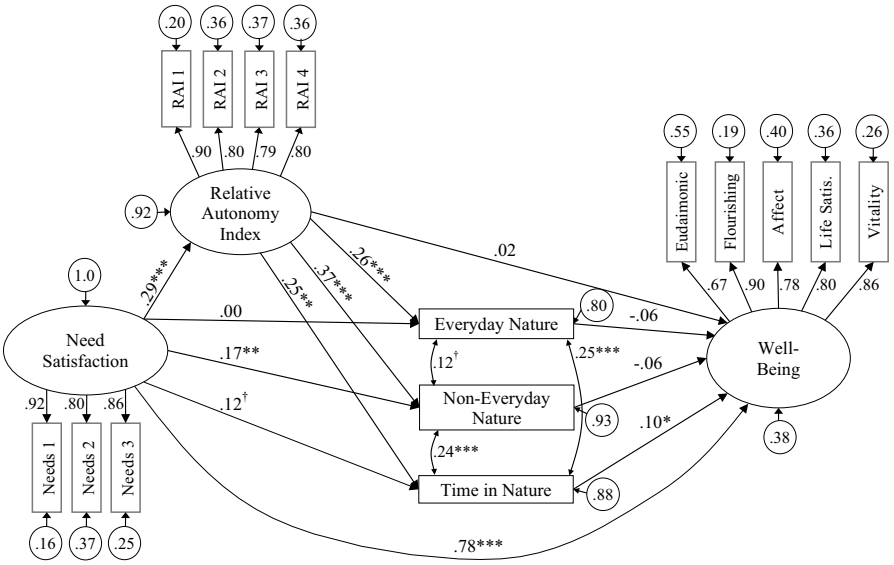

Fig. 2 Basic psychological need satisfaction while outside, nature engagement motivation, and nature behaviors as predictors of well-being. Loadings on all latent factors significant at $p < 0.001$. $^{\dagger}p = 0.07$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

0.02], $p = 0.106$), life satisfaction ($\beta = -0.04$ [− 0.16, 0.08], $p = 0.474$), flourishing ($\beta = -0.01$ [− 0.12, 0.11], $p = 0.939$), eudaimonic well-being ($\beta = -0.10$ [− 0.22, 0.02], $p = 0.090$), and vitality ($\beta = -0.09$ [− 0.21, 0.02], $p = 0.117$). Finally, correlations between relative autonomous motivation and each type of well-being were significant ($rs = 0.13$ to 0.24, $ps < 0.05$; see Table 22 in the *Supplementary Material*).

Third, we examined well-being within the previous mediation model that involved psychological need satisfaction, relative autonomous motivation, and nature engagement. Well-being was treated as a unitary latent variable for parsimony and because it can be regarded as a unitary concept comprised of a number of indicators (Kashdan et al., 2008; McMahan & Estes, 2011; DeHaan & Ryan, 2014). The model fit the data well, $\chi^2(78) = 167.58$, $p < 0.001$, CFI = 0.96, SRMR = 0.04, RMSEA = 0.060, 90% CI [0.048, 0.072]. As shown in Fig. 2, well-being was significantly related with need satisfaction ($\beta = 0.78$ [0.72, 0.84], $p < 0.001$) and time spent in nature ($\beta = 0.10$ [0.01, 0.19], $p = 0.030$), but not the RAI ($\beta = 0.02$ [− 0.10, 0.14], $p = 0.757$), everyday nature exposure ($\beta = -0.06$ [− 0.15, 0.03], $p = 0.185$), nor non-everyday nature exposure ($\beta = -0.06$ [− 0.17, 0.05], $p = 0.309$).[12]

Finally, we tested the role of relative autonomous motivation as a moderator of the nature-well-being relationship. Because we used structural equation modeling,

[12] Recognizing the conceptual similarities between need satisfaction and flourishing (Diener et al., 2010), we removed flourishing from the well-being factor and tested the same model. Changes in model fit and loadings were negligible, including the correlation between need satisfaction and well-being ($\beta = .759$ [.69, .83], $p < .001$).

interaction terms between the RAI and each type of nature exposure were created using the matched pairs approach outlined by Marsh et al., (2006). Well-being was regressed on the RAI, the three nature exposure indicators, and the three interaction terms. The model showed acceptable fit, $\chi^2(67) = 97.18$, $p < 0.001$, CFI = 0.97, SRMR = 0.05, RMSEA = 0.038, 90% CI [0.023, 0.051]. Well-being was positively related with the RAI ($\beta = 0.19$ [0.04, 0.34], $p = 0.012$), and time spent in nature ($\beta = 0.16$ [0.04, 0.28], $p = 0.013$), but not everyday and non-everyday nature exposure ($\beta = -0.08$ [− 0.19, 0.02], $p = 0.126$ and $\beta = 0.08$ [− 0.06, 0.22], $p = 0.253$, respectively). The interactions between the RAI and time spent in nature, everyday, and non-everyday nature exposure were all nonsignificant ($\beta = -0.08$ [− 0.22, 0.06], $p = 0.252$; $\beta = -0.01$ [− 0.12, 0.10], $p = 0.831$; and $\beta = 0.10$ [− 0.05, 0.25], $p = 0.169$, respectively). The full latent model is reported in the *Supplementary Material Fig. 4*.

Nature Engagement Motivation and Nature Attitudes

We examined how motivation to engage with nature relates with feelings of connection to nature, environmental concern, and outdoor fears. We present the results from each individual regulation type, autonomous vs controlled motivation, and relative autonomous motivation (see Table 4). First, we found that both types of intrinsic motivation and integrated-identified regulation were significantly related to nature relatedness (rs = 0.71 to 0.86, ps < 0.001 for experience subscale, rs = 0.70 to 0.83, ps < 0.001 for self subscale, and rs = 0.23 to 0.33, ps < 0.01 for perspective subscale), connectedness to nature (rs = 0.59 to 0.69, ps < 0.001), and environmental concern (rs = 0.21 to 0.34, ps < 0.01). Introjected regulation was also positively related to each nature relatedness subscale (rs = 0.15 to 0.33, ps < 0.05), connectedness to nature ($r = 0.14$ [0.00, 0.28], $p = 0.043$) and environmental concern ($r = 0.19$ [0.06, 0.31], $p = 0.009$). In addition, intrinsic motivation for stimulation and integrated-identified regulation were negatively related to fear of the outdoors ($r = -0.27$ [− 0.37, − 0.16], $p < 0.001$ and $r = -0.34$ [− 0.45, − 0.24], $p < 0.001$, respectively), whereas external regulation and amotivation were positively related to fear of the outdoors ($r = 0.29$ [0.17, 0.40], $p < 0.001$ and $r = 0.26$ [0.13, 0.40], $p < 0.001$, respectively).

Similarly, autonomous motivation was positively associated with nature relatedness for experience, self, and perspective subscales ($\beta = 0.90$ [0.85, 0.95], $\beta = 0.85$ [0.79, 0.90], and $\beta = 0.34$ [0.19, 0.48], all ps < 0.001, respectively). In contrast, controlled motivation was negatively related to, or unrelated to the nature relatedness for experience, self, and perspective subscales ($\beta = -0.12$ [− 0.21, − 0.02], $p = 0.005$; $\beta = -0.06$ [− 0.14, 0.03], $p = 0.204$; and, $\beta = -0.10$ [− 0.25, 0.05], $p = 0.185$, respectively). Likewise, autonomous motivation predicted connectedness to nature ($\beta = 0.73$ [0.66, 0.79], $p < 0.001$) and environmental concern ($\beta = 0.32$ [0.20, 0.44], $p < 0.001$), whereas controlled motivation was unrelated to each ($\beta = -0.06$ [− 0.17, 0.04], $p = 0.214$ and $\beta = -0.06$ [− 0.18, 0.07], $p = 0.395$). Finally, autonomous motivation was negatively related to fear of the outdoors ($\beta = -0.39$ [− 0.49, − 0.28], $p < 0.001$), but controlled motivation was positively related to fear of the outdoors ($\beta = 0.27$ [0.16, 0.38] $p < 0.001$).

Finally, these nature attitudes and affect were examined in relation to relative autonomous motivation. For nature relatedness, there were stronger relationships between the RAI and the experience ($r = 0.70$ [0.63, 0.76], $p < 0.001$) and self subscales ($r = 0.64$ [0.56, 0.71], $p < 0.001$) than the perspective subscale ($r = 0.31$ [0.17, 0.44], $p < 0.001$). The RAI was also positively related to connectedness to nature ($r = 0.57$ [0.49, 0.65], $p < 0.001$) and environmental concern ($r = 0.25$ [0.12, 0.37], $p < 0.001$), and negatively related to outdoor fears ($r = -0.40$ [−0.50, −0.30], $p < 0.001$).

Nature Engagement Motivation and Motivation in Other Contexts

We examined how motivation to engage with nature was related to motivation in other contexts. The motivation types assessed by the NEMS were mostly correlated with the same motivation types from other motivation scales (see Table 5). Intrinsic motivation to engage with nature was the only factor that correlated with intrinsic motivation in all other contexts. For instance, *intrinsic motivation for knowledge* in the context of nature engagement was correlated with the same factor in the contexts of global motivation ($r = 0.46$ [0.35, 0.57], $p < 0.001$), leisure motivation ($r = 0.61$ [0.51, 0.71], $p < 0.001$), motivation towards the environment ($r = 0.71$ [0.64, 0.79], $p < 0.001$), sports motivation, ($r = 0.53$ [0.43, 0.64], $p < 0.001$), and academic motivation ($r = 0.42$ [0.30, 0.53], $p < 0.001$). Relations between the types of motivation to engage with nature and the types of academic motivation were the lowest, but still positive. Similarly, relative autonomous motivation to engage with nature was positively related to relative autonomous motivation for leisure ($r = 0.56$ [0.47, 0.66], $p < 0.001$), pro− environmental behaviors ($r = 0.61$ [0.53, 0.70], $p < 0.001$), sports ($r = 0.45$ [0.35, 0.54], $p < 0.001$), academics ($r = 0.46$ [0.35, 0.56], $p < 0.001$), and global motivation ($r = 0.49$ [0.39, 0.58], $p < 0.001$).

General Discussion

The objective of the current research was to examine motivation to engage with nature, using SDT as a framework. Through two multi-sample studies, we found strong evidence for the distinction between autonomous and controlled forms of motivation to engage with nature, which is related to psychological need satisfaction and various outcomes, as proposed by SDT. Moreover, motivation to engage with nature was found to exist within individuals' motivational systems (as described in Vallerand, 1997), being related to, but distinct from, motivations in other contexts.

Self-Determination Theory as a Framework for Motivation to Engage with Nature

The current research is the first instance of using SDT as a framework for understanding people's motivation for engaging with nature. Previous research has

examined how natural settings satisfy psychological needs (Ceylan, 2020; Houge Mackenzie & Hodge, 2020; Landon et al., 2021) and what reasons people go to nature (Manfredo et al., 1996), our focus on motivation using SDT's framework provides many advantages. First, it allows for the identification and distinction between autonomous and controlled forms of motivation. The most common assessment of reasons for engaging with nature (i.e., the REP) tends to focus on "positive" reasons such as "to gain a better appreciation of nature", while neglecting controlling reasons for engaging with nature. The NEMS accounts for both autonomous and controlling reasons to engage with nature, which could succinctly capture the variety of reasons to engage with nature that are identified in the REP.

Second, whereas the REP has no theoretically derived predictions, the NEMS shows predictive power by distinguishing autonomous and controlled forms of motivation. People engaging with nature for autonomous reasons spend more time in nature and notice it more frequently in everyday and non-everyday settings. Autonomous motivation was also found to be more strongly related with non-everyday than everyday nature engagement, which could be explained by SDT. Indeed, non-everyday nature exposure requires more volition and intentional action than everyday nature exposure. Overall, we found that autonomous motivation plays an important role in determining behavioral engagement, even those behaviors that involve passive engagement.

Third, while nature engagement is known to be related to well-being (McMahan & Estes, 2015), SDT can explain why not all types of nature engagement could be related to well-being. Autonomous motivation to engage with nature should be more positively related to well-being than controlled motivation. The current research provides some support to this hypothesis. First, autonomous forms of motivation are positively related to various indicators of well-being, whereas controlled motivation was not. Second, relative autonomous motivation was found to be directly and indirectly (via behavioral engagement) related to well-being. However, we did not find that relative autonomous motivation moderates the relation between nature engagement and well-being. There are several potential reasons why we did not find support for this hypothesis. First of all, it is difficult to find significant interactions in correlational studies (McClelland & Judd, 1993), especially when using structural equation modeling. It is also possible that the effect only exists at a state-level, not at the general or trait-level of motivation, nature exposure, and well-being which we assessed. Alternatively, nature might have such a strong influence upon well-being that the benefits are experienced by everyone no matter their original motivation to engage with nature. Lastly, the positive relation we observed between relative autonomous motivation and well-being could simply be explained by the benefits of being autonomously motivated, no matter the context (Vallerand, 1997; Ryan & Deci, 2000b). All these reasons for not finding a significant interaction outline a potential agenda for future research.

Well-Being in the Context of Nature

As discussed above, we found that autonomous motivation is related to well-being, but we did not find that relative autonomous motivation augmented the relationship

between nature engagement and well-being. We also found that need satisfaction when in nature was significantly and positively related to well-being. This effect was not only mediated by relative autonomous motivation and behavioral engagement, but was also direct, which indicates that need satisfaction impacts well-being above and beyond motivation. Milyavskaya and Koestner (2011) found similar results across several domains (e.g., family, school, and work) where relative autonomous motivation only partially mediated the relationship between need satisfaction and well-being.

This finding is particularly important considering that nature is often regarded as a public health resource (Maller et al., 2006; Shanahan et al., 2016). The effect of need satisfaction when in nature on well-being suggests that mental health practitioners should focus more on whether needs are satisfied while in nature than on simply exposing people to nature. A natural environment that supports satisfaction of psychological needs could lead to greater well-being, whereas a natural environment that thwarts need satisfaction could hinder potential well-being benefits. For example, a surfer who goes to a surf break that is within their capability (i.e., waves are not too large or too small) may feel their psychological needs are supported, whereas, as surfer who is brought by friends to a break that is beyond their capability may feel that their psychological needs are frustrated. Therefore, need satisfaction when in nature may play a proximate role in well-being, as proposed by Deci and Ryan (2000). However, it remains difficult to distinguish the benefit of need satisfaction from the benefits of the context (i.e., nature) when predicting well-being. It might also be possible that both are essential. Indeed, Baxter and Pelletier (2019) proposed that connecting to nature might be a fourth psychological need.

Motivation to Engage with Nature and Relatedness to Nature

Beyond the effects of nature engagement on well-being, the current research also sheds a light on how people relate to nature. First, we found that autonomous motivation tends to be associated with favorable attitudes towards nature, including more relatedness and connectedness to it, higher concern for it, and less fear of it. This is congruent with the fact that valuing an object or activity is a necessary prerequisite of autonomous motivation to engage with it (Deci et al., 1994; Ryan & Connell, 1989). However, controlled motivation was unrelated or negatively related to these attitudes. This also is important to note because it may challenge the argument that nature is inherently interesting because of the biophilic connection that humans have to it (Kellert & Wilson, 1993; Wilson, 1984). Indeed, several of our findings indicate that the relation between humans and nature is more complex than has been hypothesized. For instance, there are individual differences in motivation to engage with nature, which suggests that some people are not drawn to nature as would be expected if humans have an inherent connection to it. If someone requires an external regulator to incentivize them to engage with nature, it could be evidence that they do not have an inherent connection or desire to commune with it.

Beyond the argument that nature as a whole is interesting, we also found evidence that not all natural environments are interesting. Some natural settings are dangerous

and could inspire fear (Bixler & Floyd, 1997). Fears can be based on factors as minimal as harmless insects or as extreme as natural disasters. In our sample we found individual differences in peoples' fears about nature, which could be a barrier to engagement with nature. Fear is generally an avoidance motivator (Tannenbaum et al., 2015) as people are driven to reduce the fear (Hovland et al., 1953). Thus, fear of nature could dissuade someone from going outside to nature. Within the context of SDT, fear is recognized as a controlling form of motivation, such as fear of punishment which is an external regulation or a desire to reduce fear which could be introjected regulation. Empirical research on the role of fear in autonomous versus controlled motivation has, however, been scant. A few studies suggest that fear of negative outcomes is captured by controlled motivation (Conroy, 2004) and that those who are autonomously motivated are less likely to adopt fear-based goals (Pulfrey et al., 2011). Adding to this literature, we found that autonomous motivation to engage with nature is associated with less fear of nature. By contrast, fear was positively related with external, but not introjected regulation. Fear may be dissuading some individuals from engaging with nature and they may require external regulation. Future research could examine how to enable people who are afraid of nature to engage with it by reducing fears, incentivizing engagement, or—best of all—shift to more autonomous motivation.

As mentioned, autonomous motivation to engage with nature is related with positive attitudes towards nature. Notably, though, the strength of these relationships varies, with environmental concern being the lowest. This aligns with previous research which shows that engagement with nature is not a strong predictor of environmental concern. In a systematic review, Berns and Simpson (2009) found that although the relationship between participation in outdoor activities and environmental concern may be intuitive, it may not be as strong as one might suspect. Environmental concern is not due solely to participation in nature activities, especially considering that not all outdoor activities are appreciative of nature (e.g., motor sports in nature; Dunlap & Heffernan, 1975). Thus, a weak-to-moderate relationship between motivation to engage with nature and environmental concern is further evidence that if someone is going out to nature, it is not necessarily because they want to take care of it. Further corroborating this point is the distinction we found between motivation to engage with nature and motivation to protect it.

Motivation to Engage with Nature as Part of a Motivation System

Motivation exists within a hierarchy of global, contextual, and situational levels (Vallerand, 1997). We thus examined motivation to engage with nature in relation with global motivation and motivation in other contexts. As Vallerand suggested, if someone is generally autonomously motivated, they are more likely to be autonomously motivated in their different contexts of life (e.g., sports, leisure, interpersonal relations), which is explained by both top-down and bottom-up processes. Positive correlations between contextual and global motivation suggest that they are related, but distinct.

We also proposed that similar contexts should show more similar motivation than dissimilar contexts. In line with this proposition, we found that motivation to engage with nature was more similar to sport, leisure, and pro-environmental motivation than to academic motivation. Sports and leisure activities are often conducted in natural settings and pro-environmental behaviors are directly concerned with the natural world. On the other hand, academic motivation and motivation to engage with nature were largely unrelated, with only a few moderate correlations. The existing relation between nature engagement and academic motivation is likely the result of global motivation exerting a top-down influence on both contexts (Guay et al., 2003). The presence of motivation to engagement with nature in the individual's motivation system is an important finding. First, it offers some validity to the NEMS. Second, it offers a potential avenue of future research and intervention where global motivation and motivation in other context could be used as predictors of motivation to engagement with nature, and therefore behavioral engagement in nature and resulting well-being.

Limitations

The first limitation of this research is the inclusion of mostly undergraduate students from a city that is known for outdoor recreation and has social norms of positive nature relations. These norms may have led participants to respond in a socially desirable manner such as more autonomous forms of motivation and more positive attitudes to nature, which could inflate these correlations and confirm those aspects of the theory. People from areas where these norms are not as strong may respond differently. Therefore, future research is required to determine the generalizability of these findings with other populations and in other cultures.

Second, we used a correlational design. Whereas the causal hypotheses were based upon SDT and decades of empirical research, the causal relations in the area of nature engagement still need to be evaluated. This research is thus an important first step toward more research on nature engagement using SDT as theoretical framework, offering a valid measure to researchers.

Conclusion

Self-determination theory provides an important theoretical framework for understanding motivation to engage with nature. Peoples' motivation to engage with nature varies from autonomous to controlled, despite propositions that nature is inherently interesting. People who show (relative) autonomous motivation tend to go outside to nature more often, experience higher levels of well-being, and show more concern for the environment. Future research is, however, needed to confirm this causal relation and then explore how to foster autonomous motivation, such as supporting psychological needs of autonomy, competence, and relatedness.

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Data Availability Data are available upon written request to Dr. Frederick Grouzet (fgrouzet@uvic.ca). Data cannot be deposited in a repository because we do not have consent from participants to do so. Our informed consent procedures stated that we will share data upon request.

Declarations

Conflict of interest The authors have no conflicts of interest to declare that are relevant to the content of this article. All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript. The authors have no financial or proprietary interests in any material discussed in this article.

Statistical Code Availability Available upon request to any of the authors.

Ethical Approval All procedures performed in studies were in accordance with the ethical standards of the institutional review board of the University of Victoria (Protocol # 16–446).

Consent to Participate Informed consent was obtained from all individual participants included in the study.

References

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*, 21–34. https://doi.org/10.1037/cap0000145

Berns, G. N., & Simpson, S. (2009). Outdoor recreation participation: A research summary. *Journal of Experiential Education, 32*, 79–91. https://doi.org/10.1177/105382590903200107

Bixler, R. D., & Floyd, M. F. (1997). Nature is scary, disgusting, and uncomfortable. *Environment and Behavior, 29*, 443–467. https://doi.org/10.1177/001391659702900401

Blais, M. R., Sabourin, S., Boucher, C., & Vallerand, R. J. (1990). Toward a motivational model of couple happiness. *Journal of Personality and Social Psychology, 59*, 1021–1031. https://doi.org/10.1037/0022-3514.59.5.1021

Bultena, G. L., & Taves, M. J. (1961). Changing wilderness images and forestry policy. *Journal of Forestry, 59*, 167–171.

Ceylan, M. (2020). The role of outdoor recreation activities in the dimension of meeting basic psychological needs. *International Journal of Applied Exercise Physiology*, *9*(1), 2322–3537. https://doi.org/10.26655/IJAEP.2020.1.5

Conroy, D. E. (2004). The unique psychological meanings of multidimensional fears of failing. *Journal of Sport and Exercise Psychology, 26*, 484–491. https://doi.org/10.1123/jsep.26.3.484

Deci, E. L., Eghrari, H., Patrick, B. C., & Leone, D. R. (1994). Facilitating internalization: The self-determination theory perspective. *Journal of Personality, 62*(1), 119–142. https://doi.org/10.1111/j.1467-6494.1994.tb00797.x

Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry, 11*, 227–268. https://doi.org/10.1207/S15327965PLI1104_01

DeHaan, C. R., & Ryan, R. M. (2014). Symptoms of wellness: Happiness and eudaimonia from a self-determination perspective. In *Stability of happiness: Theories and evidence on whether happiness can change* (Issue July, pp. 37–55). Academic Press. https//doi.org/https://doi.org/10.1016/B978-0-12-411478-4.00003-5

Diener, E., Emmons, R. A., Larsen, R. J., & Griffin, S. (1985). The satisfaction with life scale. *Journal of Personality Assessment, 49*, 71–75. https://doi.org/10.1207/s15327752jpa4901_13

Diener, E., Wirtz, D., Tov, W., Kim-Prieto, C., Choi, D., Oishi, S., & Biswas-Diener, R. (2010). New well-being measures: Short scales to assess flourishing and positive and negative feelings. *Social Indicators Research, 97*, 143–156. https://doi.org/10.1007/s11205-009-9493-y

Dinno, A. (2015). *Package 'paran.'* https://cran.r-project.org/web/packages/paran/paran.pdf

Driver, B. L. (1983). *Master list of items for Recreation Experience Preference scales and domains*. Rocky Mountain Forest and Range Experiment Station.

Driver, B. L., Tinsley, H. E. A., & Manfredo, M. J. (1991). The paragraphs about leisure and recreation experience preference scales: Results from two inventories designed to assess the breadth of the perceived psychological benefits of leisure. In B. L. Driver, P. J. Brown, & G. L. Peterson (Eds.), *Benefits of leisure* (pp. 263–286). Venture Publishing.

Dunlap, R. E., & Heffernan, R. B. (1975). Outdoor recreation and environmental concern: An empirical examination. *Rural Sociology, 40*, 18–30.

Dunlap, R. E., Van Liere, K. D., Mertig, A. G., & Jones, R. E. (2000). Measuring endorsement of the New Ecological Paradigm: A revised NEP scale. *Journal of Social Issues, 56*, 425–442. https://doi.org/10.1111/0022-4537.00176

Gignac, G. E. (2013). Modeling the balanced inventory of desirable responding: Evidence in favor of a revised model of socially desirable responding. *Journal of Personality Assessment, 95*, 645–656. https://doi.org/10.1080/00223891.2013.816717

Glowinski, S. L., & Moore, F. R. (2014). The role of recreational motivation in the birding participation–environmental concern relationship. *Human Dimensions of Wildlife, 19*, 219–233. https://doi.org/10.1080/10871209.2014.878966

Guay, F., Mageau, G. A., & Vallerand, R. J. (2003). On the hierarchical structure of self-determined motivation: A test of top-down, bottom-up, reciprocal, and horizontal effects. *Personality and Social Psychology Bulletin, 29*, 992–1004. https://doi.org/10.1177/0146167203253297

Hartig, T., Böök, A., Garvill, J., Olsson, T., & Gärling, T. (1996). Environmental influences on psychological restoration. *Scandinavian Journal of Psychology, 37*, 378–393. https://doi.org/10.1111/j.1467-9450.1996.tb00670.x

Honaker, J., King, G., & Blackwell, M. (2011). Amelia II: A program for missing data. *Journal of Statistical Software*, *45*(7), 1–47. https://doi.org/10.18637/jss.v045.i07

Houge Mackenzie, S., & Hodge, K. (2020). Adventure recreation and subjective well-being: A conceptual framework. *Leisure Studies, 39*(1), 26–40. https://doi.org/10.1080/02614367.2019.1577478

Hovland, C. I., Janis, I. L., & Kelley, H. H. (1953). *Communication and persuasion: Psychological studies of opinion change*. Yale University Press.

Howard, J. L., Gagné, M., & Bureau, J. S. (2017). Testing a continuum structure of self-determined motivation: A meta-analysis. *Psychological Bulletin, 143*(12), 1346–1377. https://doi.org/10.1037/bul0000125

Kamitsis, I., & Francis, A. J. P. (2013). Spirituality mediates the relationship between engagement with nature and psychological wellbeing. *Journal of Environmental Psychology, 36*, 136–143. https://doi.org/10.1016/j.jenvp.2013.07.013

Kashdan, T. B., Biswas-Diener, R., & King, L. A. (2008). Reconsidering happiness: The costs of distinguishing between hedonics and eudaimonia. *Journal of Positive Psychology, 3*, 219–233. https://doi.org/10.1080/17439760802303044

Kellert, S. R., & Wilson, E. O. (Eds.). (1993). *The biophilia hypothesis*. Island Press.

Kline, R. B. (2015). *Principles and practice of structural equation modeling* (4th ed.). Guilford Press.

Koestner, R., Losier, G. F., Vallerand, R. J., & Carducci, D. (1996). Identified and introjected forms of political internalization: Extending self-determination theory. *Journal of Personality and Social Psychology, 70*, 1025–1036. https://doi.org/10.1037/0022-3514.70.5.1025

Kyle, G. T., Absher, J. D., Hammitt, W. E., & Cavin, J. (2006). An examination of the motivation—involvement relationship. *Leisure Sciences, 28*, 467–485. https://doi.org/10.1080/01490400600851320

Landon, A. C., Woosnam, K. M., Kyle, G. T., & Keith, S. J. (2021). Psychological needs satisfaction and attachment to natural landscapes. *Environment and Behavior, 53*(6), 661–683. https://doi.org/10.1177/0013916520916255

Losier, G. F., & Koestner, R. (1999). Intrinsic versus identified regulation in distinct political campaigns: The consequences of following politics for pleasure versus personal meaningfulness. *Personality and Social Psychology Bulletin, 25*, 287–298. https://doi.org/10.1177/0146167299025003002

Losier, G. F., Perreault, S., Koestner, R., & Vallerand, R. J. (2001). Examining individual differences in the internalization of political values: Validation of the self-determination scale of political motivation. *Journal of Research in Personality, 35*, 41–61. https://doi.org/10.1006/jrpe.2000.2300

Maller, C., Townsend, M., Pryor, A., Brown, P., & St. Leger, L. . (2006). Healthy nature healthy people: "contact with nature" as an upstream health promotion intervention for populations. *Health Promotion International, 21*, 45–54. https://doi.org/10.1093/heapro/dai032

Manfredo, M. J., Driver, B. L., & Tarrant, M. A. (1996). Measuring leisure motivation: A meta-analysis of the recreation experience preference scales. *Journal of Leisure Research, 28*, 188–213. https://doi.org/10.1080/00222216.1996.11949770

Mangone, G., Capaldi, C. A., van Allen, Z. M., & Luscuere, P. G. (2017). Bringing nature to work: Preferences and perceptions of constructed indoor and natural outdoor workspaces. *Urban Forestry and Urban Greening, 23*, 1–12. https://doi.org/10.1016/j.ufug.2017.02.009

Marsh, H. W., When, Z., & Hau, K. T. (2006). Structural equation modeling of latent interaction and quadratic effects. In G. R. Hancock & R. O. Mueller (Eds.), *Structural equation modeling: A second course* (2nd ed., pp. 225–265). Information Age Publishing.

Marsh, H. W., Morin, A. J. S., Parker, P. D., & Kaur, G. (2014). Exploratory structural equation modeling: An integration of the best features of exploratory and confirmatory factor analysis. *Annual Review of Clinical Psychology, 10*, 85–110. https://doi.org/10.1146/annurev-clinpsy-032813-153700

Martens, D., & Bauer, N. (2013). Natural environments: A resource for public health and well-being? A literature review. In E. Noehammer (Ed.), *Psychology of well-being: Theory, perspectives and practice (Vol. 3)* (pp. 173–217). Nova Science Publishers.

Mayer, F. S., & Frantz, C. M. (2004). The connectedness to nature scale: A measure of individuals' feeling in community with nature. *Journal of Environmental Psychology, 24*, 503–515. https://doi.org/10.1016/j.jenvp.2004.10.001

McClelland, G. H., & Judd, C. M. (1993). Statistical difficulties of detecting interaction effects. *Psychological Bulletin, 114*(2), 376–390. https://doi.org/10.1037/0033-2909.114.2.376

McMahan, E. A., & Estes, D. (2011). Hedonic versus eudaimonic conceptions of well-being: Evidence of differential associations with self-reported well-being. *Social Indicators Research, 103*, 93–108. https://doi.org/10.1007/s11205-010-9698-0

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*, 507–519. https://doi.org/10.1080/17439760.2014.994224

Milyavskaya, M., & Koestner, R. (2011). Psychological needs, motivation, and well-being: A test of self-determination theory across multiple domains. *Personality and Individual Differences, 50*, 387–391. https://doi.org/10.1016/j.paid.2010.10.029

Newell, P. B. (1997). A cross-cultural examination of favorite places. *Environment and Behavior, 29*, 495–514. https://doi.org/10.1177/001391659702900403

Ng, J. Y. Y., Ntoumanis, N., Thøgersen-Ntoumani, C., Deci, E. L., Ryan, R. M., Duda, J. L., & Williams, G. C. (2012). Self-determination theory applied to health contexts. *Perspectives on Psychological Science, 7*(4), 325–340. https://doi.org/10.1177/1745691612447309

Nisbet, E. K., Zelenski, J. M., & Murphy, S. A. (2009). The nature relatedness scale: Linking individuals' connection with nature to environmental concern and behavior. *Environment and Behavior, 41*, 715–740. https://doi.org/10.1177/0013916508318748

O'Connell, T. S. (2010). The effects of age, gender and level of experience on motivation to sea kayak. *Journal of Adventure Education & Outdoor Learning, 10*, 51–66. https://doi.org/10.1080/14729671003669289

Paulhus, D. L. (1991). Measurement and control of response bias. In J. P. Robinson, P. R. Shaver, & L. R. Wrightsman (Eds.), *Measures of personality and social psychological attitudes* (pp. 17–59). Academic Press.

Pelletier, L. G., Vallerand, R. J., Brière, N. M., & Blais, M. R. (1989). Construction et validation de l'Échelle de motivation vis-à-vis les Loisirs (EML). *Congrès Annuel de La SQRP*.

Pelletier, L. G., Tuson, K. M., Green-Demers, I., Noels, K., & Beaton, A. M. (1998). Why are you doing things for the environment? The Motivation Toward the Environment Scale (MTES). *Journal of Applied Social Psychology*, *28*, 437–468. https://doi.org/10.1111/j.1559-1816.1998.tb01714.x

Pelletier, L. G., Rocchi, M. A., Vallerand, R. J., Deci, E. L., & Ryan, R. M. (2013). Validation of the revised sport motivation scale (SMS-II). *Psychology of Sport and Exercise, 14*, 329–341. https://doi.org/10.1016/j.psychsport.2012.12.002

Pulfrey, C., Buchs, C., & Butera, F. (2011). Why grades engender performance-avoidance goals: The mediating role of autonomous motivation. *Journal of Educational Psychology, 103*, 683–700. https://doi.org/10.1037/a0023911

Revelle, W. (2018). *Package 'psych.'*

Rosseel, Y. (2012). lavaan: An R package for structural equation modeling. *Journal Of Statistical Software*, *48*(2), 1–36. https://doi.org/10.18637/jss.v048.i02

Ryan, R. M., & Connell, J. P. (1989). Perceived locus of causality and internalization: Examining reasons for acting in two domains. *Journal of Personality and Social Psychology, 57*(5), 749–761. https://doi.org/10.1037/0022-3514.57.5.749

Ryan, R. M., & Deci, E. L. (2000a). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology, 25*, 54–67. https://doi.org/10.1006/ceps.1999.1020

Ryan, R. M., & Deci, E. L. (2000b). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*(1), 68–78. https://doi.org/10.1037/0003-066X.55.1.68

Ryan, R. M., & Deci, E. L. (2017). *Self-determination theory: Basic psychological needs in motivation, development, and wellness*. Guilford Press.

Ryan, R. M., & Frederick, C. (1997). On energy, personality, and health: Subjective vitality as a dynamic reflection of well-being. *Journal of Personality, 65*, 529–565. https://doi.org/10.1111/j.1467-6494.1997.tb00326.x

Schreyer, R. (1986). Motivation for participation in outdoor recreation and barriers to that participation--A commentary on salient issues. In *The president's commission on Americans outdoors - A literature review* (p. Motivations section pp. 1–8). Government Publishing Office.

Shanahan, D. F., Bush, R., Gaston, K. J., Lin, B. B., Dean, J., Barber, E., & Fuller, R. A. (2016). Health benefits from nature experiences depend on dose. *Scientific Reports, 6*(28551), 1–10. https://doi.org/10.1038/srep28551

Sheldon, K. M., & Hilpert, J. C. (2012). The balanced measure of psychological needs (BMPN) scale: An alternative domain general measure of need satisfaction. *Motivation and Emotion, 36*, 439–451. https://doi.org/10.1007/s11031-012-9279-4

Sheldon, K. M., Osin, E. N., Gordeeva, T. O., Suchkov, D. D., & Sychev, O. A. (2017). Evaluating the dimensionality of self-determination theory's relative autonomy continuum. *Personality and Social Psychology Bulletin, 43*(9), 1215–1238. https://doi.org/10.1177/0146167217711915

Shepard, P. (1982). *Nature and madness*. Sierra Club Books.

Shin, W. S., Kwon, H. G., Hammitt, W. E., & Kim, B. S. (2005). Urban forest park use and psychosocial outcomes: A case study in six cities across South Korea. *Scandinavian Journal of Forest Research, 20*, 441–447. https://doi.org/10.1080/02827580500339930

Shultis, J., & More, T. (2011). American and Canadian national park agency responses to declining visitation. *Journal of Leisure Research, 43*, 110–132. https://doi.org/10.1080/00222216.2011.11950228

Skår, M., Odden, A., & Inge Vistad, O. (2008). Motivation for mountain biking in Norway: Change and stability in late-modern outdoor recreation. *Norsk Geografisk Tidsskrift - Norwegian Journal of Geography, 62*, 36–45. https://doi.org/10.1080/00291950701865101

Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics* (5th ed.). Pearson Education.

Tannenbaum, M. B., Hepler, J., Zimmerman, R. S., Saul, L., Jacobs, S., Wilson, K., & Albarracín, D. (2015). Appealing to fear: A meta-analysis of fear appeal effectiveness and theories. *Psychological Bulletin, 141*, 1178–1204. https://doi.org/10.1037/a0039729

Tinsley, H. E. A. (1986). Motivations to participate in recreation: Their identification and measurement. In *The president's commission on Americans outdoors - A literature review* (p. Motivations section pp. 9–17). Government Publishing Office.

Ulrich, R. S. (1983). Aesthetic and affective response to natural environment. In I. Altman & J. Wohlwill (Eds.), *Human behavior and environment: Advances in theory and research: Vol. Vol 6* (pp. 85–125). Springer. https://doi.org/10.1007/978-1-4613-3539-9

Ulrich, R. S. (1981). Natural versus urban scenes: Some psychophysiological effects. *Environment and Behavior, 13*, 523–556. https://doi.org/10.1177/0013916581135001

Vallerand, R. J. (1997). Toward a hierarchical model of intrinsic and extrinsic motivation. *Advances in Experimental Social Psychology, 29*, 271–360. https://doi.org/10.1016/S0065-2601(08)60019-2

Vallerand, R. J., & Bissonnette, R. (1992). Intrinsic, extrinsic, and amotivational styles as predictors of behavior: A prospective study. *Journal of Personality, 60*, 599–620. https://doi.org/10.1111/j.1467-6494.1992.tb00922.x

Vallerand, R. J., Fortier, M. S., & Guay, F. (1997). Self-determination and persistence in a real-life setting: Toward a motivational model of high school dropout. *Journal of Personality and Social Psychology, 72*, 1161–1176. https://doi.org/10.1037/0022-3514.72.5.1161

Vallerand, R. J., Pelletier, L. G., Blais, M. R., Brière, N. M., Senécal, C., & Vallières, E. F. (1992). The academic motivation scale: A measure of intrinsic, extrinsic, and amotivation in education. *Educational and Psychological Measurement, 52*, 1003–1017. https://doi.org/10.1177/0013164492052004025

Vallerand, R. J., Pelletier, L. G., Blais, M. R., Briere, N. M., Senecal, C., & Vallieres, E. F. (1993). On the assessment of intrinsic, extrinsic, and amotivation in education: Evidence on the concurrent and construct validity of the Academic Motivation Scale. *Educational and Psychological Measurement, 53*(1), 159–172. https://doi.org/10.1177/0013164493053001018

van den Berg, A. E., Koole, S. L., & van der Wulp, N. Y. (2003). Environmental preference and restoration: (How) are they related? *Journal of Environmental Psychology, 23*, 135–146. https://doi.org/10.1016/S0272-4944(02)00111-1

Walker, G. J., Deng, J., & Dieser, R. B. (2001). Ethnicity, acculturation, self-construal, and motivations for outdoor recreation. *Leisure Sciences, 23*, 263–283. https://doi.org/10.1080/01490400152809115

Waterman, A. S., Schwartz, S. J., Zamboanga, B. L., Ravert, R. D., Williams, M. K., Bede Agocha, V., Yeong Kim, S., & Brent Donnellan, M. (2010). The questionnaire for eudaimonic well-being: Psychometric properties, demographic comparisons, and evidence of validity. *The Journal of Positive Psychology, 5*, 41–61. https://doi.org/10.1080/17439760903435208

White, D. (2008). A structural model of leisure constraints negotiation in outdoor recreation. *Leisure Sciences, 30*, 342–359. https://doi.org/10.1080/01490400802165131

Wilson, E. O. (1984). *Biophilia: The human bond with other species*. Harvard University Press.

Young, A. B., Ewert, A., Todd, S., Steele, T., & Quinn, T. (1995). The outdoor situational fear inventory: A newer measure of an older instrument. In G. A. Vander Stoep (Ed.), *Proceedings of the 1994 Northeastern Recreation Research Symposium; 1994 April 10–12; Saratoga Springs, NY.: Gen. Tech. Rep. NE-198.* (pp. 177–182). U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station.

Zeidenitz, C., Mosler, H. J., & Hunziker, M. (2007). Outdoor recreation: From analysing motivations to furthering ecologically responsible behaviour. *Forest, Snow and Landscape Research, 81*, 175–190.