

The extended Inclusion of Nature in Self scale



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ABSTRACT

By relying on various theoretical paradigms, extant research has developed several measurement tools for the assessment of individual environmental identity. One of the most important such tools is the Inclusion of Nature in Self measure (INS; Schultz, 2001). In comparison to other measures, the INS is very concise and easy to administer. However, because of its single-item nature, its psychometric properties and applicability domains are limited in scope. The present research proposes a four-item development of the INS – the Extended Inclusion of Nature in Self (EINS) scale. In Study 1, we explore the relevance of spatial metaphors in the assessment of self-nature connection. Based on the insights from this study, we develop an extended version of the INS and investigate its dimensionality, reliability, and validity across 5 studies. Our studies converge in suggesting that the proposed EINS is psychometrically stronger than the original INS, compares well in criterion-related validity to extant verbal scales, and has broader research applicability.

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1. Introduction

Hollywood movie maker Woody Allen once allegedly stated that he was “two with nature” (Allen, n.d.). While this is a humorous twist on the idiom “being one with something”, the quote might be true for many people with alarming consequences for the natural environment. Indeed, it has often been proposed that in order for humans to be inclined to preserve and protect nature, they need to feel connected to it (e.g., Leopold, 1949). Conversely, the environmental problems humanity is facing have to some extent been attributed to people's feeling of disconnection from nature (Crompton & Kasser, 2009).

This intuitive and powerful premise has inspired a comprehensive body of research (see Clayton, 2012 for a review). For example, Mayer and Frantz (2004) developed a 14-item Connectedness to Nature scale (CNS) and showed that their measure consistently predicted self-reported ecological behavior and biospheric concern. Their findings have been replicated numerous times with other measures as well (e.g., Dutcher, Finley, Luloff, & Johnson, 2007; Perkins, 2010). The feeling of connection to the natural environment has also been found to relate to self-reported

happiness (Capaldi, Dopko, & Zelenski, 2014). As such, connectedness to nature can help explain the often found relationship between contact to nature and different indicators of psychological well-being (Mayer, Frantz, Bruehlman-Senecal, & Dolliver, 2009; Tyrväinen et al., 2014).

In the last 15 years, a number of self-nature connection measures have been developed (see Table 1 for a list of some of the most popular measures). Tam (2013) compared the predictive validity of several of these measures in two studies. He found that the measures explained largely overlapping portions of variance in the criterion variables. However, some measures possessed explanatory power beyond the shared common factor. He concluded that there is a need to gain further insights into the meaning and dimensionality of the self-nature connection concept, to revise extant measures, and/or to develop additional measures.

In the current paper, we answer this call for further research by adopting a cognitive perspective on self-nature connection following the work of Schultz. This perspective builds on the conceptual foundations of the self-expansion model of individual identity. According to this model, an important motive for nurturing close human relationships is the expansion of the self “by including the resources, perspectives, and characteristics of the other in the self” (Aron, Aron, Tudor, & Nelson, 1991, p. 243). Schultz builds on this theoretical model and suggests that traits and characteristics of the natural environment can also be used for self-expansion purposes (Schultz, 2001, 2002). From this theoretical

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Table 1
Overview of self-nature connection measures.

Name	Description	Source
Inclusion of Nature in Self (INS)	Single-item, graphical	Schultz (2001)
Environmental Identity (EID)	24 items, verbal	Clayton (2003)
Environment Identity (EI)	11 items, verbal, bipolar	Stets and Biga (2003)
Self-Nature IAT	Implicit Association Test	Schultz, Shriver, Tabanico, and Khazian (2004)
Connectedness to Nature (CNS)	14 items, verbal	Mayer and Frantz (2004)
Connectivity with Nature (CWN)	5 items, 4 verbal and the INS	Dutcher et al. (2007)
Nature Relatedness (NR)	21 items, verbal	Nisbet, Zelenski, and Murphy (2009)
Nature Relatedness Short Version (NR6)	6 items, verbal	Nisbet and Zelenski (2013)
Love and Care for Nature (LCN)	15 items, verbal	Perkins (2010)

viewpoint, self-nature connection is defined as “the extent to which an individual includes nature within his/her cognitive representation of self” (Schultz, 2002, p. 67).

The Inclusion of Nature in Self measure directly builds on this theoretical position (INS, Schultz, 2001). In comparison to other extant measures of environmental identity, the INS is short (only one item) and convenient to administer (choice between seven pictures representing nature and self with various degrees of overlap). Yet, its single-item nature arguably limits its construct and predictive validity. Our research builds on and extends the Inclusion of Nature in Self measure. To do so, we use a drawing task to explore how people visually represent their self-nature connection in Study 1. Based on the insights from this exploratory research, we propose a four-item extension of the INS – the Extended Inclusion of Nature in Self scale (EINS). In Studies 2–4, we examine the dimensionality, validity, and reliability of the EINS. We find that the different spatial metaphors discovered in the exploratory study constitute different facets of a unidimensional self-nature connection construct, rather than additional dimensions of it. Our results indicate that the EINS builds on the strengths of the original INS, while circumventing its weaknesses, and shows superior characteristics in terms of construct and criterion validity as well as test-retest reliability. Additionally, the performance of the EINS compares well with several established verbal scales of self-nature connection.

1.1. Spatial metaphors

Over the past decades, a considerable body of evidence has accumulated on the notion that humans often use metaphors in social cognition (Landau, Meier, & Keefer, 2010). Those metaphor-based knowledge structures are formed, used, and expressed in all major aspects of everyday life (Landau et al. 2010). Relatedly, research also suggests that the representation of concepts in memory is partially based on perceptual content (Barsalou, 1999). For example, the metaphor of a straight horizontal line is often used to understand time. Events can be placed on this line, and depending on their sequence of occurrence, these events appear further to the left or right on it (Boroditsky, 2000).

More important for the current research, spatial metaphors play a role in describing and understanding various relationships and aspects of identity. This is indicated by dictionary definitions and supported by scholarly research. For example, the metaphor of connectedness is used to express a feeling of affinity (Oxford Dictionaries, 2015a). Accordingly, researchers have used the connection metaphor to discuss how humans relate to each other emotionally (Aron, Aron, & Smollan, 1992). Similarly, the metaphor of physical closeness can be used when thinking of affectionate or intimate relationships (Oxford Dictionaries, 2015b). For example, Williams and Bargh (2008) showed experimentally that the perception of larger (smaller) spatial distance is associated with the

perception of more (less) affection towards other people. People use the metaphor of centrality to express that something or somebody is essential to them (Oxford Dictionaries, 2015c). Relatedly, a whole literature stream has developed around the notion of work centrality, which is defined as “the beliefs that individuals have regarding the degree of importance that work plays in their lives” (Paullay, Alliger, & Stone-Romero, 1994, p. 225). The metaphor of absolute or relative size can also be used to express that something is of considerable importance to somebody (Oxford Dictionaries, 2015d). Congruent with this definition, Bruner and Postman (1948) showed that symbols were perceived as larger (smaller) if participants thought that they were more (less) important.

The spatial metaphor of connectedness, visualized as two overlapping circles, has been particularly impactful in stimulating research on human relationships. Levinger and Snoek (1972) used this metaphor for their theorizing about closeness in relationships. Pipp, Shaver, Jennings, Lamborn, and Fischer (1985) were the first to use this metaphor to assess relationships. They had participants draw two circles that represented their relationship with their parents at different stages in childhood. These earlier works inspired Aron et al. (1992) to develop the Inclusion of Others in the Self scale, a measure consisting of a series of seven pictures. Each picture is comprised of two circles. The overlap of the two circles varies between the pictures from full to none. Participants are then asked to indicate which of the seven pictures best describes their relationship with a person in question. This measure has proven very useful over the years and has been adapted to different other domains (e.g., Tropp & Wright, 2001 for ingroup identification; Bergami & Bagozzi, 2000 for organizational identification).

In their initial study, Pipp et al. (1985) found that other dimensions, in addition to spatial overlap, were predictive of certain verbal statements. Similarly, Aron et al. (1992) and more recently Kashima, Paladino, and Margetts (2014) explored whether variations in circle size were predictive of aspects of personal relationships. All three groups of authors obtained inconsistent results with their size-based measures (see 3.3. for a discussion). To our knowledge, current research utilizing the circle paradigm focuses mainly on the overlap item and does not utilize other, possibly relevant spatial items.

1.2. Inclusion of Nature in Self – advantages and disadvantages

Building on Aron et al. (1992), Schultz (2001) was the first to apply the spatial metaphor of two equally sized, overlapping circles to assess the self-nature connection concept. In his measure, one circle represents the self and the other nature. The overlap between these two circles represents the degree of connectedness to nature. The resulting measurement tool, the Inclusion of Nature in Self measure, has proven valuable in research on self-nature connection (INS; see first row in Table 4).

A growing body of research indicates that the INS performs well on several validity criteria. Schultz (2001) showed in his initial study that the INS predicted biospheric motivations to protect the natural environment. More evidence for its predictive validity has accumulated since then (e.g., Davis, Green, & Reed, 2009; Mayer & Frantz, 2004; Schultz, Shriver, Tabanico, & Khazian, 2004). Researchers also found that people who were exposed to nature (vs. a control condition) displayed a higher self-nature connection on the INS (Nisbet & Zelenski, 2011). Participation in an environmental education program, which included several sensory nature experiences, had a similar effect and also increased scores on the INS (Liefänder, Fröhlich, Bogner, & Schultz, 2013). We interpret these findings as evidence of the INS' content validity.

With its single item, the INS is parsimonious and takes up very little space in questionnaires. This property makes the INS an actionable measure of self-nature connection in situations where participant time is limited or when the researcher wishes to include a larger amount of other constructs in a study. This property distinguishes the INS from most of the other self-nature connection measures, which, with the exception of the short version of the Nature Relatedness scale and the Connectivity with Nature scale, tend to be relatively long (see Table 1).

The graphical nature of the measure also has advantages. A certain level of language skill is required to extract the meaning from a text-based measure which not all participants might have, especially in a sample with a considerable number of non-native speakers or in cross-cultural research involving multiple samples from different countries (Bradley & Lang, 1994).

The extreme parsimony of the INS might also constitute a disadvantage compared to alternative multi-item scales. Due to its single-item nature, reliability coefficients, such as the coefficient alpha (Cronbach, 1951), cannot be calculated (Schultz et al., 2004). Hence, the internal consistency of the measurement in a given dataset cannot be assessed. Relatedly, a minimum of four items is required to assess the quality of the measurement through confirmatory factor analysis (Long, 1983).

Single items not only prevent researchers from assessing the quality of the measurement, they also seem more susceptible to measurement error (Salzberger, 2007). It has been argued that when multiple items are used to measure a construct, each item contains a certain amount of measurement error. This measurement error is unsystematic – it sometimes randomly increases and sometimes randomly decreases the score obtained on a given item. By combining all items, these random effects may to some extent cancel out (DeVellis, 2003).

Related to this issue, multi-item measures have been shown to possess better predictive validity than single-item measures of the same construct (Diamantopoulos, Sarstedt, Fuchs, Wilczynski, & Kaiser, 2012). The same seems to be the case for the INS compared to other measures of self-nature connection. In a large-scale study, the INS correlated less than other measures (e.g., CNS, Environmental Identity) with self-reported behavior (Brügger, Kaiser, & Roczen, 2011). However, it is not clear whether these differences are statistically significant as no significance tests were reported. Tam (2013) also found that some multi-item self-nature connection measures consistently outperformed the INS in predicting different criterion variables.

Another issue is that the INS is not suitable for structural equation modeling. For this type of statistical method, measures with at least three items are desirable (Iacobucci, 2010). This shortcoming of the INS might soon be a problem for self-nature connection scholars. The nomological network around the self-nature connection concept has become fairly elaborate (see Clayton, 2012 for a review). Over the past years, researchers have made significant progress in identifying antecedents (e.g., Collado,

Staats, & Corraliza, 2013) and consequences of self-nature connection (e.g., Capaldi et al., 2014). In addition, researchers have started exploring moderators (e.g., Collado, Corraliza, Staats, & Ruiz, 2015; Zhang, Howell, & Iyer, 2014) and mediators (e.g., Gosling & Williams, 2010; Martin & Czellar, 2015) of the relationships between self-nature connection and other constructs. This means that researchers may soon wish to use statistical techniques, such as structural equation modeling to represent this complexity.

2. Overview of studies

For the reasons outlined above, the goal of the present research is to develop and validate a multi-item extension of the INS that may circumvent the limitations of the original INS while preserving its strengths.

The goal of Study 1 was to explore which spatial metaphors people use to express their self-nature connection. Based on the insights from Study 1, we developed three additional pictorial items to extend the INS (i.e., the EINS; see Table 4). The development of those items is described in Appendix C. The properties of the EINS were then investigated in four additional studies. We first investigated the dimensionality of the EINS and its validity within a broader nomological framework of environmental constructs in Studies 2a, 2b, 3a, and 3b. Finally, in Study 4, we examined the temporal stability of the new EINS scale compared to the original INS item and conceptually related verbal multi-item scales.

3. Study 1

The goal of Study 1 was to explore whether people use different spatial metaphors to represent their self-nature connection, in addition to the overlap between self and nature.

3.1. Method

3.1.1. Participants and procedure

Data for Study 1 were collected as part of a larger study on consumer relationships. We recruited 124 participants from our university participant pool and the study was completed in laboratory conditions.¹

Participants first completed a drawing task of their relationship with nature. Several other relationships (e.g., with a best friend) were included after the self-nature relationship drawings. All drawing tasks were presented in a booklet where participants were asked to read the instructions and complete a given drawing first, before moving on to the next page which contained the instructions for the next drawing. Participants then completed a series of measures pertaining to self-nature connection and environmental relations. The remainder of the study included measures unrelated to the purpose of the study and demographics.

After excluding participants who reported that they had previously completed a related class pretest ($N = 5$), who obviously misunderstood the instructions (see 3.1.2.1.; $N = 6$), or who drew so untidily that coding was rendered impossible ($N = 6$), the final sample consisted of 107 participants (mean age = 21, 52% male).

3.1.2. Measures

3.1.2.1. Drawing task. Participants were presented with a blank DIN A4 sized sheet. They were asked to draw two circles (i.e., one representing nature and one representing the self) in a configuration that best represented their relationship with nature. The exact

¹ For all the studies, the authors have reported detailed information pertaining to all measures, data exclusions, and sample size determination.

wording of the task can be found in [Appendix A](#). The drawing task was adapted from [Pipp et al. \(1985\)](#), who used it to explore how child–parent relationships change in different stages of childhood.

The drawings were coded following the recommendations of [Pipp et al. \(1985\)](#). For this purpose, two students were recruited and instructed by the first author. Coders were unaware of the purpose of the study. Coders determined the largest possible diameter of each circle and the distance between the centers of the two circles. Based on these data, they calculated the area of the two circles, the ratio of the areas, the overlap between the circles, and the overlap in % of the self-circle and in % of the nature-circle. In addition, they coded whether the circle that represented nature was in the center of the page or not.

3.1.2.2. Self-nature connection and environmental measures.

Participants' connectedness to nature was measured with the INS, the Connectedness to Nature scale (CNS; [Mayer & Frantz, 2004](#); $\alpha = 0.82$), the Love and Care for Nature scale (LCN; [Perkins, 2010](#); $\alpha = 0.95$) and the Self-Nature Implicit Association Test (IAT, [Schultz et al., 2004](#)). The CNS was chosen because it probably is the most widely used measure of the self-nature connection construct. Because it can be assumed that the CNS is a mostly cognitive measure ([Perrin & Benassi, 2009](#)), we included the LCN to tap more emotional aspects of people's environmental relation as well. We included the IAT to be able to tap into self-nature connections at an implicit level. In addition, we also measured the global worldview aspect of environmental identity with the New Ecological Paradigm (NEP, [Dunlap, Van Liere, Mertig, & Jones, 2000](#); $\alpha = 0.80$).

3.2. Results

In the first step, we analyzed different aspects of the drawings (i.e., centrality of the nature-circle on the page, area of the nature-circle, ratio of the area of the nature and self-circles, overlap of the two circles in % of the self and nature-circle). Most circles were drawn imprecisely and were oval rather than round. We kept them in our dataset unless their shape was not recognizable as a circle. Due to the high potential for outliers, we will discuss the median (rather than mean) values of the various features of the drawings ([Table 2](#)). The median distance between the centers of the circles was 21 mm. This means that participants drew the circles relatively close together. Accordingly, the circles overlapped in most drawings, lending face validity to the overlap metaphor of the original INS item. At the median, the self-circle occupied 4% of the nature-circle and the nature-circle fully took up the self-circle. This can be explained by the variation in circle sizes (i.e., the nature-circle being substantially larger than the self-circle in most drawings). The median size of the nature-circle was roughly 25% of the maximum size a circle can be on an A4 sheet. The median of the nature/self-circle ratio was 9, indicating that the nature-circles were substantially larger than the self-circles in most drawings. This finding indicates that participants also used the spatial

metaphor of size, in addition to overlap. In the drawings, the nature-circle was placed in the middle of the page by 71% of our participants. This latter result indicates that there might be value in investigating whether the relative centrality of nature may be another spatial metaphor that people may use to represent their self-nature relation. Our overall findings are visualized in [Figure B.1](#) in [Appendix B](#); an example of a drawing can be found in [Figure B.2](#).

In the following step, we analyzed the correlations between the different aspects of the self-nature drawings and the other self-nature connection measures. We used Spearman's rho correlation coefficients rather than the more common Pearson coefficient. This served two purposes. First, Spearman's rho is a coefficient of a monotone (as opposed to a linear) relationship between two variables ([Rousseelet & Pernet, 2012](#)). This is important because several of our variables involve quadratic terms (i.e., measures of area). In addition, Spearman's rho is relatively resistant to outliers ([Rousseelet & Pernet, 2012](#)). Outliers are a concern in this study due to the nature of the drawing task. The correlation coefficients are displayed in [Table 3](#). We did not include the ratio between the sizes of the circles, because the correlations of this measure were driven by the size of the nature-circle. Due to a lack of significant correlations ($p > 0.33$), the size of the self-circle is also not included in [Table 3](#). The IAT and the NEP did not produce significant correlations with the drawing task measures and we did not include them in [Table 3](#) either. Regarding the NEP, we attribute this lack of relationship to the possibility that it assesses conceptual notions (i.e., worldviews) which are more distant from self-nature connection than the CNS, LCN and INS. Regarding the IAT, the lack of relationship could be due to the possibility that participants performed the drawing in a more conscious, deliberative way and not at a more automatic, implicit level.

Of the established standard measures, the INS correlated with all aspects of the drawing task. The verbal multi-item measures (i.e., CNS and LCN) correlated only with the area of the nature-circle and the space the nature-circle occupied in the self-circle. Generally, the INS correlated with the drawings substantially more than the CNS or the LCN.

3.3. Discussion

The results from Study 1 provide several interesting insights. First, all studied aspects of the drawings produced considerable variance. This indicates that participants did indeed use several spatial metaphors to express their self-nature relationship, in addition to the overlap of the circles. Those additional metaphors might therefore be a viable basis for the development of a multiple-item INS scale.

Second, the correlations suggest that the INS is a conceptually relevant measure of self-nature connection. More specifically, the INS seems to capture the metaphor of connectedness more strongly than the metaphor of closeness. The percentage of the self-circle covered by the nature-circle was the strongest correlate of the

Table 2
Descriptive statistics of the drawing task.

	Nature central ^c	Nature area ^a	Nature/Self area ^a	Distance ^b	Overlap (% of nature)	Overlap (% of self)
Median	1	4,536	9	21	4	100
Mean	0.71	8,631	589	28	13	71
SD	0.46	9,714	2,867	29	19	39
Minimum	0	177	1	0	0	0
Maximum	1	47,143	25,281	175	100	100

Note: ^a Values are in mm²; Due to our strategy to use the largest diameter of a circle and some circles being oval, the area of some nature-circles exceeds the maximal area a perfectly round circle could have on an A4 sheet (i.e., 34,636 mm²). ^b Values are in mm. ^c Whether the nature-circle was drawn in the center of the drawing sheet (1 = yes; 0 = no).

Table 3

Correlations of the drawings with extant self-nature connection measures.

		1)	2)	3)	4)	5)	6)	7)
1)	Nature central	1						
2)	Nature area	0.340***	1					
3)	Distance	−0.243*	−0.056	1				
4)	Overlap (% of Nature)	0.084	−0.332***	−0.333***	1			
5)	Overlap (% of Self)	0.281**	0.593***	−0.547***	−0.023	1		
6)	INS	0.203*	0.419***	−0.444***	0.219*	0.551***	1	
7)	LCN	0.050	0.237*	−0.136	0.101	0.294**	0.505***	1
8)	CNS	0.143	0.264**	−0.080	0.095	0.321**	0.451***	0.716***

Note: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; + $p < 0.10$; All coefficients are Spearman's rho; INS = Inclusion of Nature in Self (single item); LCN = Love and Care for Nature; CNS = Connectedness with Nature.

INS. The distance between the centers of the circles was less strongly correlated than the overlap.

Interestingly, the percentage of the self-circle covered by the nature-circle was more strongly correlated with the INS than the percentage of the nature-circle covered by the self-circle. This may indicate that participants arrived at their score on the INS through an egocentric, as compared to a nature-centric, judgment. Participants seem to ask themselves how nature impacts them rather than how they impact nature when assessing their relationship with nature. This is in line with the Schultz (2002) definition of self-nature connection.

The size of the nature-circle consistently correlated with the verbal measures. We interpret this finding as initial evidence for the idea that this new spatial metaphor can be used to measure self-nature connection. Our finding that the ratio of the sizes of the self- and nature-circles was correlated less strongly with the other self-nature connection measures compared to the size of the nature-circle alone might explain why Aron et al. (1992), Kashima et al. (2014), and Pipp et al. (1985) obtained inconclusive results with their size-based measures. These authors used size indices that combined information on the size of both circles (i.e., the average size, ratio, or the difference between the sizes of both circles). Our results indicate that exclusively the nature-circle carries information on a person's self-nature connection, while the size of the self-circle seems to reflect some other concept(s). Combining information on the size of both circles might therefore blur potentially meaningful relationships.

Another finding is that the INS correlated strongly with the drawings and more strongly so than did the verbal CNS and LCN. While these results support the face validity of the INS, they can be partly due to a methodological artifact in the sense that the drawing task and INS share the same pictorial (vs. verbal) approach. This possibility is present despite the fact that these two measures were separated by several other tasks.

The results from Study 1 suggest that people indeed seem to use different spatial metaphors to represent their connection with nature. Based on this insight, we developed an extended version of the INS – the EINS (see Appendix C for details). The new EINS measure features three items (i.e., size, centrality, and distance) in addition to the original overlap item (see Table 4). The psychometric properties and validity of the EINS are investigated in Studies 2–4.

4. Study 2a

The primary purpose of Studies 2a and b was to explore the dimensionality of the new EINS scale. In addition, we also wished to gain initial insight into the convergent, discriminant, and criterion validity of the EINS by comparing its performance to the original INS. Thus, we investigated whether the EINS (vs. INS) would relate more strongly to the most frequently used verbal scale of self-nature connection (i.e., the CNS, Mayer & Frantz, 2004). The

criterion variables included were measures of green values and green behavior, for which we tested whether the EINS would outperform the original INS. We used measures of materialistic orientations as variables with respect to the discriminant validity of the EINS (vs. INS). Finally, we also included mood measures because extant research indicates that positive affective states may be positively related to self-nature connection (Capaldi et al., 2014).²

4.1. Method

4.1.1. Participants and procedure

Data for Study 2a were collected as part of a larger study introduced as a language and personality survey. We recruited 112 participants from our student participant pool. One participant was excluded from the analysis due to self-reported language problems and four participants because they had severe problems to complete the different tasks. This was evidenced by these participants taking much longer on average to complete the different measures ($M = 42$ min; $SD = 6$ min) than the other participants ($M = 26$ min; $SD = 7$ min). The final dataset hence consisted of 107 participants (mean age = 21; 65% male).

Upon arrival at our lab, participants completed an unrelated language task. This was followed by a happiness Implicit Association Test and two materialism measures. Choice tasks and the extended version of the INS were then administered. After an unrelated measure, participants completed a mood scale, an unrelated task, two green values measures, and the CNS. The study ended with questions about the product choice tasks, several unrelated tasks, and demographics.

4.1.2. Measures

4.1.2.1. Self-nature connection. Self-nature connection was measured with the CNS ($\alpha = 0.83$) as in Study 1. In addition, we included our newly developed EINS that showed good reliability ($\alpha = 0.82$).

4.1.2.2. Green values. We included green values measures as criterion variables because recent research suggests that a green value orientation can be a major consequence of self-nature connection, along with sustainable behavior (Martin & Czellar, 2015). We used two different measures of green values in this study, the first of which was developed by Haws, Winterich, and Naylor (2014). These authors adapted the green values concept to the consumer domain and developed a six-item green consumption values scale. The scale showed good reliability ($\alpha = 0.90$). A sample item is “It is important to me that the products I use do not harm the environment”. All items were rated on seven points (1 = Not at all; 7 = Very much).

² The authors would like to thank an anonymous reviewer regarding these points.

Table 4
Extended version of the Inclusion of Nature in Self scale.

	Answer options						
	1	2	3	4	5	6	7
Overlap ^a	Self Nature 	Self Nature 	Self Nature 	Self Nature 	Self Nature 	Self Nature 	Self Nature 
Size ^b	Nature 	Nature 	Nature 	Nature 	Nature 	Nature 	Nature 
Distance ^a	Self Nature 	Self Nature 	Self Nature 	Self Nature 	Self Nature 	Self Nature 	Self Nature 
Central ^a	Nature Center 	Nature Center 	Nature Center 	Nature Center 	Nature Center 	Nature Center 	Nature Center 

Note: Instructions preceding the EINS: "Below, please choose the pictures which best describe your relationship with the natural environment. Please answer spontaneously with what comes to your mind first."; Instructions preceding each item: ^a) "Please choose the picture below which best describes your relationship with the natural environment"; ^b) "Please choose the picture below which best describes nature when you think of your relationship with the natural environment"; The overlap item is the original INS measure developed by Schultz (2001).

Second, we used a global single-item measure of green values that read "Are you generally willing to promote the environmental cause?" and was rated from 1 (= Not at all) to 100 (= Very much).

4.1.2.3. Green behavior. Green behavior was measured with choice tasks in three different consumption domains (i.e., coffee, backpack, and TV set). In each task, participants received descriptions of two types of products. For each product type, the two options differed in how environmentally friendly they were and in some performance features. These differences were not explicitly stated but were represented as realistic cues in the product descriptions. Participants were then asked to indicate on a seven-point item how likely they were to choose one of the two options (1 = "definitely option A"; 7 = "definitely option B"). We averaged the three choices participants made to form an index of environmental purchase behavior ($\alpha = 0.59$).

4.1.2.4. Mood measures. Mood was measured with the happiness Implicit Association Test (Walker & Schimmack, 2008). This task measures the association strength between the concepts of happiness (vs. sadness) and the self. A detailed description of the Implicit Association Test procedure can be found in Greenwald, McGhee, and Schwartz (1998). We used the advanced D-scoring algorithm to code the results of this task (Greenwald, Nosek, & Banaji, 2003). In addition, we included the PANAS mood scale (Watson, Clark, & Tellegen, 1988). The positive mood ($\alpha = 0.81$) and the negative mood ($\alpha = 0.77$) subscales displayed good internal consistency.

4.1.2.5. Materialism measures. Materialism was measured with the Materialistic Values Scale (MV, Richins, 2004). This scale consisted of 15 items and was rated on seven points (1 = "strongly disagree"; 7 = "strongly agree"). A sample item is 'I like to own things that impress people'. This measure showed good internal consistency ($\alpha = 0.85$). In addition, we included the extrinsic goal subscale of the Aspiration Index (AI, Kasser & Ryan, 1996; $\alpha = 0.89$). This measure assesses how much importance people place on the achievement of extrinsic goals, such as fame and financial success

in their future (1 = "not at all important"; 7 = "extremely important"). An example item is 'You will have a job that pays well'. These scales are the most commonly used materialism measures and were found to be negatively related to environmental attitudes (Hurst, Dittmar, Bond, & Kasser, 2013).

4.2. Results

Study 1 indicated that additional spatial metaphors could be used to enrich the INS. In the present study, we investigated the dimensionality of the EINS through exploratory factor analyses. As can be seen in Table 5, a one-factor model fit the data best and all items loaded strongly and consistently on this one factor. These findings are supported by our subsequent studies as well. The correlations among the different EINS items in all studies can be found in Appendix D.

We then analyzed the correlations between the INS, the EINS, and the other constructs in our dataset (Table 6). Both the INS and EINS were related to the other variables. We then compared the sizes of the different correlation coefficients. We did this with a software tool developed by Lee and Preacher (2013). The EINS had

Table 5
Exploratory factor analyses of the EINS in Studies 2–4.

Items	Study 2a	Study 2b	Study 3a	Study 3b	Study 4 ^b
Factor loadings^a					
Overlap	0.71	0.82	0.76	0.84	0.82
Size	0.69	0.72	0.70	0.76	0.73
Distance	0.80	0.87	0.94	0.91	0.85
Centrality	0.72	0.78	0.81	0.85	0.84
Statistics					
Eigenvalue 1st factor	2.6	2.9	2.9	3.1	3.0
Eigenvalue 2nd factor	0.5	0.4	0.5	0.4	0.4
Variance extracted (1st factor)	64.7%	72.8%	73.1%	77.9%	74.2%

Note: ^a Factor loadings for Maximum Likelihood Extraction. ^b All values are based on the data from Time 1.

Table 6

Pearson correlation coefficients in Study 2a.

		1)	2)	3)	Difference ^b	Difference ^c
1)	INS	1				
2)	EINS	0.776*** ^a	1			
3)	CNS	0.507***	0.626***	1	$p = 0.01$	
4)	GREEN	0.541***	0.645***	0.529***	$p = 0.02$	$p = 0.07$
5)	GV	0.474***	0.551***	0.480***	$p = 0.08$	ns
6)	Behavior	0.384***	0.441***	0.373***	ns	ns
7)	PA	0.253**	0.181 ⁺	0.134	ns	ns
8)	NA	-.183 ⁺	-0.071	-0.049	ns ^d	ns
9)	PA (implicit)	0.121	0.160 ⁺	0.044	ns	ns
10)	AI	-0.125	-0.148	-0.109	ns	ns
11)	MV	-0.239*	-0.311**	-0.253**	ns	ns

Note: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; + $p < 0.10$.^a Coefficient not corrected for self-correlation.^b Difference between correlations involving the INS and the EINS (one-tailed tests).^c Difference between correlations involving the EINS and the CNS (two-tailed tests).^d $p = .08$ for a two-tailed test; INS = Inclusion of Nature in Self; EINS = Extended Inclusion of Nature in Self; CNS = Connectedness with Nature; GREEN = Green values (multi-item); GV = Green values (single-item); Behavior = Composite score of the three self-reported choice tasks; PA = Positive affect; NA = Negative affect; PA (implicit) = Happiness Implicit Association Test; AI = Aspiration index; MV = Materialistic values.

consistently higher correlation coefficients than the INS in all but two cases. Only for the positive and negative mood measures were the correlations for the EINS weaker compared to the INS. In three cases where the EINS outperformed the INS at face value, the differences between the EINS and the INS were statistically significant. The EINS also consistently correlated more highly with all criterion variables compared to the CNS. However, only one of these differences (i.e., with the GREEN scale) was actually statistically significant.

4.3. Discussion

The results of Study 2a suggest that the EINS has promising psychometric properties. The EINS showed high internal consistency and the exploratory factor analysis indicated that the EINS has a one-factor structure. In addition, the four items loaded consistently and strongly on this one factor explaining a high percentage of the total variance. The different spatial metaphors seem to be complementary facets of one latent construct (i.e., self-nature connection), rather different dimensions of a multi-dimensional construct.

The EINS also showed promising criterion-related validity in this study. With two exceptions, the EINS correlated higher with all criterion variables compared to the original single-item INS. Statistical tests revealed that in three out of seven cases, where the correlation coefficients of the EINS exceeded those of the INS, the correlations were statistically significantly larger. One explanation for why the difference in the size of the correlation coefficients did not reach significance in the remaining four cases is our relatively small sample size.

There could be several reasons for why we found the EINS to have superior criterion-related validity compared to the INS. First, due to its multi-item nature, the EINS might suffer less from measurement error than the original single-item INS (Salzberger, 2007). This would also be in line with the findings of Diamantopoulos et al. (2012), who found in simulation studies that a scale often outperformed its best item in predicting criterion variables. Second, the EINS might cover the self-nature connection concept more comprehensively than the INS and might therefore explain variance in the criterion variables better.

In terms of convergent validity, the EINS (vs. INS) correlated more significantly with the CNS scale. In terms of discriminant validity, both the EINS and INS correlated negatively with one of our measure of materialistic values. Interestingly, neither the EINS nor the INS was significantly related to the Aspiration Index (i.e., our

second measure of materialism). We obtained modestly sized correlations with mood measures for both the EINS and INS.

In addition, we compared the predictive ability of the EINS to the most commonly used measure of self-nature connection (i.e., the CNS). The EINS correlated more strongly with all criterion variables compared to the CNS. However, only one of the differences in those correlation coefficients was statistically significant. These findings indicate that the EINS can be a valuable alternative to the longer CNS as it performs at least equally well in predicting the criterion variables investigated.

We interpret our results as initial evidence for the value of the EINS. However, the fact that we used a student sample in this study limits the generalizability of our findings. In addition, the relatively small sample size made it difficult to find statistical support for the superiority of the EINS compared to the INS.

5. Study 2b

The goal of Study 2b was to replicate Study 2a in a different sample and with a somewhat different design by focusing on the original INS and the EINS measures. We also used a larger sample in this study to increase the power of the statistical tests.

5.1. Method

5.1.1. Participants and procedure

We recruited 590 participants online on [Crowdfunder.com](https://www.crowdfunder.com). Five participants had to be excluded from the analyses, because their answers (i.e., pattern on Likert-type scales and/or open-ended responses) raised strong doubts about the seriousness of their responses. The final dataset hence consisted of 585 participants (average age = 38, one participant failed to report her age; 42% male, two participants failed to report their gender). The median income was represented by the 50,000–59,999 USD category and 51% of the participants had at least a two-year college degree.

The study was again introduced as a language and personality survey. Participants completed an unrelated language task at the beginning of the study followed by materialism measures. Participants then completed a behavioral choice task, the EINS, and the single-item green value measure from Study 2a. The study ended with demographics and unrelated measures.

5.1.2. Measures

5.1.2.1. Self-nature connection and environmental behavior. The EINS again showed good reliability ($\alpha = 0.87$). We used the

same choice tasks as in Study 2a. Unlike in Study 2a, we randomly assigned participants to complete only one of the choice tasks ($N_{\text{backpack}} = 191$; $N_{\text{coffee}} = 199$; $N_{\text{TVset}} = 195$). We performed moderated regression analyses to check if the correlations between the INS (respectively the EINS) and the different choices differed. We did not find such a difference between the different choice tasks (i.e., $p > 0.24$ for the INS and $p > 0.14$ for the EINS). Because of this, we do not distinguish between choices in our later analyses.

5.1.2.2. Materialism measures. We included the same materialism measures used in Study 2a. The Materialistic Values scale ($\alpha = 0.89$) and the Aspiration Index ($\alpha = 0.93$) both showed good internal consistency.

5.2. Results

First, we analyzed the factor structure of the EINS through exploratory factor analysis (see Table 5). We again found support for the one-factor structure of the scale. All the items loaded consistently and highly on this one factor and explained a high portion of its variance.

We also investigated the relative criterion and discriminant validity of the EINS compared to the original INS (Table 7). The EINS and INS both correlated consistently with all criterion variables with the exception of the Aspiration Index. Similar to Study 2a, the EINS produced higher correlations with all criterion variables except the Aspiration Index compared to the INS. Regarding the environmental variables (i.e., green values and green product choice tasks), all differences between the EINS and the INS were statistically significant. With respect to discriminant validity, we replicated Study 2a and found that materialistic values correlated more negatively with the EINS (vs. INS). Neither the EINS nor the INS was significantly related to the Aspiration Index. The INS correlated slightly stronger with the Aspiration Index than the EINS but the difference was not statistically significant.

5.3. Discussion

In Study 2b, we replicated the findings from Study 2a in a demographically more heterogeneous sample, thus strengthening the external validity of our conclusions. We confirmed the one-factor structure of the EINS and the consistently good factor loadings of the newly developed items. Our results again suggested that the EINS had overall better criterion-related validity than the original single-item version. This was indicated by the fact that the EINS produced larger correlation coefficients with most criterion variables than the INS.

6. Study 3a

Studies 2a and b provide converging evidence for the one-

dimensional structure of the EINS. They also hint toward the superior construct and criterion-related validity of the EINS compared to the INS. However, data for these two studies was collected as part of larger studies. The procedures and measures included in those studies therefore limit inferences about the validity of the INS and the EINS. Study 3a was specifically designed to compare the criterion validity of the EINS with respect to the original INS using a series of criterion variables. For comparison purposes, we also included a verbal measure of self-nature relation (i.e., the six-item short version of the Nature Relatedness scale; NR6; Nisbet & Zelenski, 2013).

6.1. Method

6.1.1. Participants and procedure

This study was completed by 189 participants on [Crowdfunder.com](#) (average age = 37; 45% male). One participant failed to report his/her age and gender. Similar to Study 2a, the category from 50,000 to 59,999 USD represented the median income and 60% of participants had at least a two-year college degree. The study started with our measures of self-nature connection. The order of these measures was counter-balanced. Participants then completed a remote-association task (e.g., Bowden & Jung-Beeman, 2003) as a filler task. In this task, participants were given 12 word problems. Each word problem consisted of three words and participants were asked to find a fourth word that was related to the three given words. After this task, participants completed a task of real behavioral effort, the green value measures, an environmental worldview measure, and a measure of self-reported past behavior. The study closed with demographics.

6.1.2. Measures

6.1.2.1. Self-nature connection, green values, and worldview. We again measured self-nature connection with the INS, and our newly developed EINS ($\alpha = 0.87$). In addition, we included the six-item short version of the Nature Relatedness Scale (NR6; Nisbet & Zelenski, 2013). The NR6 had good internal consistency ($\alpha = 0.88$). We again assessed green values with the GREEN scale (Haws et al., 2014) and the single-item measures used in the previous studies. The GREEN scale showed good reliability ($\alpha = 0.95$). In addition, we measured participants' environmental worldview with the New Ecological Paradigm (Dunlap, Liere, Mertig, & Jones, 2000). This scale also displayed good internal consistency ($\alpha = 0.86$).

6.1.2.2. Green behavior. We included three indicators of green behavior. First, we included a task where we measured participants' real behavioral effort. In this task, we told participants that we were planning to create a campaign to promote environmentally relevant behaviors that most people are unaware of. For this reason, we needed them to name all environmental behaviors they could think of. This would enable us to identify behaviors that are relatively

Table 7
Pearson correlation coefficients in Study 2b.

		1)	2)	Difference ^b
1)	INS	1		
2)	EINS	0.859*** ^a	1	
3)	GV	0.467***	0.551***	$p < 0.001$
4)	Behavior	0.194***	0.232***	$p = 0.04$
5)	AI	0.068	0.039	ns
6)	MV	-0.133**	-0.192***	$p = 0.003$

Note: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; + $p < 0.10$.

^a Coefficient not corrected for self-correlation.

^b Difference between correlations involving the INS and the EINS (one-tailed tests); INS = Inclusion of Nature in Self measure; EINS = Inclusion of Nature in Self measure; GV = Green values (single-item); Behavior = Score on our choice tasks; AI = Aspiration index; MV = Materialistic value orientation.

unknown. Frequently mentioned behaviors included recycling, taking shorter showers to preserve water, and walking instead of taking the car when possible. On average, participants spent 106 s on this task ($SD = 108$ s) and mentioned five behaviors ($SD = 3.4$). Our software did not record the time for two participants due to a software error. In the reported analyses, we used the log-transformed time spent on our task and the number of behaviors mentioned as indicators of real behavioral effort towards the environment. In addition, participants reported how often they had engaged in 12 ecologically relevant behaviors in the last year (1 = never; 7 = very often). This scale was adopted from Tam (2013) and showed good internal consistency ($\alpha = 0.89$). A sample item is “Purchasing products in reusable containers”.

6.2. Results

We analyzed the correlations between the INS, the EINS, and the NR6 with the different criterion variables (Table 8). First, the EINS consistently correlated more strongly with all included criterion variables than the INS. Second, the correlation coefficients with the criterion variables did not differ between the EINS and the NR6 with two exceptions (i.e., the GREEN scale and self-reported past behavior). Interestingly, the EINS (vs. NR6) was more strongly related to our two measures of real behavioral effort at face value but these differences did not reach statistical significance.

6.3. Discussion

Study 3a replicates and extends the findings from the previous studies. It provides further evidence for the superiority of the EINS compared to the INS in terms of criterion-related validity. Indeed, the EINS consistently outperformed the INS on the criterion variables investigated: Green values, the New Ecological Paradigm, self-reported past environmental behavior, as well as environmentally-relevant real behavioral effort. In terms of convergent validity, the EINS correlated more strongly with the verbal NR6 scale than the INS. Our data also suggest that the EINS possesses comparable validity to the NR6 on the majority of the criterion variables investigated.

7. Study 3b

The purpose of Study 3b was to replicate our findings from Study 3a using another extant verbal scale of environmental identity as a comparison basis (i.e., the Love and Care for Nature scale, LCN; Perkins, 2010).

7.1. Method

7.1.1. Participants and procedure

For this study, 178 participants completed an online questionnaire on [Crowdfunder.com](https://www.crowdfunder.com). The average age was 35 years and 50% of the participants were male. Five participants failed to report their age and gender. Among our participants, 57% indicated that they possessed at least a two-year college degree. The median income was again the range of 50,000 to 59,999 USD. The procedure was identical to Study 3a with the exception that we used the Love and Care for Nature scale (LCN) instead of the NR6.

7.1.2. Measures

In this study, we included the LCN ($\alpha = 0.98$), the INS, and the EINS ($\alpha = 0.90$) as measures of self-nature connection. As in Study 3a, green values were measured with the GREEN scale ($\alpha = 0.93$) and a single-item green values measure. Participants' environmental worldview was assessed with the NEP ($\alpha = 0.86$). Green behavior was again measured with the self-reported past behavior scale adopted from Tam (2013; $\alpha = 0.91$) and our real behavioral effort task. Participants spent on average 74 s on the latter task ($SD = 82$) and named four behaviors ($SD = 3.3$).

7.2. Results

We compared the criterion-related validity of the INS, the EINS, and the LCN (Table 9). The correlations of the EINS with the different criterion variables were significantly higher than the corresponding correlations of the INS. This finding was consistent across all criterion variables. The EINS and the LCN were similar in their predictive ability with two exceptions. The correlations of the LCN with the NEP and the GREEN scales were significantly stronger compared to the correlation of the EINS with these two scales.

7.3. Discussion

Study 3b provides further evidence for the good psychometric properties of the EINS. As in Study 3a, the EINS consistently outperformed the INS in predicting a series of criterion variables. Taken together with the findings from Study 3a, this represents strong converging support for our proposition that the EINS possesses superior criterion-related validity to the INS with respect to environmentally relevant outcomes.

In terms of convergent validity, the EINS (vs. INS) was more strongly related to the LCN scale. In most cases, there was no significant difference between the LCN and the EINS in terms of predictive ability. This indicates that the EINS can be a valuable

Table 8
Pearson correlation coefficients in Study 3a.

		1)	2)	3)	Difference ^b	Difference ^c
1)	INS	1				
2)	EINS	0.815*** ^a	1			
3)	NR6	0.661***	0.800***	1	$p < 0.001$	
4)	GREEN	0.554***	0.704***	0.790***	$p < 0.001$	$p = 0.002$
5)	GV	0.508***	0.564***	0.597***	$p = 0.06$	ns
6)	NEP	0.166*	0.252***	0.228**	$p = 0.02$	ns
7)	Past Behavior	0.524***	0.621***	0.680***	$p = 0.003$	$p = 0.08$
8)	Behavior (time)	0.106	0.285***	0.227**	$p < 0.001$	ns
9)	Behavior (ideas)	0.140 ⁺	0.278***	0.219**	$p < 0.001$	ns

Note: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; ⁺ $p < 0.10$.

^a Coefficient not corrected for self-correlation.

^b Difference between correlations involving the INS and the EINS (one-tailed tests).

^c Difference between correlations involving the EINS and the NR6 (two-tailed tests); INS = Inclusion of Nature in Self; EINS = Extended Inclusion of Nature in Self; NR6 = Nature Relatedness (six-item short version); GREEN = Green values (multi-item); GV = Green values (single-item); NEP = New Ecological Paradigm; Past Behavior = Self-reported past behavior ($N = 188$); Behavior (time) = log-transformed time spent on the behavioral task ($N = 187$); Behavior (ideas) = Number of thoughts mentioned on the behavioral task.

Table 9
Pearson correlation coefficients in Study 3b

		1)	2)	3)	Difference ^b	Difference ^c
1)	INS	1				
2)	EINS	0.883*** ^a	1			
3)	LCN	0.740***	0.825***	1	$p < 0.001$	
4)	GREEN	0.660***	0.751***	0.846***	$p < 0.001$	$p < 0.001$
5)	GV	0.638***	0.728***	0.691***	$p < 0.001$	ns
6)	NEP	0.179*	0.243**	0.341***	$p = 0.04$	$p = 0.02$
7)	Past Behavior	0.641***	0.681***	0.690***	$p = 0.07$	ns
8)	Behavior (time)	0.101	0.257**	0.275***	$p < 0.001$	ns
9)	Behavior (ideas)	0.122	0.226**	0.285***	$p = 0.002$	ns

Note: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; + $p < 0.10$.

^a Coefficient not corrected for self-correlation.

^b Difference between correlations involving the INS and the EINS (one-tailed tests).

^c Difference between correlations involving the EINS and the LCN (two-tailed tests); INS = Inclusion of Nature in Self; EINS = Extended Inclusion of Nature in Self; LCN = Love and Care for Nature; GREEN = Green values (multi-item; $N = 177$); GV = Green values (single-item; $N = 177$); NEP = New Ecological Paradigm ($N = 177$); Past Behavior = Self-reported past behavior ($N = 175$); Behavior (time) = log-transformed time spent on the behavioral task ($N = 175$); Behavior (ideas) = Number of thoughts mentioned on the behavioral task.

alternative to the LCN. Since the EINS comprises only four items compared to the 15 of the LCN, the EINS might be especially valuable if space in a study is limited.

8. Study 4

Our last study examines the temporal stability of the EINS, the original INS, and two conceptually related verbal measures (i.e., the NR6 and the CNS).

8.1. Method

8.1.1. Participants and procedure

The study was conducted with students during business administration classes in a public university. Participation in our study was entirely voluntary. At Time 1, students were invited to complete a "Nature Survey" that consisted of the three self-nature connection measures mentioned above and demographics. Two weeks later (Time 2), we returned to the same classes and invited the students present to complete the identical survey again. We surveyed 138 participants at Time 1 (average age = 23 years; 48% male) and 94 participants at Time 2 (average age = 23 years; 47% male). Because class attendance is not compulsory in the concerned university, there was some variance in class sizes. Accordingly, 71 out of the 138 students who completed the survey at Time 1 also completed it at Time 2.

8.1.2. Measures

We included the EINS, the Nature Relatedness Short Version, and the Connection to Nature scales in this study. All measures showed good internal consistency at Time 1 and 2 (see Table 11).

8.2. Results

We compared the convergent validity of the INS and the EINS with respect to the verbal scales (see Table 10). Compared with the INS, the EINS correlated more strongly with the CNS. There was no difference between the correlation coefficients with regards to the NR6.

We then analyzed the test-retest correlations of the different measures in this study. All correlation coefficients exceeded $r = 0.75$ (Table 11).

8.3. Discussion

Our results indicate good performance of all measures in terms of both inter-item and test-retest reliability. The EINS showed

slightly higher figures for inter-item reliability than the other measures. It also features superior figures for temporal stability with respect to the original INS and NR6. Overall, the test-retest correlations obtained are comparable to the four-week test-retest correlations reported by Schultz et al. (2004).

9. General discussion

We used a self-expansion view of the self as a starting point for our research (Aron et al., 1991). This perspective holds that individuals are motivated to develop close relationships with the goal of including others' characteristics and properties in their self-view. In line with this cognitive paradigm, Schultz (2001, 2002) proposed that people can also be motivated to include nature as part of the self and developed the Inclusion of Nature in the Self measure. In addition to the original overlap metaphor used in extant research, our research shows that humans can represent their relationship with nature through at least three additional metaphors (i.e., distance, size, and centrality). Based on these insights, we propose a multi-item extended version of the Inclusion of Nature in Self measure (INS; Schultz, 2001). The new Extended Inclusion of Nature in Self (EINS) scale possesses good psychometric qualities. Studies with both student- and non-student samples confirm the superiority of the EINS with respect to the original INS in terms of convergent and criterion validity, as well as temporal reliability.

Our research bears implications for environmental research using measures of self-nature connection, some of which are outlined below.

9.1. Meaning of self-nature connections

To gain insight into how people think about their connection with nature, we adopted a drawing task from Pipp et al. (1985). In our exploratory Study 1, we administered this drawing task and correlated it with established measures of self-nature connection. This study indicated that people may use different spatial metaphors to express and think of their feeling of connectedness to the natural environment. Our participants did not just rely on the self-nature overlap metaphor. This was indicated by the fact that different other aspects of the drawings of our participants exhibited substantial variation between participants as well. In addition, these other aspects of the drawings correlated with several established self-nature connection measures.

In Studies 2–4, we investigated the factor structure of the EINS. All these studies converged in suggesting that a one-factor model fit our data best. Our data hence suggested that the spatial metaphors used by participants in Study 1 are not different dimensions

Table 10

Pearson correlation coefficients in Study 4 (Time 1).

		1)	2)	3)	Difference ^b
1)	INS	1			
2)	EINS	0.863*** ^a	1		
3)	NR6	0.712***	0.713***	1	ns
4)	CNS	0.661***	0.735***	0.724***	$p = 0.008$

Note: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; + $p < 0.10$.^a Coefficient not corrected for self-correlation.^b Difference between correlations involving the INS and the EINS (one-tailed tests); INS = Inclusion of Nature in Self; EINS = Extended Inclusion of Nature in Self; NR6 = Nature Relatedness (six-item short version); CNS = Connectedness to Nature scale.**Table 11**

Test-retest reliability and alphas in Study 4.

	Time	
	1	2
INS test-retest r		0.774***
EINS Cronbach's α	0.88	0.91
EINS test-retest r		0.843***
NR Cronbach's α	0.85	0.88
NR test-retest r		0.792***
CNS Cronbach's α	0.83	0.87
CNS test-retest r		0.855***

Note: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; + $p < 0.10$; INS = Inclusion of Nature in Self; EINS = Extended Inclusion of Nature in Self; NR6 = Nature Relatedness (six-item short version); CNS = Connectedness to Nature scale; For the test-retest correlations, the analysis is based on the 71 participants who completed the survey at both Times 1 and 2.

of the self-nature connection concept. Rather, they are different facets of a unidimensional construct. This means that utilizing these metaphors in addition to the overlap metaphor increases reliability and validity and ultimately helps to measure self-nature connection more comprehensively.

However, there might be merit in investigating the different spatial metaphors individually in some contexts. Future research could explore if the different facets allow for more detailed insight into how self-nature connections are formed. For instance, it could be possible that the size item might be more influenced by the presence of large-scale natural landscapes or phenomena, such as mountains or oceans, than the other items. The distance item might be more influenced by the spatial proximity of natural environments to the habitat of a given person compared to the other items. The overlap item might be more reflective of positive experiences with nature than the other items. While all the items jointly seem to indicate the level of individual connectedness to nature, the underlying processes by which different people arrive at this level might differ and deserve future investigation.

9.2. Measurement of self-nature connection

The four-item EINS provides researchers with a tool that builds on the strengths of the INS (e.g., parsimony), while circumventing its shortcomings (issues related to its single-item nature).

In Studies 2–4, we found converging evidence for the good psychometric properties of the EINS. It showed good internal consistency and criterion-related validity. In most cases, the EINS outperformed the original INS and was as good as the Nature Relatedness Short Version (Nisbet & Zelenski, 2013), Love and Care for Nature (Perkins, 2010), and Connectedness to Nature (Mayer & Frantz, 2004) scales in predicting criterion variables pertaining to environmental values, worldviews, as well as sustainable behaviors and product choices. This makes it an interesting alternative to the more established verbal multi-item scales, most of which are relatively long. As it is short and easy to administer, the EINS gives

researchers more flexibility in study design. This is especially true when participants' time is limited or if researchers intend to test more complex models which include the assessment of multiple other constructs within the same survey.

The EINS might also circumvent biases related to language skills, making it an appealing tool for studies where it is questionable whether all participants possess sufficient language skills to answer the verbal measures. Several researchers have argued for the use of picture-based measures in such contexts (e.g., De Langhe, Puntoni, Fernandes, & van Osselaer, 2011; Leiner, Rescorla, Medina, Blanc, & Ortiz, 2010). The effort of translating the measure for non-English speaking participants would also be minimal, and thus the EINS may be a valuable measure in cross-cultural research on environmental conservation.

Generally, we think that spatial metaphors are a potent framework for studying the self-nature connection concept. We encourage future research in this direction, be it through expanding our understanding of the identified metaphors or by identifying additional metaphors that could advance our knowledge of the self-nature connection concept.

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Appendix A. Instructions for the drawing task in Study 1

[Page 1 of the drawing booklet:] On the following pages of this booklet, we would like you to draw different relationships (i.e., with different people and things). You will receive instructions on what relationship to draw on the following pages. Please do not look up the different relationships in advance because we would like you to focus on each relationship one by one.

In each drawing, please draw two circles (and only two empty circles). One circle representing you and the other circle the specified relationship partner. Please draw the two circles in a meaningful configuration (i.e., in a way that you think best represents your relationship with the given relationship partner). Please be spontaneous and draw each relationship as it pops up in your mind when you read about it. After finishing the drawing, please label the two circles (e.g., with "self" for the circle that represents you in the drawing).

Please complete a drawing first, before you move on to the next page to draw the next relationship.

[Page 2 of the drawing booklet:] On the next page, please draw **your relationship with nature**. Please draw two circles (i.e., one representing you and one representing nature). Label the circle that

represents you with “self” and the nature-circle “nature”.

Please complete this drawing, before you read the instructions for the next drawing!

Appendix B

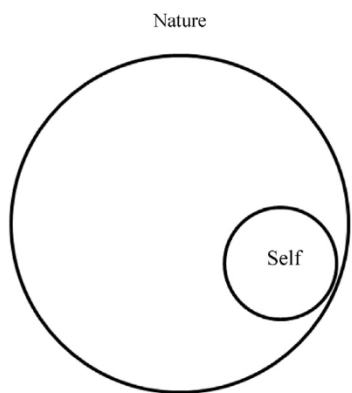


Fig. B.1. Median drawing in Study 1.

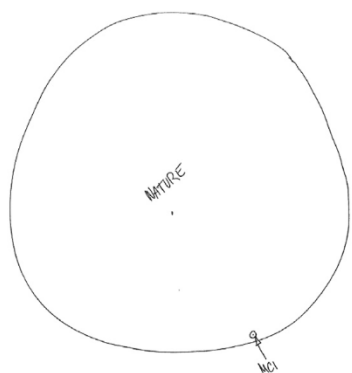


Fig. B.2. Example of a drawing in Study 1.

Appendix C. Item development for an extended version of the INS

The results from Study 1 suggested that people use various spatial metaphors to describe their feeling of connectedness to nature. Based on this insight, we constructed a total of seven new graphical items in the item development process. We ran four exploratory studies with different versions of the newly developed items. These studies did not only include the latest version of the EINS at the time of the study, they also included several criterion variables (e.g., self-nature connection measures and self-reported sustainable behavior). These variables were used to judge the quality of the items. After each study, we made changes to the items if necessary (e.g., if an item did not produce enough variance or if it did not produce sufficiently strong correlations). For example, we initially used a size item that combined a self-circle and a nature-circle. In this item, the size of the self-circle was held constant and the size of the nature circle varied from picture to picture. Around 80% of the participants chose the picture with the largest

nature-circle. To increase variability in the answers, we then used two items where participants could choose the size of the self- and the nature-circles independently. Similar to the drawing task, only the size of the nature-circle was related to our criterion variables and no combination of the self- and nature-circle size outperformed the nature-circle size in this regard. Consequently, we did not include the self-circle size in the final measure.

In some cases, we dismissed a concept for an item altogether and developed an entirely different version of it. This process continued until our data indicated that all items could be considered stable indicators of a person's self-nature connection.

Appendix D

Table 12

Correlations between the EINS items in Study 2a.

		1)	2)	3)	4)
1)	Overlap	1			
2)	Size	0.501***	1		
3)	Distance	0.582***	0.523***	1	
4)	Central	0.467***	0.529***	0.576***	1

Table 13

Correlations between the EINS items in Study 2b.

		1)	2)	3)	4)
1)	Overlap	1			
2)	Size	0.594***	1		
3)	Distance	0.719***	0.614***	1	
4)	Central	0.632***	0.578***	0.682***	1

Table 14

Correlations between the EINS items in Study 3a.

		1)	2)	3)	4)
1)	Overlap	1			
2)	Size	0.492***	1		
3)	Distance	0.731***	0.634***	1	
4)	Central	0.575***	0.646***	0.754***	1

Table 15

Correlations between the EINS items in Study 3b.

		1)	2)	3)	4)
1)	Overlap	1			
2)	Size	0.651***	1		
3)	Distance	0.758***	0.687***	1	
4)	Central	0.711***	0.636***	0.782***	1

Table 16

Correlations between the EINS items in Study 4 (Time 1).

		1)	2)	3)	4)
1)	Overlap	1			
2)	Size	0.590***	1		
3)	Distance	0.708***	0.619***	1	
4)	Central	0.695***	0.616***	0.719***	1

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