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A Scale for Differentiating Affective and Cognitive Nature Connection Dimensions, Externally Validated in Terms of Self-Transcendence and Environmental Concern

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ABSTRACT

Nature connection has important predictive power for many facets of pro-environmental attitudes and behaviors. Yet up to now, there has been no theory-based measurement to differentiate the affective and cognitive dimensions of nature connection. We followed four-step strategy to develop such an instrument. In the first step, we evaluated items from established scales, based on semantic analysis, to identify possible items to assign to affective and cognitive dimensions. In the second step, we quantitatively validated the chosen items by applying the new scales in a quantitative questionnaire survey completed by German university students (n = 237, Mage = 22.12, SD = 3.09). In the third step, we used confirmatory factor analysis to empirically separate the dimensions. Finally, in the fourth step, we conducted correlations and structural equation modeling between the newly proposed cognitive and affective nature connection dimensions and the external validation variables self-transcendence and environmental concern. Affective nature connection showed higher correlations with self-transcendence and environmental concern than its cognitive counterpart. Furthermore, self-transcendence predicted 6% of the cognitive dimension of nature connection and 20% of the affective dimension. Although both dimensions correlated significantly with each other, only affective nature connection could predict (13%) environmental concern. Moreover, self-transcendence showed a significant indirect effect on environmental concern via affective nature connection. We successfully developed a new instrument that independently measures the cognitive dimension and affective dimension of nature connection.

KEYWORDS
nature connection, affective, cognitive, self-transcendence, Environmental Concern

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Introduction

Some scholars argue that humans in Western societies have lost their inner connection to nature as a result of modern societal development (e.g.,

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Conn, 1998), which has been attributed as one of the main roots of people's harmful behavior towards the environment and decreasing environmental concern (Nisbet & Zelenski, 2013). Additionally, studies have shown that both affect and cognition predict environmental behaviors (Pooley & O'Connor, 2000). Although nature connection (NC) apparently comprises affective and cognitive subtypes, most scales measure only one comprehensive variable and do not differentiate between distinct dimensions. Defining empirically measurable and independent cognitive and affective dimensions based on the subtypes could provide insight into the distinct underlying factors of NC. Therefore, we want to develop a new instrument that independently depicts an affective dimension and a cognitive dimension of NC, as recommended by several authors (e.g., Tam, 2013; Geng et al., 2015; Perrin & Benassi, 2009).

1.1 Cognitive nature connection

NC can be seen as an appreciating understanding and awareness towards the natural world (Nisbet, Zelenski, & Murphy, 2009). As in this definition, most NC definitions include cognitive aspects (see Schultz, 2001). Furthermore, it is possible to have an interest in nature without having an affective connection (Perrin & Benassi, 2009). Cognition includes processes of knowing and awareness, such as perceiving, reasoning, or judging (VandenBos, 2007). In this regard, for future research, an isolated cognitive dimension could serve as a distinct underlying factor of NC that describes a general consciousness of an individual's relationship towards natural issues.

Environmental concern is associated with cognitive subtypes of NC (Rhead, Elliot, & Upham, 2015). In the current paper, we regard environmental concern as a belief that covers cognitive perceptions of environmental problems (Dunlap & van Liere, 1978). Environmental concern relates directly to the degree to which individuals see themselves as a part of the natural world and is therefore grounded in NC (Schultz, Shriver, Tabanico, & Khazian, 2004). Such a cognitive representation of NC suggests that environmental concern may be predicted by NC in a cognitive way: The more someone is able to think of himself as a natural part of the world, the higher the individual's environmental concern.

As NC is relatively stable over time (Geng et al., 2015), values represent a very similar fundamental personality trait that shows strong linkages to norms and behavior (Stern, 2000). Self-transcendent values could serve as a powerful predictor for NC itself (Tam, 2013) and form the basis for environmentalism (Stern et al., 1999). Schwartz (1992) defined basic human values, such as self-transcendent values, as cognitive representations of desirable goals that transcend specific actions and situations. We suggest that self-transcendence could serve as an important predictor for cognitive NC.

1.2 Affective nature connection

NC is also understood as a felt and intuitive individual bonding to the natural world (Mayer & Frantz, 2004), resulting in caring feelings towards it (Nisbet et al., 2009). This affective subtype formed a second important subordinate category of NC in past research. The term affect refers to any experience of feeling, ranging from very simple to highly complex emotional reactions (VandenBos, 2007). In future research, an affective dimension of NC

could therefore be an independent underlying factor which describes an emotion-based relation towards nature. Affective reactions often diverge from cognitive assessments of situations and primarily drive behavior (Pooley & O'Connor, 2000).

Accordingly, a purely cognitive dimension of NC seems insufficient to explain pro-environmental motivation, like environmental concern (Carmi, Arnon, & Orion, 2015). Therefore, we regard environmental concern as a belief that also takes affective perceptions of environmental problems into account (Dunlap & van Liere, 1978). Other researchers, such as Schultz et al. (2004), defined environmental concern as an affectively associated belief about environmental problems. Since environmental concern is associated with affective states (Rhead, Elliot, & Upham, 2015), environmental concern may be predicted by NC in an affective way, such as through an individual's worry about natural resources.

Basic human values serve as a foundation for attitudes and beliefs, such as NC (Stern, 2000; Geng et al., 2015). NC (Li & Ernst, 2015) and environmental concern (Stern, 2000) have been shown to be rooted in individuals' self-transcendent values (Tam, 2013). Such environmental values refer to those values that are specifically related to nature (Schultz et al., 2004). In the current paper, we regard self-transcendence as nature-orientated and altruistic values which represent environmental values. Self-transcendent values represent prosocial concerns for preserving and improving the welfare of humans and all living beings as well as nature (Schwartz, 1992). An emotionally felt relation to other living beings could lead to higher affective NC as well as to higher environmental concern because problems affect other people (Schultz, 2005).

1.2 Research questions

Although earlier studies have found different relations among empirically found cognitive and affective subtypes of NC (e.g., with environmental values; Tam, 2013) and showed that self-transcendence revealed significant relations to established scales of NC (Tam, 2013) and to environmental concern (Nisbet et al., 2013), it is still important to further examine the dimensionality of NC conceptually as well as empirically. Considering the lack of research in differentiating theoretically distinct dimensions of cognitive NC and affective NC and in determining the independent relationships between them, environmental concern, and environmental values, a conceptual framework is needed that allows the development of a new instrument capable of independently depicting the cognitive dimension and the affective dimension of NC (Beery, 2012). In the light of this, we would like to address the following research questions.

Research question 1: Can we assign established scale items to measure nature connection with respect to an affective dimension and a cognitive dimension in terms of content?

Research question 2: Can we measure an affective dimension and a cognitive dimension of nature connection as two separate variables?

Research question 3: In which way are an affective dimension and a cognitive dimension of nature connection related to self-transcendence and environmental concern?

Materials and methods

According to our three research questions, we implemented a four-step strategy that combines a theoretical and empirical approach to assign NC items to the potential affective dimension and cognitive dimension, followed by empirical validation (Figure 1).

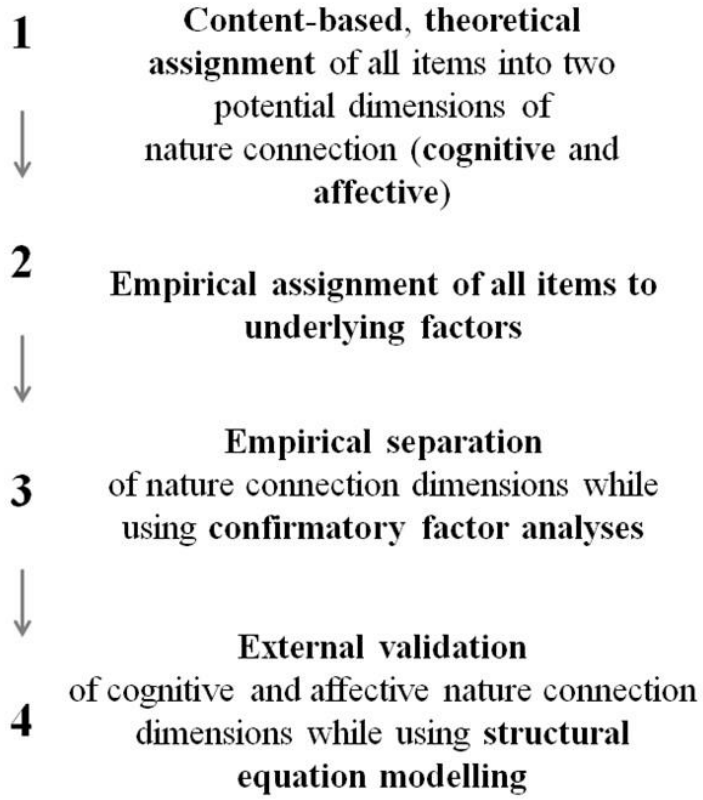

Figure 1. Strategy of our four-step scale development.

In Step 1, we conducted a content-based theoretical evaluation of established NC scale items to identify as many items as possible for initial assignment to the affective NC dimension or the cognitive NC dimension. In Step 2, we validated this assignment by performing exploratory factor analyses. In Step 3, we separated the affective dimension and cognitive dimension of NC via confirmatory factor analyses to validate the dimensions as identified in the first two steps and to further refine the new scales for subsequent investigation. Finally, in Step 4, we conducted correlations and structural equation modeling to obtain appropriate external validation of the two NC dimensions with the variables self-transcendence and environmental concern.

2.1 Sample and measures

We anonymously surveyed 237 randomly selected university students (197 females, 36 males, 4 cases of unreported gender). Our quantitative questionnaire survey was conducted at a university located in the northwest of Germany. The survey contained 47 items altogether (see Table 1) and took approximately 15 minutes to complete. The test persons' ages ranged between 18 and 39 years (M_{age} = 22.12, SD = 3.09).

Table 1. Scales as used in the current study.

Scale	Source
socio-demographic variables	authors' questioning of the students
self-transcendence	Schmidt et al, 2007
nature relatedness scale	Nisbet et al, 2008
connectedness to nature scale	Mayer & Frantz, 2004
environmental concern scale	Thompson & Ellis, 1997

We measured age and gender as basic socio-demographic sample characteristics and used established psychological scales to measure NC, environmental concern, and self-transcendence. All scales were translated from their English original into German by environmental psychology experts (see Table 10 for an overview).

Participants were asked to answer the question 'To what extent do you agree with the following statements?' on a five-point Likert scale ranging from one (I disagree) to five (I agree), except for self-transcendence items, in which respondents rated verbal portraits of people in terms of personal affinity.

2.1.1 Self-transcendence (Schmidt et al., 2007)

Self-transcendence values were measured using five items from the Portraits Value Questionnaire (Schmidt et al., 2007). Within this questionnaire, specific verbal portraits of people are presented and respondents are asked to answer the question 'How much like you is this person?' on a scale ranging from one (not at all) to five (entirely).

2.2.2 Nature relatedness (Nisbet et al., 2008)

To measure NC dimensions, we chose the well evaluated nature relatedness scale developed by Nisbet et al. (2009). This scale consists of 21 items and claims to measure a single construct called nature relatedness, which is essentially a collective NC. We decided to use this scale as it provides empirically differentiated, namely affective and cognitive, subtypes that were found through exploratory factor analyses in earlier studies (Nisbet et al., 2009). Yet the authors decided to measure only a one-factor structure, due to item cross-loadings and intercorrelations (Nisbet et al., 2009). The scale, as a one-dimensional construct, showed high internal reliability (α = 0.87) and a high test-retest reliability (r = .85; Nisbet et al., 2009).

2.1.3 Connectedness to nature (Mayer & Frantz, 2004)

To measure NC with an alternative scale and to increase an item pool that allows for empirical separation of affective and cognitive NC, we also included the well assessed 14-item connectedness to nature scale (Mayer & Frantz, 2004). The authors claim that they compiled items reflecting an affective feeling of being in community with nature as well as an experiential sense of oneness with the environment that both measure NC (Mayer & Frantz, 2004). The scale showed high internal reliability (α = 0.84) and a high test-retest reliability (r = .79) in earlier studies (Mayer & Frantz, 2004).

It is worthy of mentioning that Perrin and Benassi (2009) found that the connectedness to nature scale may also measure peoples' cognitive beliefs about nature. These different findings seem to lie in the unclear definition of the verb 'feel', which has both an affective and a cognitive bias (in English). Hence, it seems possible that the scale includes items that encompass both an affective dimension and a cognitive dimension of NC in terms of content. Thus, connectedness to nature items seem suitable for identifying a cognitive dimension and an affective NC dimension for our research.

2.1.4 Environmental concern (Ellis & Thompson, 1997)

To assess environmental concern, we used the environmental concern scale, which consists of five items (Ellis & Thompson, 1997). The authors state that environmental concern seems to reveal different conceptions of how people relate to nature and how environmental problems should be confronted (Ellis & Thompson, 1997). The scale showed high internal reliability in earlier studies (α = 0.87; Ellis & Thompson, 1997). We decided to use this scale because Ellis and Thompson (1997) already observed a link between basic personality traits and the environmental concern scale, which qualifies the scale as a useful variable for external validation.

2.2 Analyses

Based on the scales outlined above, we constructed a paper-and-pencil questionnaire using the software Teleform (Version 10.8; Teleform, 2017). After the students completed the surveys, we entered the data into the software Mplus (version 7.4), which we used for all statistical analyses (Muthén & Muthén, 2017). As the data followed a non-normal distribution, we used the robust maximum likelihood estimator (MLR option in Mplus), which is robust against any violation of the normal distribution assumption (Christ & Schlüter, 2012). We assessed all analyses using chi-square (χ^2) together with degrees of freedom (df) and the corresponding p-values, the root mean square error of approximation (RMSEA), the comparative fit index (CFI), the Tucker-Lewis index (TLI) and standardized root mean square residuals (SRMR; Kline, 2016). We regarded RMSEA values ≤ .05, CFI and TLI values ≥ .95, and SRMR values ≤ .08 as indicating a good model fit (Kline, 2016). All the presented values are standardized estimations.

2.2.1 Content-based, theoretical assignment (Step 1)

According to our first research question, we wanted to determine whether it is possible to identify an affective dimension and a cognitive dimension of NC within already established measurements, based on the wording and content of the items. To achieve this goal, we investigated which potential NC dimension (affective or cognitive) could be represented by each item of the connectedness to

nature scale and nature relatedness scale. In Step 1, we identified key terms in each of the items and cross-checked them with the APA Dictionary of Psychology (VandenBos, 2007). The definition of these terms indicates whether an item implies an affective dimension (keywords: emotion, mood) or a cognitive dimension (keywords: cognition, recognition; see Table S.1 in Supplementary material section). The selection of keywords was guided by a current definition of the terms of affect ('any experience of feeling or emotion, […] both mood and emotion are considered affective states'; VandenBos, 2007, pp. 26-27) and cognition ('all forms of knowing and awareness, […] individual percept, idea, memory, or the like'; VandenBos, 2007, pp. 201-202).

In assigning an item to a cognitive dimension or an affective dimension, it was not necessary for the item to explicitly contain the specific keywords, rather there should be a reasonable fit between keyword definition and item content. Findings indicated that the connectedness to nature scale may measure both an affective NC and a cognitive NC (Mayer & Frantz, 2004; Perrin & Benassi, 2009). However, German allows a greater differentiation between the terms 'feel' (*fühlen*) and 'think' (*denken*) than English. Thus, we decided to interpret the German word for 'feel' as an indicator of an affective NC. As a result of this first analytical step, we assigned the items from both scales to two groups. The separated items are reported in the Results section (see Table 4).

2.2.2 Empirical assignment (Step 2)

To empirically assign the items, we conducted exploratory factor analysis (EFA) in Step 2. Performing EFA is an appropriate approach to determine whether theoretically distinguished items can be sufficiently differentiated and treated as a separate latent variable during instrument development (Henson, 2006). Because of the obvious expected relationships between NC items, we performed EFAs with oblimin rotation. We conducted the EFAs in two steps. First, we measured the explored factor loadings for all (affective and cognitive) NC items that remained after Step 1 to validate the content-based assignment of the items to the affective dimension or cognitive dimension. In a subsequent step, we carried out an additional EFA with oblimin rotation for each resulting factor from the previous EFA. To obtain clear one-factor modeling of each dimension, we identified those items that loaded on an alternative factor and tried to reduce each construct to a minimum of three items to make the modeling as specific as possible. While three items are the minimum number of items necessary to carry out analyses that control for random and nonrandom measurement errors (Brown, 2015), a higher number of items can signify redundant indicators and provide less research benefit than single indicators of additional latent variables (Hayduk & Littvay, 2012). In rejecting items, we excluded NC items on the basis of (1) whether or not they could be assigned to affective NC or cognitive NC on a semantic basis during the analytical Step 1; (2) high cross-loadings in EFAs in Step 2; and (3) factor loadings < .4 in Step 2 (see Brown, 2015; Kline, 2016; Henson, 2006).

2.2.3 Empirical separation (Step 3)

As proposed for Step 3, to empirically separate the items, we conducted confirmatory factor analyses (CFA) for the resulting two dimensions of NC (affective and cognitive), for self-transcendence, and for environmental concern. By conducting CFAs, we ensured the convergent and discriminant validity of the

surveyed scales. To achieve the abovementioned goal of three-item scales within Step 3, we excluded items that had a low ratio of parameter estimates/standard error (Est./*SE)* during the CFA. The test ratio of Est./*SE* can be interpreted as a z-statistic, which means that the larger the Est./*SE*, the better an item fits a model (Brown, 2015). All analyses concerning NC are reported in the Results section of this paper.

The initial modeling for self-transcendence contained five items and showed reasonable fit indices. Conducting CFA, we excluded the two items with the lowest Est./*SE* for subsequent analyses. As a result, we obtained excellent model fit indices and a three-item scale that measures self-transcendence (see Table 2).

Table 2. Factor loadings of CFA for self-transcendence.

	Initial factor loadings	Initial Est./*SE*	Factor loadings after reduction
ST1	.52***	6.39	.53***
ST2	.52***	7.25	.56***
ST3	.47***	5.93	.46***
ST4	.44***	4.78	-
ST5	.38***	4.03	-
		Fit indices	
χ^2	82.04		45.49
df	10		3
p-value	$p < .001$		$p < .001$
RMSEA	.000		.000
CFI	1.000		1.000
TLI	1.022		1.000
SRMR	.025		.000

Note: Est./*SE* = parameter estimate coefficient divided by the standard error, ST = self-transcendence, *** = $p \leq .001$, χ^2 = chi-square, *df* = degrees of freedom, RMSEA = root mean square error of approximation, CFI = comparative fit index, TLI = Tucker-Lewis index, SRMR = standardized root mean square residuals.

The initial model for environmental concern included five items and showed no reasonable fit indices. Here again, in conducting the CFA, we excluded the two items with the lowest Est./*SE* for subsequent analyses. As a result, we obtained excellent model fit indices with a three-item solution for measuring environmental concern (see Table 3).

Table 3. Factor loadings of CFA for environmental concern.

	Initial factor loadings	Initial Est./*SE*	Factor loadings after reduction
EC1	.72***	11.66	.75***
EC2	.70***	12.49	.64***
EC3	.68***	11.76	.74***
EC4	.59***	6.92	-
EC5	.32***	3.74	-
		Fit indices	
χ^2	196.65		107.16
df	10		3
p-value	$p < .001$		$p < .001$
RMSEA	.119		.000
CFI	.911		1.000
TLI	.822		1.000
SRMR	.044		.000

Note. Est./*SE* = parameter estimate coefficient divided by the standard error, EC = environmental concern, *** = $p \leq .001$, χ^2 = chi-square, *df* = degrees of freedom, RMSEA = root mean square error of approximation, CFI = comparative fit index, TLI = Tucker-Lewis index, SRMR = standardized root mean square residuals.

2.2.4 External validation (Step 4)

As a preliminary analysis for structural equation modeling, we calculated the correlations between all the measured variables. Correlations allow a first insight into whether the predicted relations between the latent variables can be identified for our sample.

As a means of externally validating the two potential dimensions of NC, in Step 4, we used structural equation modeling (SEM) including the variables of self-transcendence and environmental concern. We treated each of our constructs as a possible latent variable. Concerning the relations between the variables outlined in the Introduction section, we assumed that self-transcendence would predict both affective NC and cognitive NC, which in turn should be related to each other and predict environmental concern. SEM allows us to assess direct effects as well as indirect relationships between the surveyed constructs, which are identified by running a Sobel test (Muthén & Muthén, 2017).

Results

3.1 Content-based, theoretical assignment of nature connection items (Step 1)

The results of our content analysis, in which we assigned items to a cognitive dimension or affective dimension of NC on a semantic basis, are shown in Table 4.

Table 4. Assignment of nature connection items.

Affective dimension of nature connection		Cognitive dimension of nature connection	
Item	**Keyword**	**Item**	**Keyword**
I often feel a sense of oneness with the natural world around me. (CNS; ANC1)	emotion	I think of the natural world as a community to which I belong. (CNS; CNC1)	cognition
I feel that all inhabitants of earth, human and nonhuman, share a common ´life force´. (CNS; ANC6)		When I think of my life, I imagine myself to be part of a larger cyclical process of living.[r] (CNS; CNC3)	
I often feel disconnected from nature.[r] (CNS; ANC2)		I think a lot about the suffering of animals. (NRS; CNC10)	
I often feel kinship with animals and plants. (CNS; ANC3)		When I think of my place on earth, I consider myself to be a top member of a hierarchy that exists in nature. (CNS; CNC5)	
I often feel part of the web of life. (CNS; ANC5)			
Like a tree can be part of a forest, I feel embedded within the broader natural world. (CNS; ANC7)		The thought of being deep in the woods, away from civilization, is frightening.[r] (NRS; CNC13)	
I feel as though I belong		I always think about	

to the earth as equally as it belongs to me. (CNS; ANC4)		how my actions affect the environment. (NRS; CNC8)	
I often feel like I am only a small part of the natural world around me and that I am no more important than the grass on the ground or the birds in the trees. (CNS; ANC8)		I recognize and appreciate the intelligence of other living organisms. (CNS; CNC2)	recognition
		I have a deep understanding of how my actions affect the natural world. (CNS; CNC4)	
I feel very connected to all living things and the earth. (NRS; ANC11)		My relationship to nature is an important part of who I am. (NRS; CNC6)	
My feelings about nature do not affect how I live my life.[r] (NRS; ANC12)		Even in the middle of the city, I notice nature around me. (NRS; CNC11)	
My connection to nature and the environment is a part of my spirituality. (NRS; ANC10)	mood	I am very aware of environmental issues. (NRS; CNC9)	
I enjoy digging in the earth and getting dirt on my hands. (NRS; ANC14)		I take notice of wildlife wherever I am. (NRS; CNC14)	
My personal welfare is independent of the welfare of the natural world.[r] (CNS; ANC9)		I am not separate from nature but a part of nature. (NRS; CNC7)	

I enjoy being outdoors, even in unpleasant weather. (NRS; ANC13)	The state of nonhuman species is an indicator of the future for humans. (NRS; CNC12)
Items that could not be assigned to either dimension	
My ideal vacation spot would be a remote, wilderness area. (NRS)	
I don't often go out in nature.[r] (NRS)	
Humans have the right to use natural resources any way we want.[r] (NRS)	
Animals, birds, and plants have fewer rights than humans.[r] (NRS)	
Nothing I do will change problems in other places on the planet.[r] (NRS)	
Some species are just meant to die out or become extinct. [r] (NRS)	
Conservation is unnecessary because nature is strong enough to recover from any human impact.[r] (NRS)	

Note. [r] = reverse-coded items, CNS = connectedness to nature scale, NRS = nature relatedness scale, ANC = affective nature connection, CNC = cognitive nature connection, in parentheses = (original scale affiliation; new item affiliation).

Seven items could not be assigned to either of the two dimensions. In total, the nature relatedness scale provided five affective and nine cognitive NC items, whereas the connectedness to nature scale provided nine affective and five cognitive NC items in terms of content.

3.2 Empirical assignment of nature connection items (Step2)

We conducted EFA with oblimin rotation for all 28 separated items in Step 1 to confirm the theoretical assignment of affective and cognitive NC. The fit indices for the one-factor modeling were unsatisfactory (χ^2 = 2481.628, *df* = 378, *p*-value < .001, RMSEA = .110, CFI = .525, TLI = .487, SRMR = .128). However, an EFA with a two-factor solution showed a good model fit (χ^2 = 2481.628, *df* = 378, *p*-value < .001, RMSEA = .066, CFI = .841, TLI = .814, SRMR = .056; see Table 5).

Table 5. EFA factor loadings with oblimin rotation for previously selected nature connection items that represent an affective dimension and cognitive dimension in terms of content

	Factor 1	Factor 2
ANC1	**.635**	.204
ANC2	.324	**.470**
ANC3	**.632**	.217
ANC4	**.683**	.072
ANC5	**.583**	.322

ANC6	**.495**	.330
ANC7	**.533**	.398
ANC8	.352	.230
ANC9	.194	.211
ANC10	**.682**	-.045
ANC11	**.588**	.337
ANC12	.267	**.447**
ANC13	**.508**	-.177
ANC14	**.438**	-.396
CNC1	**.615**	.221
CNC2	**.437**	.247
CNC3	.371	**.432**
CNC4	**.439**	**.427**
CNC5	-.154	.309
CNC6	**.767**	-.035
CNC7	.264	**.647**
CNC8	.060	**.851**
CNC9	-.023	**.645**
CNC10	.080	**.740**
CNC11	.085	**.647**
CNC12	**.447**	.000
CNC13	.180	.235
CNC14	**.601**	-.165

Note. Items with factor loadings above .4 are printed in bold; items shaded in gray were included in further analyses.

Ten affective NC items from the assigned items loaded with a value higher than .4 in terms of content on a first common factor (ANC1, 3, 4, 5, 6, 7, 10, 11, 13, and 14). Two items that had previously been assigned to the affective dimension based on the content analysis in Step 1 loaded on the second factor with a value above .4 (ANC2 and12). Two items did not show loadings above .4 on either the first or the second factor (ANC8 and 9). Thus, the ten items that constituted an affective dimension after the EFA with oblimin rotation were included in our following analyses.

Seven of the items of the previously determined cognitive dimension of NC loaded above .4 on a second factor (CNC3, 4, 7, 8, 9, 10, and 11). Item CNC 4 showed a loading above .4 on the first factor as well. Five items loaded on the first (affective) factor, with loadings above .4 (CNC1, 2, 6, 12, and 14). Two of the

items previously assigned to the cognitive dimension neither loaded on the first nor on the second factor, with loadings below .4 (ANC5, and13). In our following analysis, we included six items that constituted a common cognitive dimension after an EFA with oblimin rotation and that did not show cross-loadings >.4 on a second factor (like CNC 4 did). All the included NC items in further analyses are shaded in gray in Table 5.

3.3 Exploratory factor analyses of affective nature connection (Step 2)

Two subsequent EFAs with oblimin rotation provided additional insight into the empirical quality of the two NC dimensions. We tested the dimensions independently while conducting an EFA consecutively for each dimension. The one-factor modeling for affective NC, which included the ten items selected previously, showed insufficient fit indices (χ^2 = 643.50, *df* = 45, *p*-value < .001, RMSEA = .105, CFI = .848, TLI = .805, SRMR = .079). However, an EFA with two factors had a good model fit (χ^2 = 643.50, *df* = 45, *p*-value < .001, RMSEA = .000, CFI = 1.000, TLI = 1.008, SRMR = .023; see Table 6).

Table 6. Factor loadings of EFA with oblimin rotation for previously detected nature connection items that constitute an affective dimension in terms of content

	Factor 1	Factor 2
ANC1	**.531**	.370
ANC3	**.630**	.301
ANC4	**.682**	.392
ANC5	**.721**	.115
ANC6	**.675**	-.026
ANC7	**.662**	.100
ANC10	**.594**	**.400**
ANC11	**.627**	.152
ANC13	.288	**.673**
ANC14	.128	**.757**

Note. Items with factor loadings above .4 are printed in bold; items shaded in gray will be included in further analyses.

Eight out of the ten items loaded above .4 on a first common factor (ANC1, 3, 4, 5, 6, 7, 10, and11). Item ANC 10 also showed a loading of .4 on the second factor. Additionally, we decided to include only those items that showed loading differences >.3 on the second factor (ANC3, 5, 6, 7, and11) in the final scales.

3.4 Exploratory factor analyses of cognitive nature connection (Step 2)

We ran a second EFA with oblimin rotation for the previously detected six items of the cognitive NC dimension. The one-factor model showed a very good

model fit (χ^2 = 370.36, *df* = 15, *p*-value < .001, RMSEA = .029, CFI = .995, TLI = .992, SRMR = .024; see Table 7).

Table 7. Factor loadings of EFA with oblimin rotation for previously detected nature connection items that constitute a cognitive dimension in terms of content

	Factor 1
CNC3	.398
CNC7	**.647**
CNC8	**.818**
CNC9	**.668**
CNC10	**.759**
CNC11	**.702**

Note. Items with factor loadings above .4 are printed in bold; items shaded in gray will be included in further analyses.

We decided to exclude CNC3 for further analyses because its factor loading was below 4.

3.5 Empirical separation of nature connection dimensions (Step 3)

We conducted CFAs as a basis for further investigations of the relationships between the NC dimensions, self-transcendence, and environmental concern.

The initial modeling for affective NC showed good model fit indices. However, we excluded the two items with the lowest Est./*SE* coefficients for subsequent analyses (see Table 8). As a result, we obtained excellent model fit indices.

Table 8. Factor loadings of CFA for affective nature connection.

	Initial factor loadings	Initial Est./*SE*	Factor loadings after reduction
ANC3	.58***	9.43	-
ANC5	.73***	18.18	.76***
ANC6	.68***	13.05	.68***
ANC7	.69***	15.13	.67***
ANC11	.64***	11.36	-
		Fit indices	
χ^2	266.65		132.47

df	10	3
p-value	< .001	< .001
RMSEA	.052	.000
CFI	.987	1.000
TLI	.975	1.000
SRMR	.026	.000

Note. Est. = parameter estimate coefficient, *SE* = standard error, ANC = affective nature connection, * = $p \leq .05$, ** = $p \leq .01$, *** = $p \leq .001$, χ^2 = chi-square, *df* = degrees of freedom, RMSEA = root mean square error of approximation, CFI = comparative fit index, TLI = Tucker-Lewis index, SRMR = standardized root mean square residuals.

The initial model for cognitive NC showed good fit indices. Nevertheless, we excluded the two items with the lowest Est./*SE* coefficient for subsequent analyses (see Table 9). As a result, we obtained excellent model fit indices.

Table 9. Factor loadings of CFA for cognitive nature connection.

	Initial factor loadings	Initial Est./*SE*	Factor loadings after reduction
CNC7	.64***	14.48	.66***
CNC8	.81***	20.83	.83***
CNC9	.67***	14.15	-
CNC10	.76***	19.15	.76***
CNC11	.71***	14.15	-
		Fit indices	
χ^2	329.41		167.94
df	10		3
p-value	< .001		< .001
RMSEA	.056		.000
CFI	.988		1.000
TLI	.977		1.000
SRMR	.024		.000

Note. Est. = parameter estimate coefficient, *SE* = standard error, CNC = cognitive nature connection, ** = $p \leq .01$, *** = $p \leq .001$, χ^2 = chi-square, df = degrees of freedom, RMSEA = root mean square error of approximation, CFI =

comparative fit index, TLI = Tucker-Lewis index, SRMR = standardized root mean square residuals.

Subsequently, we constructed a scale to measure self-transcendence, affective, and cognitive NC, and environmental concern, with three items each. All the items that formed the basis for subsequent analyses are shown in Table 10. Item quality was very good (see Table S.2 in Supplementary material section).

Table 10. Latent variables with their items included in analyses after CFA

Latent Variable	Item	Item Label
affective nature connection	I often feel part of the web of life.	ANC5
	I feel that all inhabitants of earth, human or nonhuman, share a common 'life force'.	ANC6
	Like a tree can be part of a forest, I feel embedded within the broader natural world.	ANC7
cognitive nature connection	I always think about how my actions affect the environment.	CNC8
	I think a lot about the suffering of animals.	CNC10
	I am not separate from nature but part of nature.	CNC7
self-transcendence	It is important for a person to listen to people who are different from himself/herself. Even when he/she disagrees with them, he/she still wants to understand them.	ST3
	It is important for a person to be loyal to his/her friends. The person wants to devote himself/herself to people close to him/her.	ST2
	It is very important for a person to help people around him/her. The person wants to care for other people.	ST1
environmental concern	The oceans are gradually dying from oil pollution and dumping of waste.	EC1
	If things continue on their present course, we will soon experience a major ecological catastrophe.	EC2
	We are fast using up the world's natural resources.	EC3

Note. All items were used in their German translation and are presented in English for the purpose of this paper.

3.6 External Validation (Step 4)

As a means of externally validating the newly developed scales, our third research question addressed the relation between the affective dimension and cognitive dimension of NC and self-transcendence and environmental concern. Therefore, we first investigated the general relationships through correlations for all four variables in Step 4 (see Table 11).

Table 11. Correlations among the latent variables.

	ANC	CNC	ST	EC
ANC	1			
CNC	.44***	1		
ST	.44***	.24*	1	
EC	.36***	.18*	n.s.	1

Note. ANC = affective nature connection, CNC = cognitive nature connection, ST = self-transcendence, EC = environmental concern, * = $p \leq .05$, *** = $p \leq .001$, n.s. = not significant.

Based on these findings, we conducted SEM and treated each of our variables (cognitive NC, affective NC, self-transcendence, and environmental concern) as a latent variable. The estimation of our modified modeling yielded a very good model fit and very good factor loadings (see Figure 2).

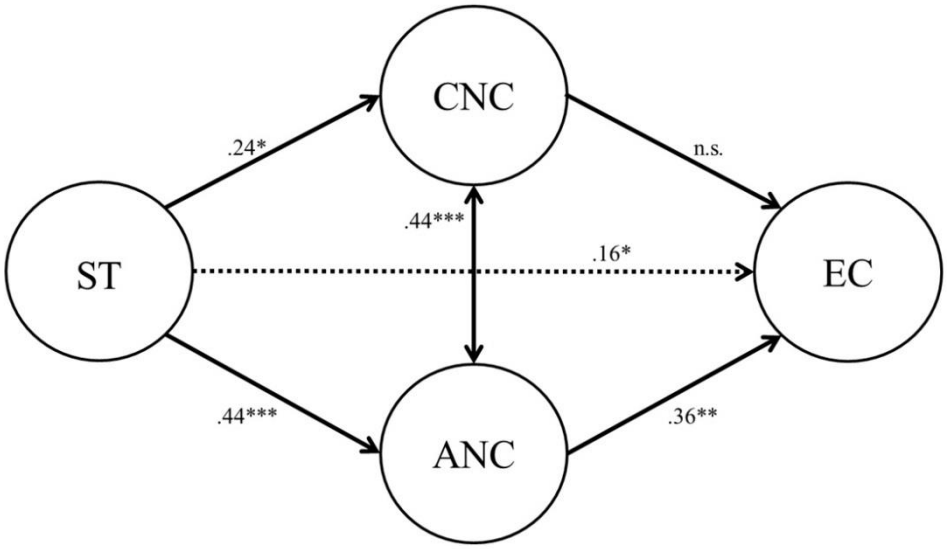

Figure 2. SEM results of the relations between cognitive (CNC) and affective (ANC) nature connection, self-transcendence (ST), and environmental concern (EC); the values represent standardized coefficients, → = regression, ↔ = correlation, ⇢ = indirect effect, * = $p \leq .05$, ** = $p \leq .01$, *** = $p \leq .001$, n.s. = not significant, $R^2_{(ST \rightarrow CNC)} = .06$, $R^2_{(ST \rightarrow ANC)} = .20$, $R^2_{(ANC \rightarrow EC)} = .13$, $\chi^2 = 662.923$, $df = 66$, $p \leq .001$, RMSEA = .011, CFI = .998, TLI = .997, and SRMR = .036.

The value cluster of self-transcendence explained 6% of the cognitive NC and 20% of the affective NC. Although cognitive NC showed a correlative relation with environmental concern, it had no significant predictive power for environmental concern. Affective NC predicted 13% of environmental concern.

Considering that self-transcendence predicted affective NC and this dimension in turn predicted environmental concern, we could identify a weak indirect effect from self-transcendence via affective NC on environmental concern by running a Sobel test (.16, $p = .017$, see Figure 2).

Discussion

Research question 1: Can we assign established scale items to measure nature connection with respect to an affective dimension and a cognitive dimension in terms of content?

We addressed this question when we assigned the items of established scales to an affective dimension and a cognitive dimension of NC based on their content. As we were able to separate NC items by using psychological keywords, we created a first basic item collection for a differentiated measure of affective NC and cognitive NC. We had to exclude seven items from the nature relatedness scale that did not fit into our predefined categories. We believe that these items may represent a more general pro-environmental attitude, which is distinct from NC (Nisbet & Zelenski, 2013). Six of these items already showed factor loadings in past research, representing a so-called 'perspective' subtype of nature relatedness (Nisbet et al., 2009). The authors tried to explain this factor as 'an indication of how one's personal relationship with the environment is manifested through attitude and behavior' (Nisbet et al., 2009, pp. 732). The advanced NR-6 scale also excluded all perspective items from their scale (Nisbet & Zelenski, 2013). It is notable that six out of seven excluded items (in terms of content) were reversely phrased items – hence, a methodological artifact seems to be possible. Our approach of using items from established NC scales that either explicitly or implicitly include cognitive and affective subtypes has proved to be a very helpful first step in differentiating an affective dimension and a cognitive dimension of NC. Both newly developed item collections represent standardized measures of NC, suggesting that NC can indeed be represented as a two-dimensional construct with an affective NC and a cognitive NC, on a semantic basis.

Research question 2: Can we measure an affective dimension and a cognitive dimension of nature connection as two separate variables?

After the content-based assignment and semantic separation, we were able to differentiate affective and cognitive items on an empirical basis. Conducting an EFA with the 28 items (14 items for each of the proposed dimension of NC), we identified two-factor modeling, although some items showed cross-loadings. In a second step, conducting an EFA with items measuring affective NC, we identified two subdimensions. We continued our analyses with those items that loaded on the first prominent factor. There were three items (ANC10, ANC13, and ANC14) that showed loadings equal to and above .4 on a second subdimension. As these three items were the last remaining items regarding the keyword 'mood' in the content-based assignment from Step 1, we suppose that the two subdimensions of affective NC were due to our keyword selection. Nevertheless, these items loaded on the affective factor when cognitive NC items were included. We can see this result as additional empirical evidence that our selection of keywords for content analysis in Step 1 was reasonable and that these items were clearly distinct from cognitive NC.

A second EFA with cognitive NC items empirically validated the one-factor modeling from Step 1. Hence, it is fair to assume that the resulting scales are an appropriate new measure for affective NC and cognitive NC.

Research question 3: In which way are an affective dimension and a cognitive dimension of nature connection related to self-transcendence and environmental concern?

The two NC dimensions showed strong correlations among each other. This synergetic effect was expected. However, we observed differences in the strength of the correlations with self-transcendence and environmental concern. Each NC dimension seems to reveal its own distinct meaning while sharing a substantial overlap: For example, affective NC showed stronger correlations with the variables of self-transcendence and environmental concern, while the cognitive dimension of NC only showed weak relationships. Affective NC seems more meaningful in association with our external validation variables.

To address the distinct effects of affective NC and cognitive NC on the external variables, we conducted SEM that showed a very good model fit. Self-transcendence showed more predictive power for the affective NC dimension (20%) than for the cognitive NC dimension (6%). Furthermore, environmental concern could only be predicted by affective NC, not by its cognitive counterpart.

A stronger relationship between self-transcendence and affective NC can be explained through their shared substantial basis. Affective NC describes a feeling of being part of nature that is shared. The items target someone's emotions of being part of something bigger than one's own life. Those feelings apply to self-transcendent values that theoretically focus on the welfare of affiliated persons and other living beings and the welfare of nature as well (Schwartz, 1992). In contrast, cognitive NC items describe an awareness about environmental conditions and their consequences. Nevertheless, one cognitive NC item asks for a self-assessment of also being part of nature – but not for a perceived feeling, like affective NC items do. The shared substantial basis of self-transcendence and cognitive NC may be lower because the cognitive NC items focus on a view that applies more to the future in terms of environmental consequences.

This substantial differentiation between our two measured NC dimensions could be the reason for the different predictive meanings regarding the external variables. Nonetheless, cognitive NC was still significantly and positively correlated with self-transcendence and environmental concern and therefore implies a meaningful relationship to them as well. Accordingly, Carmi et al. (2015) argue that a cognitive dimension can drive environmental behavior if it arouses emotions. Furthermore, several authors suggest that building up affective bonds towards nature can serve as an important, and even indispensable, motivation to protect it (e.g. Kals, Schumacher, & Montada, 1999). These findings are in line with our results which show that especially affective NC can predict environmental concern. Maybe the cognitive NC showed no predictive power for environmental concern because the affective NC is of much greater importance for this variable, even though environmental concern theoretically consists of affective and cognitive aspects (Rhead, Elliot, & Upham, 2015).

Although our findings did not indicate any expected significant relationship between self-transcendence and environmental concern (moderator and mediator effects were rejected), we identified a low indirect effect explaining environmental concern via affective NC. This could mean that an affective NC is

necessary and important for self-transcendence to influence environmental concern.

Finally, our results suggest that the distinction between cognitive NC and affective NC is an important extension of the research on NC. Our new scales provide further possibilities for investigating different dimensions of NC. We assume that a higher agreement with self-transcendent values tend to lead to a higher affective NC. Nonetheless, the cognitive dimension of NC showed an important relationship with its counterpart and may be important in supporting affective NC. A cognitive dimension of NC was not able to solely drive environmental concern. Therefore, we can state that a purely cognitive NC is not enough to explain environmental concern.

Because our sample was limited to German university students, further investigations are required to verify our new measures in additional cross-cultural and age-dependent conditions. Moreover, we recommend further investigations on the relationship between the two NC dimensions, values, and environmental concern with the goal of obtaining deeper insights into the structure of affective NC and cognitive NC. Considering that we used the 'emotional' subdimension of affective NC, it would be interesting to also investigate the other affective subdimension ('mood'). Since we measured an overall environmental concern, a more precise investigation of the different subtypes of environmental concern may provide a deeper understanding of the relationship between the NC dimensions and environmental concern. New research findings could serve as a basis for further investigations concerning, for example, environmental education to successfully foster behavioral changes (Pooley & O'Connor, 2000) through value change or enhanced environmental concern.

Disclosure statement

The Authors reported that no competing financial interest.

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