Article

Accounting for Individual Differences in Connectedness to Nature: Personality and Gender Differences

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Abstract: In the psychology of sustainability and the sustainable development framework, regarding the specific focus on the natural environment, the construct of connectedness to nature is studied in depth for its potential for environmental management. The present research focuses on individual differences, examining the relationships between connectedness to nature and the Big Five personality traits in 459 Italian university students. This work analyzes whether gender differences emerge with respect to connectedness to nature, answering a more exploratory research question, since previous studies have not considered this aspect. The results show that agreeableness and extraversion are positively associated with connectedness to nature in Italian university students. No gender differences emerged with respect to connectedness to nature. Also, the relationship between connectedness to nature and personality traits was mainly found to be gender invariant. Future perspectives for research and intervention are offered in the psychology of sustainability and the sustainable development framework.

Keywords: Connectedness to nature; personality traits; gender differences; individual differences; psychology of sustainability and sustainable development

1. Introduction

Sustainability is a broad and multidisciplinary field, covering a wide range of technical and non-technical disciplines [1]. It covers many types of systems, including those dealing with energy, water, resources, and the environment [2]. An analysis of 6459 publications on the topic over the last ten years in the journal *Sustainability* reinforces this observation [3]. The emphasis globally on the topic of sustainability received a great boost in recent years with the approval of the United Nations Sustainable Development Goals for 2015–2030, and subsequent efforts on achieving them [4].

The psychology of sustainability and sustainable development [5–7] constitutes a new research area in the field of Sustainability Science [8–10]. It offers a psychological perspective in studying the processes and improves the trans-disciplinary framework at the basis of Sustainability Science. Opening the black box of psychological processes for enhancing sustainable development provides a promising perspective [7].

The psychology of sustainability and sustainable development [5–7] considers sustainability not only in terms of the ecological environment and the economic and social environment, following a three "E" (Economy, Ecology, Equity) [11] approach, but is also focused on how to concretely realize processes of sustainability and sustainable development, and improve well-being and quality of life of each human being and the environment or environments [5–7]. Positive sustainable development

moves from the traditional focus on avoiding exploitation, depletion, and irreversible alteration, to a new innovative focus centered on promoting enrichment and equipping for growth and flexible change [5–7]. The psychology of sustainability and sustainable development perspective is centered around the construction of strengths for thriving in different environments—the natural environment, the personal environment, the social environment, the organizational environment, etc. [5–7].

In the psychology of sustainability and the sustainable development framework [5–7], a specific focus exists regarding the natural environment. In this study, the natural environment is examined by studying in-depth the construct of connectedness to nature [12] and its potential for environmental management [13].

Connectedness to nature is defined as the extent to which an individual includes nature within their cognitive representation of self; an individual's affective, experiential connection to nature [12]. People with connectedness to nature perceive themselves as part of the broader natural world, experiencing themselves as members of the broader natural community, feeling a sense of affinity with it, considering themselves as belonging to the natural world as much as it belongs to them, and believing that their well-being is related to the well-being of the natural world. The study of connectedness to nature is primarily concerned with understanding how people identify themselves with the natural environment and the relationships they form with nature [13]. Connectedness to nature affects people's physical, mental, and overall well-being due to the benefits gained by increased exposure to nature and positive experiences in the natural world [14]. A stronger commitment to nature may lead to higher human interest in environmental protection [15]. Furthermore, a greater connected sense of self to nature is associated with environmentally responsible behavior [13,16,17]. Also, connectedness to nature is a potential driver of significant environmental action [18–20] and linked to pro-environmental behavior [21], since emotional association with nature leads to an expanded sense of self and greater value placed on non-human species [22].

In the literature, the relationships between the Big Five personality traits and connectedness to nature was studied earlier, but not extensively [23–26]. These studies present similar results regarding the main personality traits that emerge as related to connectedness to nature; they are Agreeableness and Openness. Individuals who are more cooperative, friendly, and generous, and also more open to culture and experiences, perceive themselves as more connected to nature. In the study by Tam [25] on university students, the following correlations with connectedness to nature were observed: 0.34 with Agreeableness, 0.33 with Openness, 0.28 with Conscientiousness, and 0.14 with Extraversion. In the study by Zhang et al. [26] on adults, the following correlations emerged regarding connectedness to nature: 0.31 with both Agreeableness and Openness, 0.16 with Conscientiousness, and 0.14 with Extraversion. In the Italian context via the study by Di Fabio and Bucci [23] carried out on high school students, the authors found the following correlations with connectedness to nature: 0.32 with Agreeableness, 0.28 with Openness, and 0.19 with Conscientiousness. In a more recent study by Di Fabio and Kenny [24] conducted on Italian workers, the following correlations were seen with connectedness to nature: 0.39 with both Agreeableness and Openness, and 0.13 with Extraversion.

However, based on an analysis of the literature concerning connectedness to nature a gap is observed, in that, until now, gender differences in relation to connectedness to nature have not been investigated. Therefore, one of the important aims of this study is to test the existence of any gender differences related to the connectedness to nature construct.

According to the delineated theoretical framework, a study was carried out with Italian university students. Regarding the relationships between connectedness to nature and personality traits, we hypothesized that:

H1. *Agreeableness and Openness are the two personality traits more positively correlated with connectedness to nature (i.e., having higher Pearson r values among personality traits).*

H2. *Conscientiousness and Extraversion also are positively correlated with connectedness to nature.*

H3. *Emotional Stability is the only personality trait not correlated with connectedness to nature.*

We also aim to establish if the relationship between personality traits and connectedness to nature is affected by gender, since prior research did not consider gender in their analysis. The importance of testing gender invariance is on the basis that gender differences in emotions have been documented [27]. Connectedness to nature also has an emotional component, and for this reason testing gender invariance in the relationship between personality traits and connectedness to nature is interesting. Note that, with respect to gender, because prior research does not consider differences regarding connectedness to nature, we consider these research questions to be more of an exploratory nature.

2. Material and Methods

2.1. Participants

The participants in the study were 459 Italian university students (female: 57%; males: 43%; mean age = 23.64 years, SD = 3.19) from different types of degree courses at the University of Florence (Psychology: 45.53%; Economics 9.15%; Engineering: 8.93%; Informatics: 8.28%; Education Sciences: 6.75%; Pharmacy: 5.66%; Law: 4.79%; Literature: 4.14%; Political Sciences: 3.92%; Architecture: 1.53; Medicine: 1.31%). In the study, participants completed the Big Five Questionnaire (BFQ) [27], and the Italian version [28] of the Connectedness to Nature Scale (CNS) [12].

2.2. Measures

Big Five Questionnaire (BFQ). The Big Five Questionnaire [28] is composed of 132 items with a 5-point Likert scale response format ranging from 1 = Absolutely false, to 5 = Absolutely true. The questionnaire permits the evaluation of five personality traits: Extraversion (example of item: "It's easy for me to talk to people I do not know"); Agreeableness (example of item: "I almost always know how to meet the needs of others"); Conscientiousness (example of item: "Before assigning a job, I spend a lot of time reviewing it"); Emotional stability (example of item: "Usually I do not react in an exaggerated way, even to strong emotions"); and Openness (example of item: "All novelty fascinates me"). Regarding reliability, Cronbach's alpha coefficients were found to be as follows: 0.81 for Extraversion, 0.73 for Agreeableness, 0.81 for Conscientiousness, 0.90 for Emotional stability, and 0.75 for Openness. With regard to convergent validity, referring to the literature, the five personality traits of BFQ correlated with analogous scales of the NEO Personality Inventory Revised (NEO-PI-R) [29]. Concerning divergent validity, the BFQ factors did not show significant correlation with the Wechsler Adult Intelligence Scale (WAIS) [30].

Connectedness to Nature Scale (CNS). The Italian version [31] of the Connectedness to Nature Scale [12] is composed of 14 items with response options on a 5-point Likert scale ranging from 1 = Strongly agree, to 5 = Strongly disagree. Examples of items and views in line with a strong connectedness to nature are: "I often feel part of the web of life", "Like a tree can be part of a forest, I feel embedded within the broader natural world", and "I have a deep understanding of how my actions affect the natural world". The Cronbach's alpha coefficient for the total score of the CNS is 0.91. This coefficient is a measure of internal consistency and reliability (i.e., how much the measurement is stable over time), and in general indicates good reliability for values above 0.70. Regarding concurrent validity, correlations emerged in the literature for connectedness to nature with authenticity [32] and meaning in life [33].

2.3. Procedure

The questionnaires were group-administered by a trained psychologist and in accordance with Italian Privacy Law. The order of administration was counterbalanced to control the effects of presentation.

2.4. Data Analysis

We first verified the preconditions necessary for Pearson correlation. For each Pearson correlation, we assessed the variables' normality (asymmetry and kurtosis values), homoscedasticity, and linearity. For Student t tests, normality and homogeneity of variance were assessed. Furthermore, we investigated gender differences in the variables by means of Cohen's d coefficient and through confirmatory factor multigroup analysis. Finally, multicollinearity was checked for the independent variables that were included in our multiple regression model.

3. Results

In Table 1, the descriptive statistics are reported for our sample. The data refer to all dimensions involved in the data collection. It is seen in Table 1 that Extraversion and Emotional Stability dimensions are the only variables among all considered to achieve at least a small gender-related effect size [34]. Men showed higher scores than women on Extraversion ($t(457) = 3.07$; $p = 0.002$) and Emotional Stability ($t(457) = 2.68$; $p = 0.008$). The other personality traits and the CNS score do not show statistically significant gender-related differences.

Table 1. Descriptive statistics of Big Five personality traits and Connectedness to Nature scores for sample.

Variable	Women		Men		Gender Differences Cohen's d
	M	s.d.	M	s.d.	
Big Five Questionnaire (BFQ) Extraversion	73.92	8.85	76.63	10.02	0.29
Big Five Questionnaire (BFQ) Agreeableness	78.59	8.96	77.77	9.13	0.09
Big Five Questionnaire (BFQ) Conscientiousness	80.60	9.84	81.16	10.55	0.05
Big Five Questionnaire (BFQ) Emotional Stability	66.83	11.13	69.69	11.59	0.25
Big Five Questionnaire (BFQ) Openness	80.45	9.54	80.03	10.46	0.04
Connectedness to Nature Scale (CNS)	46.76	8.00	46.34	8.14	0.05

Note: M = mean; s.d. = standard deviation.

In Table 2, correlations between the Big Five personality traits and connectedness to nature are reported for the university students surveyed. Except for Emotional Stability, all other Big Five Questionnaire dimensions exhibit a significant positive linear relationship with CNS scores. High scores on Extraversion, Agreeableness, Conscientiousness, and Openness are associated with a high CNS level. The same type of statistically significant relationships are also maintained across gender, with similar magnitudes of the Pearson r coefficients. In other words, for each correlation the absolute value was similar between men and women.

Table 2. Correlations between Big Five personality traits and Connectedness to Nature.

	Connectedness to Nature		
	Total	Males	Females
Extraversion	0.18 *	0.18 *	0.19 **
Agreeableness	0.30 **	0.35 **	0.26 **
Conscientiousness	0.24 **	0.18 *	0.29 **
Emotional Stability	0.01	0.05	0.02
Openness	0.26 **	0.27 **	0.25 **

Note: * $p < 0.05$; ** $p < 0.01$.

3.1. Connectedness to Nature Invariance Across Gender

Prior to investigating the degree to which the Big Five Questionnaire's dimensions account for variance in Connectedness to Nature Scale scores, we first seek to determine the degree of CNS measurement invariance through a multiple group analysis (men/women). We carry out a one-factor Confirmatory Factor Analysis (CFA) with the 14 items of the scale as indicators of the latent variable. Indeed, determining measurement invariance (i.e., the degree to which the factor loadings and intercepts of the latent variable are equivalent across groups) is a fundamental step to assess group-related differences. We test three types of invariance: configural (i.e., structural CFA model is equivalent for men and woman), metric (i.e., factor loadings are the same across gender, but intercepts can vary), and scalar (i.e., both factor loadings and intercepts are equivalent across gender). Ideally, a construct should reach scalar invariance [34]. This analysis is conducted using SPSS-AMOS software. The results of the multigroup analysis are shown in Table 3.

Table 3. Statistics for multigroup analysis.

	χ^2/df	TLI	CFI	RMSEA	SRMR
Configural invariance	2.34	0.88	0.90	0.05	0.060
Metric invariance	2.22	0.89	0.91	0.05	0.066
Scalar invariance	2.13	0.90	0.91	0.05	0.066

Note: χ^2/df = ratio chi square/degree of freedom; CFI = Confirmatory Fit Index (≥ 0.90); TLI = Tucker–Lewis Index (≥ 0.90); SRMR = Standardized Root Mean Square Residual (≤ 0.08); RMSEA = Root Mean Square Error of Approximation (≤ 0.08).

For the one-factor CFA multigroup analysis, we rely on modification indices and we let some errors (i.e., e12⬌e14, e1⬌e3, e6⬌e13, e4⬌e14, e4⬌e12) covary to reach an overall adequate fit (i.e., to satisfy most of the fit statistics cut-offs). For the sake of clarity, we specify that for covariated errors, "e" stands for "error", the numeric label refers to the number of the item (example: e12 is the error related to the item 12), and the symbol "⬌" signals which couple of errors covariate. All the invariance models exhibit an adequate fit overall, with the scalar invariance model achieving the best fit. The difference between the models is found not to be significant ($\Delta \chi^2$ configural-metric = 9.97; *p.* = 0.69; $\Delta \chi^2$ configural-scalar = 27.14; *p.* = 0.45). Nevertheless, the results of the multigroup analysis suggest that the CNS across gender is scalar invariant for the sample of students examined.

3.2. Testing the Predictive Power of Big Five Personality Dimensions Across Gender

At this stage, we investigate the relationship between Big Five personality traits and connectedness to nature scores using a multiple regression modelling approach. Further, we test whether the relationship between personality traits and connectedness to nature is gender invariant. We exclude from the analysis the Emotional Stability trait, since its relationship with CNS is not statistically significant for either men or women (see Table 2), and thus does not respect the assumption for the regression procedure.

In Table 4 we summarize the results of the overall model (i.e., where men and women are considered together) and of gender-specific models (i.e., where men and women are analyzed separately).

Table 4. Multiple regression models between Big Five personality traits and connectedness to nature.

| | Connectedness to Nature | | | | | | | | |
| | Overall Model | | | Men Model | | | Women Model | | |
	t	β	p	t	β	p	t	β	p
Extraversion	2.54	0.12	0.011	1.92	0.14	0.05	2.07	0.13	0.04
Agreeableness	4.61	0.22	0.001	4.29	0.30	0.001	2.34	0.15	0.02
Conscientiousness	2.54	0.12	0.011	0.17	0.01	0.86	3.26	0.20	0.001
Openness	1.74	0.09	0.08	1.50	0.12	0.13	0.99	0.07	0.32
	$R^2 = 0.14$			$R^2 = 0.16$			$R^2 = 0.14$		

As can be seen from Table 4, the overall model ($F_{(4, 454)} = 18.37$; $p = 0.001$) identifies Agreeableness as the most predictive factor in the model. Individuals with a high degree of agreeableness appear to be more connected with nature. Moreover, Extraversion and Conscientiousness appear to contribute to explaining CNS variance, while Openness does not seem to be a reliable predictor in this model. The Men ($F_{(4, 192)} = 9.43$; $p = 0.001$) and Women ($F_{(4, 257)} = 10.54$; $p = 0.001$) models also exhibit statistically significant results. We observed the same positive linear relationships between Agreeableness and connectedness to nature across gender. The Extraversion results from the overall model are confirmed in each gender-specific model as well. Openness, as in the overall model, does not appear to be a statistically significant predictor of CNS scores.

Interestingly, the relationship of Conscientiousness with CNS appears to be the only non-gender-invariant in the model. Conscientiousness levels appear to affect CNS scores in the women sample, while this relationship is not significant for the male participants. Apart from Conscientiousness, the relationship between personality dimensions and CNS seem to be invariant across gender.

4. Discussion

In the psychology of sustainability and the sustainable development framework [5–7] with a focus on the natural environment, the present research examines the relationships between connectedness to nature and the Big Five personality traits in Italian university students. This work also analyzes whether gender differences exist with regard to connectedness to nature, answering to a more exploratory research question, since previous studies do not consider this aspect.

The three hypotheses are confirmed according to the prior results in the literature [23–26], extending the research on the correlations of personality traits with the Connectedness to Nature Scale. Agreeableness and Openness are the two personality traits more positively associated with connectedness to nature in university students, and in males and in females, confirming the first hypothesis. Individuals who are more cooperative, friendly, generous, and also more open to culture and experience perceive themselves as more connected to nature in terms of being part of the comprehensive natural world, experiencing themselves as members of the wider natural community, belonging to the natural world as much as it belongs to them, and believing that their well-being is connected with the well-being of the natural world [12]. However, multiple regression analysis highlighted that Openness was not an important predictor when all of the Big Five personality traits were examined together. For this reason, the first hypothesis concerning Openness could be considered only as partially confirmed. In general, Openness can be conceived as related with connectedness to nature, as was observed from the correlation analysis. Nevertheless, Openness did not appear as important for modeling and predicting CNS.

Also, the second hypothesis is confirmed because a positive relationship between Conscientiousness and Extraversion with CNS is observed in university students. In particular, Conscientiousness is more related to CNS than Extraversion. This means that the tendency to be organized, show self-discipline, act dutifully, aim for achievement, and prefer planned rather than spontaneous behavior [29] seems to be more associated with nature than the tendency to

be very dynamic, energetic, active, dominant, and talkative. Furthermore, in female individuals conscientiousness is more related to a greater perception of connection to nature, perhaps suggesting that carefulness and diligence are more related to attention to nature for females than for males. The connectedness to nature for females could involve aspects of scrupulosity and perseverance expressing care and consideration in the processes of recognition and relevance regarding nature; for males, on the contrary, these personality aspects seem irrelevant for contact with the natural world.

The third hypothesis is also confirmed, as the results of the present study show that Emotional Stability is not correlated with CNS, as is the case for previous results reported in the literature [23–26].

Regarding gender differences in relation to CNS, no differences are observed between males and females in university students. This may appear to be a counterintuitive result, since we could stereotypically think that women are more sensitive to aspects linked to the natural world. But these are only initial results that need to be confirmed in future research. However, this result is noteworthy because it responds to an existing gap in the international literature with regards to the question of gender differences in relation to CNS. The experimental evidence from this study on the relations between gender and our dimensions of interest highlight a statistical independence. Such a finding is promising to support the further modeling of the complex dynamics involved. Furthermore, the multiple regression analysis appeared to support the claim that the relationship between the Big Five personality traits and CNS should be considered mostly as gender invariant. In other words, the CNS predictors appear to be the same ones for men and women, and they appear to have the same predictive strength, with the exception of Conscientiousness, which seems to be particularly important in predicting CNS levels only for women.

Notwithstanding that the present study reveals interesting relationships between personality traits and CNS, and in general is not influenced by gender, it has some limitations. Firstly, the university students are not representative of all geographical areas in Italy, and thus the results are not generalizable. For this reason future studies should be extended to consider participants from other parts of Italy. It would also be interesting to expand the research to include other targets, for example high school students. Furthermore, this research could be replicated in different international contexts. Other limitations include the cross-sectional data collection and the use of self-report measures.

Despite these limitations, the present study provides an in depth examination of the connectedness to nature construct that can potentially affect environmental management [13]. In a psychology of sustainability and sustainable development framework [5–7], also considering a positive primary preventive perspective [35–40], the future perspective for research and interventions could be opened in relation to connectedness to nature. It could be interesting to investigate if the same results emerge using different models of personality traits, such as the HEXACO-60, which measures six broad personality dimensions, including the dimension of Honesty and Humility. It also could be interesting to compare the present results with results in relation to the Nature Relatedness Scale [41]. Regarding connectedness to nature, it could be interesting to examine if, and how, other psychological variables can be modified through specific training, since personality traits are considered substantially stable in the literature [29]. These variables could be relative to a context of interactions that are more general and extensive, such as empathy [23,24], positive relational management [42], and emotional intelligence [43–45], and to a more specific organizational context, for example workplace relational civility [46], academic relational civility [47], and human capital sustainability leadership [48]. Specific training sessions have been built to increase these relational variables in terms of primary prevention intervention. If future studies continue to identify (1) positive links between these relational aspects and the connection with nature [24] and (2) the importance of these relational variables in addition to personality traits in the variance accounted for in relation to the connection with nature, then further possibilities of psychoeducational interventions and primary prevention perspectives could be open for sustainability and sustainable development. Furthermore, among the practical implications, it is also important to consider specific interventions aimed at directly developing a connectedness to nature.

Since perceptions toward the environment are relevant in relation to environmental behaviors on the basis of the relationship between attitudes and behaviors [49], connectedness to nature could be considered a proxy variable for making inferences about important environmentally protective and responsible behaviors [50]. Referring to the study of psychological variables relevant to open the black box of concrete sustainability processes [7], connectedness to nature emerges as a relevant construct for sustainability of the natural environment, in terms of being a promising perspective for research and intervention for improving the future.

5. Conclusions

Connectedness to nature is shown to be a promising construct for environmental sustainability, and thus may also be one for reaching the United Nations Sustainable Development Goals for 2015–2030, due to its potential for environmental management and its connections with people's physical, mental, and overall well-being. Connectedness to the nature is associated with a higher human interest in environmental protection, environmentally responsible behavior, significant environmental action, and pro-environmental behavior. The psychology of sustainability and sustainable development offers important contributions to the study of sustainability and sustainable development, including new perspectives and opportunities to better understand the processes involved in sustainability and sustainable development, and to act in a way that realizes concrete progress. Studying connectedness to nature and analyzing it through the psychological lens could permit the discovery of contributions of other psychological variables useful for better environmental sustainability, as well as the well-being of all human beings. The new research area of the psychology of sustainability and sustainable development provides new awareness in the study of sustainability issues, and using the psychological perspective for studying connectedness to nature and paying attention to the process to improve it, appears to introduce a promising contribution to sustainability science.

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