

Relationships Between Nature-Related Variables and Noctcaelador

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ABSTRACT – Previous research indicates relationships between noctcaelador, a felt bond with the night sky, and nature-related variables. However, this remains relatively unexplored. In the current study 203 adults completed measures of noctcaelador, night sky watching frequency, openness to experience, and several nature-related variables including preferences for the outdoors, nature connectedness, engagement with beauty in nature, inclusion of nature in self, place attachment, and place related restorative outcomes. Noctcaelador and night sky watching were related to most nature-related variables at the bivariate level. However, regression analyses found that after accounting for openness, experiencing beauty in nature was the only independent nature-related variable to uniquely predict noctcaelador. The only nature-related variable uniquely associated with night sky watching, on the other hand, was preference for the outdoors. Noctcaelador incrementally predicted night sky watching frequency above openness and nature-related variables. Limitations of the results, implications, and suggestions for future research are discussed.

Keywords:

Noctcaelador; Night sky; Nature connectedness; Nature in self; Engagement with beauty in nature; Place attachment; Restorative outcomes

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Introduction

Bell et al. (2014) notes that most research examining human-nature relationships involves daytime variables; there is a dearth of research examining night-related nature experiences. To partly fill this gap, they investigate individuals' experiences while night sky watching, i.e., stargazing, and propose that "dark nature" activities may increase quality of life. Recent studies examining night sky watching support this through findings that engaging with night sky imagery helps restore mental focus and reduce feelings of alienation and psychological distress and promote psychological "healing" (Gankhuu et al., 2023; Tanaka et al., 2025; Vertue et al., 2026).

Engagement with the night sky is relatively common. Many adults (e.g., 57.5–88.0%) report purposefully viewing the night sky at least monthly (Heim, 2019; Kelly, 2026a; Mace & McDaniel, 2013). Moreover, there are indications that the night sky has been of importance to humans for millennia (Sheehan, 2010). Considering psychological benefits, frequency of the behavior among large percentages of contemporary adults, and historic importance of the night sky, the relative lack of research on human-night sky relationships is somewhat striking.

Noctcaelador

Noctcaelador is a psychological construct identified as an attempt to understand human's relationship with the night sky; the term is coined from the Latin *nocturnus* (nocturnal), *caelum* (sky), and *adorare* (to adore) (Kelly, 2003). Noctcaelador describes a personally meaningful bond or attachment with the night sky (Kelly, 2026a). Identified through factor analysis, the variable accounts for a majority of the variance in night sky attitudes and behaviors (Kelly, 2006a). Additionally, qualitative evidence supports the existence of noctcaelador (Blair, 2018; McNiven, 2025).

Research reveals that noctcaelador largely exists in the factor space of, but is meaningfully separate from, openness to experience of the Big Five personality model (Kelly, 2021, 2025a). Connection with the night sky is associated with more feelings of awe and restoration after viewing night sky imagery (Martens et al., 2026) suggesting it may partly explain positive effects of night sky engagement. Noctcaelador is related to astro-tourism (Tapada et al., 2023), artistic and intellectual leisure interests (Kelly, 2021), rational and alternative-strategy-seeking coping strategies (Kelly & Kelly, 2008; Idris, 2018), but reports of less existential wellbeing (Kelly, 2026b). Other findings indicate noctcaelador is related to a divergent and novelty-seeking personality style, but is mostly unrelated to fluid intelligence (Kelly, 2025b) or educational attainment (Ndlovu, 2016).

Two approaches to conceptualize noctcaelador have been suggested. One suggests that noctcaelador may partly stem from a permeable psychological structure which facilitates absorptive engagement and feelings of calm and "wholeness" related to night sky watching experiences (Kelly, 2019; Kelly & Daughtry, 2025). This may partly occur though influences on attachment and meaning-related psychological structures (Kaufman et al., 2026; Kelly & Daughtry, 2026a). Another approach proposes that noctcaelador may be a form of nature connectedness suggesting that connection with the night sky might develop through similar paths as bonds with nature including sensory experiences of the night sky and related reactions of positive emotion, perceiving beauty, meaning making, and general compassion (Barnes & Passmore, 2024).

Interestingly, regular access to the night sky is not always related to feeling connected with it (Cieraad & Dalley, 2026). This leaves open the possibility that noctcaelador may develop partly through means other than regular night sky exposure including nature experiences. Over the past several decades many variables have been identified and utilized to study nature-related experiences and preferences such as place attachment, restorative outcomes of nature, inclusion of nature in the self, nature connectedness, engagement with beauty, and a preference for spending time outdoors.

Nature-Related Variables

One of the earlier concepts developed to understand humans' relationship with nature is place attachment. Place attachment refers to psychological attachment to a personally meaningful place (Altman & Low, 1992). This often includes an emotional bond and perceived specialness of the place for preferred activities. While place attachment research typically includes natural places, it is, of course, possible to be attached to built or indoor places as well. Generally, place attachment increases over time spent in the place and is stronger for clearly defined and local versus general places, i.e., one's home in the countryside rather than rural places (Lewicka, 2011). Core determinants of place attachment appear to be a level of interest in a place that rouses and sustains attention and ability to be one's authentic self in the place (Hao et al., 2026).

Another line of research to understand humans' relationship with the environment focuses on restorative outcomes of nature. Restoration theories suggest that natural spaces enhance restoration of psychological resources, such as attention and coping (Kaplan, 1995; Ulrich et al., 1991). Research supports this indicating that the more a natural environment is perceived as extraordinary, the larger the restorative gains, particularly among individuals with more openness to experience (Bai et al., 2025). These restorative effects are associated with physiological changes as well as self-reported perceptions (Koivisto & Grassini, 2024).

Along with restorative outcomes and place attachment, the concept of inclusion of nature in the self may partly explain how bonds develop with natural environments. Building from theory on social cognition and bonding, inclusion of nature in self describes the extent to which individuals include aspects of nature in their self-representation (Schultz, 2001). The concept largely includes cognitive components. However, it theoretically extends to affective caring about the place and commitment to stewardship (Schultz, 2002). Though inclusion of nature in self mostly has been used to understand how to improve pro-nature behavior and beliefs (e.g., Fehnker et al., 2022), it also relates to felt connections with humanity and positive emotions (Chen et al., 2022).

A broad concept to understand the human-nature experience is nature connectedness. Nature connectedness describes a general sense of oneness with the natural world (Mayer & Franz, 2004). The concept is somewhat broader than inclusion of nature in self by explicitly including awareness of nature as well as related positive emotions and feelings of self-transcendence while in nature (Passmore et al., 2025). Development of more nature connectedness is suggested to follow pathways from nature engagement to affective reactions, personal meaning, and compassion (Lengieza et al., 2025; Richardson et al., 2020).

The construct of engagement with beauty in nature was recently introduced as part of general trait-like tendencies to appreciate and engage with beauty (Diessner et al., 2018). The concept is broader than the name implies including awareness of beauty along with perceived increases in positive emotion, perceived physiological stimulation (e.g., increased heart rate), and oneness with the universe when engaging with natural beauty (Diessner et al., 2008). Research indicates that exposure to nature increases experience of beauty in nature and levels of happiness (Richardson & McEwan, 2018). There is some interconnection between nature connectedness and engagement of beauty in nature. Zhang and colleagues (2014) report that engagement with beauty in nature moderates the relationship between nature connectedness and wellbeing.

A potentially important concept less discussed in nature experience research is preferences for indoor and outdoor environments. Outdoor preferences are linked to more feelings of nature connectedness (Rosa et al., 2023). Louv (2005) suggests existence of a profound societal nature-deficit from more time typically spent indoors over the past several decades and links this to increases in incidence of mental and physical health conditions. Childhood experiences of disgust and fear in natural environments as well as lower perceived quality of outdoor spaces are related to less preference for time outdoors in adulthood (Sugiyama et al., 2021). Indoor-outdoor preferences may also be passed down through generations (Lee & Burns, 2022). However, many individuals who report preferences for outdoor activities, depending on availability of suitable environments, may spend more time indoors (Avsar & Kizilaslan, 2025).

The Current Study

Few previous studies examined relationships between noctcaelador with nature-related variables. As such, the purpose of the current study was to further investigate relationships of noctcaelador and nature-related experiences. Such findings might provide more understanding of noctcaelador's place in the broader context of human-natural environment research.

Kelly (2003) originally posited noctcaelador as a form of place attachment. While this has not been specifically examined, recent descriptions suggest noctcaelador extends beyond psychological attachment to include personal significance, positive reactions, enjoyment, and engagement with the night sky (Kelly, 2026a). Earlier findings indicated that individuals scoring higher on noctcaelador tended to report preferring outdoors environments (Kelly & Kelly, 2005). More recently, Barnes and Passmore (2024) found that noctcaelador was significantly associated with higher scores on nature connectedness. Noctcaelador has also been related to a blended factor of worry about world affairs and environmental matters (Kelly, 2026c). Finally, Gao and Zhu (2025) found a relationship between noctcaelador and urban nightscape affect, which seems to include elements of preferences for outdoor urban night environments and associated feelings of restoration.

Given previous relationships with nature-related variables (Barnes & Passmore, 2024; Kelly & Kelly, 2005), and the original conceptualization of noctcaelador as a form of place attachment (Kelly 2003), it was expected that, at the bivariate level, noctcaelador would have significant small to moderate correlations with the nature-related variables discussed above (preferences for the outdoors, nature connectedness, engagement with beauty in nature, nature in self, place attachment, and place related restorative outcomes). Further, considering previous findings that noctcaelador is related to self-structure and absorptive and emotional reactions to the night sky and aesthetically rich material (Daughtry, 2026; Kelly, 2008; Kelly et al., 2006; Kelly & Daughtry, 2025, 2026a), it is expected that noctcaelador would independently relate to nature-related variables that reflect emotional response and self-identity (e.g., restorative outcomes of nature, beauty in nature, and inclusion of nature in the self).

Previous research found relationships of both nature-related and night sky variables with openness to experience (Di Fabio & Kenny, 2021; Kelly, 2025a; Milfont & Sibley, 2012; Silvia et al., 2015). Hence, openness was included as a control variable. Moreover, engagement with (i.e., watching) the night sky is strongly related to, but not equivalent with, noctcaelador (Kelly, 2026a; Kelly, Kelly, et al., 2006).

Ergo, reports of night sky watching frequency were included as an adjacent behavioral variable for comparison with noctcaelador.

Method

Participants

The sample included 203 (163 women and 37 men, 3 nonbinary) university students. The average age of the sample was 18.89 years ($SD = 1.58$) ranging from 18–31. Most participants identified their race/ethnicity as Latinx ($n = 103$, 50.7%), followed by White/non-Hispanic participants ($n = 51$, 25.1%), African American/Black ($n = 11$, 5.4%), Asian ($n = 11$, 5.4%), Native American ($n = 2$, 1.0%), or “other” ($n = 20$, 9.9%). Five participants (2.5%) did not report race/ethnicity. Most participants self-identified as freshmen ($n = 134$, 66.0%), followed by sophomores ($n = 43$, 21.2%), juniors ($n = 16$, 7.9%), and seniors ($n = 10$, 4.9%).

Procedure

Participants were recruited from an undergraduate psychology participants pool. Participants had the choice of participating in a research study or an equivalent alternative assignment to earn nominal course credit. Participants could choose between several running studies including the current larger study titled “Personality Styles.” After providing electronic consent, participants reported sociodemographics and completed the measures described below using a secure online survey platform. No time limits were imposed on survey completion and all participant data were included. This study was approved by the local Institutional Review Board (Protocol #2025-1828-NRR-v2.7361).

Measures

Noctcaelador. The 10-item Noctcaelador Inventory (Kelly, 2004) measures a significant personal bond with the night sky, e.g., “Having time to look at the night sky is important to me.” Participants respond to items using a 1 (*Strongly disagree*) to 5 (*Strongly agree*) scale. Responses are totaled. Higher scores indicate more noctcaelador. Validity support and a coefficient alpha reliability coefficient of .92 have been reported (Kelly, 2004, 2019; Batey & Kelly, 2005).

Night Sky Watching. A 2-item Night Sky Watching Frequency scale was used to estimate how often individuals have engaged in night sky watching over the past several months. The scale was expanded from single item measures used previously (Kelly, 2026a; Kelly, Kelly, et al., 2006). Items include, “How often do you intentionally look at the night sky?” and “How often do you watch the night sky for more than a few moments?” Participants respond to items using a 0 (*Never*) to 4 (*Very often*) scale. Responses are averaged. Higher scores indicate more frequent night sky watching. Validity support and a single-item reliability coefficient of .715 was reported for the single-item version (Kelly, 2026a). To examine validity of the 2-item measure, a principal axis factor analysis of the items resulted in extraction of a single factor accounting for 78.8% of the systematic variance (eigenvalue = 1.58), suggesting preliminary construct validity.

Indoor-Outdoor Preferences. A 4-item abbreviated version of the 9-item Indoor-Outdoor Preferences Scale (Kelly & Kelly, 2005) was used to assess preference for the indoors versus the outdoors, e.g., “Overall, would you describe yourself as an outdoor person or an indoor person?” “Indoors” was defined for participants as any building, house, or other structure, whereas outdoors was defined as anything not indoor. Participants respond using a 1 (*Definitely outdoors*) to 7 (*Definitely indoors*) scale. Responses are totaled. Lower scores indicate more outdoors, and higher scores more indoors, preferences. Preliminary validity support and a coefficient alpha reliability coefficient of .93 were reported for the 9-item scale (Kelly & Kelly, 2005).

Nature Connectedness. The 6-item Nature Connection Index (Richardson, et al., 2019) measures individuals’ psychological and emotional relationship with nature, e.g., “I find being in nature really amazing.” Participants respond using a 1 (*Completely disagree*) to 7 (*Completely agree*) scale. Responses are totaled. Higher scores indicate more nature connectedness. Validity support and a coefficient alpha reliability coefficient of .92 have been reported (Richardson, et al., 2019).

Engagement with Beauty in Nature. The 4-item Natural Beauty subscale from the Engagement with Beauty Scale (Diessner et al., 2008) measures engagement with beauty in nature, e.g., “When perceiving beauty in nature I feel emotional, it ‘moves me,’ such as feeling a sense of awe, or wonder or excitement or admiration or upliftment.” Participants respond using a 1 (*Very unlike me*) to 7 (*Very much like me*) scale. Responses are totaled. Higher scores indicate more engagement with and

positive responses of beauty in the natural environment. Validity support and a coefficient alpha reliability coefficient of .80 have been reported (Diessner et al., 2008).

Inclusion of Nature in Self. A 2-item scale was used to measure inclusion of nature in self by asking participants to respond to two statements: “I feel a strong relationship with the natural environment” and “I feel very interconnected with nature.” Participants respond using a 1 (*Very unlike me*) to 7 (*Very much like me*) scale. Responses are totaled. Higher scores indicate more perceived inclusion of nature in the self. This scale was based largely on Schultz’s single item Inclusion of Nature in Self scale (Schultz, 2001) which uses degrees of overlapping circles to “describe your relationship with the natural environment.” The current scale was intended to make a verbal scale of this concept. Correspondence with Schultz’s pictorial scale is not assumed. Validity support of Schultz’s single-item scale (Schultz, 2001; Schultz & Tabanico, 2007) and a two-week retest reliability coefficient of .77 has been reported (Martin & Czellar, 2016) suggesting validity and stability of the construct. To examine validity of the current 2-item measure, a principal axis factor analysis of the items resulted in extraction of a single factor accounting for 84.4% of the systematic variance (eigenvalue = 1.69), suggesting preliminary construct validity.

Place Attachment. The 6-item Abbreviated Place Attachment Scale (Boley, et al., 2021) measures bonds with a specific place including feelings of place-related identity and dependence, e.g., “No other place can compare to my favorite place.” Given the need for a specific reference, before completing this measure participants were primed by asking them to “think about your favorite place” and name or describe it. Participants respond using a 1 (*Strongly disagree*) to 5 (*Strongly agree*) scale. Responses are totaled. Higher scores indicate more place attachment. Validity support and an average coefficient alpha reliability coefficient of .90 have been reported (Boley, et al., 2021). Participants were also asked to indicate if their favorite place was indoors or outdoors.

Restorative Outcomes. The 6-item Restorative Outcomes Scale (Korpela et al., 2008) measures a tendency to experience perceived emotional and cognitive restoration resulting from being in a favorite place, e.g., “Visiting my favorite place is a way of clearing and clarifying my thoughts.” Participants respond using a 1 (*Strongly disagree*) to 7 (*Strongly agree*) scale. Responses are totaled. Higher scores indicate more perceived place-related personal restoration. Validity support and a coefficient alpha reliability coefficient of .92 have been reported (Korpela et al., 2008).

Openness to Experience. The 6-item Openness to Experience scale of the NEO-Five Factor Inventory-30 (Körner, et al., 2008) measures enjoyment of aesthetics and receptiveness to new ideas and experiences, e.g., “I am excited by the patterns I find in art and nature.” Participants respond using a 0 (*Strongly disagree*) to 4 (*Strongly agree*) scale. Responses are totaled. Higher scores indicate more openness to experience. Validity support and a coefficient alpha reliability coefficient of .67 have been reported (Körner, et al., 2008, 2015).

Statistical Analyses

SPSS v. 32 for Windows was used for statistical calculations. Descriptive statistics and coefficient alpha coefficients were computed for all measures. Preliminary gender differences were examined using independent samples *t*-tests. Correlations with age and university classification (e.g., 1 = freshman, etc.) were examined using Pearson Product Moment correlation coefficients. Given the race/ethnic makeup of the sample, possible racial/ethnic differences were examined by regrouping participants into Latinx and non-Latinx categories and using *t*-tests for comparison. Pearson correlations were calculated to examine relationships between variables. A hierarchical linear regression was calculated using noctcaelador as the criterion and loading openness to experience as a predictor on Step 1. On Step 2, the nature-related variables were loaded simultaneously and night sky watching was added on Step 3. To examine if noctcaelador incrementally predicts an adjacent behavioral marker above personality and nature-related variables, linear regressions were calculated using night sky watching as the criterion, loading openness on Step 1, nature-related variables simultaneously on Step 2, and noctcaelador on Step 3. Variable Inflation Factors (VIFs) were calculated to examine collinearity for regressions, with a VIF below 5 considered acceptable (Hair et al., 2019). Correlation coefficients and standardized betas were interpreted as small, medium, or large if above .10, .30, and .50, respectively (Cohen, 1988). Normality of the data was determined using George and Mallery’s (2010) suggestion that skewness and kurtosis statistics within ± 2 can be considered relatively normally distributed. Coefficient alphas of at least .70 were considered adequate (Hair et al., 2019). Findings were considered significant if $p < .050$ (two-tailed).

Results

Measure descriptives are presented in Table 1. Using the criteria noted above, all measures could be considered relatively normally distributed. Internal consistency reliability for all measures was good.

Table 1: Descriptive statistics of measures

Variable	<i>M</i>	<i>SD</i>	Skewness	Kurtosis	α
Noctcaelador	34.64	8.48	−0.23	−0.30	.934
Night Sky Watching	2.16	0.97	0.17	−0.55	.881
Indoor-Outdoor	15.59	6.19	−0.04	−0.77	.891
Nature Connectedness	32.25	7.16	−1.15	1.87	.920
Engagement with Beauty	17.47	5.60	−0.15	−0.61	.828
Nature in Self	8.11	3.14	−0.31	−0.55	.916
Place Attachment	22.73	4.56	−0.54	0.78	.858
Restorative Outcomes	33.93	6.00	−0.96	2.00	.827
Openness	14.81	4.71	−0.50	0.60	.825

Preliminary analyses for sociodemographic variables found significant gender differences for indoor-outdoor preferences, $t = 2.30$, $p = .023$, with women indicating more indoor preference ($M = 16.04$, $SD = 6.11$), than men ($M = 13.49$, $SD = 6.12$). No other significant gender differences were observed, $ts < 1.21$, $ps > .22$. There were no significant correlations of any variables with age, $rs < .12$, $ps > .11$. University classification, a presumed indicator of level of higher education, was not significantly correlated with any variables, $rs < .08$, $ps > .29$. There were no significant race/ethnic differences for any variables, $ts < 1.27$, $ps > .20$. Given these preliminary findings, no sociodemographic variables were used in multivariate models.

Table 2 presents categories of average scores for night sky watching frequency. Total N did not equal 203 due to missing data. Only 5.5% indicated “never” intentionally viewing the night sky. The largest category was “sometimes” (37.7%). Collapsing the categories, 66.8% of the sample indicating intentionally viewing the night sky at least sometimes while 33.2% reported watching the night sky “never” or “rarely.” A substantial 29.1% of the current sample reported night sky watching “often” or “very often.” These frequencies are consistent with previous findings that about 64.3% of students purposefully viewed the night sky at least monthly while 34.1% viewed the night sky at least weekly (Kelly, 2026a).

Table 2: Night sky watching frequencies

Score	<i>n</i>	%
0.0–0.9 (Never)	11	5.5%
1.0–1.9 (Rarely)	55	27.7%
2.0–2.9 (Sometimes)	75	37.7%
3.0–3.9 (Often)	42	21.1%
4.0–4.9 (Very Often)	16	8.0%
Total	199	100.0%

Correlation coefficients are presented in Table 3. A strong relationship was found for noctcaelador with night sky watching frequency and engagement with beauty. Moderate significant correlations were found between noctcaelador and all other variables except for indoor-outdoor preferences, which was not significant. Contrary to noctcaelador, night sky watching frequency had a significant moderate correlation with outdoor preferences but not place attachment. Nature variables were generally interrelated with exceptions for place attachment. Engagement with beauty and nature in self were strongly related sharing over half their variance. Openness was significantly related to all variables except indoor-outdoor preferences supporting its inclusion as a covariate for multivariate analyses.

Of the 201 participants reporting if their favorite place was indoors or outdoors, 98 (48.8%) indicated indoors and 103 (51.2%) endorsed outdoors. Individuals reporting their favorite place was outdoors scored significantly higher on noctcaelador ($M = 36.60$, $SD = 8.86$) than those endorsing indoors ($M = 32.56$, $SD = 7.56$), $t(196) = 3.44$, $p < .001$. Indoor and outdoor favorite place groups were

not significantly different on place attachment, $t(199) = 0.78, p = .437$. As a consistency check, favorite place location also was calculated for indoor-outdoor preferences. As expected, individuals classifying their favorite place as outdoors significantly reported their preference for outdoor environments ($M = 12.88, SD = 5.51$) whereas those reporting their favorite place as indoors preferred the indoors ($M = 18.45, SD = 5.60$), $t(199) = 7.10, p < .001$. The strength of the correlation between noctcaelador and place attachment remained unchanged when controlling if one's favorite place was indoors or outdoors, $r = .19, p = .008$.

Table 3: Correlations between study measures

Variable	1	2	3	4	5	6	7	8
1. Noctcaelador								
2. Night Sky Watching	.65**							
3. Indoor-Outdoor	-.11	-.24**						
4. Nature Connectedness	.34**	.22**	-.20**					
5. Engagement with Beauty	.51**	.34**	-.21**	.47**				
6. Nature in Self	.47**	.37**	-.23**	.51**	.76**			
7. Place Attachment	.19**	.04	.13	.19**	.16*	.12		
8. Restorative Outcomes	.26**	.18*	-.09	.26**	.21**	.21**	.54**	
9. Openness	.40**	.28**	.03	.34**	.43**	.40**	.19**	.22**

Note: $N = 202$. * $p < .05$, ** $p < .01$

Table 4: Regression models predicting noctcaelador

Variable	Step 1			Step 2			Step 3		
	β	t	p	β	t	p	β	t	p
Openness	.40	6.13	<.001	.19	2.77	.006	.11	1.85	.065
Indoor-Outdoor				-.02	0.33	.740	.06	1.09	.276
Nature Connectedness				.01	0.13	.899	.04	0.62	.534
Engagement with Beauty				.27	2.81	.006	.22	2.77	.006
Nature in Self				.15	1.55	.122	.04	0.52	.603
Place Attachment				.05	0.68	.501	.08	1.32	.188
Restorative Outcomes				.09	1.17	.243	.03	0.50	.621
Night Sky Watching							.52	9.49	<.001
$\Delta R^2 = .162, F = 37.56,$				$\Delta R^2 = .162, F = 7.57,$			$\Delta R^2 = .219, F = 90.04,$		
$p < .001$				$p < .001$			$p < .001$		

Table 5: Regressions predicting night sky watching

Variable	Step 1			Step 2			Step 3		
	β	t	p	β	t	p	β	t	p
Openness to Experience	.28	4.01	.017	.16	2.15	.033	.04	0.68	.496
Indoor-Outdoor				-.15	2.19	.030	-.14	2.42	.016
Nature Connectedness				-.06	0.68	.496	-.06	0.91	.362
Engagement with Beauty				.10	0.91	.365	-.07	0.82	.414
Nature in Self				.21	1.96	.051	.11	1.30	.194
Place Attachment				-.06	0.73	.465	-.09	1.35	.178
Restorative Outcomes				.11	1.34	.182	.06	0.81	.417
Noctcaelador							.62	9.49	<.001
$\Delta R^2 = .076, F = 16.05,$				$\Delta R^2 = .117, F = 4.58,$			$\Delta R^2 = .261, F = 90.04,$		
$p < .001$				$p < .001$			$p < .001$		

VIFs were examined prior to interpreting regression models. VIFs were ≤ 2.7 suggesting collinearity was not a problem. Regression models predicting noctcaelador are presented in Table 4. On Step 1, openness to experience accounted for a significant 16.2% of the variance in noctcaelador. Adding nature-related variables on Step 2 accounted for an additional 16.2% of the variance. On Step 2, openness remained significantly related to noctcaelador as was engagement in beauty in nature. Finally, adding night sky watching on Step 3 accounted for a substantial increase of 21.9% of the variance in noctcaelador. At this step, openness was no longer significant but engagement with beauty and night sky watching were uniquely related to noctcaelador.

Regressions predicting night sky watching frequency are presented in Table 5. On Step 1, openness to experience accounted for a significant 7.6% of the variance. Adding nature-related variables on Step 2 accounted for a significant increase of 11.7% of the variance in night sky watching. On this step, openness was a significant predictor along with outdoor preferences. Inclusion of nature in the self approached but did not reach statistical significance. Adding noctcaelador on Step 3 accounted for a substantial, significant 26.1% increase of the systematic variance in night sky watching. On this step only outdoor preferences and noctcaelador significantly accounted for independent variance in night sky watching.

Discussion

The results were generally consistent with expectations. At the bivariate level, noctcaelador was significantly associated with most variables in the expected direction. The exception was with indoor-outdoor preferences, though the direction was towards outdoor preferences. The primary conclusions of the findings seem to be that noctcaelador occupies a partially overlapping, but psychologically distinct, position within the network of nature-related constructs. Similarly, noctcaelador and night sky watching frequency, though strongly related, have partly different associations in the regressions suggesting they reflect different aspects of the night sky experience. These findings are discussed further below.

Consistent with previous work, night sky watching was reported as a relatively frequent activity among respondents (Kelly, 2026a; Kelly, Kelly, et al., 2006). On par with previous findings, noctcaelador was correlated with nature connectedness at near the same magnitude as reported by Barnes and Passmore (2024). Also, as noted by previous researchers (e.g., Nisbet & Zelenski, 2013), nature-related variables were generally intercorrelated. The correlation magnitude between noctcaelador and openness to experience was near that reported from other samples (Kelly, 2025a).

The regression findings provide more nuance suggesting that openness to experience alone accounted for a similar amount of the variance in noctcaelador as the nature-related variables combined. Being attuned with and having emotional responses to beauty in nature was a consistent predictor diminishing only slightly after including night sky watching. This might suggest that watching the night sky and reacting to its beauty might have cumulative, yet independent, influences on noctcaelador. Similarly, the regression predicting night sky watching found that openness accounted for variance even after including nature-related variables. Outdoor preferences were the only significant nature-related predictor of night sky watching though feeling nature is part of the self neared significance. Outdoor preferences remained significant for night sky watching even after accounting for noctcaelador. An implication of the different independent associates of noctcaelador and night sky watching is the apparent distinctiveness of noctcaelador as an individual differences construct and night sky watching as an adjacent behavior though they share substantial variance.

Taken together, the regression results could imply that being more open to experience might make one more likely to engage in night sky watching and develop noctcaelador. Yet, preferred time outdoors (along with adoration of the night sky) seems to influence night sky watching, perhaps partly by making the night sky more present and available. However, in terms of a bond with the night sky, awe-inspiring reactions to it after frequent observation could accumulate to influence noctcaelador. This is consistent with findings that exposure to night sky imagery increased levels of noctcaelador (Kauman et al., 2026). The relationship between noctcaelador and night sky watching is likely reciprocal.

The difference from Kelly & Kelly's (2005) finding of a significant relationship between noctcaelador and outdoor preferences is notable. The difference may have resulted partly from abbreviating the Indoor-Outdoor Scale, generational shifts toward more indoor activity (Zhai et al., 2023), and/or night sky imagery becoming more accessible in digital formats (Bjelajac et al., 2021; Brooks, 2026; McNiven, 2025). It is interesting that the relationship in the current study between night sky watching and outdoor preferences had a similar magnitude to the relationship between

noctcaelador and outdoor preference observed previously (Kelly & Kelly, 2005). This may also suggest a difference between the samples in perceptions of what noctcaelador means, i.e., watching and/or connection.

While noctcaelador was originally suggested to be a form of place attachment (Kelly, 2003), the current findings do little to support this. The relationship between noctcaelador and place attachment, though significant, was relatively small. However, it is noteworthy that individuals noting their favorite place as outdoors, compared to indoors, did score higher on noctcaelador. Additional research might examine this more closely. In any case, though the current results do not contradict that noctcaelador might indicate psychological attachment to the night sky, it seems less likely that it is a form of place attachment.

The change in noctcaelador's relationship with nature connectedness at the bivariate level and after including openness and other nature variables is notable. On the one hand, noctcaelador is somewhat related to feelings of connection with the natural world. This is not surprising considering Barnes and Passmore's (2024) conceptualization. On the other hand, after accounting for openness and other nature-related variables, particularly reactions to natural beauty and to some extent inclusion of nature in the self, the relationship between noctcaelador as conceptualized here and nature connectedness was largely diminished.

Nevertheless, processes suggested as inherent in nature connectedness (Richardson et al., 2020) might also be interpreted as present in noctcaelador: i.e., sensory engagement through night sky watching, affective reactions – particularly responses to beauty in nature and emotional relief and comfort (Kelly & Daughtry, 2026a), personal meaning and importance as included in Noctcaelador Inventory items (e.g., "Having time to watch the night sky is important to me"), and perhaps compassion as evidenced by a correlation with desire to protect dark skies (Barnes & Passmore, 2024). As such, noctcaelador may indicate a parallel disposition to nature connectedness, but the current results do not provide evidence that, as measured in this study, it represents the same domain per se.

An intriguing finding was that engagement with beauty in nature remained independently associated with noctcaelador after accounting for openness and multiple nature-related variables. This may imply that a psychological connection with the night sky develops less from broad environmental identity or general feelings of connectedness with nature than from the emotional experience evoked during encounters with the aesthetic beauty of the night sky. Constructs such as nature connectedness, inclusion of nature in self, and place attachment seem to indicate enduring beliefs, identities, or relationships with the natural environment. In contrast, engagement with beauty reflects an immediate affective response characterized by awe, admiration, emotional movement, and feelings of transcendence. It may be that these emotional reactions, rather than generalized environmental attitudes, are most closely aligned with the development of a felt bond with the night sky.

Taking the finding that openness to experience and engagement with beauty independently related to noctcaelador highlights the additional role of psychological structure in noctcaelador (Kelly & Daughtry, 2025). It may be that noctcaelador indicates a personality structure that allows for being emotionally moved by natural beauty, and perhaps beauty in general (Kelly, 2008). At the least, the present findings support the contention that multiple routes to noctcaelador may exist, e.g., influences of nature and psychological structure (Kelly & Daughtry, 2026a).

An overall implication considering the finding of a relationship between emotional reactions to beauty in nature and an affinity for the night sky might be support for Bell et al.'s (2014) suggestion of "dark nature" activities as improving health. Though health and well-being were not examined in the current study, the findings might imply that one outcome of a significant bond with the night sky is to promote "doses" of night sky engagement which may in turn be beneficial to health (Cox et al., 2017).

Limitations of the current study include the use of a relatively young university student sample which might not generalize to community samples. The use of a cross-sectional methodology does not allow for causal inferences. Self-report instruments might also be problematic given potential reporting biases. This may be particularly true because reports of nature-related behaviors could be subtly influenced by socially desirable responding (Vesely & Klöckner, 2020). This concern might be partially assuaged by the findings that the means of most variables fell near the expected midpoint of the scale and relative normality of the distributions. Nevertheless, participants' actual behaviors and responses to natural stimuli were not assessed, only their generalized recall.

Future research is needed to correct the above limitations. Obvious suggestions are to utilize experience sampling and experimental designs rather than broad self-report measures. Another suggestion would be to utilize larger community samples that might allow more generalization to the

general population. Additionally, since openness has been associated with a permeable psychological structure (McCrae, 1994) and findings indicate the latter may be important in noctcaelador (Kelly & Daughtry, 2026b), it would be useful to better understand if permeability of the psychological structure may be involved in the relationship between nature experiences, particularly beauty in nature, and noctcaelador. Additionally, it would be interesting to examine further if the processes suggested to be involved in development of nature connectedness (Richardson et al., 2020) would predict noctcaelador if used as simultaneous predictors. Research specifically naming the night sky as the target of a place attachment scale in relation to noctcaelador and night sky watching might also be of interest in further understanding the parameters of meaning individuals place on the night sky and elements of their bond.

In conclusion, the current study helps to place noctcaelador in the context of nature-related experiences and environmental psychology. It was found that noctcaelador was strongly related to night sky watching and emotional responses to beauty in nature. Associations between openness to experience and noctcaelador and night sky watching were also found. These findings suggest that noctcaelador may be conceptualized more as a stable individual difference in the tendency to form emotionally meaningful bonds with one particular form of natural aesthetic experience, the night sky, than a generalized connection with nature. Additional research is suggested to replicate and extend the current results among larger community samples.

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