

On the Psychological Function of Noctcaelador: Relationships with Secure Attachment Across Levels of Well-being

William E. Kelly¹, Don Daughtry²

¹Department of Psychology, University of the Incarnate Word, San Antonio, Texas, USA

²Department of Psychology, Texas A&M University – Kingsville, Kingsville, Texas USA

Abstract:

Previous research found inconsistent results regarding individuals' relationship with the night sky and well-being. One possible explanation for these discrepancies is a proposal that meaning and functions of noctcaelador – a significant personal bond with the night sky – varies across levels of well-being. To explore this, 157 adults completed measures of noctcaelador, comfort and emotional relief associated with the night sky (night sky comfort), secure attachment, and well-being. Moderated mediation analysis indicated the association between noctcaelador and secure attachment varied by level of well-being, as did the indirect relationship between night sky comfort and secure attachment through noctcaelador. Among individuals lower in well-being, night sky comfort was indirectly associated with secure attachment through noctcaelador. This indirect pathway was not observed among individuals at moderate or high levels of well-being. These findings suggest that noctcaelador may represent a common psychological bond with the night sky whose function differs according to psychological adjustment, serving perhaps more regulatory or attachment-related roles among individuals lower in well-being.

Keywords: Noctcaelador, Night sky, Attachment theory, Attachment styles; Well-being, Nature connectedness.

1. Introduction

Much of the variation in individuals' psychological relationship with the night sky is purportedly accounted for by a latent construct that has been coined as noctcaelador, from the Latin *nocturnus* (nocturnal), *caelum* (sky), and *adorare* (to adore) (Kelly, 2003). While noctcaelador was originally defined as psychological attachment to the night sky, it can be more broadly conceptualized as a personally significant psychological bond with the night sky, expressed through perceived personal importance, engagement, *as well as* attachment (Kelly, 2026). Although noctcaelador likely extends beyond attachment alone, retention of this element suggests that, for some individuals, mental representations of the night sky may exist within broader psychological structures that include attachment-like security and personal significance. However, noctcaelador relates to attachment-related psychological processes remains unexplored.

Previous research found noctcaelador was associated with other individual differences traits. For instance, noctcaelador was related to openness to experience, artistic and intellectual interests (Kelly, 2021),



problem solving and adaptive coping styles (Idris, 2018), appreciation of urban nightscapes (Gao & Zhu, 2025), and expending resources to travel to engage in stargazing (Tapada et al., 2023). Guided exposure to night sky imagery was shown to increase noctcaelador and experiences of personal meaning (Kaufman et al., 2026).

Engagement with the night sky is consistently associated with positive emotional experiences such as reduced isolation, stress relief, and feelings of emotional healing (Gankhuu et al., 2023; Tanaka et al., 2025). Similarly, Kelly and Daughtry (2007) found that noctcaelador was strongly related with feelings of emotional relief and soothing associated with night sky watching. Furthermore, positive emotional reactions to the night sky appear higher among individuals reporting greater personal significance of the night sky (Martens et al., 2026).

Findings concerning trait-like psychological adjustment and relationships with the night sky have been less consistent. One study reported that a measure of night sky connectedness was associated with higher well-being and lower emotional dysregulation, whereas a measure of noctcaelador was not (Barnes & Passmore, 2024). Likewise, findings regarding environmental variables have been mixed. Cieraad and Dalley (2026) observed little association between connection with the night sky and regular availability of the night sky attributed to local light pollution, though most participants expressed desirability of less light pollution. Collectively, the above findings suggest that while engagement with the night sky is generally perceived as beneficial and access to may be considered generally desirable, the meaning of one's relationship with the night sky may vary across individuals.

A possible explanation for these mixed findings is that noctcaelador develops through multiple psychological pathways. Kelly (2019) proposes that noctcaelador is more likely to develop when individuals with an open, permeable psychological structure repeatedly become psychologically absorbed in the night sky and begin to utilize it as a means of psychological regulation, stabilization, and soothing (for simplicity, hereafter we refer to this as night sky comfort). Consistent with the model, the relationship between a more permeable psychological structure and noctcaelador was mediated by night sky comfort (Kelly & Daughtry, 2025). Qualitative evidence parallels this indicating the night sky evokes strong "visceral and affective experiences" (p. 516; Putra et al., 2025) which, over time, could evoke a bond with the night sky (Grahn et al., 2021).

As alluded to above, the retained attachment component of the broadened noctcaelador concept, while not solely defining the construct, may indicate broader psychological structures involving representations of meaning, security, and emotional regulation similar to the mental models included in attachment theory (Bowlby, 1988). As such, attachment theory might still provide a partial framework for understanding how noctcaelador involves broader psychological systems involving meaning, security, and emotional regulation. Secure attachment – emotional bonds and ability to comfortably rely on others – is generally associated with effective emotional regulation, feelings of safety, and psychological stability, i.e., a secure base (Wallin, 2007). Secure attachment is thought to form through positive experiences and related neurochemical reactions (Sable, 2008).

Although attachment processes are often discussed in interpersonal contexts, meaningful emotional bonds can also develop with non-human objects, i.e., things, places, or symbols that provide comfort or psychological security. For instance, a large survey of adolescents found that connection with non-human objects was relatively common, particularly among individuals with less well-being (Erkolahti et al. 2023). Similarly, attachment to geographical places may also satisfy individual psychological needs (Ariccio et

al., 2021) and become internalized symbols as part of an individual's identity (Pagano et al., 2025). Overall, the ability to attach securely may indicate a personality style suggesting integrated psychological structures of related memories and beliefs about security (Cassidy & Shaver, 2016).

If the night sky serves a type of comfort associated regulatory function for some individuals (Kelly, 2009), higher levels of noctcaelador might indicate that night sky-related mental representation and associative meaning structures become integrated with a broader network of psychological security and attachment processes. If so, noctcaelador might be expected to relate to general secure attachment style. However, this relationship may not be uniform across all individuals. This caveat of the psychological structure model of noctcaelador suggests that the psychological function of noctcaelador may partly depend on an individual's level of well-being given possible different psychological structures and needs (Kelly, 2019). If noctcaelador connects to broader psychological structures, then access to those structures may likewise vary according to psychological state. Consistent with this possibility, previous manipulations of positive and negative mood states were associated with access to corresponding similar cognitive structures (Miranda & Persons 1988).

Regarding noctcaelador, among individuals experiencing lower well-being, repeated experiences of night sky comfort may contribute to the development of noctcaelador, which in turn may become associated with broader psychological structures involving security and stabilization (Kelly, 2019). Consequently, for individuals higher in noctcaelador and lower well-being, engagement with the night sky may facilitate access to these attachment-like structures, amplifying feelings of comfort and security. In contrast, among individuals with greater well-being, noctcaelador may primarily reflect expected experiences of aesthetic appreciation, contemplative engagement, existential meaning, or fascination with the night sky (Blair, 2017), relatively independent of attachment-related needs. From this perspective, noctcaelador may represent the same personally significant psychological bond while serving different psychological functions according to an individual's level of well-being.

The present study investigated these possibilities by examining whether well-being moderates the relationship between noctcaelador, night sky comfort, and secure attachment style. Based on the above review and theory (Kelly, 2019), it was hypothesized that the association between noctcaelador and secure attachment would differ across levels of well-being.

2. Method

2.1 Participants and Procedure

Participants included 157 (99 women, 53 men, and 5 did not identify) adults enrolled in undergraduate psychology courses at a university in the Southwest United States. The average age of the sample was 20.80 years ($SD = 3.28$). Most participants identified their race/ethnicity as Latinx ($n = 112, 71.3\%$), followed by White/Caucasian ($n = 23, 14.6\%$), Black or African American ($n = 9, 5.7\%$), Asian ($n = 5, 3.2\%$), Native American ($n = 1, 0.7\%$), and "Other" ($n = 7, 4.5\%$).

After providing written informed consent, participants completed questionnaires in small group settings. No exclusionary criteria or time limits were imposed for questionnaire completion. The study was approved by the local research ethics committee. Portions of this data using different variables and hypotheses were reported previously (Kelly & Daughtry, 2026).

2.2 Measures

2.2.1 Noctcaelador. The 4-item version of the Noctcaelador Inventory (Kelly, 2019) measures a personally significant psychological bond with the night sky, e.g., “Having time to look at the night sky is important to me.” Participants responded using a 1 (strongly disagree) to 5 (strongly agree) scale. Higher total scores indicated more noctcaelador. Adequate reliability ($\alpha = .87$) and validity have been reported (Kelly, 2019).

2.2.2 Night Sky Comfort. The 5-item Night Sky Coping Scale (Kelly & Daughtry, 2007) was originally described as a measure of using the night sky as a coping resource. However, based on item content we use the scale as a measure of comfort and relief associated with the night sky, e.g., “The night sky is comforting to me.” Participants responded using a 1 (strongly disagree) to 5 (strongly agree) scale. Higher total scores indicated more night sky comfort. Adequate reliability ($\alpha = .86$) and validity have been reported (Kelly & Daughtry, 2007).

2.2.3 Secure Attachment. The 5-item Secure Attachment Subscale of Mikulincer et al.’s (1990) attachment scale measures a secure attachment style, e.g., “I don’t often worry about being abandoned.” Participants responded using a 1 (strongly disagree) to 7 (strongly agree) scale. Higher total scores indicated a more secure attachment style. Adequate reliability ($\alpha = .79$) and validity have been reported (Mikulincer et al., 1990).

2.2.4 Well-Being. The 8-item short form of the Oxford Happiness Questionnaire (Hills & Argyle, 2002) measures subjective perceptions of general psychological well-being, e.g., “I am well satisfied about everything in my life.” Participants responded using a 1 (strongly disagree) to 6 (strongly agree) scale. Higher total scores indicated more well-being. Adequate reliability ($\alpha = .72$) and validity have been reported (Grigoriadou et al., 2024; Hills & Argyle, 2002).

2.3 Statistical Analyses

Statistical analyses were conducted with SPSS v. 32 for Windows. Pearson Product Moment correlations were used to examine relationships between variables. Model 15 of the PROCESS macro for SPSS (Hayes, 2022) was used to examine moderation and moderated mediation. Secure attachment was used as the outcome variable (Y), while night sky comfort was the predictor (X). Noctcaelador was used as the mediator (M) and well-being as the moderator (W) of both the direct effects and the second-stage path from noctcaelador to secure attachment. The 16th, 50th, and 84th percentiles were compared for low, average, and high levels of well-being, respectively. PROCESS uses bootstrapping to determine confidence intervals. We used 10000 bootstraps for more accurate estimates (Hesterberg, 2015). Results are considered significant if 0 does not fall within the bootstrapped 95% confidence interval. Results were considered statistically significant if $p < .050$.

3. Results

Descriptive statistics, internal consistencies, and correlation coefficients are shown in Table 1. Noctcaelador was strongly and positively correlated with night sky comfort. Night sky comfort was weakly but significantly associated with secure attachment. Well-being was positively associated with secure attachment but was not significantly associated with noctcaelador or night sky comfort.

In the PROCESS mediator analyses, the model predicting noctcaelador accounted for 57.9% of its variance, $F = 213.54$, $p < .001$. Night sky comfort strongly predicted noctcaelador, $B = .61$, $SE = .04$, $t = 14.61$, $p < .001$, 95% CI [.52, .69].

Table 1: Descriptive Statistics and Correlations Between Variables

| Variable | 1 | 2 | 3 | M (SD) | α |
|-----------------------------|-------|------|-------|--------------|----------|
| 1. Noctcaelador | | | | 10.71 (4.87) | .89 |
| 2. Night Sky Comfort | .76** | | | 15.49 (6.12) | .92 |
| 3. Secure Attachment | .13 | .17* | | 21.69 (6.29) | .64 |
| 4. Well-being | -.12 | -.02 | .40** | 32.88 (6.79) | .67 |

Note: $N = 157$. * $p < .050$, ** $p < .010$.

Table 2: Moderated Regression Model Predicting Secure Attachment

| Predictor | B | SE | t | p | 95% CI |
|--|-------|-----|------|------|---------------|
| Night Sky Comfort | -1.34 | .59 | 2.25 | .026 | [-2.51, -.16] |
| Noctcaelador | 2.17 | .75 | 2.89 | .004 | [.69, 3.66] |
| Well-being | .39 | .15 | 2.52 | .013 | [.08, .69] |
| Night Sky Comfort × Well-being | .04 | .02 | 2.48 | .014 | [.01, .08] |
| Noctcaelador × Well-being | -.06 | .02 | 2.75 | .007 | [-.11, -.02] |
| $R^2 = .239$, $F = 9.48$, $p < .001$ | | | | | |

The full outcome model predicting secure attachment is presented in Table 2. The model accounted for 23.9% of the variance in secure attachment. All variables independently significantly predicted secure attachment. The interaction between night sky comfort and well-being was significant, indicating that the direct association between night sky comfort and secure attachment varied by level of well-being. The interaction between noctcaelador and well-being was also significant, indicating that the association between noctcaelador and secure attachment also varied by level of well-being.

Conditional (moderated) effects from the PROCESS model are presented in Table 3. Among individuals with higher well-being, greater night sky comfort was associated with more secure attachment, whereas this relationship was not observed at lower or average levels of well-being. In contrast, the positive association between noctcaelador and secure attachment was mostly evident among individuals with lower well-being and decreased as well-being increased. Thus, the relationship between noctcaelador and secure attachment also appeared to depend on overall well-being.

Conditional indirect effects (moderated mediation) are presented in Table 4. For individuals with lower well-being, night sky comfort was positively associated with secure attachment through noctcaelador. This indirect effect was not observed at average or higher levels of well-being. Consistent with this pattern, the index of moderated mediation was significant and negative, indicating that the indirect effect of night sky comfort on secure attachment through noctcaelador decreased as well-being increased.

Table 3: Conditional Effects of Night Sky Comfort and Noctcaelador on Secure Attachment Across Levels of Well-Being

| Predictor | Well-being | Effect | SE | p | 95% CI |
|-------------------|------------|--------|------|------|---------------|
| Night Sky Comfort | Low | -.233 | .179 | .195 | [-.585, .120] |
| | Moderate | .022 | .119 | .854 | [-.213, .256] |
| | High | .361 | .152 | .019 | [.060, .662] |
| Noctcaelador | Low | .583 | .215 | .008 | [.158, 1.008] |
| | Moderate | .216 | .146 | .142 | [-.073, .506] |
| | High | -.273 | .209 | .193 | [-.685, .140] |

Table 4: Conditional Indirect Effects of Night Sky Comfort on Secure Attachment Through Noctcaelador

| Well-being | Indirect Effect | BootSE | 95% CI |
|------------------------------|-----------------|--------|----------------|
| Low | .353 | .147 | [.068, .641] |
| Moderate | .131 | .092 | [-.049, .314] |
| High | -.165 | .121 | [-.400, .079] |
| Index of Moderated Mediation | | | |
| | Index | BootSE | 95% CI |
| | -.037 | .015 | [-.065, -.008] |

4. Discussion

The present findings supported the hypothesis that the relationship between noctcaelador and secure attachment would differ according to level of well-being. Consistent with previous findings, feelings of comfort and emotional calming were strongly associated with noctcaelador, sharing over half their variance (Kelly & Daughtry, 2007). Also consistent with previous findings, secure attachment was related to well-being (Spence et al., 2022). Although the correlation coefficient between noctcaelador and secure attachment was nonsignificant, the moderated mediation revealed an interesting pattern.

In the current data, consistent with theoretical predictions (Kelly, 2019), the relationship between noctcaelador and secure attachment depended upon levels of well-being. Among individuals lower in well-being, noctcaelador was positively associated with secure attachment, and the association between night sky comfort and secure attachment operated indirectly through noctcaelador. Among individuals average or higher in well-being, this indirect pathway was not observed; instead, night sky comfort showed a direct positive relationship with secure attachment. This pattern suggests that feeling soothed by the night sky may contribute to the development of noctcaelador, but the psychological function of noctcaelador appears to differ by level of well-being.

Among those lower in well-being, repeated experiences of comfort associated with watching the night sky may contribute to the development of noctcaelador, which in turn may become integrated with broader attachment-related psychological structures (Mikulincer, 1995). As such, among individuals with lower well-being, the noctcaelador bond may partly serve a regulatory or possibly compensatory function, with



the night sky functioning as a source of solace, emotional relief, and psychological “steadiness.” In contrast, among individuals higher in well-being, noctcaelador appears less tied to attachment-related security. For the latter individuals, the personal significance of the night sky may instead reflect more contemplative, aesthetic, existential, or experiential engagement, suggestions that have been noted previously (Barnes & Passmore, 2024; Blair, 2018; Kelly, 2021). A possible extension would be that noctcaelador functions as part of a broader meaning structure through which the night sky becomes variously associated with comfort, security, contemplation, or personal significance. Additional study is needed to explore this possibility.

The present research broadens understanding of the possible development of noctcaelador. The present findings suggest that noctcaelador may develop through multiple psychological pathways including repeated experiences of comfort that become integrated with broader psychological structures involving security and soothing. This possible pathway is in addition some implicated in previous research such as openness to experience, interest patterns (Kelly, 2021), permeable psychological boundaries, emotional comfort (Kelly & Daughtry, 2025), and nature connectedness (Barnes & Passmore, 2024).

The findings may also partly reconcile mixed results in the broader night sky and nature-related literature. Prior studies have linked night sky connection with restoration, positive affect, connection with nature, and well-being (Barnes & Passmore, 2024; Martens et al., 2026; Tanaka et al., 2025), whereas other work has emphasized stress reduction, regulation, and psychological permeability (Gankhuu et al., 2023; Kelly, 2009, 2019; Kelly & Daughtry, 2025). Though some of these differences may have been due to measurement approaches, the present results suggest that these seemingly disparate perspectives are not necessarily contradictory. The night sky may be broadly experienced as soothing or emotionally beneficial, but its meaning and function may vary across individuals.

Meta-analytic work indicates that connection and engagement with nature are generally associated with better mental and physical health (Barragan-Jason et al., 2023). The current study indicates a possible nuance to that conclusion. That is, the function of a nature-related bond may depend on intrapsychic characteristics of the individual. For some, nature more broadly, and the night sky more specifically, may be primarily restorative or contemplative. For others, especially those lower in well-being, it may become integrated with broader psychological structures related to comfort and security. This distinction may be important for future research on noctcaelador, nature connectedness, and environmental psychology more broadly.

Several limitations should be considered when interpreting the present findings. First, the cross-sectional design does not allow causal conclusions regarding development of noctcaelador. Although the proposed model is theoretically consistent with the findings, it is possible that higher noctcaelador increases the emotional comfort individuals derive from the night sky (Martens et al., 2026) or that reciprocal relationships exist among these variables. Longitudinal studies are needed to clarify how personally significant psychological bonds with the night sky develop over time. Second, the measures of secure attachment and well-being demonstrated only modest internal consistency in this sample. Although their reliability might be considered adequate for exploratory research, future studies should examine these relationships using more comprehensive attachment and well-being measures and determine whether similar patterns emerge.

Future research could investigate relationships among the various pathways through which noctcaelador may develop. While, per the current results, it is possible that repeated experiences of comfort associated

with the night sky contribute to the development of noctcaelador, other pathways may also exist and vary by level of well-being. For example, noctcaelador also may develop through nature and aesthetic appreciation, existential reflection, scientific curiosity, spiritual experience, repeated engagement with astronomy (Barragan & Meltzoff, 2024; Daughtry, 2026; McNiven, 2025). Comparing these developmental pathways may help explain how noctcaelador serves different psychological functions across individuals. It would be interesting to examine if paths involving nature connectedness and relationships with the night sky also have similar pathways regarding well-being. Further investigation of these functions may help clarify the role of noctcaelador within broader theories of personality, attachment, and human relationships with the natural world.

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