

ORIGINAL ARTICLE

# “Hypnotic” Attachment to the Night Sky: Theoretical Considerations and an Abbreviated Measure of Noctcaelador

William E. Kelly<sup>1\*</sup>

<sup>1</sup>California State University, Bakersfield

## ABSTRACT

Noctcaelador (attachment to the night sky) was conceptualized as a hypnotic, self-stabilizing attachment most often present among individuals with a flexible, permeable psychic structure. An abbreviated version of the Noctcaelador Inventory (the NI-4) was developed and evaluated in six samples (N=747). Across all samples the NI-4 correlated highly with the original scale. The NI-4 possessed good structural validity, criterion validity, convergent and discriminant validity, internal consistency, and test-retest reliability. A 60% reduction of items led to little decrease in the psychometric properties of the scale or its ability to detect relationships with hypothetically related variables. With its brevity, the NI-4 can easily be included as a measure of noctcaelador in longer research protocols and in situations in which time is extremely limited.

**Keywords:** Absorption, hypnosis proneness, noctcaelador, night sky, measurement

*“After a bad day, I like to go outside and look up at the stars. I don’t know why. It just makes things seem better.” – A psychotherapy client.*

Throughout human history the night sky has been an important component in the lives of many individuals. Anthropological studies indicated that night sky watching has attracted humans as a means of gaining spiritual and aesthetic inspiration (Brecher & Feirtag, 1979; Hawkins, 1983; Hoskin, 1999) and prognosticating and gaining insight (Wyman, 1936). Further, it has been suggested that the night sky has been used to attain a trancelike state for mystical experiences (Sheehan, 2010). The appeal of

the night sky in contemporary times has received comparatively little attention. Nevertheless, the importance of the night sky appears to continue despite light pollution in urban areas. In one recent sample of over 1,100 adults visiting a national park in the United States, 57% reported observing the night sky at least monthly (Mace & McDaniel, 2013). Further, Holbrook (2009) reported that night sky watching was ranked third as an evening activity following reading and watching television. These findings suggested that a large number of individuals engage in night sky watching.

## Noctcaelador Defined

In attempts to better understand the psychology of night sky watching, previous research factor analyzed items with content that reflected night sky-related behaviors and attitudes (Kelly, 2003, 2004a, 2006; Kelly & Kelly, 2003). Consistently, one factor was identified across samples that accounted for the majority of the variance in night sky-related variables. This factor was termed “noctcaelador” and defined as an individual differences trait “emotional

\*Correspondence: wkelly.csub@gmail.com  
William Kelly, Department of Psychology; California State University,  
Bakersfield; Bakersfield, CA 93311, USA

Received: 02 January 2018 Accepted: 21 May 2018



attachment to, or adoration for, the night sky" (Kelly, 2003, p. 196). Research using qualitative methodology also found evidence supporting the existence of noctcaelador. For instance, Blair (2016) reported strong positive sentiments expressed in interviews by residents in a "dark sky" community which appear to demonstrate noctcaelador. Given the strong relationship between noctcaelador and absorption (Kelly, Daughtry, & Kelly, 2006) and previous observations of trance-like states resulting from watching the night sky (Sheehan, 2010), perhaps noctcaelador could be re-conceptualized as a "hypnotic" attachment to the night-sky.

### **Theoretical Considerations for Noctcaelador**

Harkening to Sheehan's (2010) observation that the night sky promoted a trance-like state, one of the strongest correlates of noctcaelador identified thus far was psychological absorption ( $r=.64$ ; Kelly et al., 2006). Absorption has been described as a form of trait hypnotic susceptibility in which individuals have a tendency to become intensely engrossed in a particular stimulus (Tellegen & Atkinson, 1974). Given associations with absorption and findings that night sky watching assisted in mood regulation (Kelly, 2003; Kelly & Daughtry, 2007), Kelly (2009) posited that the night sky served as an aesthetically complex, hypnotic stimulus which individuals with a permeable and flexible psychic structure might begin to identify as a secure (i.e., consistent and safe) attachment object.

Based on the above speculations, from the perspective of both attachment theory (Bowlby, 1988) and Self Psychology (Kohut, 1977), it could be conjectured that an absorptive "interaction" with the night sky might be one means of maintaining a cohesive, regulated psyche among certain individuals. Indeed, observation of the night sky has been found experimentally to promote positive mood and decreased levels of perceived stress (Dao, 2016). Such states could be conceptualized as manifestations of regulation of the psychic structure. It would seem plausible, then, that individuals for whom the night sky regularly served this purpose would develop an attachment to it, perhaps through a process of reinforcement (Zajonc, 2001). Though it is likely that

individuals high in noctcaelador would also be able to become absorbed in other aesthetically pleasing stimuli as well to modulate their moods and integrate their psyches (Kelly, 2008a), the night sky might serve as a more stable attachment object than other stimuli. Its permanence, vastness, complexity, and ubiquitous nature would make the night sky a relatively consistent and available object to be prized and foster a sense of predictable peace and safety, similar to Kohut's (1971) notion of the selfobject.

Development of noctcaelador would likely be through one's direct experience of the hypnotic, self-regulating benefits of the night sky. This might begin either through introductions to the night sky from others (i.e., watching with others or at their suggestion; see Blair, 2016), or simply as trial and error based on curiosity and exploratory behavior (Kelly, 2007; Kelly & Daughtry, 2016). Though individuals might have been exposed to the night sky and perceived its mood regulating effects, not all develop noctcaelador. To understand which individuals are more likely to be amenable to the absorptive properties of the night sky, and subsequently form an attachment, we must consider the role of psychic structure.

Previous studies have found that noctcaelador was related to possessing a relatively flexible, permeable psychic structure (Kelly, 2008a; Kelly & Kelly, 2010, 2014). A more permeable psyche would indicate perhaps that individuals with more noctcaelador had "thinner" boundaries of the psyche (Hartmann, 1991) and thus were able to experience the hypnotic effects of the night sky more fully or intensely (Hartmann, 1984). It is also possible that these individuals' (those with thinner boundaries) relatively unguarded psychic structures make them more amenable to becoming attached to the night sky in the first place, just as they are more likely to attach to other people (Hartmann, 1991). Portions of these suppositions have been supported by previous research. For instance, it was reported in one study that observing images of the night sky was a more powerful experience for individuals with permeable psychic structures than those with relatively less permeability (Silvia, Fayn, Nusbaum, & Beaty, 2015).

It is also possible that the night sky serves different purposes for individuals at various levels, or states, of well-being (cf., Miranda and Persons, 1988). For healthier individuals, watching the night sky might simply be a pleasurable activity with potential peak experiences and resulting pleasant feelings as described by Blair (2016). Yet for some individuals who have low levels of well-being, the night sky might be needed to regulate the psyche. In other words, some individuals with lower wellbeing might utilize the meditative, hypnotic properties of the night sky as a safe attachment object which helps to prevent or limit depletion or fragmentation of the psyche. This would be partly manifested in regulation of unpleasant emotional states (Kelly & Daughtry, 2007; Kohut, 1977; Wallin, 2007).

I hasten to add that for the majority of individuals, night sky watching is a normal, enjoyable activity. No evidence has been presented suggesting that night sky watching, or noctcaelador, is pathological. Indeed, given that the nonclinical samples of individuals with higher noctcaelador studied thus far apparently cope and function relatively effectively in the world (Kelly & Kelly, 2008), it seems that although they might experience more primary process mentation such as magical ideation (Kelly & Daughtry, 2005) and unusual perceptual experiences (Kelly, 2006), they are able to combine with it a rational, intellectual cognitive style (Kelly, 2005) and thereby appear able to experience what has been termed regression in the service of the ego (cf., Knafo, 2002; McCrae, 1994).

### **Towards a Briefer Measure of Noctcaelador**

To this point, most research on noctcaelador has utilized the 10-item Noctcaelador Inventory (NI; Kelly, 2004a). Though 10 items is not overly long, it perhaps demands more time and attention than is necessary given repeated findings that the NI accounts for a single factor and has a very high internal consistency (Kelly, 2004a, 2008b). This could indicate redundancy in the scale items. Therefore, it might be possible to reduce the length of the NI and increase its utility while continuing to capture the construct it purports to measure. In consideration of research participants' time and mental energy, there have

been numerous attempts to shorten research scales recently while maintaining adequate reliability and validity. Examples include a single item measure of self-esteem (Robins, Hendin, & Trzesniewski, 2001), and a 10-item measure of the five factors of personality (Rammstedt & John, 2007). The aim of the current study was to create an abbreviated measure of noctcaelador that tapped the construct adequately (relative to the original NI), and could readily be fit into lengthy research protocols without causing undue burden to respondents.

### **The Current Study**

In order to reduce the likelihood of capitalizing on chance findings, six samples were used to develop and test the properties of an abbreviated noctcaelador scale. The development of the abbreviated measure was accomplished using a criterion key approach (Gregory, 2011). Specifically, items that were found to most strongly discriminate between astronomical society members, who were thought likely to have high levels of noctcaelador, and a control group were selected for the abbreviated scale. The analyses subsequently reported in this article largely focused on the abbreviated scale's part-whole correlations and comparisons of correlations between the abbreviated and longer NI with other measures. Also examined were the internal consistencies, test-retest reliability, criterion validity, structural validity, convergent validity, and discriminant validity. For convergent validity, correlations were planned between the abbreviated and longer NI with measures of constructs measuring psychic structure that were theoretically hypothesized, and previously found empirically, to have robust correlations with noctcaelador. These included psychological absorption (Kelly et al., 2006), creativity (Kelly & Kelly, 2014), and openness to experience (Kelly & Kelly, 2010). For discriminant validity, correlations were calculated between the short and long NI for extraversion, agreeableness, neuroticism, conscientiousness, and gender. As found in previous studies (Kelly, 2004a, b), these variables had no hypothetically predicted relationships with noctcaelador.

Based on the previous research and the theoretical propositions outlined above, it was expected that an

abbreviated (and full-length) measure of noctcaelador would positively, significantly correlate with measures of absorption, creativity, and openness to experience (convergent validity). However, given that extraversion, agreeableness, neuroticism, and conscientiousness tap social functioning, emotional stability, and approach to tasks, no obvious theoretical rationale was seen for relationships to a construct representing hypnotic attachment to the night sky and its theoretically associated flexible, permeable psychic structure. Therefore, nonsignificant relationships were expected between measures of noctcaelador and extraversion, agreeableness, neuroticism and conscientiousness (discriminant validity).

## METHOD

### Participants

The first sample (S1) included 95 members of astronomical societies (82% male;  $M_{\text{age}} = 47.2$ ,  $SD = 11.3$ ) in Australia, originally collected by Batey and Kelly (2005). The societies had open memberships, the only prerequisite being an enjoyment of astronomy and sky watching. Also in S1 was a group of 95 controls (75% male;  $M_{\text{age}} = 45.1$ ,  $SD = 12.0$ ) selected from a normative NI database of 1,340 individuals collected over a period of five years. Individuals from the normative group were selected for S1 based on gender and age in an effort to match the astronomy society members. In total, then, S1 included 190 participants (78% male). There was no statistically significant difference between the astronomical society members and controls with regards to gender,  $\chi^2(1) = 1.5$ ,  $p > .05$ , and age,  $t(188) = 1.3$ ,  $p > .05$ .

The second sample (S2) consisted of 210 university students (74% female;  $M_{\text{age}} = 20.9$ ,  $SD = 1.2$ ; 79% white Caucasian) whereas the third sample (S3) consisted of 127 university students (51% female;  $M_{\text{age}} = 19.8$ ,  $SD = 1.7$ ; 93% white Caucasian). The fourth sample (S4) included 65 university students (86% female;  $M_{\text{age}} = 26.2$ ,  $SD = 5.6$ ; 89% white Caucasian). S5 consisted of 90 university students (77% female;  $M_{\text{age}} = 21.3$ ,  $SD = 1.7$ ; 86% white Caucasian). Finally, sample six (S6) included 65 students (69% female;  $M_{\text{age}} = 21.4$ ,  $SD = 2.7$ ; 83% white Caucasian).

### Measures

**Noctcaelador Inventory (NI).** The 10-items of the Noctcaelador Inventory (NI; Kelly, 2004a) were rated by participants using a 5-point Likert scale ranging from 1 ("Strongly Disagree") to 5 ("Strongly Agree"). Responses to each item were summed to compute a total NI score, higher scores indicated more noctcaelador. According to Kelly, the NI was normally distributed, did not correlate significantly with age, gender, or social desirability, and had good factorial validity (one factor, interpreted as noctcaelador, accounted for 61% of the variance in responses), internal consistency ( $\alpha = .92$ ), and test-retest reliability ( $r = .88$ , one month). Kelly provided validity support through correlations with self-reported night sky watching behaviors.

### Convergent and Discriminant Validity Measures.

Several scales were chosen to provide convergent and discriminant validity for the shortened scale and to allow comparison of its performance relative to the NI. Two measures were selected to provide "direct" convergent validity of the abbreviated NI. These were two five-item measures of night sky-related attitudes, i.e., "Do you enjoy looking at the sky, or that which is in the night sky, at night?" (NSA; Kelly, 2003) and behaviors, i.e., "In the past 6 months, how often have you made it a point to look at the night sky?" (NSB; Kelly & Kelly, 2003). In preliminary factor analyses using the current data, one factor was extracted for both the NSA and NSB, and both accounted for the majority of the variance in responses. This provided some evidence of structural validity of these measures. Participants responded using a 5-point scale ranging from 1 ("Strongly Disagree" or "Never") to 5 ("Strongly Agree" or "Very Often"). Coefficient alphas in the current study for the NSA and NSB scales were .86 and .82, respectively.

As additional measures of convergent validity, scales that assessed creative personality and psychological absorption were selected. Creativity was assessed using the 20-item self-report Scale of Creative Attributes and Behavior, i.e., "I spend much of my time creating things" (SCAB; K. Kelly, 2004). The SCAB assessed hypothesized indicators of a creative personality style and engagement

in creative behaviors. Participants responded using a 7-point scale ranging from 1 ("Strongly Disagree") to 7 ("Strongly Agree"). The coefficient alpha in the current study was .86. Absorption was assessed using the 12-item Absorption Scale of the Brief Form of the Multidimensional Personality Questionnaire, i.e., "It's possible for me to be completely immersed in nature or art and feel my state of consciousness has been altered" (B-AS; Patrick, Curtin, & Tellegen, 2002). Participants responded "True" or "False" to each item. The coefficient alpha in the current study was .82.

The Ten Item Personality Inventory (TIPI; Gosling, Rentfrow, & Swann, 2003) was selected as a brief measure of the Big Five personality factors (neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness) using two items for each factor. Openness (i.e., "Open to new experiences, complex") was considered a measure for convergent validity, while extraversion, ("Extraverted, enthusiastic"), agreeableness ("Sympathetic, warm"), neuroticism ("Anxious, easily upset"), and conscientiousness ("Dependable, self-disciplined") were considered for discriminant validity. Participants responded to TIPI items using a 7-point scale ranging from 1 ("Disagree Strongly") to 7 ("Agree Strongly"). Internal consistencies in the current study were generally consistent with those of Gosling et al., with an average coefficient alpha of .49. Gosling et al. considered this reliability level acceptable for two-item scales given that coefficient alpha is partly dependent on number of items. However, given the seemingly low internal consistency, average inter-item correlations were calculated as well for TIPI scales to confirm adequate item homogeneity. For all scales, average inter-item correlations were above .10 ( $M = .35$ ), indicating adequate internal consistency despite lower coefficient alphas (Briggs & Cheek, 1986).

### Procedures

After being invited to participate in "A Study of Personality and Attitudes," participants who granted informed consent completed subsets of the measures described above. The order of placement of the NI in survey protocols varied across samples. All samples

provided self-reports on the 10-item NI allowing comparisons between the full and abbreviated versions of the scale. In addition to the NI, S3 completed the TIPI, S4 completed the NSA and NSB scales, and S5 completed the SCAB and B-AS. S6 completed the NI twice with a one month interval between sessions in order to estimate stability in scores across time. Measures were completed in group settings before the beginning of regular class times, except for the astronomical society members in S1 who completed the NI before or after gatherings.

## RESULTS

### Abbreviating the NI

To select items for the abbreviated NI, responses between astronomical society members and controls in S1 were compared. Separate *t*-tests were calculated for each NI item. A Bonferroni correction indicated that in order to reduce Type 1 error an adjusted  $p < .005$  (.05 / 10) would be needed to determine significance between groups for each item. This turned out not to be an issue, as all but two items exceeded this threshold at  $p < .00001$ . Additionally, a measure of effect size (Cohen's *d*) was calculated for each item to determine the relative strength of the standardized differences between means. NI item content, means, standard deviations, *t*-test results, and effect sizes for S1 were presented in Table 1. Based on the effects sizes and *t* ratios, four items (items 5, 6, 4, & 1, in descending order of effect size) were found to strongly differentiate the groups. These items were retained as the abbreviated scale and hereafter termed the NI-4 for further analyses. Specific wording of NI-4 items and instructions to respondents were presented in the Appendix.

### Criterion Validity

To examine the criterion validity of NI-4 total scores, as compared to the 10-item NI, *t*-tests were calculated between astronomical society members and controls for both variables. For the 10-item NI, the astronomical society members ( $M = 38.14$ ,  $SD = 7.37$ ) scored significantly higher than controls ( $M = 30.25$ ,  $SD = 9.88$ ),  $t(188) = 6.23$ ,  $p < .00001$ ,  $d = .91$ , accounting for 17% (adj.

**Table 1. Comparisons Between Astronomical Society Members and Controls**

Summary of Item Content	Astrosocieties		Controls		t	p<	d
	M	SD	M	SD			
<b>5. Time for watching</b>	4.08	.78	2.77	1.10	9.53	.00001	1.39
<b>6. More pleasure watching</b>	3.78	1.11	2.70	1.18	6.44	.00001	.94
<b>4. Like to watch often</b>	4.13	.73	3.22	1.23	6.10	.00003	.90
<b>1. Emotional attachment</b>	3.97	.98	3.04	1.19	5.84	.00001	.85
7. Watching pleases me	4.29	.76	3.68	.99	4.77	.00001	.70
9. Fondness for night sky	3.96	.86	3.27	1.22	4.54	.00001	.65
3. Spend all night watching	3.40	1.23	2.63	1.22	4.32	.00001	.63
8. Feel connected to night sky	3.53	1.13	2.82	1.18	4.22	.00004	.62
10. Adore objects in night sky	3.58	1.10	3.06	1.19	3.10	.002	.45
2. Mesmerized watching	3.42	1.30	3.04	1.18	2.10	.05	.31

Note: *N* = 190. For ease of reference, items are presented ranked by effect size. Items in bold italics were selected for the NI-4.

**Table 2. Means, Standard Deviations, and Coefficient Alphas for the NI-4 and NI for All Samples**

Sample	r	NI-4			NI		
		M	SD	α	M	SD	α
S1	.95 <sup>†</sup>	13.85 <sup>†</sup>	4.06 <sup>†</sup>	.88 <sup>†</sup>	34.19 <sup>†</sup>	9.55 <sup>†</sup>	.94 <sup>†</sup>
S2	.96	10.93	3.90	.86	28.50	9.67	.95
S3	.98	9.80	4.09	.91	26.14	10.17	.96
S4	.95	11.48	3.42	.85	30.21	8.60	.94
S5	.95	10.69	3.20	.86	28.63	7.79	.93
S6	.96 <sup>†</sup>	11.05 <sup>†</sup>	3.40 <sup>†</sup>	.87 <sup>†</sup>	28.61 <sup>†</sup>	8.18 <sup>†</sup>	.94 <sup>†</sup>

Note: *r* = correlations between the NI-4 and NI. <sup>†</sup>Averaged across both groups or administrations.

*R*<sup>2</sup>) of the variance. For the NI-4, the astronomical society members (*M* = 15.96, *SD* = 2.85) scored significantly higher than controls (*M* = 11.74, *SD* = 4.00), *t* (188) = 8.39, *p* < .00001, *d* = 1.22, accounting for 27% (adj. *R*<sup>2</sup>) of the variance. Thus, shortening the scale improved its criterion validity with an increased 10% of variance accounted for in differentiating the criterion and control groups.

**Associations between the NI-4 and NI**

An important issue for the current study was the extent to which the new abbreviated scale represented the original scale. Table 2 presented correlations between the NI and NI-4 for all samples. As seen in the table, the full NI and NI-4 were highly correlated across all samples with an average correlation of .96, representing 92% shared variance. In terms of variance, after a 60% reduction of items from the NI to NI-4, the loss of variance was 8%. The shorter scale appeared to represent the content of the original NI well with little reduction in variance.

Also, presented in Table 2 are means, standard deviations, and coefficient alphas of the NI-4 and 10-item NI for all samples in the current study. As seen in the table, average NI-4 scores were consistent with the 10-item version in that their means generally fell just below the expected midpoint of scores. Further, the internal consistencies of the NI-4 remained high, with an average coefficient alpha of .87, relative to the full NI with an average coefficient alpha of .94. These results demonstrated that the shortened scale was relatively homogenous and had a respectably low amount of error for a 4-item scale. Skewness and kurtosis examinations for the NI-4 (-.07, -.43, respectively) and NI (.11, -.36, respectively) and Kolmogorov-Smirnov tests for the NI-4 (1.07, *p* > .26) and NI (1.01, *p* > .20) indicated relatively normal distributions.

**NI-4 Validity Compared with the NI**

Having selected items for the abbreviated scale and demonstrated its criterion validity, the next step was to

**Table 3. Response Rates for NI-4 Items, Factor Loadings and Item-Total Correlations in S2**

Item	Response Frequency					M	SD	FL	r
	"1"	"2"	"3"	"4"	"5"				
Emotional attachment	47	50	55	42	16	2.67	1.24	.84	.74
Like to watch often	21	38	33	97	21	3.28	1.17	.81	.66
Time for watching	41	60	77	25	7	2.51	1.04	.91	.81
More pleasure watching	49	69	50	28	14	2.48	1.18	.83	.69

Note: S2 = Sample 2. N = 210. FL = factor loading. r = item-total scale correlation.

examine the factorial, convergent, and discriminant validities of the NI-4 using the full NI as a reference point. The results were noted below in terms of form of validity examined.

**Factorial Validity**

Factor analyses for the NI and NI-4 were conducted on responses from S2. For the 10-item NI, replicating previous research (Kelly, 2004a), one factor with an eigenvalue greater than one (eigenvalue = 6.90) was extracted which accounted for 68.98% of the variance in responses. Factor loadings ranged from .77 to .88, with an average loading of .83. A factor analysis of only the NI-4 items produced a single factor (eigenvalue = 2.89) which accounted for 71.71% of the variance. In this analysis factor loadings ranged from .83 to .91, averaging .85. Therefore, there appeared to be a very small increase (2.73%) in variance accounted for by the shorter scale. Response rates for NI-4 items, factor loadings, and item-total scale correlations for S2 were presented in Table 3. Parenthetically, factor analyses were also conducted on NI-4 items for the other five samples in this study. The results were all similar: one factor was extracted with an eigenvalue greater than 1 that accounted for an average of 73.20% of the variance with an average factor loading of .86.

Gorsuch (1983) indicated that factors accounting for at least 50% of the variance define a strong factor which likely represents a single underlying construct. Hence, from these analyses, it can be determined that, like the 10-item NI, the NI-4 had a unidimensional factor structure, accounted for a large proportion of the variance in responses, and likely represented a single underlying construct. Overall, the NI-4 appears to continue to tap

the construct it was intended to measure seemingly as well as the 10-item NI.

**Convergent and Discriminant Validity**

Convergent validity was examined by correlations between the NI-4 and variables which hypothetically should relate to night sky attachment: night sky attitudes and behaviors, openness to experience, creativity, and psychological absorption. Discriminant validity was examined by correlations between the NI-4 and scales with no theoretically hypothesized relationship: gender, extraversion, agreeableness, conscientiousness, and neuroticism. Given that the largest number of correlations calculated for any sample was 5, to reduce Type I error it was decided to use a Bonferroni corrected  $p < .01$  ( $p < .05 / 5$ ) for all significance tests.

Correlations between validity measures and the 10 and 4-item NIs were presented in Table 4. As seen in the table, both the NI-4 and NI had strong correlations with NSA and NSB. Furthermore, both NI scales had moderate to strong correlations with openness, creativity, and

**Table 4. Convergent and Discriminant Validity Correlations for the NI-4 and NI**

Scale	NI-4	NI
Night Sky Attitudes <sup>a</sup>	<b>.76</b>	<b>.83</b>
Night Sky Behaviors <sup>a</sup>	<b>.72</b>	<b>.74</b>
B-AS <sup>a</sup>	<b>.60</b>	<b>.62</b>
SCAB <sup>a</sup>	<b>.34</b>	<b>.34</b>
Openness <sup>a</sup>	<b>.42</b>	<b>.46</b>
Neuroticism <sup>b</sup>	-.14	-.14
Extraversion <sup>b</sup>	.18	.21
Agreeableness <sup>b</sup>	-.06	-.05
Conscientiousness <sup>b</sup>	-.15	-.14
Gender <sup>b</sup>	.07	.07

Note: B-AS = Brief Absorption Scale; SCAB = Scale of Creative Attributes and Behavior. <sup>a</sup>Indicates convergent validity variable. <sup>b</sup>Indicates discriminant validity variable. Correlations significant at  $p < .01$  are set in bold italics.

absorption. The average convergent validity coefficient for the NI-4 was .57 (32% shared variance). For the 10-item NI the average coefficient was .60 (36% shared variance). There was a decrease of 4% shared variance, or  $r=.03$ , in the validity coefficient moving from the 10 to four-item scale. Unexpectedly, one of the largest discrepancies between the full and abbreviated NI was for NSA, a change in  $r$  from .83 (69% shared variance) to .76 (58% shared variance). Though the difference between these correlations was not statistically significant,  $z = 1.07$ ,  $p > .25$ , the loss of 11% shared variance in a variable which was considered an important aspect of noctcaelador should be noted. These results indicated that abbreviating the scale reduced the ability of the NI to tap into positive attitudes about the night sky although it retained its ability to tap into night sky-related behaviors. Relationships with the other convergent validity variables showed either no, or small, decreases in shared variance going from the 10 to four-item NI.

Discriminant validity of the NI-4 was examined by its correlations with gender, neuroticism, extraversion, agreeableness, and conscientiousness. To examine gender correlations, data from S2, S3, S4, and S5 were combined to create a larger, more statistically sensitive, dataset ( $N = 492$ ; 343 females, 150 males,  $M_{age} = 21.4$ ,  $SD = 3.2$ ). Gender was dummy coded for correlations (1=male, 2=female). Discriminant validity analyses were presented in Table 4. As seen in the table, correlations were nonsignificant between the NI-4 and gender, neuroticism, extraversion, agreeableness, and conscientiousness. The strength of correlations was relatively consistent for the 10 and 4-item versions of the scale. The average discriminant validity correlation for *both* the NI-4 and 10-item NI was .12, a shared variance of 1.4%. Although not a planned comparison, the correlations between the 10 and 4-item NI versions and age in the sample combined to compare genders were also very small, both  $r=.01$  and provided additional evidence of discriminant validity.

In comparing the five convergent and five discriminant validity indices for the NI-4, the average shared variance accounted for 32% and 1.4%, respectively. These findings demonstrated the ability of the NI-4 to correlate with hypothetically related variables and have substantially

smaller relationships with scales to which it was not hypothetically related. Findings for convergent and discriminant validity were comparable between the 10-item NI and NI-4. Nevertheless, researchers should maintain awareness that there was a small decrease in convergent validity coefficients when moving from the 10-item NI to the NI-4, perhaps necessitating the use of somewhat larger sample sizes to identify smaller effects.

### Test-Retest Reliability of the NI-4

Test-retest reliability of the NI-4 was examined in S6. The test-retest correlation of the 10-item NI was .85 after a one-month interval. The NI-4 was slightly lower, with a .81 test-retest coefficient. In terms of variance, the NI had 72% stable variance whereas the NI-4 had 66% stable variance, a difference of 6%. These findings are relatively consistent with Kelly's (2004a) previous findings for the 10-item NI.

## DISCUSSION

The current study sought to measure individuals' love for the night sky more economically using an abbreviated version of the NI. The NI (Kelly, 2004a) has provided a foundation for investigations of noctcaelador using 10 items. Though not overly long relative to some scales measuring a single construct, i.e., the 68-item Ego Strength Scale (Barron, 1953), the NI was able to be reduced to a simple and brief 4-item scale. The NI-4 was developed by identifying NI items which strongly differentiated between a group of individuals hypothetically high in noctcaelador (astronomical society members) and controls. The scale could be completed in as little as half a minute and embedded in longer research protocols with relative ease without undue demands on participants' time or mental energy.

In some ways the NI-4 appeared to be a more psychometrically pure measure than the 10-item measure (i.e., better criterion and structural validity). However, this brevity and purity does come with the cost of a slightly reduced convergent validity coefficient (an average loss of  $r=.03$ ), test-retest reliability (a loss of  $r=.04$ ), and internal consistency (a loss of  $\alpha=.09$ ). Hence, the use of

larger samples may be needed to identify significant relationships. On the other hand, though small losses were observed, the NI-4 was able to maintain reliabilities that easily exceeded minimal expectations for research instruments (Nunnally, 1978) and produced convergent validity indices that were well above average correlations in psychological research (Hemphill, 2003).

The scale possessed good psychometric properties, and appeared to tap the same construct as the 10-item NI. Likely as a result of its development strategy, the NI-4 was better able to discriminate between astronomical society members and controls. The NI-4 had good reliability, both in terms of internal consistencies across several samples and test-retest reliability. Validity findings were also promising. For instance, structure of the scale was unidimensional and this appeared to be stable across several samples. Importantly, the convergent and discriminant validity indices were adequate and the scale was sensitive to variance in measures to which it was hypothetically predicted to relate, but less sensitive to variables to which it was not hypothesized to relate.

In addition to the development of shorter scale for noctcaelador, this study confirmed previous findings of the ability to measure the construct's relative stability across time, and the relationships between noctcaelador and creativity (Kelly & Kelly, 2014), psychological absorption (Kelly et al., 2006), and openness to experience (Kelly & Kelly, 2010).

Though the current findings for the NI-4 were promising, it would be useful to determine if the scale can account for variance outside of absorption and other hypnotic-related variables. Such investigations would serve the purpose both of assessing the prowess of the brief scale and also determining the boundaries of the noctcaelador construct outside of hypnosis proneness. Moreover, though Kelly (2003) originally suggested noctcaelador might be a form of place attachment (see

Altman & Low, 1992), no investigations have examined this possibility. Future studies could use the NI-4 to examine its relationship to place attachment and other environmental variables such as attitudes towards light pollution (Mace & McDaniel, 2013), and connectedness to nature (i.e., Mayer & Frantz, 2004). Indeed, it appeared from the studies described in this report that the NI-4 would be a suitable measure to further examine different conceptualizations of noctcaelador (i.e., hypnotic mood regulating stable object versus environmental place attachment, or somewhere in between).

Though the findings regarding the NI-4 in this study were promising, there were limitations which should be considered and addressed in future research. For example, though developed partly using astronomical society members, the NI-4 was mostly examined with samples of college students. Additional research is needed using more diverse samples in order to better understand the scale's properties and correlates in different populations. Also, there is a dual edge to the sword of brief measurement, though the scale developed in the current study was intended to be brief, limitations of shorter scales do exist. For instance, their content validity is limited; it is difficult, if not impossible, for them to fully capture the nuances of the constructs under investigation in only a few items. Moreover, the NI-4 was developed by abbreviating a 10-item scale which may or may not have been able to tap the construct adequately itself. It might be useful for researchers to develop additional instruments to measure noctcaelador using larger item pools tied to theoretical propositions rather than the more empirically derived NI.

**Acknowledgements:** The author thanks Jason Batey for his assistance in data collection.

**Conflicts of Interest:** The author does not declare any conflict of interest.

## References

- Altman, I., & Low, S. M. (Eds.). (1992). *Place attachment*. New York: Plenum Press.
- Barron, F. (1953). An ego-strength scale which predicts response to psychotherapy. *Journal of Consulting Psychology, 17*, 327-333.
- Batey, J., & Kelly, W. E. (2005). Criterion-group validity of the Noctcaelador Inventory: Differences between astronomical society members and controls. *Individual Differences Research, 3*, 200-203.
- Blair, A. (2016). *Sark in the dark: Wellbeing and community on the dark sky island of Sark*. Ceredigion, Wales, UK: Sophia Centre Press.
- Bowlby, J. (1988). *A secure base: Clinical applications of attachment theory*. London: Routledge.
- Brecher, K., & Feirtag, M. (Eds.). (1979). *Astronomy of the ancients*. Cambridge, MA: MIT Press.
- Briggs, S. R., & Cheek, J. M. (1986). The role of factor analysis in the development and evaluation of personality scales. *Journal of Personality, 54*, 106-148.
- Dao, A. (2016). *Emotional and social responses to stargazing: What does it mean to lose the dark?* (Unpublished thesis). Illinois Wesleyan University, Bloomington, IL.
- Gorsuch, R. L. (1983). *Factor analysis*. Hillsdale, NJ: Erlbaum.
- Gosling, S.D., Rentfrow, P.J., & Swann, W.B., Jr. (2003). A very brief measure of the Big-Five personality domains. *Journal of Research in Personality, 37*, 504-528.
- Gregory, R.J. (2011). *Psychological testing: History, principles, and applications (6th ed)*. Upper Saddle River, NJ: Pearson.
- Hartmann, E. (1984). *The nightmare: The psychology and biology of terrifying dreams*. New York: Basic Books.
- Hartmann, E. (1991). *Boundaries in the mind: A new psychology of personality*. New York: Basic Books.
- Hawkins, G.S. (1983). *Mindsteps to the cosmos*. New York: Harper and Row.
- Hemphill, J.F. (2003). Interpreting the magnitudes of correlation coefficients. *American Psychologist, 58*, 78-79.
- Holbrook, J. (2009). *The sky in our lives survey 2008*. Presented at International Astronomical Union Symposium: The Role of Astronomy in Society and Culture, Paris, France.
- Hoskin, M. (Ed.). (1999). *The Cambridge concise history of astronomy*. Cambridge, UK: Cambridge University Press.
- Kelly, K. E. (2004). A brief measure of creativity among college students. *College Student Journal, 38*, 594-596.
- Kelly, W. E. (2003). Night-sky watching attitudes among college students: A preliminary investigation. *College Student Journal, 37*, 194-196.
- Kelly, W. E. (2004a). Development of an instrument to measure noctcaelador: Psychological attachment to the night-sky. *College Student Journal, 38*, 100-102.
- Kelly, W.E. (2004b). The "OCEAN" and the night-sky: Relations between the Five-Factor Model of Personality and noctcaelador. *College Student Journal, 38*, 406-408.
- Kelly, W. E. (2005). Some cognitive characteristics of night-sky watchers: Correlations between social problem-solving, need for cognition, and noctcaelador. *Education, 126*, 328-333.
- Kelly, W. E. (2006). Watching the night-sky and seeing things that aren't there: Relationships among noctcaelador, dissociative experiences, and hallucination-proneness in a non-clinical sample. *Counseling and Clinical Psychology Journal, 3*, 148-159.
- Kelly, W.E. (2007). Getting a thrill from the night-sky: The relationship between sensation seeking and noctcaelador. *Psychology Journal, 4*, 40-46.
- Kelly, W. E. (2008a). Relationship between noctcaelador and aesthetic sensitivity: Art-related personality factors associated with college students' night-sky watching. *College Student Journal, 42*, 265-269.
- Kelly, W.E. (2008b). Factorial validity, reliability, and measurement equivalence of the Noctcaelador Inventory across three ethnic groups. *Journal of Instructional Psychology, 35*, 271-274.
- Kelly, W.E. (2009). Nightmares and starscapes: Nightmare frequency and night-sky watching. *Sleep and Hypnosis, 11*, 46-50.
- Kelly, W. E., & Daughtry, D. (2005). Relationship between magical ideation and noctcaelador. *Perceptual and Motor Skills, 101*, 373-374.
- Kelly, W.E., & Daughtry, D. (2007). Sleep-length, noctcaelador, and watching the night-sky to cope. *Individual Differences Research, 5*, 150-157.
- Kelly, W.E., & Daughtry, D. (2016). The case of curiosity and the night sky: Relationship between noctcaelador and three forms of curiosity. *Education, 137*, 204-208.
- Kelly, W., Daughtry, D., & Kelly, K.E. (2006). Entranced by the night sky: Psychological absorption and noctcaelador. *Psychology and Education, 43*, 22-27.
- Kelly, W. E., & Kelly, K. E. (2003). Further identification of noctcaelador: An underlying factor influencing night-sky watching behaviors. *Psychology and Education, 40*, 26-27.
- Kelly, W.E., & Kelly, K.E. (2008). Let the stars be your guide through troubled times?: The relationship between noctcaelador and coping. *Psychology and Education, 45*, 10-15.
- Kelly, W. E. & Kelly, K. E. (2010). Bring on the night: Openness to experience and interest in night-sky watching. *Individual Differences Research, 8*, 214-219.
- Kelly, W.E., & Kelly, K.E. (2014). An examination of noctcaelador and creativity. *Psychology and Education, 51*, 26-32.
- Knafo, D. (2002). Revisiting Ernst Kris's concept of regression in the service of the ego in art. *Psychoanalytic Psychology, 19*, 24-49.
- Kohut, H. (1971). *The analysis of the self*. New York: International Universities Press.
- Kohut, H. (1977). *The restoration of the self*. New York: International Universities Press.
- Mace, B.L., & McDaniel, J. (2013). Visitor evaluation of night sky interpretation in Bryce Canyon National Park and Cedar Breaks National Monument. *Journal of Interpretation Research, 18*, 39-57.
- Mayer, F.S., & Frantz, C.M. (2004). The connectedness to nature scale: A measure of individuals' feeling in community with nature. *Journal of Environmental Psychology, 24*, 503-515.
- McCrae, R.R. (1994). Openness to Experience: Expanding the boundaries of Factor V. *European Journal of Personality, 8*, 251-272.
- Miranda, J. & Persons, J. B. (1988). Dysfunctional thoughts are mood-state dependent. *Journal of Abnormal Psychology, 97*, 76-79.
- Nunnally, J. C. (1978). *Psychometric theory (2nd ed)*. New York: McGraw-Hill.
- Patrick, C.J, Curtin, J.J., & Tellegen, A. (2002). Development and validation of a brief form of the Multidimensional Personality Questionnaire. *Psychological Assessment, 14*, 150-163.
- Rammstedt, B., & John, O.P. (2007). Measuring personality in one minute or less: A 10-item short version of the Big Five Inventory in English and German. *Journal of Research in Personality, 41*, 203-212.

Robins, R. W., Hendin, H. M., & Trzesniewski, K. H. (2001). Measuring global self-esteem: Construct validation of a single-item measure and the Rosenberg self-esteem scale. *Personality and Social Psychology Bulletin, 27*, 151–161.

Sheehan, W. (2010). *A passion for the planets: Envisioning other worlds from the Pleistocene to the age of the telescope*. New York: Springer.

Silvia, P. J., Fayn, K., Nusbaum, E. C., & Beaty, R. E. (2015). Openness to experience and awe in response to nature and music: Personality and profound aesthetic experiences. *Psychology of Aesthetics, Creativity, and the Arts, 9*, 376-384.

Tellegen, A., & Atkinson, G. (1974). Openness to absorbing and self-altering experiences ("absorption"), a trait related to hypnotic susceptibility. *Journal of Abnormal Psychology, 83*, 268-277.

Wallin, D.J. (2007). *Attachment in psychotherapy*. New York: Guilford Press.

Wyman LC. (1936). Navajo diagnosticians. *American Anthropologist, 38*, 236-246.

Zajonc, R.B. (2001). Mere exposure: A gateway to the subliminal. *Current Directions in Psychological Science, 10*, 224-228.

**Appendix. NI-4**

Instruction: Using the following scale, describe how much you typically disagree/agree with each statement.					
1=Strongly disagree, 2=Disagree, 3=Neither agree or disagree, 4=Agree, 5=Strongly Agree					
1. I feel an emotional attachment to the night sky.	1	2	3	4	5
2. I like to go outside and look at the sky at night often.	1	2	3	4	5
3. Having time to look at the night sky is important to me.	1	2	3	4	5
4. I find more pleasure in looking at the night sky than most people.	1	2	3	4	5