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4 Examining the connection between nature connectedness and dark personality

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6 **RUNNING TITLE**

7 Nature connectedness & dark personality

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26 **ABSTRACT**

27 The psychological construct of nature connectedness - the depth of an individual's relationship
28 with the natural world - has not only been associated with benefits for mental well-being but has
29 also shown relationships with personality traits relevant to the dark personality literature. These
30 include agreeableness, cognitive and affective empathy, and callous and uncaring traits. Across
31 two independently-sampled studies we delineate relationships between explicit and implicit
32 indices of nature connectedness and dark personality. In Study 1 ($N = 304$), psychopathy (and
33 Machiavellianism) was associated with self-reported, but not implicitly-measured, nature
34 connectedness. Moreover, individuals scoring high on dark personality exhibited a preference for
35 inner-city, relative to suburban or rural living. In Study 2 ($N = 209$), we replicated the findings of
36 Study 1 in relation to explicit measures of nature connectedness but did not find further
37 relationships between dark personality and the population densities of where participants had
38 previously lived. Limitations of implicit and pseudo indices of nature connectedness are outlined,
39 and the results are discussed in relation to future research and the potential role of nature
40 connectedness interventions in forensic populations. Data, syntax, and the manuscript pre-print
41 are available here: [https://osf.io/3mg5d/?view_only=b5c7749d4a7945c5a161f0915a2d0259].

42 **KEYWORDS**

43 Nature Connectedness; Psychopathy; Narcissism; Machiavellianism; Sadism

44 **1. Introduction**

45 The importance of human-nature connectedness is fast becoming an established area of research
46 within mainstream psychology. So much so that in England, the benefit of human connection
47 with nature on health and well-being has been recognised through governmental policies seeking
48 to connect people with nature whilst addressing key aspects of environmental concern such as
49 those threatening biodiversity (DEFRA, 2011; 2018). Having spent much of our evolutionary
50 history within the natural environment, humans are thought to have an innate affinity with
51 nature; the Biophilia hypothesis (Wilson, 1984). This interconnectedness with the natural world
52 manifests through both cognitive and affective dimensions and is represented by the
53 psychological construct of *nature connectedness* (Capaldi, Dopko, & Zelenski, 2014). Nature
54 connectedness is an identity marker that an individual is a part of the larger natural world and the
55 natural world is a part of oneself (Mayer, Frantz, Bruelman-Senecal, & Dolliver, 2009; Schultz,
56 2001). It is a multi-faceted construct that encompasses cognitive, affective, and personality
57 factors, and which can drive behaviour (Kals, Schumacher, & Montada, 1999; Mayer & Frantz,
58 2004; Schultz, 2001; Mackay & Schmitt, 2019).

59
60 Nature connectedness can be indexed on a continuum and in adults, nature it is considered to be
61 stable across time (Nisbet, Zelenski, & Murphy, 2009), yet malleable to nature-based
62 interventions whereby sustained increases can be achieved (Richardson & Sheffield, 2017;
63 Richardson, Cormack, McRobert, & Underhill, 2016). Recent work focusing on children aged 10
64 to 15 years however has identified a sharp decline in nature connectedness which does not
65 recover until their 20s (Richardson et al., 2019). Increases in nature connectedness have been
66 linked to a number of well-being benefits including lower anxiety and greater vitality, happiness,
67 resilience, and life satisfaction (Cervinka, Röderer, & Hefler, 2011; Martyn & Brymer, 2016;
68 Pritchard, Richardson, Sheffield, & McEwan, 2019; Ryan et al., 2010). Behavioural changes

69 have also been linked to higher nature connectedness, most of those investigated relate to pro-
70 environmental behaviours such as recycling and nature conservation. (Mackay & Schmitt, 2019;
71 Martin et al., 2020; Otto & Pensini, 2017; Richardson et al., 2020). Moreover, maintaining
72 strong connections with society and the natural world appear key to alleviating negative affective
73 and cognitive functioning (Caccioppo & Hawkey, 2009; Narvaez, 2013), which, when
74 combined with findings of nature connectedness-related pro-social behaviour and greater
75 agreeableness, empathy, and perspective-taking (Fido & Richardson, 2019; Passmore & Holder,
76 2017; Zhang, Piff, Iyer, Koleva, & Keltner, 2014), strikes a strong juxtaposition with the
77 Hobbesian viewpoint that selfish and aggressive behavioural trends in westernised societies are
78 normalised and considered ‘adaptive’. Such traits account for some of the variation observed in
79 so-called *dark* personalities (Heym et al., 2019; Lynam & Derefinko, 2006), which themselves
80 can be considered adaptive in nature (Hall & Benning, 2006). Thus, exploring nature
81 connectedness in relation to dark personalities may be of interest to researchers and clinicians.
82

83 Dark personalities are commonly characterised by the dark triad, which is comprised of
84 psychopathy (i.e., a callous disregard for others), narcissism (i.e., vanity and self-centeredness),
85 and Machiavellianism (i.e., cynicism and manipulation); three conceptually-distinct yet
86 overlapping personality traits which can be measured throughout the general population (Paulhus
87 & Williams, 2002). Measures of the dark triad, such as the Short Dark Triad (SD3; Jones &
88 Paulhus, 2014) and The Dirty Dozen (Jonason & Webster, 2010) provide quick and efficient trait
89 measures; beneficial for complex and time-consuming research studies, and tailoring the
90 discussion of research findings in public arenas (see Reidy et al., 2015). However, they are
91 limited in terms of artificially increasing independence of subscales, thus failing to account for
92 overlap or underpinning drivers (Patrick & Drislane, 2015), and failing to comprehensively tease
93 apart some of the sub-domains which comprise each trait (Vize, Lynam, Collison, & Miller,

94 2018). Taken together, the dark triad encapsulates a constellation of aversive and antagonistic
95 personalities, which in some circumstances can manifest in disagreeable, hostile, and aggressive
96 behaviours (Jones & Paulhus, 2010; Paulhus, 2014; Paulhus & Williams, 2002). Individuals
97 scoring high on the dark triad personality are typically socially dominant (Ho et al., 2012) and
98 show reduced empathic concern towards others (Vonk, Zeigler-Hill, Ewing, Mercer, & Noser,
99 2015). Moreover, dark personality might also be characterised alongside additional related
100 facets, such as everyday sadism (Buckels, Jones, & Paulhus, 2013), or be investigated more
101 holistically using a composite measure, such as the *dark core* (Volmer, Koch, & Wolff, 2019).
102
103 Regardless of varying conceptualisations of the dark personality, to date, there has been no
104 published research which has explicitly explored the relationship between the dark triad and
105 nature connectedness. Fido and Richardson (2019) investigated nature connectedness in relation
106 to callous, uncaring, and unemotional traits which are a hallmark of psychopathy (Frick, 2004;
107 Vasey, Kotov, Frick, & Loney, 2005). Fido and Richardson described negative relationships
108 between self-report measures of nature connectedness, callous and uncaring, but not unemotional
109 traits in a sample derived from the general population. These associations were mediated by
110 higher scores on an empathy measure; however, the investigation did not consider that wider
111 social connectedness more generally may have underpinned these observed results. It is vital to
112 delineate this in light of psychopathy being characterised, at least in part, by a reduced capacity
113 to develop authentic social relationships (see Viding & McCorry, 2019 for a review). One point
114 for consideration is that the sample in Fido and Richardson was heavily biased towards female
115 respondents, in whom dark triad traits manifest differently (e.g., Chiorri, Garofalo, & Velotti,
116 2019). We will return to sex differences later. Although Fido & Richardson (2019) is a useful
117 starting point, in that callous and uncaring traits are undeniably aligned with the dark triad, and

118 psychopathy more specifically, correlates of nature connectedness and the dark triad more
119 generally remain unexplored.

120
121 Although not directly measuring nature connectedness, a study by Jonason (2018) is informative.
122 Jonason explored living preference in association with dark triad traits. Across three,
123 independently sampled studies based in the United States of America, a robust preference for
124 city-, relative to suburban- or rural-living was associated with increased self-reported dark triad
125 traits, in particular, psychopathy. Such preferences were explained through city-living being
126 considered more appealing for those wishing to live fast-paced, exploitative, and parasitic
127 lifestyles (Jonason, Koenig, & Tost, 2010). This aligns well with the wider dark triad literature,
128 such as the sexually promiscuous nature of those high in dark personality, whose utility of
129 reproductively-adaptive strategies, such as short-term mating, is proliferated in the presence of
130 greater population density (Jonason, Li, Webster, & Schmitt, 2009). Living in areas with higher
131 population density likely suits those with high psychopathic traits' marked ability to manipulate
132 and extort others, with a reduced risk of being caught or exposed (Jonason & Webster, 2012).

133
134 Differential manifestations of dark triad traits based on sex and gender are commonly
135 acknowledged; men often score higher than women on narcissism and psychopathy (Cale &
136 Lilienfeld, 2002; Chiorri et al., 2019; Grijalva, et al., 2015; Jonason & Davis, 2018; Jonason,
137 Lyons, Bethell, & Ross, 2013; Szabó & Jones, 2019). Moreover, female individuals who are high
138 in Machiavellianism are more likely to engage in short-term sexual behaviour than males who
139 are also high in Machiavellianism (Jones & de Roos, 2017). Sex differences were seen in
140 Jonason (2018) for living preference; male but not female participants who scored higher in
141 psychopathic traits tended to live in more densely-populated areas (Jonason, 2018).

142

143 To date, investigations in nature connectedness and dark personality has only indexed nature
144 connectedness through either self-report questionnaires or overt proxy measures, such as living
145 preference or population density. However, nature connectedness might be considered a
146 phenomenon so ingrained that it exists outside of conscious control (or awareness) of an
147 individual, and so implicit measurement of nature connectedness may be beneficial (Frantz,
148 Mayer, Norton, & Rock, 2005; Schultz, Shriver, Tabanico, & Khazian, 2004). To compound this
149 argument, self-report measures of nature connectedness might be biased by social desirability
150 (Bruni & Schulz, 2010), which, although has not noticeably masked existing findings of inverse
151 relationship between nature connectedness and dark triad-related traits (Fido & Richardson,
152 2019), may attenuate effect sizes through both the augmentation of nature connectedness scores
153 and reduction of response variation (Bruni & Schulz, 2010). Moreover, since manipulation and
154 deceit are at the core of the dark triad, and thus dark personality, exploring hypothesised
155 associations on a subconscious level seems a logical next step (Jones & Figueredo, 2013).
156 Further to this, nature connectedness can be measured through both implicit (Schulz, Shriver,
157 Tabanico, & Khazian, 2004) and explicit means (Nisbet & Zelenski, 2013; Richardson et al.,
158 2019).

159
160 Within the literature, the Implicit Association Test (IAT; Greenwald, McGhee, & Schwarz,
161 1998) has been the predominant tool used to implicitly measure nature connectedness (Schultz et
162 al., 2004). The IAT is a computerised task that assumes clusters of relationships between
163 conceptualisations of the self and wider psychological constructs, which are formed and
164 reinforced through experience. The speed at which individuals respond to stimuli that mirror a
165 given underlying implicit association (e.g., they see themselves connected with nature), relative
166 to incompatible associations, is thought to reflect the strength of these implicit associations. For
167 example, responses on the nature-based IAT have previously been associated with pro-biospheric

168 concerns, with moderate test-retest reliability up to four-weeks (Schultz et al., 2004; Schultz &
169 Tabanico, 2007). Nevertheless, during data collection for this manuscript, key limitations of the
170 IAT were published, which must be acknowledged here. Schimmack (2019) summarises that
171 without sufficient means to assess the IAT's construct validity, variation between explicit and
172 implicit measures may be explained by measurement error alone. Indeed, it is vital not to
173 compound so-called implicit personality constructs with the underpinning cognitive process by
174 which the IAT claims to measure. Our results are discussed in the context of this critique.

175
176 Study one examined the extent to which both implicit and explicit measures of nature
177 connectedness are associated with dark personality traits, namely psychopathy, narcissism,
178 Machiavellianism, and sadism. We expected dark personality traits to be [1] negatively
179 associated with both implicit and explicit measures of nature connectedness, and [2] greater in
180 samples reporting a preference for inner-city, relative to rural and/or suburban living. The effect
181 of sex was also explored. Study two sought to replicate any explicit associations observed in
182 study one, in addition to replicating and extending findings of Jonason (2018) in terms of
183 population density data within a sample derived from the UK. Specifically, we hypothesised that
184 individuals who had historically lived in areas subject to larger population densities would show
185 [3] lower nature connectedness, and [4] increased dark personality traits.

186

187 **2. Study 1**

188 **2.1. Method**

189 **2.1.1. Participants**

190 A minimum target sample size of 222 participants was determined as a function of an a priori
191 power analysis using G*Power (version 3.1.9.2). For practical importance, a medium effect size
192 and standard alpha level of .05 were used to give 95% power in our planned analyses. In

193 accordance with guidelines for stabilizing estimation error in correlation analyses ($N = 250$;
194 Schönbrodt & Perugini, 2013) and as a means of accounting for incidents of missing data and
195 participant withdrawals, we aimed to recruit upwards of 300 participants.

196
197 A total of 304 participants ($M_{\text{age}} = 30.44$, $SD = 10.55$; 51% male) responded to an online
198 advertisement placed on the crowdsourcing website *Prolific* in January 2019. Inclusion criteria
199 required participants to be fluent in English, of UK nationality, and aged 18 years or over.
200 Participants provided written informed consent in accordance with approved central university
201 research protocols [*institution masked for peer review*] and national ethical guidelines by ticking
202 a box on both the first and last pages of our online survey. All completers were reimbursed with
203 £2.50 for their participation.

204

205 **2.1.2. Materials**

206 **Demographics and Geographical Preferences.** Participants were asked to report their age, sex,
207 and ethnicity. They also completed a single forced-choice question that asked where participants
208 would “prefer to live” among three options: city, suburbs, or rural.

209

210 **Nature Relatedness Scale (NRS6; Nisbet et al., 2009).** The NRS6 comprises 6 items that
211 measure ones’ connectedness to nature (e.g., “My relationship to nature is an important part of
212 who I am”) using a 5-point scale. Each item is rated using a scale anchored from “*Disagree*
213 *Strongly*” to “*Agree Strongly*” with higher scores indicative of greater connectedness to nature.
214 Cronbach's $\alpha = .83$. We also pre-registered the use of the Nature Connection Index (NCI;
215 Richardson et al., 2019) in addition to the NRS6. However due to recent research suggesting a
216 strong relationship between the two measures ($r = .67$; Richardson et al., 2019) and in an effort

217 to use comparable measures to Fido and Richardson (2019), we did not collect data on the NCI
218 here.

219

220 **Short Dark Triad (SD3; Jones & Paulhus, 2014).** The SD3 comprises 27 items that measure
221 traits scores of Machiavellianism (9 items; e.g., “Make sure your plans benefit you, not others”;
222 Cronbach’s $\alpha = .78$), narcissism (9 items; e.g., “I insist on getting the respect I deserve”;
223 Cronbach’s $\alpha = .71$), and psychopathy (9 items; e.g., “People who mess with me always regret
224 it”; Cronbach’s $\alpha = .74$) using a 5-point scale. Each item is rated using a scale anchored from
225 “*Strongly Disagree*” to “*Strongly Agree*” and high scores indicate a greater presence of the traits.
226

227 **Short Sadistic Impulse Scale (SSIS; O’Meara, Davies, & Hammond, 2011).** The SSIS
228 comprises 10 items that measure traits scores of sadism (e.g., “I have hurt people because I
229 could”) using a 5-point scale. Each item is rated using a scale anchored from “*Strongly*
230 *Disagree*” to “*Strongly Agree*” and high scores indicate greater sadistic traits. Cronbach’s $\alpha =$
231 $.79$.

232

233 **Social Connectedness Scale (SCS; Lee & Robbins, 1995).** To identify a unique contribution of
234 nature connectedness over more general feelings of connectedness to the social world, we used
235 the SCS; an 8-item measure of one’s social connectedness (e.g., “I have no sense of togetherness
236 with my peers”). Each item is rated on a 6-point scale anchored from “*Strongly Agree*” to
237 “*Strongly Disagree*” and is reverse scored prior to summation. Higher scores indicate greater
238 social connectedness. Cronbach’s $\alpha = .94$.

239

240 **Implicit Nature Connectedness.** In addition to self-reported nature connectedness, we measured
241 implicit nature connectedness using an IAT first reported in Schultz et al. (2004). This IAT was

242 generated using iatgen (Carpenter et al., 2018) in line with Greenwald, Nosek, and Banaji’s
 243 (2003) guidelines, and was embedded within a Qualtrics survey. The IAT tasks participants with
 244 classifying stimuli as relating to targets (i.e., “Me” and “Not me”) and/or environments (i.e.,
 245 “Nature” and “Built”) as quickly and accurately as possible (see Table 1. for full word list).
 246 Participants were instructed to categorise each stimulus with their left and right index fingers by
 247 pressing the ‘E’ or ‘I’ keys on their keyboard device. Stimuli were presented in the centre of the
 248 screen, one at a time, and errors were indicated with the presentation of a red cross. Participants
 249 were required to correct any mistakes before being presented with the next stimulus.
 250

Table 1. IAT Stimuli

Nature	Built	Me	Not me
Animals	Building	I	It
Birds	Car	Me	Other
Plants	City	Mine	Their
Whales	Factory	Myself	Them
Trees	Street	Self	They

251
 252 The IAT consisted of 7 blocks. Blocks 1 (*Nature-Built*) and 2 (*Me-Not me*) consisted of 20 trials
 253 each and allowed participants to both familiarise themselves with the stimuli as well as practice
 254 classifying targets and environments separately. Blocks 3 and 4 (*Nature/Me-Built/Not me*)
 255 contained targets linked to compatible environments (i.e., one being connected with nature).
 256 Block 3 was a practice block which consisted of 20 trials, and Block 4 was a test block which
 257 consisted of 40 trials. Afterwards, the environment labels switched sides and participants were
 258 asked to practice this new position (Block 5; *Built-Nature*; 20 trials). Blocks 6 and 7 (*Built/Me-*
 259 *Nature/Not me*) followed the same format as Blocks 3 and 4, save that targets were now linked to

260 incompatible environments (i.e., one not being connected with nature). The presentation order of
261 compatible and incompatible blocks was randomised, as was the initial left/right positioning of
262 the environment label. Quicker categorisation of stimuli in the compatible, relative to
263 incompatible blocks is indicative of an individual viewing themselves as being more connected
264 with nature.

265

266 **2.1.3. Procedure**

267 As per functionality of *Prolific*, only users accessing the website via a computer could take part
268 in the study in order to ensure successful completion of the IAT. Participants initially entered
269 their demographic information and residential preference into Qualtrics survey software.
270 Following this, the NR6, SD3, SSIS, and SCS measures were presented in a randomised order to
271 reduce the likelihood of order effects influencing the data. Finally, participants completed the
272 IAT. On average, the study took around 25 minutes to complete, and this procedure was
273 approved by an institutional ethical review panel prior to data collection.

274

275 **2.1.4. Statistical Analysis**

276 First, Pearson correlations were computed between explicit and implicit measures of nature
277 connectedness, and sub traits of the dark personality (i.e., Machiavellianism, narcissism,
278 psychopathy, and sadism) in relation to the whole sample, and within each sex specifically. To
279 confirm a unique association with nature connectedness, partial correlations were conducted on
280 significant associations to control for social connectedness. Comparisons of correlations were
281 performed after undergoing Fisher's *Z* transformations. Second, we used a MANOVA to
282 investigate whether geographical preference (i.e., city, suburban, and rural) and/or sex differed as
283 a function of dark personality traits.

284

285 **2.2. Results**

286 Prior to statistical analysis, we used the iatgen software (Carpenter et al., 2018) to compute a
287 standardised D score for each participant as a function of their response times throughout the test
288 blocks of the IAT. Positive scores were indicative of a stronger association between themselves
289 and nature (stronger connection to nature), and negative scores were indicative of a stronger
290 association between themselves and built environments (weaker connection to nature), at an
291 implicit level. A score of 0 indicated no difference between implicit connections to nature or
292 built environments. Measures of nature connectedness (z -skew = -1.93; z -kurtosis = -1.26),
293 psychopathy (z -skew = 2.03; z -kurtosis = -1.95), narcissism (z -skew = 2.09; z -kurtosis = 0.07),
294 Machiavellianism (z -skew = -1.87; z -kurtosis = 0.07), and social connectedness (z -skew = 2.37;
295 z -kurtosis = -2.51) were normally distributed, however scores for sadism were not (z -skew =
296 16.56; z -kurtosis = 25.65). As such, correlations conducted using sadism were conducted using
297 Spearman coefficients.

298
299 The iatgen software identified that four participants did not complete all of the necessary trials,
300 and a further nine participants responded with excessive speed. As such, these participants were
301 removed from analyses that used the IAT measure, leaving 291 participants. All other analyses
302 were conducted on all 304 participants. The mean D score for the sample was .37 ($SD = .36$) and
303 was significantly different from zero, $t(290) = 17.34$, $p < .001$, $d = 1.02$, suggesting that as a
304 whole, the sample identified themselves as being connected with nature, on an implicit level.

305
306 **2.2.1. Bivariate Correlations**
307 Bivariate correlations between explicit and implicit measures of nature connectedness and scores
308 on the domains of the dark personality are displayed in Table 2. Correlations are presented for
309 the whole sample and as a function of sex.

310
311 Taking the sample as a whole, the explicit measure of nature connectedness was positively
312 associated with the IAT response ($r = .30, p < .001$) and negatively associated with psychopathy
313 ($r = -.30, p < .001$), Machiavellianism ($r = -.15, p = .01$), and sadism ($\rho = -.26, p < .001$). The
314 IAT response was negatively associated with Machiavellianism ($r = -.20, p < .001$). These
315 associations held after controlling for social connectedness using partial correlations. As a
316 function of sex, the explicit measure of nature connectedness was positively associated with IAT
317 responses in both male ($r = .29, p < .001$) and female participants ($r = .27, p < .001$). Moreover,
318 the explicit measure of nature connectedness was negatively associated with psychopathy ($r = -$
319 $.33, p < .001$) and sadism ($\rho = -.23, p = .01$) in male participants, and psychopathy ($r = -.21, p =$
320 $.01$) and sadism ($\rho = -.23, p = .005$) in female participants. Further, IAT responses were
321 negatively associated with Machiavellianism ($r = -.19, p = .02$) and sadism ($\rho = -.24, p = .003$),
322 but only in female participants.

323
324 [Table 2. presented at the end of the manuscript]

325 326 **2.2.2. Regression Analyses**

327 Linear multiple regression analysis was used to explore the extent to which psychopathy,
328 Machiavellian, and narcissism could account for variance in both explicit and implicit measures
329 of nature connectedness. Sadism was omitted from this analysis because it showed a positively
330 skewed distribution, which was not resolved following \ln -transformation. We conducted separate
331 analyses for male and female participants to account for potential differences in sex.

332
333 When using an explicit measure (see Table 3), the model in male participants accounted for
334 12.6% of variance in nature connectedness, $F(3, 151) = 7.24, p < .001$, with psychopathy

335 (negative) sharing independent variance with nature connectedness. The same model in female
336 participants accounted for 10.5% of variance in nature connectedness, $F(3, 145) = 5.64, p = .001$,
337 with psychopathy (negative) and narcissism (positive) sharing independent variance with nature
338 connectedness. When using an implicit measure, the model was not statistically significant in
339 either male or female samples (see Table 4).

340

341 [Table 3 and 4. presented at the end of the manuscript]

342

343 **2.2.3. Multivariate Analysis of Variance**

344 A 3 x 2 factorial MANOVA was used to investigate whether levels of self-reported dark
345 personality traits (i.e., psychopathy, Machiavellianism, and narcissism) differed as a function of
346 residential preference (i.e., city, suburbs, and rural) and sex. There was no statistically significant
347 interaction between residential preference and sex, Pillai's $V = .03, F(6, 594) = 1.50, p = .177$,
348 $\eta^2p = .02$.

349

350 **2.2.3.1. Residential Preference**

351 There was a significant main effect of residential preference, Pillai's $V = .10, F(6, 594) = 5.34, p$
352 $< .001, \eta^2p = .05$, on all domains: [1] psychopathy, $F(2, 298) = 7.27, p < .001, \eta^2p = .05$, [2]
353 Machiavellianism, $F(2, 298) = 7.31, p < .001, \eta^2p = .05$, and [3] narcissism, $F(2, 298) = 9.27, p <$
354 $.001, \eta^2p = .06$. Specifically, individuals with a preference for living in the city scored higher on
355 psychopathy ($p < .001, d = .54$), narcissism ($p < .001, d = .51$), and Machiavellianism ($p < .001,$
356 $d = .56$) than those with a preference for living in rural areas, and higher on measures of
357 psychopathy ($p = .032, d = .27$) and narcissism ($p < .001, d = .47$) than those with a preference
358 for living in the suburbs. Moreover, individuals with a preference for living in suburban, relative

359 to rural areas, reported higher Machiavellianism ($p = .023$, $d = .33$). Means and standard
 360 deviations for each domain are presented in Table 5.

361

Table 5. Means and standard deviations personality scores across geographical preference.

	Total ($n = 304$)	City ($n = 128$)	Suburban ($n = 112$)	Rural ($n = 64$)	p
Psychopathy	2.13 ± .61	2.26 ± .64	2.09 ± .59	1.93 ± .53	.032 , < .001 , .062
Machiavellianism	3.11 ± .62	3.23 ± .61	3.09 ± .61	2.89 ± .61	.083, < .001 , .023
Narcissism	2.57 ± .58	2.73 ± .62	2.47 ± .51	2.43 ± .53	< .001 , < .001 , .670

Note. p values are presented in order of the following comparisons: [1] City-Suburban, [2] City-
 Rural, [3] Suburban-Rural. Significant differences are in bold.

362

363 2.2.3.2. Sex

364 There was a significant main effect of sex, Pillai's $V = .13$, $F(3, 296) = 15.07$, $p < .001$, $\eta^2p =$
 365 $.13$, such that male participants scored higher than female participants on measures of
 366 psychopathy, $F(1, 298) = 26.63$, $p < .001$, $\eta^2p = .08$, and Machiavellianism, $F(1, 298) = 31.52$, p
 367 $< .001$, $\eta^2p = .10$. There were no sex differences in scores of narcissism, $F(1, 298) = 3.22$, $p =$
 368 $.074$, $\eta^2p = .01$. Means and standard deviations for each domain are presented in Table 6.

369

Table 6. Means and standard deviations of dark personality scores across sex.

	Total ($n = 304$)	Male ($n = 155$)	Female ($n = 149$)	p
Psychopathy	2.13 ± .61	2.32 ± .62	1.93 ± .53	< .001
Machiavellianism	3.11 ± .62	3.29 ± .58	2.92 ± .61	< .001
Narcissism	2.57 ± .58	2.63 ± .54	2.52 ± .62	.10

370

371 2.3 Discussion

372 In Study 1 when using an explicit measure of nature connectedness, we found a negative
 373 relationship between nature connectedness and psychopathy for both male and female

374 participants. In female participants we also found a positive relationship between nature
375 connectedness and narcissism. Surprisingly, this pattern of results was not seen for implicit
376 measures of nature connectedness. That is, there was no relationship between the dark
377 personality traits and nature connectedness when nature connectedness was measured with the
378 IAT.

379
380 Unlike Jonason (2018), there was no sex difference in residential preference. However,
381 individuals who scored highly on dark personality traits expressed a preference for living in a
382 city over suburban or rural areas. Although useful in understanding relationships between dark
383 personality and current living status, this finding does not, however, allow for the assessment of
384 historical living practice. A historical record of residence might be better suited to characterising
385 living preference, as this would partially mitigate any influence of circumstantial living, such as
386 temporary accommodation for the purposes of work or education. This is addressed in the second
387 of our studies.

388

389 **3. Study 2**

390 **3.1. Methods**

391 **3.1.1. Participants**

392 Following data sampling guidelines outlined in Study 1, a total of 235 participants ($M_{\text{age}} = 35.42$,
393 $SD = 11.81$; 60% male) were recruited to Study 2 via an online advertisement placed through
394 *Prolific* in March 2019. This sample size is comparable to that reporting similar comparisons in
395 Jonason (2018). Inclusion criteria required participants to be fluent in English, of UK nationality,
396 and aged 18 years or over. Participants were excluded if they had already participated in Study 1
397 (automatic screening item) or had lived and worked outside of the UK since the age of 18 years
398 (to avoid a potential confound). Participants provided written informed consent in accordance

399 with approved central university research protocols [*institution masked for peer review*] and
400 national ethical guidelines by ticking a box on both the first and last pages of our online survey.
401 All completers were reimbursed with £0.80 for their participation.

402

403 **3.1.2. Materials**

404 Measures of nature connectedness (NRS6) and the dark triad (SD3) were the same as those
405 reported in Study 1.

406

407 **3.1.3. Procedure**

408 Participants initially entered their demographic information as well as postal areas (not full
409 postal code) they have resided in (and associated duration in years) since the age of 18 into
410 Qualtrics survey software. The age of 18 years was chosen to best-reflect the age whereby
411 Westernised-individuals begin to make choices of where to live. Following this, the NRS6 and
412 SD3 measures were presented in a randomised order. On average, the study took around 10
413 minutes to complete.

414

415 **3.1.4. Statistical Analysis**

416 First, an average population density score (persons per hectare) was calculated for each
417 participant by averaging out the population density of each postal area a participant had
418 previously resided (derived from UKCrimeStats.com), as a function of the years they had spent
419 there. For example, an individual who had lived in NG1 (Nottingham, density: 77.09) for 2 years
420 and OX1 (Oxford, density: 10.47) for 5 years after the age of 18 would have a density score of
421 29.50 $((2*77.09) + (5*10.47)) / 7$. This decision was taken as a means of adding specificity
422 over and above simply recording that a participant has resided within a certain area at one point
423 in time. Afterwards, Pearson correlations were computed between population density scores,

424 measures of nature connectedness, and sub traits of the dark triad (i.e., Machiavellianism,
 425 narcissism, psychopathy).

426

427 **3.2. Results**

428 Of the original 235 participants, 26 did not provide enough information to accurately derive their
 429 population density scores. As such, these participants were removed from the analysis, leaving a
 430 final sample of 209 participants ($M_{\text{age}} = 35.38$, $SD = 11.64$; 59.8% male). On average, since the
 431 age of 18, participants reported living in postal areas with a population of 36,922 ($SD =$
 432 20,539.74, $Range = 1,492$ to 153,812), and a population density of 24.31 persons per hectare (SD
 433 $= 25.51$, $Range = .16$ to 148.59).

434

435 **3.2.1. Bivariate correlations.**

436 Bivariate correlations between population density scores, measures of nature connectedness, and
 437 sub traits of the dark triad (i.e., Machiavellianism, narcissism, psychopathy) are displayed in
 438 Table 7. Population density was not associated with either nature connectedness, nor any sub
 439 trait of the dark triad. Nature connectedness was negatively associated with both
 440 Machiavellianism ($r = -.18$, $p = .01$) and psychopathy ($r = -.33$, $p < .001$). These findings held
 441 when correlations were examined in male and female participants separately.

442

Table 7. Bivariate correlations between population density scores, measures of nature connectedness, and sub traits of the dark triad

	α	[1]	[2]	[3]	[4]	[5]
[1] Density	-	-	-.08	.10	.06	.08
[2] NRS	.85		-	-.18**	.12	-.33***
[3] Mach	.77			-	.31***	.44***
[4] Nar	.77				-	.29***
[5] Psy	.80					-

Note. NRS = Nature Relatedness Scale, Mach = Machiavellianism, Nar = Narcissism, Psy = Psychopathy. ** $p < .01$, *** $p < .001$. Cronbach's alpha = α

443

444 **3.3 Discussion**

445 Study 2 aimed to replicate the findings from Study 1 whilst addressing residential preference
446 more directly through a historical measure. Nature connectedness was negatively associated with
447 Machiavellianism and psychopathy but not narcissism. There was no relationship between the
448 dark triad sub traits and population density.

449

450 **4. General Discussion**

451 The studies presented demonstrate a consistent negative relationship between explicit measures
452 of nature connectedness and psychopathy. Importantly, this finding was observed in both male
453 and female participants, independently, and held after controlling for social connectedness;
454 suggesting a unique role of connectedness to nature in predicting psychopathic traits. Moreover,
455 in Study 1 we also observed negative relationships between [1] *explicit* measures of nature
456 connectedness and Machiavellianism and sadism, as well as [2] *implicit* measures of nature
457 connectedness and Machiavellianism, but not psychopathy. Also, individuals with a preference
458 for living in the city, relative to rural areas, reported greater dark personality traits. Interestingly,
459 in Study 2, population density was not associated with any sub trait of the dark triad. As such our
460 hypotheses regarding the relationship between nature connectedness and individual variation in
461 dark personality traits are only partially supported.

462

463 One's connectedness with the natural world has been shown to be an independent predictor of a
464 wide range of health and well-being-related benefits (see Richardson et al., 2017 for a review).
465 From a psychological perspective, individuals reporting greater levels of nature connectedness
466 exhibit greater vitality, happiness, resilience, and life satisfaction, as well as lower anxiety

467 (Cervinka et al., 2011; Martyn & Brymer, 2016; Pritchard et al., 2019; Ryan et al., 2010).
468 Moreover, people with higher nature connectedness also show fewer callous and uncaring traits
469 (Fido & Richardson, 2019). These correlates typify much of the classical characterisation of
470 psychopathy, and dark personality more generally (Lynam & Derefinko, 2006; Paulhus &
471 Williams, 2002). We extended these findings to show that when measured explicitly via self-
472 report, nature connectedness was negatively associated with psychopathic, Machiavellian, and
473 sadistic, but not narcissistic personality traits. Of importance, these associations held after
474 controlling for individual variation in social connectedness. This suggests that there is something
475 unique about our innate connection with nature and its potential role in modulating dark
476 personality (Frantz et al., 2005; Wilson, 1984). Moreover, when modelled together, psychopathy
477 emerged as the only dark personality trait predictor of nature connectedness across both male and
478 female participants; suggesting that this association may be being driven by individual variation
479 in psychopathic personality traits. It is vital, however, that these results are discussed within the
480 framework that the SD3 (Jones & Paulhus, 2014) offers only a composite measure of
481 psychopathy (with questions mostly pertaining to antisocial behaviour), and which does not tease
482 apart affective and interpersonal (primary psychopathy) and/or lifestyle and antisocial (secondary
483 psychopathy) dimensions. Although our data provides an initial foothold into the role of dark
484 personality and nature connectedness, future research should aim to develop this understanding
485 using a more comprehensive measure of psychopathy, such as the Self-Reported Psychopathy
486 Scale (Paulhus, Neumann, & Hare, 2016).

487
488 Furthermore, we compared individuals' residential preference with the degree of reported dark
489 personality. Those who indicated a preference to reside in the city, relative to rural environments
490 reported significantly greater levels of Machiavellian, psychopathic, and narcissistic personality
491 traits. The latter two facets held when comparing the more environmentally-similar geographical

492 locations of the city and suburbs. Such findings are comparable to those reported by Jonason
493 (2018); thus, allowing us to extend those findings internationally to a UK sample. However, we
494 were not able to replicate the relationships between population density and facets of the dark
495 triad in Study 2. Although this disparity might be explained by Jonason (2018) reporting only
496 small effect sizes within a much larger sample, it seems more likely that this is a result of our
497 attempt to calculate a historical, rather than cross-sectional living preference. Limitations of this
498 approach are as follows. First, residential history was provided without context, and as such,
499 individuals reporting greater levels of dark triad traits might find themselves residing in areas of
500 lower population density as a function of those areas allowing them to engage in higher
501 education and/or employment in the hope of yielding higher socioeconomic status (Persson &
502 Lillienfeld, 2019). Low density areas might also currently be providing access to targets of
503 manipulation, or simply ease of access to less-affordable inner-city areas. Second, we calculated
504 the population density statistics as a function of residential, rather than daytime population in
505 line with Jonason (2018). Areas such as those within the East of London (e.g., E1 postal code)
506 have a relatively small residential (~69,523) compared to daytime population (~257,024). As
507 such, although existing studies lack context as to why people live where they live, results may be
508 masked by some individuals who score higher on dark personality traits, preferring to reside in
509 locations whereby potential targets of manipulation are transient; thus further reducing their
510 chances of being caught (Hare, 2003). As such, findings of Study 2 should be taken with great
511 caution, especially as population density was not associated with self-reported nature
512 connectedness - suggesting that these two measurements are not comparable for these purposes.
513
514 Psychopathy was not associated with nature connectedness when measured implicitly using the
515 nature-based IAT. This finding is unexpected. If inverse relationships between nature
516 connectedness and psychopathy exist, then we would expect to see a greater impact of social

517 desirability when nature connectedness was measured explicitly rather than implicitly; partially
518 due to recent paradigm shifts to support pro-environmental opinions. That we did not find any
519 relationship between psychopathy and implicit nature connectedness is surprising. Below, we
520 offer two potential explanations for this finding which differ as a function of one's belief in the
521 IAT as a valid measure of implicit bias. First, if the nature-based IAT is valid, it is possible that
522 individuals with greater psychopathic personality traits report a reduced connection with nature
523 when asked explicitly, possibly as an overt indication of superiority (Wai & Tiliopoulos, 2012),
524 when in actuality they have no opinion about nature or their connection with it. This would
525 support existent delineations of inverse associations between psychopathy, empathy and
526 compassion (Jonason & Krause, 2013; Jonason & Kroll, 2015; Lee & Gibbons, 2017), and would
527 partially explain the mediating role of empathy between psychopathy-related traits (i.e.,
528 callousness and uncaring) and nature connectedness observed in Fido and Richardson (2019).
529 Second, and more plausible in our eyes, this null finding might be an artefact of the lack of
530 validity of the nature-based IAT to accurately measure implicit bias for nature-related beliefs.
531 This would map closely onto the recent critique of Schimmack (2019) regarding validity, as well
532 as previous concerns pertaining to the IAT being fallible to uncontrolled environmental
533 confounds impacting presentation time and response latency, as well as wider conceptual flaws
534 (Blanton, Jaccard, Gonzales, & Christie, 2006). Moreover, this perspective would also help to
535 explain the relatively low correlation ($r = .30$) between explicit and implicit scores of nature
536 connectedness reported here, indicating that the two measure conceptually different things.

537

538 Additionally, although individuals purporting to favour inner-city, relative to suburban or rural
539 living scored higher on narcissistic traits, in neither study was nature connectedness associated
540 with narcissism. This partially mirrors that of Jonason (2018) who explained their findings of
541 inner-city preference through more densely populated areas providing greater opportunity for

542 external validation (Jonason & Schmitt, 2017). Of note, we did not find associations between
543 historical geographical living preference and narcissism in Study 2, neither as a composite group
544 nor when split as a function of sex, whereas Jonason did find an association. In addition, non-
545 pathological narcissism has previously shown to be associated with prosocial behaviour (Kauten
546 & Barry, 2016) and the perceptions of one's own relationships (Barry & Kauten, 2014). Such
547 behaviours act to proliferate favour and admiration (Pincus et al., 2009) for the narcissist, and as
548 such, we would have expected to see positive associations with nature connectedness here, due to
549 it arguably being a socially-desirable characteristic.

550

551 **4.1. Strengths, Limitations, and Applied Implications**

552 Limitations and future avenues of investigation are discussed below. First, in line with a growing
553 surge of social science research being conducted online (see Bohannon, 2016), the online
554 surveys and experiments reported here are fallible to poor environmental control and participant
555 identity verification. However, Prolific has been shown to have comparative data quality to
556 laboratory-based participants, as well as alternative crowdsourcing websites such as Amazon's
557 Mechanical Turk (Peer, Brandimarte, Samat, & Acquisti, 2017), and so was a viable data
558 collection method for this report. Second, save for the IAT, data reported here are self-reported
559 and so might contain elements of bias or untruth. As such, future replication might consider the
560 use of combining self- with other-reported personality to validate such responses. Third, a
561 strength of Study 1 is that it controlled for variation in social connectedness, however given
562 items of the NRS6 rely strongly on self-reported affective reactions, it would also have been
563 desirable to control for more general affective tendencies. Fourth, despite this manuscript adding
564 to the growing literature supporting a potential role of nature connectedness in understanding the
565 manifestation of psychopathic-relevant traits (Fido & Richardson, 2019; Jonason, 2018), we are
566 still naive to both [1] how these relationships manifest within forensic and clinical samples, and

567 [2] whether interventions known to increase nature connectedness might bring about change in
568 dark triad-related behaviour. As nature connectedness is malleable through simple interventions
569 such as merely noticing good things in nature (Richardson & Sheffield, 2017), there is an
570 opportunity to explore new approaches to forensic interventions. The three good things in nature
571 intervention has proven effective in urban environments, particularly for those with low nature
572 connectedness (McEwan et al. under review). By undertaking replication and extension to
573 studies such as these, it may be possible to further our understanding of the proposed benefit of
574 nature connectedness; above and beyond its current utility for indices of health and well-being.

575

576 **5. Conclusion**

577 These two studies represent the first attempt to explore the relationship between dark personality
578 and the psychological construct of nature connectedness, specifically. Although not supported by
579 methodologically-limited population density data, individuals scoring high on the dark triad
580 show a preference for residing in inner-city, relative to suburban or rural areas and also score low
581 on explicit measures of nature connectedness. Given interventions have shown that nature
582 connectedness can be improved, particularly in those with lower connectedness and in urban
583 environments, the potential role of nature connectedness interventions in forensic populations
584 should be explored.

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588

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Table 2. Bivariate correlations between explicit and implicit measures of nature connectedness and scores on the domains of the dark personality

	Whole Sample							Sex					
	α	[1]	[2]	[3]	[4]	[5]	[6]	[1]	[2]	[3]	[4]	[5]	[6]
[1] NRS6	.83	-	.30***	-.15**	.07	-.30***	-.26***	-	.29***	-.14	-.01	-.33***	-.23**
[2] IAT	-		-	-.20***	-.04	-.11	-.10	.27**	-	-.12	.02	-.06	.12
[3] Mach	.78			-	.23***	.37***	.38***	-.08	-.19*	-	.26***	.31***	.36***
[4] Nar	.71				-	.35***	.20***	.16*	-.06	.17*	-	.37***	.17*
[5] Psy	.74					-	.49***	-.21**	-.05	.31***	.31***	-	.45***
[6] SSIS	.79						-	-.23**	-.24**	.26***	.18*	.46***	-

Note. NRS6 = Nature Relatedness Scale, IAT = Implicit Association Test, Mach = Machiavellianism, Nar = Narcissism, Psy = Psychopathy, SSIS = Short Sadistic Impulse Scale. Correlations above the diagonal = Male participants, correlations below the diagonal = Female participants.

* $p < .05$ ** $p < .01$ *** $p < .001$ Cronbach's alpha = α

Table 3. Results of linear multiple regression analysis on explicit measures of Nature Connectedness by sex.

	Male					Female					Fisher's Z
	β	95% CI		<i>t</i>	<i>p</i>	β	95% CI		<i>t</i>	<i>p</i>	
		Lower	Upper				Lower	Upper			
Psychopathy	-.36	-4.08	-1.51	-4.30	< .001	-.28	-4.68	-1.15	-3.27	< .001	-.77
Machiavellianism	-.06	-1.82	.84	-.72	.47	-.04	-1.79	1.13	-.45	.66	-.17
Narcissism	.14	-.23	2.69	1.67	.10	.26	.83	3.72	3.11	.002	-1.08

Table 4. Results of linear multiple regression analysis on implicit measures of Nature Connectedness by sex.

	Male					Female					Fisher's Z
	β	<i>t</i>	<i>p</i>	95% CI		β	<i>t</i>	<i>p</i>	95% CI		
				Lower	Upper				Lower	Upper	
Psychopathy	-.04	-.39	.70	-.14	.09	.02	.18	.86	-.10	.12	-.51
Machiavellianism	-.13	.72	.47	-.08	.17	-.03	-.36	.72	-.11	.08	-1.36
Narcissism	.72	-1.40	.17	-.20	.03	-.19	-2.17	.03	-.20	-.01	9.28