Research Communications

Age and connection to nature: when is engagement critical?

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<u>**Running heads:**</u>
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Age and connection to nature

Conservation organizations are increasingly aware of the need to motivate pro-environmental behavior by connecting people with nature. However, to maximize the effectiveness of the limited resources available, there needs to be a better understanding of the variability in people's connection to nature shown at different ages. We examined connection to nature among people aged 5–75 years, using two popular measures, in a cross-sectional UK sample, based on the hypothesis that there would be clear, age-related patterns in people's connection to nature, with specific "breakpoints" associated with differences in feelings of connection. Data were collected across a variety of locations. Analysis of generalized additive models revealed similar age-related patterns for both measures, with connection declining from childhood to an overall low in the mid-teens, followed by a rise to the early 20s and reaching a plateau that lasts to the end of the lifetime. Both measures also showed that females generally had higher connection scores than males. These findings have implications for conservation.
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It is increasingly recognized that providing technical and ecological information to target audiences and decision-makers about a conservation issue is not enough to result in a change in audience behavior to provide a solution (Toomey *et al*. 2017). When assessing conservation issues, it is important to consider human social contexts alongside the ecological characteristics. Underlying social and psychological factors influence many conservation issues by motivating human behavior (Clayton and Myers 2015; Whitty 2018). For example, both external (eg social networks) and internal (eg values, beliefs, attitudes) factors influence conservation behavior (Amel *et al*. 2017). Attitudes are largely based on emotions, and the strength of an emotional connection toward the natural environment is associated with pro-environmental behavior (Hinds and Sparks 2008). In contrast, emotional disconnection hinders conservation (Fletcher 2016). Although there is disagreement about the direction and strength of links between attitudes and pro-environmental behaviors (Barthel *et al*. 2018; Linder *et al*. 2018), an increasing number of conservation activities focus on developing an individual's connection to nature. This strategy is based on the assumption that changing attitudes through interventions targeting behavioral, affective (emotions, feelings) and cognitive (knowledge) pathways will lead to more positive conservation behaviors. As such, understanding and developing the emotional relationship between people and nature – that is, fostering their "connection to nature" (Rands *et al*. 2010) – must be a key component of conservation efforts.

"Connection to nature" is a multidimensional construct – comprising emotional, cognitive, and behavioral traits – that describes an individual's relationship with nature, and is often centered on particular locations or landscapes (Zylstra *et al*. 2014; Ives *et al*. 2017). As with other complex traits that vary over a lifetime, such as agreeableness and attachment to others (Roberts *et al*. 2006), connection to nature may also fluctuate with age. If conservation organizations can understand this variability, they can allocate their resources more effectively in their outreach strategies by identifying the target audience groups that require more engagement.

Because nature disconnection often starts in childhood, early development of connection may promote pro-environmental attitudes and behaviors in adulthood (Cheng and Monroe 2012; Barthel *et al*. 2018). However, developing connection in other age-groups may be more beneficial for encouraging pro-conservation behavior. In the UK, types of charitable behavior, including conservation activities, vary with age; for instance, more 16–24-year-olds volunteer than any other age-group but are the least likely to donate, whereas individuals over the age of 65 are most likely to regularly donate, and contribute the most money (CAF 2017). Social norms are a reliable determinant of pro-environmental behavior (Farrow *et al*. 2017), and this is consistent with the notion that an individual's attitudes and behavior are influenced by their beliefs about the attitudes of other relevant people (eg parents; Ajzen 1991). Specifically, perceived family values toward nature influence children's interest in pro-environmental behaviors (Cheng and Monroe 2012). Connecting parents and grandparents may therefore support connection to nature in children.

Beyond overall positive correlations between age and connection to nature (Hunt *et al*. 2017), little is understood about differences in connection over the span of a lifetime. We used two popular measures, the short-form Nature Relatedness Scale (NR-6; Nisbet and Zelenski 2013) and the Connection to Nature Index (CNI; Cheng and Monroe 2012), to examine connection in a cross-sectional UK sample. We hypothesized that there would be age-related patterns in connection.

Methods

Participants and procedures

Face-to-face data were collected from outdoor locations (adult and school visits to eight Royal Society for the Protection of Birds [RSPB] sites, plus one Field Studies Council site) and indoor locations (four school classrooms, Tesco [a grocery and merchandise retailer in the UK] staff and customers at one superstore) between summer 2012 and summer 2015; 396 participants (children: 7–12 years of age, males = 71, females = 81; teenagers: 13–19 years of age, males = 33, females = 99; adults: 20–83 years of age, males = 48, females = 63; and unknown = 1) completed a composite questionnaire incorporating demographic (age/gender) questions and the two connection measures (the CNI and the NR-6; see also WebTables 2 and 3). Data collected from face-to-face interviews were used in the analysis due to difficulties associated with accessing children and teenagers via online survey methods, and because this data collection was part of a broader study of connection-to-nature metrics. The adult modal sample size was one per year; therefore, in order to increase the sample size, data were collected from 2051 participants (males = 963, females = 1088) via an online survey in January 2018. For each connection measure, analysis of variance (ANOVA) investigating age and method variables found no statistically significant effect of method ($P > 0.05$), and data were therefore pooled.

Measures

To improve the validity of any conclusions about age-related patterns in connection to nature, two different measures were used: the CNI and the NR-6. The CNI is a trait measure of connection that was originally devised for use with children and is used to measure aspects of connection to nature described as enjoyment, oneness, empathy, and responsibility (Cheng and Monroe 2012). The CNI scale consists of 16 items rated on a five-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5). An overall score is calculated from the mean of the 16 items, with higher scores indicating a stronger connection to nature. The CNI had high internal reliability in this study (Cronbach's $\alpha = 0.88$).

The NR-6 (Nisbet *et al*. 2009) is considered to be a temporally stable measure of an individual's cognitive, affective, and experiential connection to nature. It comprises six items from the full questionnaire (Nisbet and Zelenski 2013), which are scored and averaged in the same way as the CNI. The NR-6 also had high internal reliability (Cronbach's $\alpha = 0.84$).

Data analyses

Analyses were conducted using R version 3.4.3 (R Core Team 2017). Basic analyses were carried out using built-in mathematical functions and the R package "psy" (Falissard 2012). Incomplete face-to-face samples were deleted; of these, four participants failed to provide their age, 24 participants failed to complete the CNI, and 14 individuals failed to complete the NR-6. Because sample sizes were small (in the single digits) for those 80 years of age and above, datasets were truncated at 79 years of age. Final sample sizes for the CNI and NR-6 datasets were 2381 (child: $n = 140$; teen: $n = 171$; adult: $n = 2070$) and 2390 (child: $n = 145$; teen: $n = 171$; adult: $n = 2074$), respectively. Connection measures had good internal consistency across age cohorts (Cronbach's α: CNI: child = 0.85, teen = 0.86, adult = 0.90; NR-6: child = 0.86, teen = 0.84, adult = 0.89).

For each measure, data were first examined in relation to (1) gender, (2) age, and (3) gender*age interactions. With no a priori expectations about the relationship between age and connection, we then fitted a smoothing curve using generalized additive models (GAMs; a statistical method that identifies points in datasets where the relationship between two variables appears to change), which were developed using the R package "mgcv" (Wood

2011). GAMs were used to predict the CNI and NR-6 scores for individuals between 5 and 75 years of age. Finally, linear piecewise regression models built with the R package "segmented" (Muggeo 2008) were used to identify "breakpoints", or specific age points where the strength or direction of relationship between age and connection changed to the greatest extent. Although data showed signs of heterogeneity and non-normality, because we were interested only in identifying breakpoints and not in the form of the linear models, linear piecewise regression was considered appropriate. Visual inspection of the GAM graph indicated two main changes in the data pattern, and consequently regression models were developed with one, two, and three breakpoints. Initial breakpoint values varied several times within each set, and Akaike information criterion (AIC) values (which indicate the quality or accuracy of the GAM model) were used to compare models.

Results

CNI

CNI data were determined to be left-skewed (skew = –0.57, $z = -10.70$, $P < 0.01$). Females ($n = 1286$, median = 4.19) had higher CNI scores than males ($n = 1095$, median = 4.06). Gender and age were significant variables in relation to CNI, but no significant interaction was detected between gender and age, indicating that gender bias in sampling would not account for any observed age effects (ANOVA; gender: $F = 43.83$, $P < 0.01$; age: $F = 56.71$, $P < 0.01$; gender*age: $F = 0.80$, $P > 0.05$). CNI scores were lower among teens than the other two cohorts (child: median = 4.19; teen: median = 3.75; adult: median = 4.28) and these differences were statistically significant (Tukey's honestly significant difference [HSD]; teen–adult: $\bar{x}$ difference = –0.47, $P < 0.01$; teen–child: $\bar{x}$ difference = –0.43, $P < 0.01$), whereas no significant difference was detected between the groups child and adult (Tukey's HSD; $\bar{x}$ difference = –0.04, $P = 0.84$). No gender bias in sampling was observed, as analysis of CNI scores by age-group and gender showed an effect of age-group (ANOVA; $F = 43.88$, $P < 0.01$) and of gender ($F = 30.78$, $P < 0.01$) but no age-group*gender interaction effect ($F = 0.31$, $P > 0.1$). Due to the observed gender difference, males and females were modeled separately; the GAMs showed that the smooth term for age was significant and explained 6.5% and 3.4% of the deviance in females and males, respectively (Figure 1; WebTable 1).

For breakpoint analysis, comparison of AICs revealed that the addition of one and two breakpoints improved models for both genders, given that the decrease in AIC exceeded 10 (Burnham and Anderson 2004). For females, comparing breakpoints with the GAM graph indicated that the three-breakpoint model was defining details around the teenage change rather than across the life span; the presence of only a seven-point decrease in AIC between the two- and three-breakpoint models indicated support for the two-breakpoint model. Similarly, the two-breakpoint model was best suited for males as well, based on the AIC (WebTable 1).

NR-6

As with CNI data, NR-6 data were also left-skewed (skew = –0.37, $z = -7.14$, $P < 0.01$) with no gender difference (females: $n = 1292$, median = 3.67; males: $n = 1098$, median = 3.67). For age-groups, teen scores were again lower than both child and adult scores (child: $n = 145$, median = 3.67; teen: $n = 171$, median = 3.34; adult: $n = 2074$, median = 3.67) and these differences were statistically significant (Tukey's HSD; teen–adult: $\bar{x}$ difference = –0.44, $P <$ 0.01; teen–child: $\bar{x}$ difference = –0.45, $P < 0.01$); as before, differences between child and adult scores were non-significant (Tukey's HSD; child–adult: $\bar{x}$ difference = 0.00, $P > 0.1$).

For comparison with CNI, GAMs were developed separately for each gender. The female GAM showed that the smooth term for age was significant and explained 4.8% of deviance, while the male GAM was non-significant and explained only 2.4% of deviance (WebTable 1). Figure 2 shows the predicted values from the GAMs. Because the dip in connection between childhood and early adulthood was present in males despite the apparent insignificance of the age–NR-6 relationship, another GAM was developed for male data truncated to under 25 years of age. This GAM showed that the smoothed age term was significant in this age range (n = 164, estimated degrees of freedom = 3.36, F = 3.99, P = 0.004) and explained 10.8% of the deviance.

The breakpoint analysis results identified two breakpoints at similar locations to those in the CNI–age analysis. For females, the three-breakpoint models failed to converge, whereas for males there was little difference between the two- and three-breakpoint models (AIC difference was less than two). Therefore, the two-breakpoint models were considered to be the most reasonable based on AIC values (Burnham and Anderson 2004), indicating differences in connection trends around 16 years of age and 19 years of age (WebTable 1).

Discussion

This study shows age-associated differences in connection to nature, and these findings can inform future research and conservation action. Beyond simple positive correlations, this is, to the best of our knowledge, the first study to investigate the shape of the connection–age relationship. Using cross-sectional data and a simple exploratory analysis of changes in levels of connection over time, we provide a snapshot of current nature connection in the UK, and our results support the hypothesis of clear age-related patterns in connection to nature, with specific breakpoints associated with changes in the strength and direction of this relationship. Both of the measures used revealed that the biggest differences in connection occurred in the teenage years. Connection was significantly lower among teenagers than in children under the age of 12, and was at its lowest point among 15–16 year olds, after which connection scores continued to increase until they plateaued in adulthood (Figure 3). While CNI analysis showed a comparatively steady gradual increase after the teenage trough, NR-6 analysis showed a steep incline followed by an undulating plateau in adulthood. Both measures also revealed a difference in connection to nature between males and females, although the age-related patterns remained broadly similar. With the exception of individuals in their late 20s (as measured by NR-6), males consistently reported lower levels of connection than females. This is consistent with previous findings that females tend to be associated with higher degrees of pro-environmental concerns, attitudes, and behaviors (Scannell and Gifford 2013).

In addition to large changes (of around a quarter of a point) in teenage connection, the NR-6 results suggest fluctuating connection during adulthood. Observed differences between the two GAMs may be attributable to the slightly different aspects of the connection-to-nature construct evaluated by the two measures, and the appropriateness of the scales for different age-groups. Although previous research has indicated that both scales perform well across ages (eg Bragg *et al*. 2013), the NR-6 was designed for use with adults, whereas the

CNI was intended for child cohorts, and this may have influenced our results. Fluctuations throughout adulthood may have been more accurately tracked by the NR-6 than the CNI approach, and the childhood-to-mid-teen dip may be less severe (as indicated by CNI) rather than more severe (as indicated by NR-6).

Several different hypotheses can be formed about the cause of the patterns presented in this analysis of cross-sectional data: one interpretation is that of a cohort effect, whereby connection is stable over time (Kaiser *et al*. 2014) and variations across ages are due to generational differences in lifestyle, leisure, social, and environmental conditions. A second hypothesis is that of a longitudinal effect, with data demonstrating lifetime trends. The observed patterns may also be the result of a combination of the two. With regard to cohort differences, references to nature in popular literature have decreased steadily since the 1950s (Kesebir and Kesebir 2017), suggesting a generational difference in interest that may be reflected in connection. However, this interpretation is challenged by the question of why connection would be low among the cohort of children born around the turn of the new millennium and higher in children born just a few years before or after. The longitudinal interpretation appears more appropriate to explain the teenage dip. There could be a number of reasons for trends in connection (Zylstra *et al*. 2014; Ives *et al*. 2017), and one hypothesis we would like to test in the future is the age relationship with social life-stages. For example, the observed decline from childhood to the mid-teens coincides with increasing school pressures toward exams in the UK (Klinger *et al*. 2015), and the post-age-16 connection rise coincides with becoming independent and leaving home (in the UK, over 50% of individuals have moved away from home by 23 years of age; Office for National Statistics 2017), which may facilitate a re-engagement with nature. We suggest that future work should focus on the roles that social, cultural, and life-stage influences have on connection to nature.

The models presented have theoretical and practical implications for conservation. Overall, the GAM results demonstrate the importance of considering underlying levels of connection when assessing changes in connection to nature over time or between groups. The early teenage decline highlights a specific demographic for which targeted attempts to reduce this dip may be effective. However, this requires longitudinal research to determine whether efforts to reduce the decline might provide a platform promoting greater connection throughout the remaining lifetime, or whether short-term changes would soon revert to age-associated type later in life. Given the low point in connection at 15–16 years of age, we suggest it may be pragmatic to focus on increasing the connection of older teenagers (Figure 3), as raising their connection could mean entry into their adult years with a higher level of connection and exhibiting more pro-conservation behavior through the remainder of their lives (Cheng and Monroe 2012).

While revealing further research needs with respect to connection to nature, our results demonstrate gender- and age-associated variation in nature connection across children, teenagers, and adults, and underscore the importance of developing audience-specific nature conservation interventions in both policy and practice. If, as evidence suggests, connection to nature promotes pro-environmental behaviors, human health, and well-being (Zylstra *et al.* 2014), this research indicates that targeted support is required for developing connection in specific age-groups, while conservation interventions may be more successful if aimed at sectors of the population with higher levels of connection. These findings should be considered alongside the prevalence of various conservation behaviors by age (CAF 2017). Together with information about marketing, conservation psychology, and behavior change, our results could inform more effective conservation of nature.

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Supporting Information

Additional, web-only material may be found in the online version of this article at

Figure 1. Predicted Connection to Nature Index (CNI) scores for ages 5–75 years from generalized additive models (GAMs) for females (red) and males (blue) with 95% confidence intervals (dotted lines). CNI scores ranged from 1 to 5.

Figure 2. Predicted Nature Relatedness Scale (NR-6) scores for ages 5–75 years from GAMs for females (red) and males (blue). Dark lines represent predicted means with 95% confidence intervals (dotted lines). NR-6 scores ranged from 1 to 5.

Figure 3. Connection scores increased among older teens after a mid-teen low; as such, reconnecting older teenagers with nature before and as they enter adulthood could be critical.

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