The gradual development of the preference for natural environments

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Abstract

Adults demonstrate aesthetic preferences for natural environments over urban ones. This preference has influenced theories like Biophilia to explain why nature is beneficial. While both adults and children show cognitive and affective benefits after nature exposure, it is unknown whether children demonstrate nature preferences. In the current study, 4-to-11 year-old children and their parents rated their preferences for images of nature and urban scenes. Parents' preferences matched those of a normative adult sample. However, children demonstrated robust preferences for urban over natural environments, which significantly decreased with age. Nature exposure as reported by parents did not predict children's preferences. Children with more nearby nature had lower reported inattentiveness, but this was unrelated to children's preferences for nature. These results provide an important step into future research on the role of preference in how children and adults benefit from nature.

Key words: nature preferences, development, nature exposure, Attention Restoration Theory, Biophilia

People's preferences for natural environments over urban environments are robust and have been extensively documented (Ibarra et al., 2017; R. Kaplan & Kaplan, 1989; van den Berg, Hartig, & Staats, 2007). Nature preferences are so strong that researchers have found that the distributions of adults' preference ratings for many kinds of nature and urban photos barely overlap (S. Kaplan, Kaplan, & Wendt, 1972). These preferences are observable in property choices. City dwellers pay a premium for a sea view from their apartment window, and vacationers can upgrade their room to avoid a view of the parking lot. And while there is some regional variation, adults preferences for nature are even found cross culturally (R. Kaplan & Yang, 1990; Ulrich, 1993).

Decades of research demonstrate that, in addition to finding natural environments preferable to urban ones, adults experience a variety of benefits from interacting with nature. These effects include improvements in mood (Bratman, Hamilton, Hahn, Daily, & Gross, 2015; Hartig, Evans, Jamner, Davis, & Garling, 2003), positive physical health outcomes (Kardan et al., 2015; Nielsen & Hansen, 2007), and better executive functioning (Berman, Jonides, & Kaplan, 2008; Berman et al., 2012; Berto, 2005; Van Hedger et al., 2018).

Some theoretical accounts, such as Biophilia (Kellert & Wilson, 1995) and Stress Reduction Theory (SRT) (Ulrich et al., 1991), suggest that these preferences for nature arise from humans evolving in natural environments. Though there is disagreement on how this occurs—whether this innate affinity is genetically programmed or works through a form of biologically-prepared learning—a common explanation for why nature is preferred is that only a tiny fraction of evolutionary history has occurred in urban

environments, and the remainder in natural ones. In addition, proponents of SRT argue that this preference for nature can explain some of the reduced stress and improved mood after interactions with natural environments, and this in turn can improve cognitive performance. An alternate account of nature-induced changes in cognition is Attention Restoration Theory (ART) (S. Kaplan, 1995; S. Kaplan & Berman, 2010). ART proposes that the cognitive improvements seen after nature interactions are not driven by mood or preference, but rather result from resting top-down directed-attention resources.

Though generally not as well studied, many of the positive effects of nature are also found in children. Nature interventions have been shown to decrease children's levels of stress (Corraliza, Collado, & Bethelmy, 2012; Wells & Evans, 2003). Additionally, reductions in symptoms of attention deficit hyperactivity disorder (ADHD) and decreased levels of inattentiveness have been documented in children after nature walks (Taylor & Kuo, 2009) and from play in natural settings (Amoly et al., 2014; Faber Taylor & Kuo, 2011; Mårtensson et al., 2009).

In adults, there is evidence that nature's effects of on cognition may be independent from those on emotion and mood, with the latter being driven by preferences, and the former resulting from alternate mechanisms (Berman et al., 2008, 2012; Stenfors et al., 2018). A question is whether the same would be true of children, and even more importantly whether children have preferences for nature.

One study conducted on this topic involved asking 9- to 12-year-old children to make a map or drawing of their favorite places. They found that the vast majority of the illustrations were outdoors, featuring lawns, playgrounds, parks, etc. (Moore, 1986),

suggesting that older children may display an affinity for nature similar to adults. However, it cannot speak to the preferences for children under 9 years of age, nor does it examine whether or not the child's preference for natural spaces was indeed an indication of an affinity for nature, as opposed to a more general preference for areas associated with recreation. Other research has addressed children's environmental reasoning, and found that elementary school children believe nature has intrinsic value and that preserving nature is important (Kahn, 1997). Children also seem to show visual preferences for certain types of natural environments over others (Balling & Falk, 1982). Overall, while there is some preliminary evidence that children may appreciate and enjoy nature, no empirical work has directly examined natural versus urban preferences in children across a broad age range.

Though not explicitly studying children's preferences, a recent study (Sobko, Jia, & Brown, 2018) examined whether children's feelings of connectedness to nature could influence behavioral outcomes as measured by the Strengths & Difficulties Questionnaire. This study was limited to correlations between parent-report measures, but did provide some preliminary evidence that young children with an appreciation of nature may experience fewer emotional, social, and cognitive problems overall.

The primary goal of the current study was to examine whether or not this preference for natural environments exists in children, and whether children's preferences are consistent across development. This study was also designed to examine what individual geographical and social variables might relate to children's environmental preferences, such as living near nature, playing in natural environments, and parental

nature preferences. A final aim of this study was to determine whether the previously documented benefits of nature are linked to whether or not children prefer such environments. To test this, we examined children's environmental preferences and collected measures of their cognitive, social and emotional behaviors.

Based on the powerful affinity for nature that has been documented in adults, we expected that children would show similar preferences for natural environments. However, the opposite effect was found. Children overall have fairly strong urban preferences which decrease with age. We also find that, on average, children's preferences are more similar to those of their parents than to non-parents, but nature exposure does not relate to their preferences. Lastly, our study shows evidence that nature has positive effects on children's attention. However those cognitive benefits were not driven by preference, a result inline with Attention Restoration Theory. In summary, we find that children's preferences for nature develop over time, but that these preferences do not affect the positive cognitive effects of nature on children.

Method

Participants

Data from 251 children and 187 parents or guardians were collected. Twelve children were excluded from analysis due experimenter note that the child had clear difficulty understanding the task or failed to complete all trials of the task. The final sample included 239 children between the ages of 4 and 11 years and 182 adults (162 parents and

16 grandparents/other non-parent guardians). Gender split of the children in the final sample was relatively even (112 male, 127 female). Of the 239 usable children, 61 were siblings of another child participant.

The lower limit of the age range was selected based on a short pilot study previously conducted with 3- to 6-year-olds, which showed that children under 4 years of age had a very difficult time understanding the task. Our goal was to collect usable data from at least twenty children per one-year age bin, and we stopped data collection when we reached this goal. Previous stimulus validation studies in our lab have found that obtaining preference ratings from about twenty participants for each image is sufficient to gain reliable estimates of preference (Kotabe, Kardan, & Berman, 2017). Additional sample information by age bin can be found in Table 1.

Table 1. Child participant breakdown by age and gender

Age Bin	N (% of total)	# F (# M)
4 years	21 (8.8%)	11 (10)
5 years	29 (12.1%)	16 (13)
6 years	42 (17.6%)	16 (26)
7 years	34 (14.2%)	15 (19)
8 years	30 (12.6%)	18 (12)
9 years	27 (11.3%)	15 (12)
10 years	30 (12.6%)	19 (11)
11 years	26 (10.9%)	17 (9)
Total	**239**	**127 (112)**

Procedure

Instructions. Data collection occurred in lab and at a nearby museum. In the museum, experimenters directly approached families that appeared to have children in the correct age range to invite them to participate in a short research study. In both cases, parents (or guardians) provided informed consent for their child's participation before any additional study procedures occurred. Once parental consent and child assent were obtained, the child went through the picture sorting task procedure with an experimenter while another experimenter ran through the same task with the parent. The instructions for the task were as follows: "You are about to see sets of four pictures, and you will be asked to put them in order based on how much you like them. On the one end you will see a frowny face, and on the other you will see a smiley face. I want you to move these pictures around so that the pictures are in order of the one you like the least by the frowny face to the one you like the most by the smiley face. When you've put the photos in order of your least to your most favorite, you can press the green button to go onto the next set of pictures." All child participants had these basic instructions explained to them (and additional information and clarification added with 4 to 6 year old children), then completed four practice trials with the experimenter where they were asked to sort images of children's bedrooms before continuing onto the real task. To ensure that children understood the task, the researchers took the children through these practice trials very deliberately and carefully, asking children to verbally indicate their preference for the photos as they moved them along the frowny-to-happy-face scale. Child participants who

struggled with comprehending the task were still run through full procedures, but their lack of understanding was noted, and they were subsequently excluded from analysis. Adults were provided with the same general instructions but did not complete the practice trials.

Stimuli. Participants evaluated sets of 10 photos, previously rated on naturalness and preference in a separate, normative adult sample. There were two different image sets used in this experiment (parents and children always completed the task with the same image set). In each set, there were 6 categories of photos based on previous normative adult evaluations of their aesthetic value (measured on a 1-7 likert scale from 1 = strongly dislike to 7 = strongly like) collected before the current study. These categories were high aesthetic value nature (two images), low aesthetic value nature (two images), high aesthetic value urban (two images), low aesthetic value urban (two images), very high aesthetic value nature (one image), and very low aesthetic value urban (one image). Images in the high aesthetic value nature and high aesthetic value urban categories were matched on preference, as were those in low aesthetic value nature and urban (see Table 2 for pre-ratings). The unmatched images (very high aesthetic value nature and very low aesthetic value urban) were included based on research in our lab that finds these photos reliably elicit more extreme ratings in an adult sample. We have been unable to find sufficiently highly preferred urban images to match the very high aesthetic value nature (and nature to match the very low aesthetic value urban) which inevitably leads to a design in which conditions are not completely crossed. However, we chose to include these images

as an additional, separate test of whether children's preferences map onto the preferences

we see in adults.

Table 2. Average image aesthetic value pre-ratings

Ratings on a 1-7 scale (1 = strongly dislike, 7 = strongly like) for images in each picture set, aggregated from a normative adult sample.

	Very High Aesthetic Value Image	High Aesthetic Value Image #1	High Aesthetic Value Image #2	Low Aesthetic Value Image #1	Low Aesthetic Value Image #2	Very Low Aesthetic Value Image
Picture Set 1						
Nature	6.31	5.30	5.12	3.28	3.12	
Urban		5.29	5.11	3.28	3.06	2.09
Picture Set 2						
Nature	6.19	5.02	4.86	3.30	3.22	
Urban		5.04	4.88	3.30	3.22	1.77

Task. The task was completed on a touch-screen tablet, which allowed participants

to drag the photos left and right to put them in the preferred order. The task included 10

trials where four photos were shown at a time. The presentation of images was

randomized (across trials and across starting positions within a trial) but the task used an

algorithm to ensure that each of the 10 images were compared to all other images at least

once. (see Figure 1 for a display of the task).

Figure 1. Task Design

Upper panel depicts a trial from the practice rounds. Lower panel depicts a trial from the actual experiment.
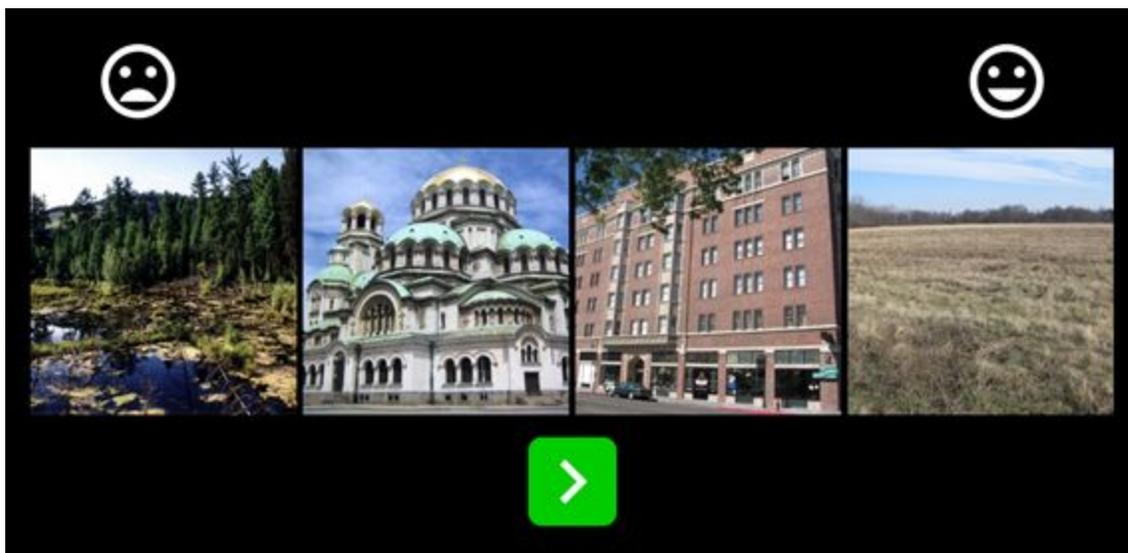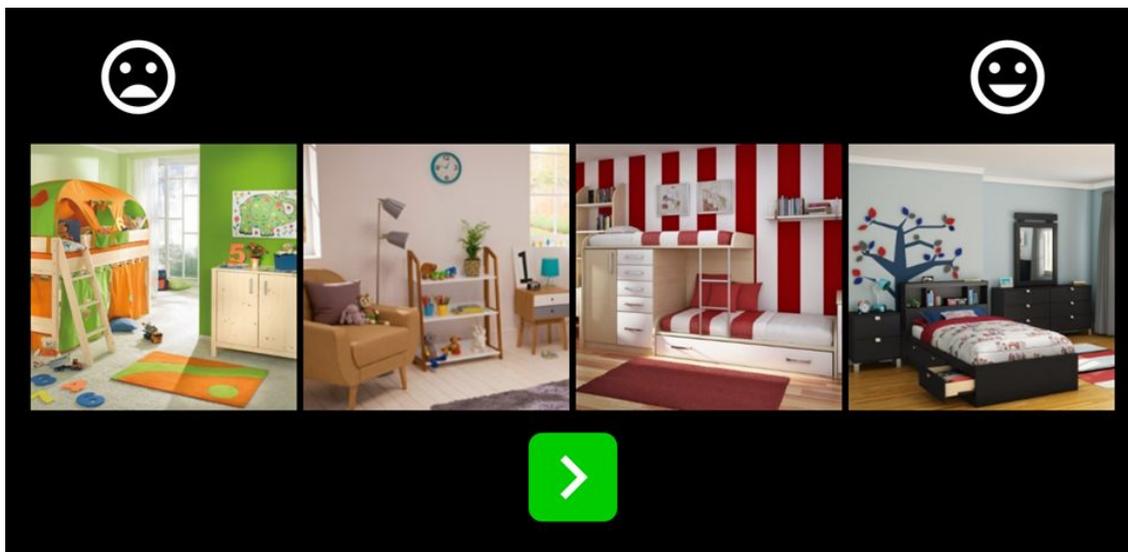
Additional Measures. Parents were also asked to complete a number of optional questionnaires about their child. Standard demographic measures were collected (birthdate, gender, ethnicity, household income, parental education) as well as zip code, which was used to calculate objective greenspace/land cover types from the 2011 National Land Cover Database (NLCD). From the NLCD data, we calculated amount of natural features nearby (summed coverage of values for water, deciduous forest, evergreen forest, mixed forest, shrub, grassland, pasture, cultivated land, woody wetlands, and herbaceous wetlands) as well as a ratio of low to high developed land, calculated by taking the amount of open-to-low developed land and dividing by the amount of medium-to-high developed land.

We also collected parent-reported natural features near the child's home (and school or daycare if applicable). This questionnaire, adapted from (Tilt, Unfried, & Roca, 2007), asks about the presence of nine types of natural features within an approximate half mile distance from home or school. The total number of features near home (or the average of home and school/daycare if both included) was used to calculate parent-reported nearby natural features.

Additionally, the types of children's play environments outside of school and daycare hours and during school/daycare hours (if applicable) were assessed. The play environments questionnaire, adapted from (Amoly et al., 2014; Faber Taylor & Kuo, 2011), asked parents to indicate the environments that their child typically plays in most of the

time during a warm week in autumn or spring. Play in more natural versus more built spaces was calculated by taking the number of natural play environments (big trees and grass, open grass, "wild" places, waterfronts, deserts, and farms) and subtracting the number of built or indoor environments (deep indoors, indoors with windows, paved or built places, public indoors).

Lastly, we asked parents to fill out the Strengths & Difficulties Questionnaire (Goodman, Lamping, & Ploubidis, 2010), which assesses peer problems, conduct problems, emotional problems, hyperactivity/ inattentiveness, and prosocial behaviors.

Not all parents provided full questionnaire data during the study. Of the usable sample of 239 children, age and gender were collected for all 239 participants, 235 have basic demographic information (ethnicity, income, parental education), 195 provided their home zip code, 200 completed the parent-reported nearby natural features questionnaire, 171 completed the typical play environments questionnaire, and 151 completed the Strengths and Difficulties Questionnaire (see Table 3 for full breakdown).

Table 3. Questionnaire Data in Current Sample

Percentages reflect the number of children with the measure out of the total usable children.

Total Usable Children	Demographic information	US zip code	Parent-report Nearby Nature	Parent-report Nature Play	Strengths & Difficulties Questionnaire
239	**235** (98%)	**195** (82%)	**200** (84%)	**171** (72%)	**151** (63%)

Data Analysis

The output from the picture sorting task was 10 trials of pictures ranked from 1 (least preferred in trial) to 4 (most preferred in trial). Occasionally, participants accidentally hit the advance button twice in a row, skipping the trial. To account for this, trials that had a duration less than 1 second were removed from the data.

The average rating used for visualization (in <u>Figure 2</u>) was calculated by taking the average position of each photo across the 4 trials in which it occurred, resulting in a value between 1 (always chosen as least preferred) and 4 (always chosen as most preferred) for each picture. For subsequent statistical analyses, these average ratings were sorted from highest to lowest to create a full 1 to 10 ranking of all images in the set. In the case where multiple images had the same average rating, the higher ranking was given to the image that was more preferred in the trial(s) that included both images. Because the statistical analysis procedures used (described in the Statistical Analysis section) are not easily graphed, these average ratings were used to visualize the pattern of results.

A subset of adult participants (15 out of 182) were excluded from analysis after being identified as likely completing the task in reverse. This assessment was based on having both exceptionally low ratings (1 to 1.75 out of 4) of the very high aesthetic value nature images and high ratings (3.25 to 4) of the very low aesthetic value urban images. The very high aesthetic value nature images and very low aesthetic value urban images received very reliable ratings in previous stimulus validation studies and across the rest of

the adult sample in the current study. Given that the adults were given the instructions but did not do any practice trials with an experimenter, and on a few occasions parents realized they were doing the task in reverse and told the experimenter this was the case, we felt confident that these adults were likely not paying close attention to the frown/smile anchors and simply made their rankings backwards. Including these 15 adults in any analyses did not alter the direction or significance of any results.

Statistical Analysis of Task Data. As the task data were ordinal and included repeated measures, we conducted regression analyses using a proportional odds mixed model (McCullagh, 1980), fit using the "ordinal" package (Christensen, 2018) in R 3.5.1 (R Foundation for Statistical Computing, www.rproject.org). This analysis models the effect of predictors across the "cut-points" between categories of the ordinal criterion variable. In the case of our data, there were 10 categories (ranks 1 through 10) resulting in nine cut-points. The proportional odds model predicts the log odds of a given response being below each cut-point, under the assumption that a predictor's effects do not significantly differ across cut-points (i.e., the proportional odds assumption). If the proportional odds assumption is met, the model yields cumulative odds ratios that do not depend on the specific cut-points used. To test the proportional odds assumption, we modelled predictor separately as nominal effect and as an ordinal effect, and the model fits were compared via likelihood-ratio test. In all cases, the model fits did not significantly differ, indicating that the proportional odds assumption was met (i.e., the effect of predictors did not differ across cut-points). Maximum likelihood parameter estimates were obtained using an adaptive Gauss-Hermite quadrature approximation using 11 quadrature points (Lesaffre &

Spiessens, 2001), implemented through the nlminb function in R. Participant was included as a random intercept in our analyses to account for repeated measures. To specifically analyze age-related changes in the very high aesthetic value nature and very low aesthetic value urban categories, proportional odds modelling was conducted using the lrm function in the R package 'rms' (Harrell, 2018).

Analysis of Environmental Exposure and SDQ variables. To examine the relation between individual differences in children's nature exposure and cognitive functioning as measured by the Strengths & Difficulties Questionnaire, a multiple imputation procedure (Rubin, 1987) was first employed to handle participants with varying amounts of missing questionnaire data. Multiple imputation was performed using the "mice" package in R (van Buuren, 2018). This package implements multivariate imputation by chained equations, while preserving both extant relations in the data and the level of uncertainty about these relations. An analysis was conducted by running 40 imputations on our dataframe which contained about 17% missingness, using predictive mean matching as imputation method. Multiple imputation procedures are appropriate when the amount of missing data is not extreme, as in this case (Rubin & Schenker, 1991). Next, statistical analyses were run on the 40 imputed datasets, where the outputs contain the pooled effects of the statistical model across all imputations, and contain an additional error term for the effect of imputation. The R package "miceadds" (Robitzsch, Grund, & Henke, 2018) was used to generate pooled correlations among variables across all imputed datasets.

Analysis of Parent-Child Similarity of Preference. To analyze whether children's preferences reflect those of their parents, the Euclidean distance between children's

rankings of photos and their parents' rankings were calculated and compared to non-parents. A standard distance calculation was performed, using the image ranks for all 10 images for kids and parents:

$$\sqrt{(img1rank_{child} - img1rank_{parent})^2 + (img2rank_{child} - img2rank_{parent})^2 + \ldots + (img10rank_{child} - img10rank_{parent})^2}$$

This calculation was also performed on each child and every adult other than the child's parent in the same picture set. These calculations were then averaged, to create a value of the average distance of the child and the **n** other adults. That is, (

$$\sqrt{(img1rank_{child} - img1rank_{adult\ 1})^2 + (img2rank_{child} - img2rank_{adult\ 1})^2 + \ldots + (img10rank_{child} - img10rank_{adult\ 1})^2}$$

$$+ \ldots +$$

$$\sqrt{(img1rank_{child} - img1rank_{adult\ n})^2 + (img2rank_{child} - img2rank_{adult\ n})^2 + \ldots + (img10rank_{child} - img10rank_{adult\ n})^2}$$

) divided by **n**.

Results

Environmental Preferences differ between Children and Adults

To test for preference differences between adults (i.e., parents and guardians in the current study) and children, a proportional odds mixed model was conducted using rank (1-10) as an outcome variable, environment type (nature/urban) and aesthetic value (high/low) as within-subject predictors, categorical age (adult/child) as a between-subjects predictor, and participant as a random variable. The model using the full interaction of predictor variables did not yield a significant 3-way interaction, and did not

differ in goodness of fit from the model including only 2-way interactions, so the results of the more parsimonious model are reported.

A significant interaction of categorical age and environment type was found (B = 1.44, Z = 11.45, OR = 0.27, 95% CI [0.18, 0.30], p < 0.001), where children showed a greater preference for urban images compared to adults. Adults and children also differed in their preference for photos based on aesthetic value (B = 0.36, z = 2.90, OR = 0.70, 95% CI [0.54, 0.89], p = 0.003). Specifically, adults preferred the high aesthetic value images (compared to low aesthetic value ones) to a greater extent than did children (see Figure 2).

Children's Environmental Preferences

To test for children's preferences and how they may be influenced by age, a proportional odds mixed model was again employed using rank (1-10) as an outcome variable, environment type (nature/urban) and aesthetic value (high/low) as within-subject factors, child age as a continuous predictor, and subject as a random variable.

Group Effects

Results of this analysis showed a main effect of environment, where children generally preferred the urban environments compared to natural ones (B = -0.83, Z = -7.10, OR = 0.44, 95% CI [0.35, 0.55], p < 0.001). There was also a main effect of aesthetic value where children exhibited greater preferences for high aesthetic value images (B = 1.73, Z = 14.5, OR = 5.65, 95% CI [4.47, 7.14], p < 0.001). A significant interaction of environment and aesthetic value was also found (B = 0.70, Z = 4.31, OR = 0.50, 95% CI [0.36, 0.68], p <

0.001) where children exhibited a larger ranking difference between high and low aesthetic

value nature scenes compared to urban scenes (see Figure 2).

Figure 2. Preference for Environment Types in Adults and Children

Plotted are the average ratings for each image type (VHA_N = Very High Aesthetic value Nature, HA_N = High Aesthetic value Nature, LA_N = Low Aesthetic value Nature, HA_U = High Aesthetic value Urban, LA_U = Low Aesthetic value Urban, VLA_U = Very Low Aesthetic value Urban) in the adult and child samples. The boxes represent the four conditions that are completely crossed for statistical analysis. In this chart, higher ratings (closer to 4) represent more favored image types and lower ratings (closer to 1) represent less liked image types. Error bars indicate +/- SEM.
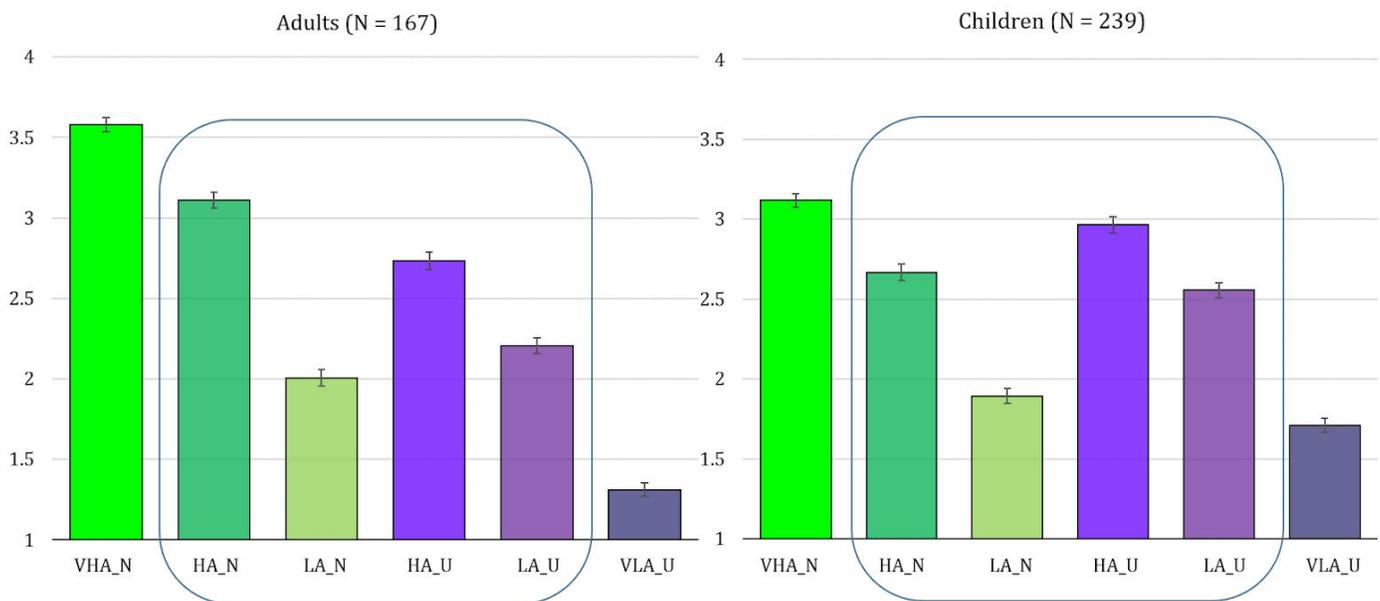
Age-Dependent Preferences

Importantly, both children's preference for environment type and aesthetic value showed significant interactions with age. With increasing age, children showed a lessened preference for urban environments over natural ones ($B = 0.32$, $Z = 4.30$, $OR = 1.39$, 95% CI [1.18, 1.63], $p < 0.001$). Additionally, children preferred images of high over low aesthetic value to a greater degree with increasing age ($B = 0.27$, $Z = 3.31$, $OR = 1.31$, 95% CI [1.11, 1.53], $p < 0.001$; Figure 3).

Age related changes in the very high aesthetic value nature images and very low aesthetic value urban images were examined in separate proportional odds regressions, predicting the rank of the image (1 to 10) by child age. A significant effect of age was found on rankings of very high aesthetic value nature images ($B = -0.43$, $Z = -3.62$, $OR = 0.65$, 95% CI [0.51, 0.82], $p < 0.001$), where higher preference rankings were associated with increasing child age. There was also a significant effect of age on ranking of very low aesthetic value urban images ($B = 0.68$, $Z = 5.59$, $OR = 1.98$, 95% CI [1.56, 2.52], $p < 0.001$). For this category, as age increased, children's preferences for these images decreased (Figure 3). In summary, as children aged, their preferences began to look more similar to those of adults.

Figure 3. Developmental Changes in Environmental and Aesthetic Value Preference

The top panels represent differences calculated from average ratings, plotted across age groups. The environment preference measure ("Nature - Urban") displayed in the upper left panel was calculated by subtracting the average of the high and low aesthetic value Urban categories from the average of the high and low aesthetic value Nature categories. Similarly, the aesthetic value measure ("High - Low Aesthetic Value") displayed in the upper right panel was calculated by subtracting the average of ratings for Low Aesthetic value Nature and Urban photos from the High Aesthetic value Nature and Urban photos. The bottom panels represent average ratings for the Very High Aesthetic value Nature category (lower left) and Very Low Aesthetic value Urban category (lower right), divided across age bins. Error bars represent +/- SEM.
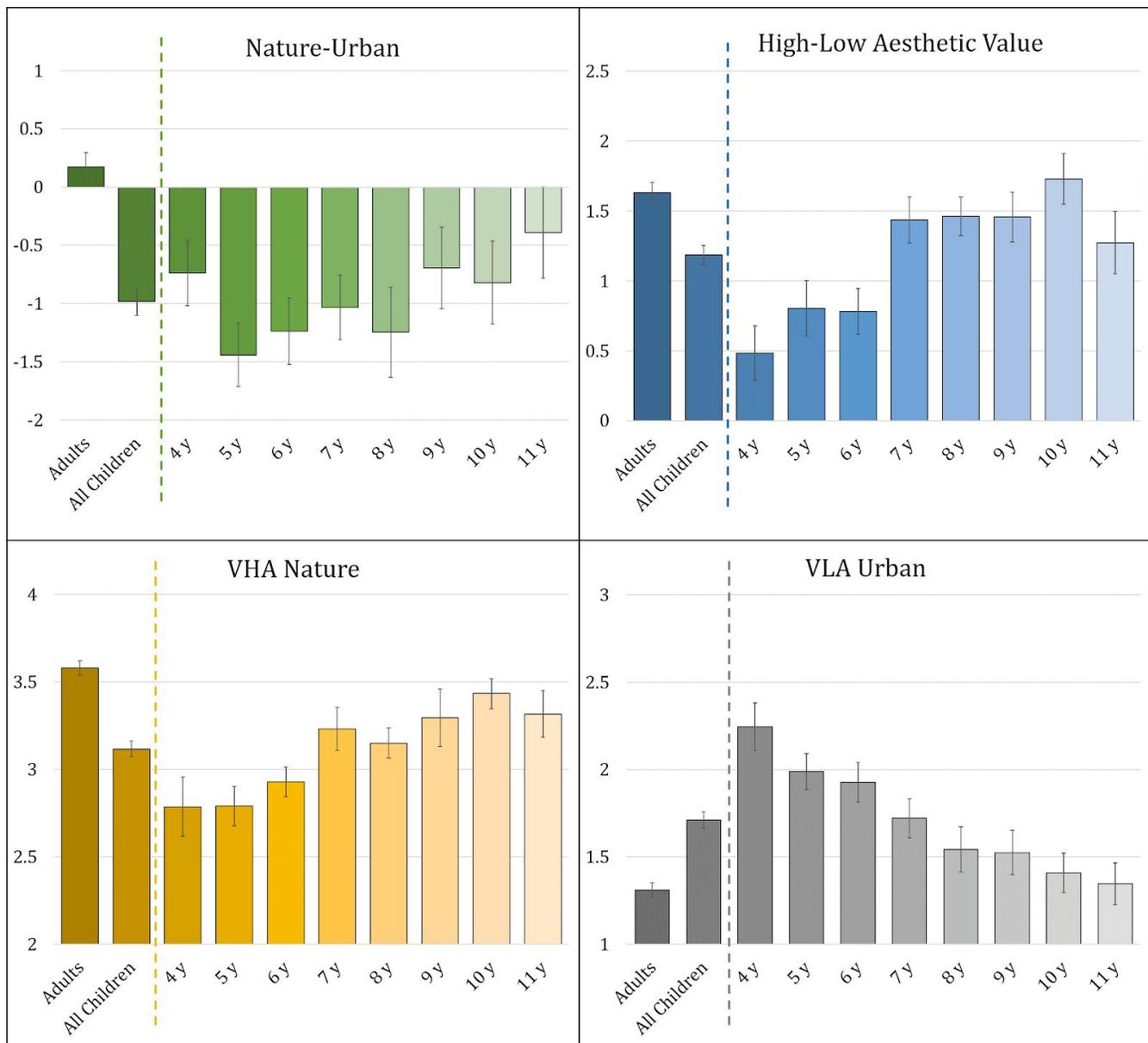
Relations between nature exposure, nature preference, and children's behavior

A goal of this study was to see whether any of the observed benefits of nature exposure on children's cognitive, social, and emotional functioning could be explained by individual differences in children's nature preferences. Another aim was to see if nature exposure was linked to preference. For this purpose, the datasets obtained from our multiple imputation procedure were used to overcome missing data, where both linear regressions and correlations were performed on each of the imputed datasets. The results of each analysis are pooled and include correction for the error term generated by the imputations. For all correlations conducted, Fisher-z transformed coefficients are reported.

Nearby Nature Predicts Children's Attention

Based on extensive prior research that looked at the effects of nature exposure on children's attentional functioning, a confirmatory analysis was conducted examining the effects of nearby nature and play in nature on the parent-reported hyperactivity/ inattentiveness subscale from the SDQ. As predicted, greater parent-reported nearby natural features were correlated with lower scores on the SDQ hyperactivity/ inattentiveness subscale (r = -0.21, 95% CI [-0.36, -0.05], p = 0.008). However, income was also negatively correlated with hyperactivity/ inattentiveness (r = -0.24, 95% CI [-0.4, -0.06], p = 0.009). Thus, separate analyses were run to see whether natural features were still predictive when income was included in the model. Results from a linear regression indicated that both greater parent-reported natural features and higher income were significant independent predictors of children's inattentiveness/ hyperactivity (Natural

features: B = -0.26, Z = -2.32, p = 0.022; Income: B = -0.29, Z = -2.25, p = 0.026).

Surprisingly, play in more natural environments was not significantly related to this SDQ

measure (ps = 0.2).

Other Nature-Behavior Relations

An exploratory analysis was conducted to examine whether parent-reported

interactions with nearby nature (natural features near home/school), parent-reported play

in natural over built environments, or objective measures of nearby nature (zip code based

NLCD measures of natural features and high versus low developed space) were correlated

with any of the other SDQ subscales: conduct problems, emotional problems, peer

problems, and prosociality.

Results of the full correlation matrix can be found in Table 4. As expected, there

were strong correlations between NLCD natural features and parent-reported nearby

natural features (r = 0.47, 95% CI [0.32, 0.55], p < 0.001), as well as NLCD natural features

and play in natural environments (r = 0.32, 95% CI [0.18, 0.44], p < 0.001).

More parent-reported nearby natural features were modestly correlated with lower

scores on the SDQ conduct problems subscale (r = -0.15, 95% CI [-0.3, -0.01], p = 0.047), but

was not related to any other SDQ subscales. Play in natural environments and nearby

natural features calculated from zip-code based national land cover data (NLCD) were not

related to any SDQ measures (all p > 0.13).

Table 4. Correlation matrix of nearby nature, SDQ, demographics, and child environmental preference

Fisher-z transformed coefficients are listed for all correlations between parent-reported and objective nature, SDQ subscales, SES measures, and children's environmental preferences. Coefficients highlighted in blue with ** indicate a *p*-value of less than 0.01, and those highlighted in green with * indicate *p* < 0.05. P-values reported take into account the standard error generated by running these analyses on multiply imputed datasets, and as such, coefficients with a greater error term may not be statistically significant despite a higher value for the coefficient itself.

	PR Nat Play	NLCD Nat Feat	NLCD Dev	SDQ Emot	SDQ Cond	SDQ Inatt/ Hyper	SDQ Peer	SDQ Prosoc	Income	Mom Ed	Child Env Pref
PR Nat Feat	.37**	.47**	.32**	0	-.15*	-.21**	-.06	.13	.15	.03	-.03
PR Nat Play		.32**	.18*	-.08	-.08	-.11	-.1	.11	.05	.14	.02
NLCD Nat Feat			.63**	-.13	-.09	-.1	-.13	.1	-.05	.01	-.03
NLCD Dev				-.08	-.06	-.08	0	.1	.05	.05	-.04
SDQ Emot					.34**	.39**	.36**	.26**	-.3**	-.11	.01
SDQ Cond						.54**	.08	-.44**	-.24*	-.12	-.13
SDQ Inatt							.18*	-.34**	-.24**	-.21*	-.04
SDQ Peer								-.12	-.22	-.08	.07
SDQ Pros									.1	.05	-.03
Income										.46**	-.13
Mom Ed											-.1

[Legend: PR Nat Feat = Parent-reported nearby natural features, PR Nat Play = Parent-reported measure of child's play in nature over built space, NLCD Nat Feat = natural features calculated from zip-code level NCLD data, NLCD Dev = ratio of open/low to medium/high developed space from zip-code level NLCD data, SDQ Emot = Emotional problems subscale, SDQ Conduct = Conduct problems subscale, SDQ Inatt = Inattentive/Hyperactive subscale, SDQ Peer = Peer problems subscale, SDQ Pros = Prosocial behavior subscale, Income = family household income, Mom Ed = Maternal Education, Child Env Pref = Child's preference for natural over urban environments]

Children's Nature Preferences are Unrelated to Exposure

To examine whether individual differences in nature preferences played a role in any of the observed nature benefits on behavior, a metric of nature versus urban preference was also examined in the correlations. This metric was calculated by taking the average rank for the four nature images, and subtracting the average rank of the four urban images. Interestingly, children's environmental preferences were not related to any nearby nature exposure variables or any of the SDQ measures (see Table 4).

Parental Influences on Children's Preferences

Results of a paired t-test comparing child-parent distance and child-nonparent average distance indicated that the distance between rankings of parents and children (M = 10.17, SD = 3.2) was smaller than the distance between children and the non-parents (M = 10.71, SD = 1.7; t(203) = 3.12, p = 0.002). This shorter distance indicates that, overall, children demonstrated more similar preferences to those of their own parent relative to parents of other children viewing the same images.

To see whether parent-child similarity was affected by child age, a mixed model ANOVA was run predicting distance from child-parent pairs versus child-nonparent pairs and child year of age, with a random effect for subject. The results of this analysis did not indicate that age significantly interacted with parent-child similarity (ps = 0.7).

<u>Discussion</u>

Do the pervasive preferences for nature reported in adults (R. Kaplan & Kaplan, 1989) also exist in young children? Unexpectedly, our results yielded compelling evidence that this is not the case. This study found that, in general, fairly robust urban preferences were found in the age range we tested (4 to 11 years). However, this preference for urban environments decreased with children's age. If an innate, biophilic response is indeed responsible for the affinity for nature observed in adults, this developmental trajectory fits most readily with a biologically-prepared learning account.

Young children show a considerable urban preference, but this counterintuitive finding does not appear to have an obvious cause. One feature that strongly relates to children's preferences is stimulus novelty (Cantor & Cantor, 1964). A novelty account would make the argument that children find the urban images more interesting because they are less familiar. This is an unlikely explanation for our results, however, as none of the parent-reported or objective measures of nature near children's homes or schools were related to their preferences. We did find that on average, children's preferences looked more similar to their parent's than to other adults in the study. Thus, one possible influence for children's environmental preferences could be the transmission of parental preferences. However, this effect was small and does not account for the overall large difference between adults and children. As this study was not designed specifically to examine why children prefer urban or natural environments, it is poorly suited to provide a

satisfactory answer to this question. The observed effects do provide an exciting avenue for additional research to identify what underlying mechanisms drive these preferences.

This study also provides support for the idea that children need not prefer natural environments to reap the cognitive benefits. We identified a significant correlation between greater nearby nature and children's inattentiveness and hyperactivity, which was not related to children's preferences. This pattern is consistent with Attention Restoration Theory (S. Kaplan & Berman, 2010), which suggests that nature exposure improves cognitive functioning through replenished attentional capacity, and does not rely on preference-driven mood changes. Additionally, if young children do not generally prefer nature, then it is possible that the cognitive benefits observed for children after nature exposure may not be due to preference (Dadvand et al., 2015; Faber Taylor & Kuo, 2011; Taylor & Kuo, 2009; Wells, 2000). However, as this study does not involve directly manipulating nature exposure for these children, these data do not lend themselves to strong conclusions on the topic. To directly test this, future empirical studies that utilize nature interventions on children's cognitive functioning should consider including a measure of children's environmental preferences.

Like all others, our study is not without limitations. First, though we are using the same anchors and verbal descriptions of preference in both adults and children (i.e., "like", "favorite"), it is impossible to tell with the current design whether we are tapping into the same psychological construct. For example, it could be that children and adults differentially weight the desire to be in a given environment when making a preference evaluation. Again, future research would be required to rule out this and possible

alternative explanations. Another limitation relates to the age range chosen. Though a pilot study indicated that we would have difficulty collecting data from children under 4 years old with this paradigm, there are potentially fascinating and important developmental effects in infants and younger children that require investigation with age-appropriate experimental procedures. Our 11-year old participants do not display preference patterns identical to those of adults, and as such, extending this work into older ages would be required to fully examine the developmental trajectory. Lastly, though our study used multiple picture sets to allow for generalizing above a given set of photos, it would be beneficial to implement this paradigm with a wider array of potential images.

These data provide the first step in a broader series of studies that can attempt to understand why children and adults differ in their environmental preferences, what drives age-dependent changes in preference, and whether nature preferences are necessary for all, some, or none of the observed cognitive, emotional and health benefits of nature exposure in children.

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