

# Seeing Community for the Trees: The Links among Contact with Natural Environments, Community Cohesion, and Crime

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*Individuals may be losing touch with nature as their contact with it decreases worldwide. Although the consequences for people's personal well-being outcomes are becoming well documented, there is almost no research examining the social correlates of contact with nature. This article used a large nationally representative sample to link objective (percent greenspace) and subjective measurements of contact with nature, community cohesion, and local crime incidence. The perceived quality, views, and amount of time spent in nature were linked to more community cohesion, and in turn, the perception of cohesive communities enhanced individual well-being outcomes and contributions back to society through higher workplace productivity and environmentally responsible behaviors. Our findings also indicated that local nature was linked to lower crime both directly and indirectly through its effects on community cohesion.*

**Keywords:** nature, well-being, community cohesion, crime, SDT

**R**apid population growth and expanding infrastructure have transformed over half of the Earth's land surface (Hooke and Martin-Duque 2012). The result is that human contact with nature has declined considerably as people become more urbanized, spend leisure time indoors with technological forms of entertainment, and read children's stories with increasingly urbanized backgrounds (Roberts and Foehr 2008, Pew 2012). Recent estimates put 70% of Europeans and half of people worldwide in urban areas, with figures expected to rise in coming years (United Nations 2012). Theorists have proposed that this trend may be moving individuals toward poorer ties with others and less cohesive societies (Forrest and Kearns 2001).

A large and growing number of empirical studies provides evidence that contact with nature increases positive emotions (e.g., Tarrant 1996, Hartig et al. 2003, White et al. 2010) and contributes to physical health (e.g., Leather et al. 1998, Hartig et al. 2003, Maas et al. 2006) and life satisfaction (e.g., Kaplan 1995, Vemuri and Costanza 2006), among many other indicators of health and well-being. In addition, people actively seek out nature in order to relax (Chiesura 2004), sometimes traveling relatively long distances in order to reach natural areas (e.g., Scrinzi et al. 1995). Indeed, a growing field of

psychotherapy termed *adventure therapy* uses contact with nature as part of a larger therapeutic technique—or sometimes as the therapeutic technique itself (e.g., Hattie et al. 1997, Duncan et al. 2010); basic research and clinical applications suggest a nontrivial link between nature and wellness. In addition to these direct effects, nature can act as a buffer against the negative subjective and physiological correlates of stress (e.g., Ulrich et al. 1991, Fuller et al. 2007). Further research indicates that these positive effects may occur because nature exposure fosters a sense of vitality that is central to well-being and supports coping (Ryan et al. 2010). These health benefits are robust enough that living in natural environments may reduce mortality risk and reduce socioeconomic inequalities (Mitchell and Popham 2008).

Although a considerable literature exists on these individual well-being outcomes of contact with nature, little is known about its *social* consequences. Central to this research is the idea that contact with nature might enhance the quality of social and community interactions because it promotes a sense of connection with the outside world that generalizes to other people. This idea has its roots in the psychological perspective of self-determination theory (SDT; Ryan and Deci 2000) and a complementary approach

from evolutionary science, the biophilia hypothesis (Wilson 1984, 1993). The biophilia hypothesis posits that all humans have an innate affiliation to other living organisms and organic systems such that people intrinsically connect and relate to natural environments. In later work, Kellert (2012) argued that human affection, aversions, and communication are closely contingent on closeness to nature. The biophilia hypothesis is often explained in evolutionary terms: From this perspective, our ancestors experienced day-to-day life in natural environments, and nature served as the source of food and survival (e.g., Wilson 2007). Some have pointed to our evolved fear of potentially harmful natural stimuli (e.g., snakes) and lack of inherent fear of potentially harmful modern-day stimuli (e.g., handguns) as further evidence that this is an evolutionarily and biologically based instinct (Gullone 2000), and other research has shown that humans are drawn to natural environments that were conducive to survival and flourishing (Appleton 1975, Orians 1980). In summary, the biophilia hypothesis and supporting research suggest that immersing oneself in natural environments is an inherently satisfying activity, one that promotes a sense of connection in people regardless of background and location.

SDT further argues that all humans have a basic and innate need for relating and connecting to others or to the world around them (Ryan and Deci 2000, Kneezel and Emmons 2006). Relatedness needs are often, but not exclusively, satisfied through interactions with others (Deci and Ryan 2012). For example, research has suggested that the need for relatedness can be satisfied in the context of certain games, including those providing a mix of human- and computer-controlled characters (Przybylski et al. 2010). More pertinent to this article, recent work has shown that individuals feel close and connected to natural environments after contact with them (Mayer et al. 2008, Weinstein et al. 2009). Important to our reasoning is work informed by SDT, which suggests that the more relatedness people experience, the more they will seek further relatedness; presumably, this snowball effect could result when the initial sense of relatedness is satisfied by natural environments and extends to relationships with other people (Moller et al. 2010). This psychological work provides a theoretical framework for understanding why natural environments may promote relationships between people: Natural spaces foster a sense of relating to the outside world, which generalizes to a caring and closeness with other people.

### Community cohesion

Not surprisingly, mutual caring and feelings of connectedness, in turn, shape people's community interactions (Gilchrist 2009). This article therefore explores the idea that community cohesion and the benefits it bestows are promoted by contact with nature. There is some evidence to support this suggestion. A sense of place is closely tied into a sense of community: "when the latent bond of common interest in the place...draws people together and enables them to express common sentiments through joint action"

(Wilkinson 1991, p. 7). From this interactional perspective (Kaufman 1959, Wilkinson 1991), the physical space is invested with meanings that affect and are affected by the interactions of residents (see also Theodori and Kyle 2013); the physical structure of space can encourage the support and caring that underlie social cohesion or social capital (Patrick and Wickizer 1995). The simple presence of natural environments can facilitate social experiences, bringing people out of their homes and offices and into communal spaces, but they only do so if natural environments are made accessible. Self-reported connectedness to nature has been linked to higher perceived empathy for others (Mayer and Frantz 2004). In addition, qualitative interviews and observational data have indicated that natural spaces in urban areas encourage public social interactions (Sullivan et al. 2004, Dines and Cattell 2006). Experimental work suggests that people exposed to nature for brief experimental procedures using images or plants within a laboratory setting are more likely to give money to others in an economics game and espouse more social goals (Weinstein et al. 2009); however, no one has applied this work to understanding the links between nature and society as a function of longer-term contact. Given that brief but powerful effects observed in laboratory settings may generalize to longer-term behavioral and experiential shifts when individuals are exposed to comparable stimuli in their daily life (e.g., Anderson and Dill 2000), it is reasonable to expect that observations of changing social behavior after brief periods of contact with nature may translate to impactful changes in social and community experiences when people are exposed to nature in their daily lives.

### Crime

The strength of a community extends beyond cohesion, to the levels of crime and aggression. A higher-quality community life crucially involves a lower incidence of crime, which feeds into perceptions of safety (Raphael et al. 2001). Neighborhoods high in crime are also characterized by community members' distrust, hostility, and lower perceptions of community cohesion (Greenberg et al. 1982, Taub et al. 1984, Sampson and Groves 1989). Furthermore, these relations between strong intracommunity bonds and crime occur independent of socioeconomic factors, although these also play a big role in determining crime levels (Skogan 1989).

Crime rates have been associated with a number of characteristics of the area, including economic deprivation and unemployment (Bursik and Grasmick 1993, Gould et al. 2002), highly populated urban areas (Danziger 1976), and higher temperature (Ranson 2014). Historically, vegetated areas have been associated with greater perceptions of the possibility of crime (e.g., Nasar 1982). However, some work has suggested that more natural surroundings are negatively associated with crime and proposed this link to be due to nature facilitating residents spending more time outdoors and monitoring their environment (Kuo and Sullivan 2001).

Importantly, these population-level data show that areas of a US city with more nature also have less crime and controls for density of apartment units, apartment vacancy rates, and building height, among other possible confounds.

### Other outcomes of social cohesion: Media use, happiness, work performance, and environmental concern

Increasingly, findings suggest that the community has an important role in promoting health and a sense of happiness (Raphael 1999, Robert 1999, Boutilier et al. 2000) and that social cohesion is particularly important in this respect (Wilkinson 1991). The impact of nature on communities extends across important elements of wellness and to a number of personal reactions and daily behaviors. For example, research has shown that community cohesion increases individuals' general sense of well-being (Morrow et al. 1999, Bramstone et al. 2002). As social needs are satisfied, people also spend less time in solitary media-use behaviors that offer an escape from daily life, such as watching television and spending time on the Internet (Katz and Foulkes 1962, Katz 2002, Bickham et al. 2006); instead, they may spend free time with important others. Benefits extend further into workplace behavior, and research shows that socially supportive contexts at home, such as community cohesion, predict better work performance (e.g., Bliese et al. 1996, Voydanoff 2001). The benefits of community cohesion may extend beyond the social and personal sphere to the environmental concern that benefits global environmental problems, and research shows that when individuals live in more cohesive societies, they are more likely to contribute with environmentally friendly behaviors (Roseland 2000).

### Present research

The present research links contact with nature and important covariates with social cohesion outcomes, and by doing so, we extend previous work in a number of ways. It is the first study to test social correlates of both objective (actual, coded geographic data) and subjective (self-reported) contact with nature in a systematic way. Second, we rely on a community sample randomly selected from a large cohort and weighted to be nationally representative, and we can therefore make generalizations across geographic (urban versus rural) and socioeconomic groups in the population. Third, we control for an extensive list of potential social and personal confounds (e.g., community-level and individual socioeconomic status). Finally, we explore *contact* as including both exposure (through viewing nature) and engagement with nature (through visiting natural areas). Presumably, individuals surrounded by natural environments may derive little benefit if they perceive nature to be of low quality or inaccessible or if they do not spend time in natural environments. In the present research, we test the links between daily contact with nature around one's home and community and social outcomes. Using a nationally representative sample, we test the hypothesis that daily contact

with nature around one's home and community is linked to higher levels of social cohesion and lower levels of crime, which in turn has individual well-being outcomes. Analyses were conducted using two conservative methods: Because of the large number of potential predictors tested, model-selection techniques (Burnham and Anderson 2002) were used to objectively identify the most predictive and concise regression models from candidate models based on different hypotheses; this approach is less vulnerable to experimenter bias than conducting many independent analyses, and it increases a researcher's power to identify key effects. In addition, a structural equation model was constructed to concurrently assess the links among nature, community cohesion, and personal outcomes.

### The participants and procedure

This study was conducted using an online interview administered to the participants in the 150,000-person Harris Poll panel of Great Britain. A subset of panelists (15,173) was selected at random from the base sample and invited by email to take part in the survey; responses were accepted until the survey was closed two weeks later. Data from the weighted responding sample were collected over a 2-week period in late September 2011. This process yielded a cohort of 2079 adults (1040 men and 1039 women) ranging in age from 22 years to 65 years ( $M = 43.21$  years,  $SD = 11.49$  years), who provided the information outlined below. Statistical weightings were performed for age, gender, race/ethnicity, education, region, and household income when necessary to bring them into line with their actual proportions in the population based on UK census data. Participant incomes ranged from less than £10,000 to over £150,000 per year (income,  $M = £14,000$  per year,  $SD = £10,000$ ) and came from across the United Kingdom (the areas most highly represented consisted of South East, 15.8% of the participants; London, 12.5%; Northern Ireland and Scotland, 11.1%; North West, 10%; and South West, 9.6%). The online survey assessed community predictors, socioeconomic and other demographic standing, subjective contact with greenspace (used as a surrogate for nature), perceived community cohesion, and individual experiences of well-being. The means for major study variables (described individually in the section below), which are split by gender, age, income, and education, are presented in table 1.

**Objective measure of local nature.** We extracted information at the level of wards (the primary unit of UK electoral geography) on their percent cover by nature from the General Land Use Database (GLUD; ODPM 2001) for England and from the CORINE database (the Coordination of Information on the Environment database, or CORINE; EEA 2000) for elsewhere. *Natural cover* was defined very broadly to include gardens, parks, woods, meadows, and farmland, mapped to a 5-square-meter resolution (Richardson and Mitchell 2010). *Vegetated areas* included gardens, parks, woods, meadows, and farmland (separate sources of nature were not

**Table 1. Nature and Community Cohesion.**

	Gender				Age				Income				Education			
	Men		Women		Younger		Older		Low		High		Low		High	
Predictors	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Contact with nature (subjective)	-0.04	(0.7)	0.02	(0.7)	-0.13	(0.7)	0.13	(0.7)	-0.10	(0.8)	0.04	(0.7)	-0.03	(0.7)	-0.00	(0.7)
Contact with nature (Objective)	50.98	(26.1)	53.06	(27.1)	48.12	(25.8)	56.42	(26.8)	50.56	(27.1)	52.82	(26.3)	53.97	(24.8)	50.31	(27.2)
<b>Outcomes</b>																
Community cohesion	2.84	(1.0)	2.90	(1.0)	2.77	(1.0)	2.99	(0.9)	2.82	(1.0)	2.89	(1.0)	2.82	(1.0)	2.91	(1.0)
Crime	-0.012	(1.0)	0.0	(1.0)	0.11	(1.1)	-0.12	(0.8)	0.04	(1.0)	-0.02	(1.0)	-0.01	(1.0)	0.01	(1.0)
<b>Community factors</b>																
Socio-economic deprivation	21.38	(13.9)	20.81	(13.2)	23.32	(14.4)	18.58	(12.1)	24.05	(14.3)	19.46	(12.8)	21.71	(13.9)	20.56	(13.2)
Population density	23.80	(24.5)	23.07	(25.1)	24.87	(25.8)	18.31	(19.7)	23.07	(23.7)	25.62	(30.6)	22.65	(24.1)	28.03	(28.0)
Unemployment rate	1.48	(0.5)	1.42	(0.5)	1.46	(0.5)	1.39	(0.5)	1.45	(0.5)	1.39	(0.5)	1.45	(0.5)	1.42	(0.5)
Wages	664.53	(177.25)	669.78	(180.8)	659.02	(178.0)	696.36	(179.7)	651.41	(168.0)	768.42	(212.0)	659.22	(170.9)	716.68	(217.2)
<b>Individual outcomes</b>																
Happiness	3.35	(0.6)	3.32	(0.6)	3.28	(0.6)	3.39	(0.6)	3.21	(0.6)	3.40	(0.6)	3.31	(0.6)	3.35	(0.61)
Media use	0.99	(0.4)	0.91	(0.4)	0.97	(0.4)	0.94	(0.4)	0.99	(0.4)	0.92	(0.4)	0.96	(0.4)	0.95	(0.4)
Environmental action	3.28	(1.2)	2.35	(1.1)	3.38	(1.1)	2.43	(1.2)	2.52	(1.1)	2.54	(1.2)	2.58	(1.2)	2.49	(1.1)
Performance at work	7.64	(1.5)	7.88	(1.1)	7.52	(1.5)	8.03	(1.4)	7.75	(1.5)	7.77	(1.4)	7.86	(1.5)	7.68	(1.4)

Means for all study predictors and covariates split by gender, age, income, and education. Crime scores are standardized here because the original scores are large and arbitrary. Wages reflect weekly earnings.

quantified). Databases provided a percentage of the land in a given ward that contains nature.

**Subjective contact with local nature.** Participants reported the extent to which the view out of their home windows was 1, *built-up*, to 10, *natural* ( $M = 5.28$ ;  $SD = 2.58$ ). We also measured accessibility: “How easy is it to get to ‘nature?’” using a scale of 1, *very difficult*, to 7, *very easy* ( $M = 6.13$ ,  $SD = 1.15$ ). To measure the quality of nature, the participants were asked, “How do you perceive the quality of accessible nature?” with a scale from 1, *terrible*, to 7, *excellent* ( $M = 5.37$ ,  $SD = 1.25$ ). Finally, participants responded to the question, “How often do you visit nature?” from 1, *never visit my local nature or any other nature*, to 8, *every day* ( $M = 4.13$ ,  $SD = 1.94$ ). These items were subjected to a principal-components analysis; all four loaded on a single factor with an eigenvalue of 2.07 (no loading was lower than 0.63). Items were averaged to create a single construct we termed *nature contact*.

**Community Cohesion.** Community cohesion was thought to reflect a sense of relatedness with other people that emerged from exposure to nature (Weinstein et al. 2009). It was measured with four items paired with a 5-point scale (1, *not at all true*; 5, *very much true*), with the following items: “I care

about other people in my neighbourhood,” “I feel connected to other people in my neighbourhood,” “I feel that people within my neighbourhood are on ‘same team,’” and “I would help my neighbours if they required 1 hour of my time.” We then calculated the mean of the four items as an overall community cohesion score; the reliability was high ( $\alpha = .88$ ,  $M = 2.87$ ,  $SD = .98$ ).

**Crime.** Crime statistics were extracted from the United Kingdom’s National Archive Database (2012), which records the frequency of 12 crimes requiring police intervention that took place over a period of one year (2011). The crimes included violence, endangering life, wounding, harassment, common assault, and robbery; all were analyzed together. The crime incidence per ward ranged from 99.3 to 6691.58 for the year ( $\alpha = .94$ ,  $M$  number of crimes = 1294.47,  $SD = 1288.46$ ). The most common crimes tended to be violence, criminal damage, and woundings; the average occurrence was above 1500. For analysis, the crime incidence was  $\log_{10}$ -transformed to normalize its distribution.

**Criterion constructs at the individual level.** Happiness was measured using the Positive and Negative Affect Scale (Watson et al. 1988). The participants reported on how much they

felt each of 20 adjectives reflecting general happiness, with a scale of 1, *very slightly or not at all*, to 7, *extremely often*. Negative indicators were reversed, and all items were averaged ( $\alpha = .91$ ,  $M = 3.33$ ,  $SD = 6.05$ ). The participants also reported, using an open-ended question, on their *media use*: the number of hours they watch television ( $M = 11.77$ ,  $SD = 10.17$ ) or spend time on the Internet ( $M = 12.43$ ,  $SD = 11.68$ ) in a given week. In addition, the participants responded to the question, “How is your overall performance at work?” in terms of 1, *worst performance*, to 10, *best performance* ( $M = 7.76$ ,  $SD = 1.46$ ). Finally, we measured environmental concern: “How much action do you take, typically, to preserve the environment?” with a scale ranging from 1, *I take almost no action*, to 5, *I take a lot of action on a daily basis* ( $M = 2.53$ ,  $SD = 1.16$ ).

### Covariates

The following constructs were controlled for at individual and community levels.

**Socioeconomic (SE) deprivation.** We used the Indices of Deprivation ([www.communities.gov.uk/communities/research/indicesdeprivation](http://www.communities.gov.uk/communities/research/indicesdeprivation)) produced by Communities and Local Government (CLG; [www.communities.gov.uk](http://www.communities.gov.uk)) to derive a socioeconomic deprivation score for the English participants, supplemented by the Scottish Index of Multiple Deprivation ([www.scotland.gov.uk/Topics/Statistics/SIMD/Overview](http://www.scotland.gov.uk/Topics/Statistics/SIMD/Overview)), the Northern Ireland Multiple Deprivation Measure 2010 ([www.nisra.gov.uk/deprivation/nimdm\\_2010.htm](http://www.nisra.gov.uk/deprivation/nimdm_2010.htm)), and the Welsh Index of Multiple Deprivation (<http://wales.gov.uk/topics/statistics/theme/wimd/?lang=en>) for the participants outside of England. The Index of Multiple Deprivation contained separate indices for separate domains of deprivation (e.g., ward-level income, employment, and health deprivation and disability), which were simply averaged. The scores ranged from 0.93 to 82.50 ( $M = 21.09$ ,  $SD = 14.97$ ).

**Population density.** The participants were asked to provide their UK postcode data, which was coded using Geoconvert (2012), an online geography-matching and conversion tool which allows analysis of UK postcode data. On the basis of Geoconvert statistics, postcodes were given a number indicating how rural or urban the area, ranging from 1, *rural*, to 4, *urban*, with a national mean of 3.67 ( $SD = .73$ ) as an indicator of population density. In addition, the statistics on population size were compiled using data taken by the 2011 UK Census. The Census is the most complete source of information for the United Kingdom and includes quality assurance indicators (<http://ons.gov.uk>). The population size was controlled for in analyses on crime for a measurement of crime incidence as a function of population size.

**Unemployment rate.** The unemployment rate was derived from the Office for National Statistics (<http://neighbourhood.statistics.gov.uk>) neighborhood statistics index based on 2011

census data. The unemployment rate was defined as the proportion of active members of the population (defined as those at working age who are seeking or available to work) who are unemployed. Rates ranged from 0% to 2.9%, with a national mean of 1.44 ( $SD = 0.49$ ).

**Weekly household wages.** Weekly household wages were derived from model-based estimates for households (Office of National Statistics; <http://neighbourhood.statistics.gov.uk>). This index estimates income per household per week in pounds sterling, from data identified during the period April 2007–April 2008. This was the latest data available at this time and fitted with the time period covered in the current study; wages ranged from £350 to £1640 per week ( $M = 669.40$ ,  $SD = 173.05$ ).

**Socioeconomic standing (SES).** The participants were asked, “How financially secure do you feel?” with a scale of 1, *not at all secure*, to 5, *extremely secure* (the mean responding was 2.70,  $SD = 2.70$ ), and their gross income—their total 2010 household income before taxes—was included as an objective indicator of wealth. Finally, we measured education with the item: “Which of the following, if any, is the highest educational or professional qualification you have obtained?” with a range from “no formal qualification” to “master’s/PhD or equivalent”. A principal-components analysis showed the three scales loaded onto a single factor with an eigenvalue of 1.55 and lowest loading at 0.63; they were standardized and averaged to create a “socioeconomic standing” composite.

**Exploratory additional covariates.** We tested two potential confounds that may result from current and previous experiences linked to our primary constructs. First, we measured and controlled for time socializing. The participants used an open-ended format to report on the hours spent socializing face to face per week ( $M = 5.74$ ,  $SD = 8.46$ ); this construct was used to account for the possibility that more social individuals also reported higher perceptions that their community was cohesive. Second, we measured people’s childhood contact with local nature with the question, “Thinking back to when you were growing up, do you consider that you grew up in an area that was...” paired with a scale ranging from 1, *mostly surrounded by buildings, (i.e., town or city centre)*, to 3, *mostly surrounded by uncultivated natural nature (forests, mountains, natural streams, lakes)*.

### Preliminary descriptive analyses

Missing data (less than 10% of responses) was estimated with multiple imputations (Rubin 1987). Preliminary Spearman rank correlations offered a first view of the relations between living conditions and contact with nature. Socioeconomic deprivation was linked to lower objective nature, locally ( $\rho = -.41$ ,  $p < .001$ ) and higher population density ( $\rho = .28$ ,  $p < .001$ ). Individuals living in socioeconomically deprived areas also reported fewer views of nature or of natural environments

**Table 2. The Spearman rank correlations between living conditions, subjective and objective qualities of nature, crime, and community cohesion.**

	1	2	3	4	5	6	7	8	9	10	11	12
1. Socioeconomic deprivation												
2. Population density	.19											
3. Unemployment rate	.26	.17										
4. Weekly wages	.17	-.08	-.18									
5. Individual socioeconomic standing	-.15	-.04	-.06	.29								
6. Objective nature	-.36	-.54	-.26	.06	.01 <sup>^</sup>							
7. Perceived views of nature	-.30	-.42	-.15	.10	.08	.50						
8. Perceived quality of nature	-.17	-.19	-.09	.16	.17	.18	.34					
9. Accessibility of nature	-.14	-.12	-.08	.12	.10 <sup>^</sup>	.13	.22	.64				
10. Hours visiting nature	-.10	-.15	-.09	.09	.11	.12	.25	.36	.29			
11. Subjective nature composite	-.25	-.31	-.15	.14	.16	.33	.64	.81	.73	.66		
12. Community cohesion	-.10	-.12	-.06	.04	.14	.12	.23	.25	.15	.25	.31	
13. Crime	.43	.20	.01 <sup>^</sup>	-.18	.02 <sup>^</sup>	-.35	-.27	-.06 <sup>^</sup>	.05 <sup>^</sup>	-.06 <sup>^</sup>	-.16	-.04

Note: The analyses are based on  $N = 2079$ . All correlations were significant at  $p < .001$  unless indicated with a <sup>^</sup> symbol. The variables 1, 2, 3, 4, and 6 are at the community level. Individual socioeconomic standing refers to individuals' socioeconomic standing, with higher scores reflecting better standing. Correlations are shown for the individual indicators of contact with nature (variables 7–10) as well as the composite they comprise (variable 11).

( $\rho = -.35, p < .001$ ), lower quality ( $\rho = -.20, p < .001$ ), and accessibility ( $\rho = -.17, p < .001$ ), and they were less likely to spend time in nature ( $\rho = -.12, p < .001$ ). Correlations between study constructs are presented in table 2.

Further analyses showed that, not surprisingly, the presence of nature translated to higher perceptions that nature was available. People living in areas with high objective nature reported more views of local nature ( $\rho = .51, p < .001$ ), higher-quality nature ( $\rho = .19, p < .001$ ), and greater accessibility to nature ( $\rho = .13, p < .001$ ), and they reported spending more time in nature ( $\rho = .13, p < .001$ ; table 1). Bonferroni corrections for these correlations set a new significant  $p$  at .002 (.05/21, across all correlations in table 1), but all correlations remained significant even after corrections. These correlation analyses included simple relations between our predictors of interest and community cohesion, but we then focused on more detailed analyses in which we conducted controlled-for potential covariates and confounds.

### Model selection for community cohesion and crime

We analyzed demographic and nature predictors of community cohesion and crime using multiple regression (ordinary least squares) models within the framework of model selection based on the Akaike Information Criterion (AIC; Burnham and Anderson 2002).

This widely used analytic approach permits an objective assessment of *ideal* (defined as the most concise and predictive) regression models that is free from researcher

bias (Burnham and Anderson 2002); it is therefore the most appropriate approach to use when dealing with a large number of predictors.

We first established an a priori set of models based on our own hypotheses. For community cohesion, we fitted 15 models and the null model (i.e., the model without any predictors). The 15 defined models systematically tested combinations of individual- and community-level covariates and main predictors (objective + subjective contact with nature) based on theory. Thus, we tested competing hypotheses that (a) only demographics (and not nature) were linked to community cohesion, (b) only contact with nature (and not demographics) was linked to cohesion, (c) both independently explained the variance and should be taken into consideration, or (d) none of the predictors accounted for sufficient variance to justify the loss of parsimony. See table 3 for more detail on the models and hypotheses. By including objective and subjective contact with nature in separate models, we allowed that each could be independently important or, alternatively, that the importance of one supersedes the other.

For the crime incidence, we fitted three models as well as the null model. Information on the crime incidence was only available at the ward level, so we used the crime incidence of each ward as the response variable ( $\log_{10}$ -transformed) and included only our ward-level predictor (i.e., objective nature) and covariates (i.e., population size, population density, socioeconomic deprivation, unemployment rate, and

**Table 3. All models predicting community cohesion ordered by model fit (from best to worst fit).**

Hypothesis for model	AIC	$\Delta_i$	Akaike weights	$R^2$
1. Individual covariates + subjective nature	5581.11	0.00	0.56	.11
2. Individual covariates + both objective and subjective nature	5582.33	1.22	0.31	.12
3. Individual and community covariates + subjective nature	5585.02	3.91	0.08	.11
4. Individual and community covariates + both objective and subjective nature	5585.96	4.85	0.50	.12
5. Subjective nature	5607.41	26.21	0.00	.10
6. Both objective and subjective nature	5608.21	27.10	0.00	.10
7. Community covariates + subjective nature	5610.72	29.61	0.00	.10
8. Community covariates + both objective and subjective nature	5611.97	30.85	0	.10
9. Individual covariates + objective nature	5727.88	146.76	0	.05
10. Individual and community covariates + objective nature	5729.16	148.05	0	.05
11. Individual covariates + community covariates	5734.25	153.14	0	.05
12. Individual covariates	5746.03	164.91	0	.04
13. Community covariates + objective nature	5788.78	207.67	0	.02
14. Community covariates	5794.12	213.01	0	.02
15. Objective nature	5795.49	214.38	0	.02
16. Null model	5825.05	243.94	0	

Note: All models are based on simple linear regression of factors affecting community cohesion. The models are ranked according to the Akaike Information Criterion (AIC); the third highest-ranking model did not account for sufficient variability in the outcome ( $\Delta$ AIC more than 2.0), so it was not interpreted. Community cohesion was assessed at the individual level, with community- and individual-level predictors included as potential covariates across 16 theoretically driven models.

**Table 4. All models predicting crime ordered by model fit (from best to worst fit).**

Hypothesis for model	AIC	$\Delta_i$	Akaike weights	$R^2$
1. Covariates and Predictor	531.959	0.000	1.000	.29
2. Covariates only	594.496	62.54	0	.25
3. Predictor only	721.338	189.38	0	.16
4. Null model	917.829	385.87	0	

Note: The models are ranked according to the Akaike Information Criterion; the second and third highest-ranking model did not account for sufficient variability in the outcome ( $\Delta$ AIC more than 2.0) and therefore were not interpreted. Crime was assessed at the ward level and predicted by community covariates only; these were tested across four theoretically driven models to test four predictors.

weekly wages) in the analysis. As before, our models tested competing hypotheses that (a) only the covariates were linked with crime, (b) local nature accounted for the variance in crime, (c) both explained variance independently of each other, or (d) neither explained sufficient variance (also see table 4).

From the fitted models, we selected best-fitting models using the AIC, calculated with the following equation:  $AIC = n \log(\text{residual ss}/n) + 2k$ . We computed  $\Delta$ AIC as a measure of the difference between the highest-ranked model (i.e., the model with the smallest AIC) and other competing models. For these sets of models, Akaike weights ( $w_i$ ) were calculated. A given  $w_i$  can be interpreted as the expected probability of that model being the best one among the full set. Model inference was then made on all models within 95% cumulative Akaike weights (i.e., 95% confidence set of models; Johnson and Omland 2004).

**Community cohesion.** The model-selection exercise suggested that the top three models with the smallest AIC represented

the 95% confidence set of models based on the calculated Akaike weights (table 3 presents the results for all models, presented in order of goodness of fit). Subjective contact with nature, age, gender, and socioeconomic standing (SES) were included in all the three models, and in particular, 95% confidence intervals of the estimated coefficients for subjective nature, age, and SES did not overlap with zero (the findings are detailed in supplemental table S1), indicating that these three factors were particularly important in explaining the variation in community cohesion; see also table 5 for detailed results of the multiple regression model using robust standard errors. The positive coefficient for subjective nature suggests that the level of community cohesion is positively associated with subjective contact with local nature, independent of the effects of age and SES.

**Crime.** Table 4 presents all the three hypothesis-driven models, and table 5 presents findings for the best model based on AIC; the model with community covariates and objective nature was clearly the best-fitting model, with  $w_i$

**Table 5. Detailed results of top fitting models for community cohesion and crime, separately.**

	<i>b</i>	Robust se	<i>t</i> with robust se	<i>t</i> with typical se	<i>r</i> <sup>2</sup>
Predicting community cohesion					
Age	0.01	0.002	4.99***	2.89***	.01
Gender	0.07	0.041	1.71	1.71	.00
SE standing	0.14	0.010	1.40	5.05***	.02
Subjective nature	0.38	0.029	13.10***	12.50***	.08
Predicting crime					
Population size	0.001	0.002	0.77	3.32***	.01
SE deprivation	23.59	3.901	6.04***	9.18***	.05
Population density	62.34	37.622	1.66	1.91	.01
Unemployment rate	-351.7	42.796	-8.22***	-9.90***	.06
Weekly wages	-0.36	0.186	-1.94	-1.65	.01
Objective nature	-9.73	1.593	-6.11***	-8.12***	.04

Results are based on multiple regression analysis. Partial *r*<sup>2</sup> is the independent variance for each variable after accounting for other predictors defined in the model. The *b*s and standard errors for crime were based on raw variable scores (not log transformed) to give more intuitive results; *t* values are identical to analyses using the transformed variable \**p* < .05. \*\*\**p* < .001.

more than 0.99 (see also supplemental table S2 for details on all models tested). In the best model, 95% confidence intervals of estimated coefficients did not overlap with zero for population size, socioeconomic deprivation, unemployment rate, weekly wages, and objective nature, indicating that these four factors were important in explaining the variation in ward-level crime incidence. The negative coefficient for objective nature suggests that wards with more objective nature are associated with a lower crime incidence.

**Exploratory additional analyses**

To account for alternative explanations for the findings reported above, we re-analyzed the top-fitting models for community cohesion and crime. First, we ran the model predicting community cohesion, controlling for two potential alternative explanations: (1) that individuals who grew up in natural environments would select to place themselves in natural environments and would also have a greater sense of community and (2) that those who spend more time socializing are more likely to be outside and are therefore exposed to nature and may have a greater sense of community. Second, we re-analyzed the top-fitting models for both cohesion and crime for urban and rural areas, separately.

**Exploratory covariates.** We found that there was no link between a current sense of community and childhood nature contact ( $\beta = -.00, t(2072) = -0.20, p = .84, d = .01$ ), but those who spent more time socializing were more likely to report a sense of community ( $\beta = .07, t(2072) = 3.19, p < .001, d = .14$ ). Controlling for these potential confounds, we found similar associations between community cohesion and contact with nature ( $\beta = .28, t(2072) = 12.80, p < .001, d = .56$ ), with individual socioeconomic standing, gender, and age also being retained as covariates (and together accounting for 12% of variance). Given that a previous link has been identified between temperature and crime rates

(Ranson 2014), an exploratory model tested the effects of objective nature, controlling for average annual temperature across England. The results showed that temperature did not account for the link identified between objective nature and crime rates (see the supplemental temperature analyses for the method and findings related to this analysis).

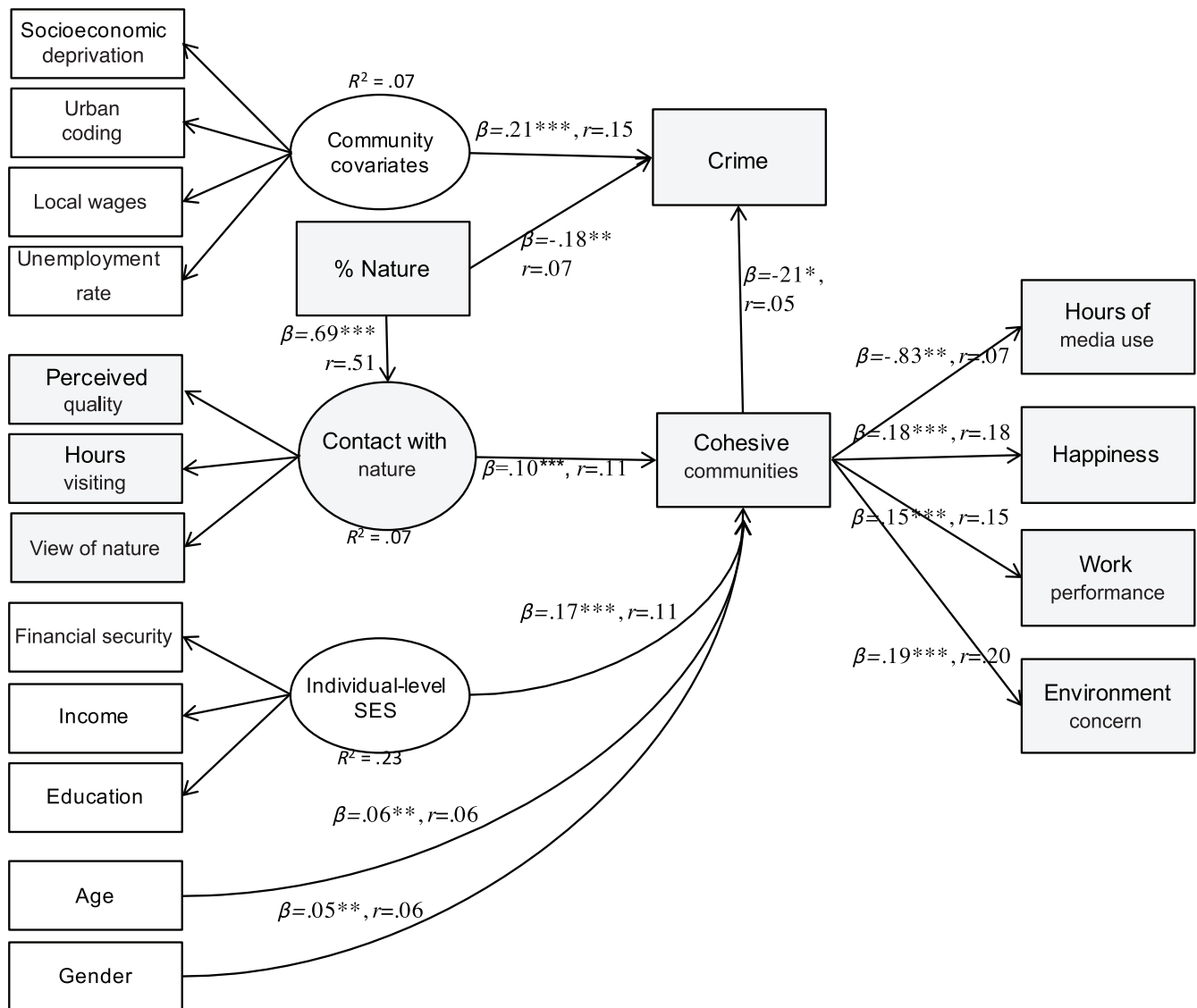
**Urban and rural applications.** When we re-ran the top fitting model for community cohesion separately for rural and urban respondents we found that, controlling for covariates, contact with nature was linked to more community cohesion for individuals living in both urban ( $\beta = .27, t(1435) = 19.39, p < .001, d = 1.03$ ) and rural ( $\beta = .27, t(634) = 6.84, p < .001, d = .54$ ) communities. An equivalent split analysis for crime incidence—again controlling for covariates—showed no link between objective nature and crime in rural settings ( $\beta = -.10, t(282) = -1.65, p = .10, d = -.21$ ), although a link was present in urban areas ( $\beta = -.13, t(870) = -3.84, p < .001, d = .21$ ).

**Structural model**

To test an integrative model linking nature to community outcomes, as well as exploring the effects community has on individuals, we conducted a structural equation model (Kline 2010), simultaneously testing relations among contact with nature, community cohesion and crime, and individual outcomes (see figure 1 for the full estimated model). From the model-selection results presented above, objective local nature was expected to directly link to lower crime but not to community cohesion. We also expected that a latent factor representing contact with nature (perceived views of nature, perceived quality of nature, and time spent in nature) would directly lead to community cohesion. New to the structural equation model, we set paths to individual outcomes of cohesive communities, namely indicators of well-being, such as happiness and amount of time spent online and watching

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**Figure 1.** The full structural model. Structural equation model with personal and societal outcomes of community cohesion, including significant links only. The arrows are as drawn in the initial model; the circles reflect latent (combined or composite) variables, whereas the squares represent observed variables. The shaded spaces designate the primary constructs of interest, whereas the unshaded spaces refer to covariates. All analyses are correlational and conducted at individual levels. \* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .

television (the latter of these was a negative indicator), and indicators of individual contributions back to the society, such as work performance and environmental action. Finally, we tested whether nature leads to lower crime indirectly by increasing community cohesion. To ensure these effects did not directly result from the personal (age; gender; and socioeconomic status, which includes income, education, and financial security) and social covariates (population density, socioeconomic deprivation, local wages, and local unemployment) of primary interest, we controlled for these in the model.

Figure 1 presents the standardized coefficients ( $\beta$ s) and effect sizes for these data. The results of the model showed

that living in more natural areas (from objective coding) was linked to more contact with nature ( $b = .02, t = 26.71, p < .001$ ). However, contact with nature did not, in turn, directly relate to any individual well-being indicators, although a trend indicated more contact was linked with somewhat lower media use ( $b = -.91, t = -1.84, p = .07$ ), contact with nature and affect ( $b = .02, t = 0.21, p = .54$ ) contact with nature and environmental action ( $b = -.02, t = -0.36, p = .72$ ).

Looking at the links with crime, community-level socioeconomic status was linked to lower crime ( $b = -112.85, t = -8.03, p < .001$ ). Controlling for this, both objective local nature ( $b = -7.61, t = -2.35, p = .02$ ) and community

cohesion ( $b = -246.84$ ,  $t = -2.40$ ,  $p = .02$ ) were linked to lower crime rates in the community.

Finally, the model concurrently included the effects of nature on community cohesion and, indirectly, personal indicators of well-being. Our findings showed that personal socioeconomic status was linked to more community cohesion ( $b = .80$ ,  $t = 4.87$ ,  $p < .001$ ) and that age ( $b = .01$ ,  $t = 2.95$ ,  $p = .003$ ) and gender ( $b = .11$ ,  $t = 2.63$ ,  $p = .008$ ) were also linked to cohesion. Similar to outcomes from the regression analyses presented above and controlling for the effects of demographics, contact with nature was linked to more community cohesion ( $b = .20$ ,  $t = 4.83$ ,  $p < .001$ ). In turn, community cohesion was related to fewer hours spent on media use ( $b = -.82$ ,  $t = -3.15$ ,  $p < .001$ ), higher levels of self-reported happiness ( $b = .11$ ,  $t = 8.06$ ,  $p < .001$ ), greater perceptions that one is higher performing at work ( $b = .22$ ,  $t = 6.86$ ,  $p < .001$ ), and higher engagement in environmental action ( $b = .23$ ,  $t = 9.06$ ,  $p < .001$ ). This model provided adequate fit to the data (CFI = .88, GFI = .96, NFI = .86, RMSEA = .056), with RMSEA and GFI suggesting good fit (Miles and Shevlin 1998, Hu and Bentler 1999) and CFI/NFI suggesting just acceptable fit, with values more than .90 (Bollen 1989).

## Conclusions

A large body of research provides evidence that contact with nature provides benefits for well-being, health, and environmental consciousness (see, e.g., Tarrant 1996, Leather et al. 1998, Vining 2003, Fuller et al. 2007, Mitchell and Popham 2008, Ryan et al. 2010). The present work was aimed at broadening our understanding of the consequences of contact with nature by investigating more fully the role of nature on social rather than personal outcomes, operationalized in terms of community cohesion and local crime.

Our analyses inform previous work in two ways: First, the current findings, using a quantitative approach on a nationally representative sample, support the view that the quality of contact with nature can improve the social connections and the well-being of individuals. Subjective experiences of the views of nature from the home, the quality of nature, and the amount of time spent in nature were linked to perceiving one's community as close and cohesive. Moreover, these effects were in place even when taking into account the socioeconomic standing of individuals and, separately, of their communities. Second, they indicate that increases in well-being due to contact with nature may be in part because individuals who can contact local nature perceive more cohesive communities. These results support the idea of the broad positive effects of nature being due, at least in part, to enhancing connections with the community. This suggests that the biophilia hypothesis' claim that we are intrinsically drawn and connected to natural environments and self-determination theory's explanation of the relatedness need and its positive effects together provide a theoretical underpinning from which to draw a greater understanding of the positive effects of nature on social interactions.

Regression models suggested that about 8% of the variance in community cohesion could be explained by subjective experiences of local nature alone (table 5), a striking finding given that individual predictors such as income, gender, age, and education together accounted for only 3% of independent variance; it appears that the role of natural spaces was robust in comparison with other constructs we would expect would influence people's experiences in society.

In documenting social benefits, these findings support and expand on empirical work showing links between nature and more generalized tendencies to prosociality (Mayer and Frantz 2004, Weinstein et al. 2009). Finally, these findings inform the community- and place-attachment literatures by supporting an interactional perspective that physical space can shape the relationships among community members (Patrick and Wickizer 1995, Theodori and Kyle 2013). Although this research offers additional evidence that natural characteristics link with perceptions of closeness, future work could usefully explore the psychological mechanisms by which this relation occurs, such as by defining the meaning that nature has to individuals (Wilkinson 1991).

In addition, path analyses suggest social cohesion was correlated with personal outcomes that may have improved the day-to-day life of individuals: higher levels of happiness, fewer hours spent on media sources such as television or videogames, better perceived workplace performance, and more environmental action; therefore, social cohesion was linked to individual well-being and contribution back to society on a number of important dimensions. In fact, when accounting for the indirect effects of nature on personal outcomes through social cohesion, there was no direct path from nature to happiness, productivity, or environmental action. These results indicate that perceiving social cohesion may be an important mechanism by which nature increases well-being and the likelihood that people will contribute to their community. These findings are consistent with suggestions that a community's civic behaviors enhance the productivity and wellness of its members (Putnam 1993).

In both path analyses and model averaging, the availability of objective nature local to a participant's community was linked to the level of crime in his or her community. Controlling for key demographic factors, the more nature in one's surroundings, the less crime was reported in an area. After removing the variability from covariates, objective nature accounted for 4% additional variance in crime rates (table 5). We argue that this is a substantive variability, given that it assessed only quantity and not quality or accessibility, its comparative predictive power alongside powerful predictors such as socioeconomic deprivation (5%), and real-world importance placed on crime reductions of around 2%–3%. Although not precisely the same, a drop in UK crime of 3% was recorded between 2010 and 2013 and equated to 3.7 million fewer offenses in the country during this period (House of Commons Report 2014), and 3% drops in crime have supported stricter sentencing decisions (Bell et al. 2014). The

exploratory analyses indicated that it is particularly important for reduced crime that nature be available in urban settings. Moreover, in path analyses, local nature was also linked to crime incidence indirectly through fostering social cohesion, which substantiates previous research in a US city linking percentages of nature with lower crime incidence (Kuo and Sullivan 2001). Crime is lower in communities that are mutually supportive, have a high level of organization, and are therefore able to coordinate more local resources for crime prevention (neighborhood watches, neighbor calls to police after suspicious activity; Brown and Wycoff 1987, Sampson and Groves 1989); therefore, the relational benefits of nature may lead to less actual criminal behavior and likely to lower perceptions of crime, although this was not tested here. The positive impact of local nature on neighbors' mutual support may discourage crime, even in areas lower in socioeconomic factors.

In highlighting the relationship between contact with local nature and both community cohesion and crime, this article has interesting implications for those who plan developments and govern communities. Greater consideration of greenspace provision in developments may help with these societal—as well as individual—outcomes. Our findings that beneficial social indicators are linked to contact with nature in urban as well as rural areas further support this assertion. Although beyond the scope of this article—and noting that different approaches are not mutually exclusive—it would be interesting to compare the costs and benefits of greenspace provision for community cohesion and crime reduction with those of traditional approaches, such as policing. This article provides a necessary preliminary to that: evidence in support of greenspace provision as one potential option for tackling crime reduction.

These findings should be viewed in light of several limitations. First, despite having controlled for a range of possible confounds, our conclusions relied on a correlational method that precluded making causal links. For example, there may be other characteristics of rural living—such as neighbors from a similar ethnocultural background or lower neighbor turnover rates—that are responsible for the correlations we observed between nature and community. In future research, experimental methods supported by quasi-experimental designs using real world environments may be well suited to examining these issues, and instrumental variable estimation could be tested for potential endogeneity bias (see, e.g., Gould et al. 2002). Experimental groups could be asked to interact in natural and nonnatural environments to collect data with behavioral as well as self-report indicators of cohesion. To study the effects of long-term contact with nature, school and work groups could be randomly assigned to interact in natural or nonnatural environments during retreats and over longer periods of time. Second, despite an otherwise high level of population representation, our findings relied on adults ranging in age from 22 to 65 years; this limits the generalizability of the present findings, and future research should explore the effects on younger and

older individuals who may respond differently to natural spaces; given that younger individuals are exposed to more crime (Farrington 1986) and older individuals experience more loneliness (Lenhoff et al. 1966), it seems plausible that natural spaces are even more important to cohesion and closeness in these groups.

In this research, we have explored the role that nature, broadly, has on a sense of community, but future research should differentiate among types of vegetation that may have distinct effects (e.g., gardens, meadows, forests, and lakes), should reveal the links with more or less human-dominated landscapes (e.g., gardens versus woodlands), and should determine whether more biodiversity is important; dissecting the role of different natural environments could help inform more targeted interventions. Finally, future work could usefully explore in more depth the links with workplace productivity and well-being, workplace productivity, teamwork, and the consequent productivity in businesses located where greenspace has (or has not) been designed into the surroundings, for example.

The present findings offer a new perspective for understanding the links between nature and the social experience. Stringent model testing commonly used in the conservation literature to deal with large numbers of predictors was used to test a small number of clear hypotheses while controlling for a number of known noise and confounding factors. These showed that the perceived quantity of nature and direct contact with high-quality nature are linked to higher social cohesion. Our results also identified social cohesion as an important mechanism through which nature links to personal well-being (e.g., happiness, work performance) and socially responsible behaviors (e.g., environmental concern), and they linked the quantity of nature to community-level crime incidence. These findings add to our growing understanding of the frequently overlooked benefits that people get from nature (Millennium Ecosystem Assessment 2005). Some of these so-called ecosystem services—such as the provision of wild-caught fish or timber or the regulation of climate through carbon sequestration—are relatively tangible and amenable to quantification. However, the apparent benefits of contact with nature on social cohesion—and in turn of social cohesion on crime incidence, individual happiness, and performance in the workplace—are more challenging to tease apart and measure. This article contributes to raising awareness of their apparent significance and encourages further exploration of how they arise. We also hope that it stimulates consideration of how best to ensure that nature, at many different levels, can continue to benefit individuals and society into the future.

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**Supplemental material**

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**References cited**

Anderson CA, Dill KE. 2000. Video games and aggressive thoughts, feelings, and behavior in the laboratory and in life. *Journal of Personality and Social Psychology* 78: 772–790.

Appleton J. 1975. *The Experience of Landscape*. Wiley.

Bell B, Jaitman L, Machin S. 2014. Crime deterrence: Evidence from the London 2011 riots. *The Economic Journal* 124: 480–506.

Bickham DS, Rich M. 2006. Is television viewing associated with social isolation? Roles of exposure time, viewing context, and violent content. *Archives of Pediatrics and Adolescent Medicine* 160: 387–392.

Blane D, Brunner E, Wilkinson RG, eds. 1996. *Health and Social Organization: Towards a Health Policy for the Twenty-First Century*. Routledge.

Bliese PD, Halverson RR. 1996. Individual and nomothetic models of job stress: An examination of work hours, social cohesion, and well-being. *Journal of Applied Social Psychology* 26: 1171–1189.

Bollen KA. 1989. A new incremental fit index for general structural equation models. *Sociological Methods and Research* 17: 303–316.

Boutilier M, Cleverly S, Labonte R. 2000. Community as a setting for health promotion. P in Poland B, Green LW, Rootman I, eds. *Settings for Health and Promotion: Linking Theory and Practice*. Sage.

Bramstone P, Pretty G, Chipeur H. 2002. Unravelling subjective quality of life: An investigation of individual and community determinants. *Social Indicators Research* 59: 261–274.

Brown LP, Wycoff MA. 1987. Policing Houston: Reducing fear and improving service. *Crime and Delinquency* 33: 71–89.

Burnham KP, Anderson DR. 2002. *Model Selection and Multimodel Inference: A Practical Information-Theoretic Approach*. Springer.

Bursik RJ Jr, Grasmick HG. 1993. Economic deprivation and neighborhood crime rates, 1960–1980. *Law and Sociology Review* 27: 263.

Danziger S. 1976. Explaining urban crime rates. *Criminology* 14: 291–296.

Deci EL, Ryan RM. 2000. The “what” and “why” of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry* 11: 227–268.

———. 2012. Self-determination theory. P– in Van Lange PAM, Kruglanski AW, Higgins ET, eds. *Handbook of Theories of Social Psychology*, vol. 1. Sage.

Dines N, Cattell V. 2006. *Public Spaces, Social Relations and Well-Being in East London*. Policy Press.

European Environment Agency. 2000. CORINE Land Cover 2000. European Environment Agency. (6 October 2015; <http://www.eea.europa.eu/publications/CORO-landcover>)

Farrington DP. 1986. Age and crime. *Crime and Justice* 7: 189–250.

Forrest R, Kearns A. 2001. Social cohesion, social capital, and the neighbourhood. *Urban Studies* 38: 2125–2143.

Fuller RA, Irvine KN, Devine-Wright P, Warren PH, Gaston KJ. 2007. Psychological benefits of greenspace increase with biodiversity. *Biology Letters* 3: 390–394.

GeoConvert. 2012. UK Data Service Census Support. (6 October 2015; <http://geoconvert.mimas.ac.uk>)

Gilchrist A. 2009. *The Well-Connected Community*, 2nd ed. Policy Press.

Gould ED, Weinberg BA, Mustard DB. 2002. Crime rates and local labor market opportunities in the United States: 1979–1997. *Review of Economics and Statistics* 84: 45–61.

Greenberg S, Rohe WM, Williams JR. 1982. *Safe and Secure Neighborhoods: Physical Characteristics and Informal Territorial Control in High and Low Crime Neighborhoods*. US Department of Justice, National Institute of Justice.

Gullone E. 2000. The biophilia hypothesis and life in the twenty-first century: Increasing mental health or increasing pathology? *Journal of Happiness Studies* 1: 293–321.

Hartig T, Evans GW, Jamner LD, Davis DS, Gärling T. 2003. Tracking restoration in natural and urban field settings. *Journal of Environmental Psychology* 23: 109–123.

Hattie J, Marsh HW, Neill JT, Richard GE. 1997. Adventure education and outward bound: Out-of-class experiences that make a lasting difference. *Review of Educational Research* 67: 43–87.

Hooke RLeB, Martin-Duque, JF. 2012. Land transformation by humans: A review. *GSA Today* 22: 4–10.

Hu LT, Bentler PM. 1999. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling* 6: 1–55.

Johnson JB, Omland KS. 2004. Model selection in ecology and evolution. *Trends in Ecology and Evolution* 19: 101–108.

Kaplan S. 1995. The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental Psychology* 15: 169–182.

Katz E, Foulkes D. 1962. On the use of the mass media as “escape”: Clarification of a concept. *Public Opinion Quarterly* 26: 377–388.

Katz JE, Rice RE, eds. 2002. *Social Consequences of Internet Use: Access, Involvement, and Expression*. MIT Press.

Kaufman HF. 1959. Toward an interactional conception of community. *Social Forces* 38: 8–17.

Kawachi I, Kennedy BP. 1997. The relationship of income inequality to morality: Does the choice of indicator matter? *Social Science and Medicine* 45: 1121–1127.

Kline RB. 2010. *Principles and Practice of Structural Equation Modeling*, 3rd ed. Guilford Press.

Kneezel T, Emmons RA. 2006. Personality and spiritual development. Pp. 266–278 in Benson PL, Roehlkepartain EC, King PE, Wagener L, eds. *The Handbook of Spiritual Development in Childhood and Adolescence*. Sage.

Kuo FE, Sullivan WC. 2001. Environment and crime in the inner city: Does vegetation reduce crime? *Environment and Behavior* 33: 343–367.

Leather P, Pyrgas M, Beale D, Lawrence C. 1998. Windows in the workplace. *Environment and Behavior* 30: 739–762.

Lenhoff FG, Forbes R, Baker PT, Weiner JS, Sataloff HLBJ, Alvin MTBJ. 1966. Age and Loneliness. *British Medical Journal*: 1585.

Maas J, Verheij RA, Groenewegen PP, de Vries S, Spreeuwenberg P. 2006. Green space, urbanity, and health: How strong is the relation? *Journal of Epidemiology and Community Health* 60: 587–592.

Mayer FS, Frantz CM. 2004. The Connectedness to Nature Scale: A measure of individuals’ feeling in community with nature. *Journal of Environmental Psychology* 24: 504–515.

Mayer FS, Frantz CM, Bruehlman-Senecal E, Dolliver K. 2008. Why is nature beneficial? The role of connectedness to nature. *Environment and Behavior* 41: 607–643.

Miles J, Shevlin M. 1998. Effects of sample size, model specification, and factor loadings on the GFI in confirmatory factor analysis. *Personality and Individual Differences* 25: 85–90.

Millennium Ecosystem Assessment. 2005. *Ecosystems and Human Well-Being: A Framework for Assessment*. Conceptual Framework Working Group of the Millennium Ecosystem Assessment. Island Press.

Mitchell R, Popham F. 2008. Effect of contact with natural environment on health inequalities: An observational population study. *Lancet* 372: 1655–1660.

Moller AC, Deci EL, Elliot AJ. 2010. Person-level relatedness and the incremental value of relating. *Personality and Social Psychology Bulletin* 36: 754–767.

Morrow G. 1999. Conceptualising social capital in relation to the well-being of children and young people: A critical review. *Sociological Review* 44: 744–765.

Nasar JL. 1982. A model relating visual attributes in the residential environment to fear of crime. *Journal of Environmental Systems* 11: 247–255.

[ODPM] Office of the Deputy Prime Minister. 2001. *Generalised Land Use Database Statistics for England*. ODPM.

Orians G. 1980. Habitat selection: General theory and applications to human behavior. Pp. 49–63 in Lockard JS, ed. *The Evolution of Human Social Behavior*. Elsevier.

Patrick D, Wickizer T. 1995. Community and health. Pp. 46–92 in Amick B, Levine S, Tarlov A, Walsh DC, eds., *Society and Health*. Oxford University Press.

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- PEW Charitable Trust. 2012. Technology and Media Use. Pew Charitable Trust. (6 October 2015; [www.pewtrusts.org/our\\_work\\_detail.aspx?id=56](http://www.pewtrusts.org/our_work_detail.aspx?id=56))
- Przybylski AK, Rigby CS, Ryan RM. 2010. A motivational model of video game engagement. *Review of General Psychology* 14: 154–166.
- Putnam RD. 1993. The prosperous community: Social capital and public life. *The American Prospect* 4: 35–42.
- Raphael D, Bryant T. 2000. Putting the population into population health. *Canadian Journal of Public Health* 91: 9–13.
- Raphael D, Renwick R, Brown I, Steinmetz B, Schdev H, Phillips S. 2001. Making the links between community structure and individual well-being: Community quality of life in Riverdale, Toronto, Canada. *Health and Place* 7: 179–196.
- Ranson M. 2014. Crime, weather, and climate change. *Journal of Environmental Economics and Management* 67: 274–302.
- Richardson EA, Mitchell R. 2010. Gender differences in nature and health relationships in the United Kingdom. *Social Science and Medicine* 71: 568–575.
- Roberts DF, Foehr UG. 2008. Trends in media use. *Future Child* 18: 11–37.
- Roseland M. 2000. Sustainable community development: Integrating environmental, economic, and social objectives. *Progress in Planning* 54: 73–132.
- Ryan RM, Deci EL. 2000. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist* 55: 68–78.
- Ryan RM, Weinstein N, Bernstein J, Brown KW, Gagné M. 2010. Vitalizing effects of being outdoors and in nature. *Journal of Environmental Psychology* 30: 159–168.
- Rubin DB. 1987. *Multiple imputation for nonresponse in surveys*. Wiley.
- Sampson R, Groves WB. 1989. Community structure and crime: Testing social disorganization theory. *American Journal of Sociology* 94: 774–802.
- Skogan WG. 1989. Communities, crime, and neighborhood organization. *Crime and Delinquency* 35: 437–457.
- Sullivan WC, Kuo FE, DePooter SF. 2004. The fruit of urban nature: Vital neighborhood spaces. *Environment and Behavior* 36: 678–700.
- Tarrant MA. 1996. Attending to past outdoor recreation experiences: Symptom reporting and changes in affect. *Journal of Leisure Research* 28: 1–17.
- Taub RP, Taylor DG, Dunham JD. 1984. *Paths of Neighborhood Change: Race and Crime in Urban America*. University of Chicago Press.
- Theodori GL, Kyle GT. 2013. Community, place, and conservation. Pp. 59–70 in Stewart WP, Williams DR, Kruger LE, eds. *Place-Based Conservation: Perspectives from the Social Sciences*. Springer.
- [United Nations] United Nations, Department of Economic and Social Affairs, Population Division. 2012. *World Urbanization Prospects, the 2009 Revision: Highlights*. (6 October 2015; <http://esa.un.org/unpd/wup/index.htm>)
- Vemuri AW, Costanza R. 2006. The role of human, social, built, and natural capital in explaining life satisfaction at the country level: Toward a national well-being index (NWI). *Ecological Economics* 58: 119–133.
- Vining J. 2003. The connection to other animals and caring for nature. *Human Ecology Review* 10: 87–99.
- Voydanoff P. 2001. Incorporating community into work and family research: A review of basic relationships. *Human Relations* 54: 1609–1637.
- Watson D, Clark LA, Tellegen A. 1988. Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology* 54: 1063–1070.
- Weinstein N, Ryan RM. 2010. When helping helps: An examination of motivational constructs underlying prosocial behavior and their influence on well-being for the helper and recipient. *Journal of Personality and Social Psychology* 98: 222–224.
- Weinstein N, Przybylski AK, Ryan RM. 2009. Can nature make us more caring? Effects of immersion in nature on intrinsic aspirations and generosity. *Personality and Social Psychology Bulletin* 35: 1315–1329.
- Wells NM. 2000. At home with nature: The effects of nearby nature on children's cognitive functioning. *Environment and Behavior* 32: 775–795.
- White M, Smith A, Humphryes K, Pahl S, Snelling D, Depledge M. 2010. Blue space: The importance of water for preference, affect, and restorativeness ratings of natural and built scenes. *Journal of Environmental Psychology* 30: 482–493.
- Wilkinson KP. 1991. *The community in rural America*. Greenwood Press.
- Wilson EO. 1984. *Biophilia*. Harvard University Press.
- . 1993. Biophilia and the conservation ethic. P in Kellert SR, Wilson EO, eds. *The Biophilia Hypothesis*. Island Press.
- . 2007. Biophilia and the conservation ethic. Pp. 249–258 in Penn DJ, Mysterud I, eds. *Evolutionary Perspectives on Environmental Problems*. Transaction.
- Ulrich RS, Simons RF, Losito BD, Fiorito E, Miles MA, Zelson M. 1991. Stress recovery during contact with natural and urban environments. *Journal of Environmental Psychology* 11: 201–230.

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