

## Science & Society

### Biophilia revisited: nature versus nurture



Bengt Gunnarsson <sup>1,2,\*</sup> and  
Marcus Hedblom <sup>3</sup>

**The ‘Biophilia’ hypothesis highlighting humans’ innate, positive response to nature is both increasingly accepted and questioned. Studies support an updated Biophilia. The interplay between inheritance and environment, including culture, governs an individual’s response, from positive to negative. Variety in urban green spaces is needed to optimise benefits to all residents.**

#### The importance of urban green spaces

Stressors in urban environments are currently increasing mental disorders globally, but the well-being and stress reduction in city dwellers are greatly promoted by nature contact [1]. Therefore, urban green spaces are important for public health. Yet, the underlying cause of why nature is a powerful mitigator is poorly understood.

It has long been suggested that nature contact unconsciously leads to various positive responses. For instance, the ‘Biophilia’ (see [Glossary](#)) hypothesis offers an evolutionary explanation. In brief, people have an innate tendency to spontaneously attach to benevolent nature [2]. The Biophilia concept has been embraced by some urban planners to meet challenges in cities by adding nature, as evidenced by, for example, the *Biophilic Cities Journal*. Conversely, the opposite tendency, ‘Biophobia’, seems to increase in frequency, probably due to disconnection from nature in city inhabitants [3]. However, the Biophilia hypothesis is

far from universally accepted, and some social scientists have been pointing out that firm evidence is lacking [4].

A further understanding of why humans are affected by nature could provide valuable insights into how to design and manage urban green spaces to improve health. How, then, can the validity of Biophilia be assessed? We argue that a way forward is to examine three basic questions. First, is there an automatic positive response to nature? Second, if so, is such a response found in all humans, or is it conditional? Third, what intrinsic factors govern the response to nature?

#### Automatic positive response to nature?

In a study of automatic associations, pictures with natural and urban environments were shown to the participants [5]. In an approach/avoidance task, the participants, with the help of a computer mouse, would either pull towards or push away an image, depending on the thickness of the frame around the image. This experimental design ensured that the influence of the picture was unconscious because it was not relevant for the task. On average, participants approached images with natural environments significantly faster than urban settings with buildings, even though the images had the same aesthetic rating. Overall, the study suggests that people unconsciously approach nature but avoid cities, supporting the Biophilia hypothesis [5].

In another study of immediate responses, participants were asked to indicate the affective **valence** of their reaction to Chinese characters preceded by natural and urban pictures [6]. The study design was based on inability to read Chinese, so the valence mirrored the reaction to the natural or urban picture. The participants showed an immediate positive affect of nature pictures but a complex response regarding urban images. Interestingly, the

#### Glossary

**Autonomic nervous system:** the involuntary part of the nervous system consisting of sympathetic and parasympathetic parts that have opposite functions.

**Biophilia:** an unconscious and innate need to affiliate with nature and living organisms.

**Biophobia:** an instantaneous negative response, such as fear or anxiety, to certain organisms, or natural environments.

**Heart rate variability (HRV):** indicator of changes in the balance between sympathetic and parasympathetic parts in the autonomic nervous system.

**Heritability:** part of variance in a trait that is attributed to differences in genes within a population.

**Nature orientation:** a psychological construct assessing the individual’s relation to nature, for example, covering the range from ‘nature and I are two’ to ‘nature and I are one.’

**Parasympathetic:** part of the autonomic nervous system that is associated with contentment, affiliation, and safeness, that is, ‘being’ mode.

**Phenotypes:** morphological (e.g., height), physiological (e.g., blood pressure), behavioural (e.g., running speed), or any other trait, or subset of such traits, observable in an organism.

**Valence:** kind of emotion, that is, positive, neutral, or negative.

more nature exposure during childhood, the less positive response was observed for urban images. The findings suggested that unconscious positive affective responses to nature may be innate but responses to urban settings are in part shaped by early experiences. Although the results can be interpreted differently (see [6]), they also support the Biophilia hypothesis. A tentative answer to the first question is ‘yes,’ there is an automatic positive response to benevolent nature, but childhood experiences could be important to adult response. However, the studies mentioned [5,6] used a limited sample of nature pictures, which means that more experiments with greater variation in natural environments will be needed before a generalised conclusion can be drawn.

#### Response variation between individuals?

In a series of extraordinary field experiments with rigorous design, **heart rate variability (HRV)** was measured in large, matched samples of young Japanese

males who were exposed to real forests and urban landscapes, respectively [7]. The HRV tracked changes in the **autonomic nervous system**, and, for instance, indicators of **parasympathetic** activity (i.e., positive emotions) were obtained. This opens up the possibility for detailed analysis of objectively measured response. For instance, 316 (65%) of 485 participants showed an increase in parasympathetic activities (positive emotions) while walking in a forest setting compared with an urban environment [7]. This means that 35% did *not* show such an increase, and it is therefore at odds with the Biophilia hypothesis. Overall, this suggests that differences between individuals in response to various environments have complex causes, indicated by a continuous variation in HRV [7]. The second question concerning a positive response in all humans is likely answered 'no.' Could nature *or* nurture be the explanation for this?

### Intrinsic factors governing response to nature?

Intrinsic factors have been examined in a pioneering study on genetic effects on people's **nature orientation** and experience [8]. The investigation was based on a twin design ( $n = 1153$  pairs), that is, contrasting the assessments on identical and nonidentical, twins. The findings revealed that identical twins resembled each other more than nonidentical twins in nature orientation, with an estimated **heritability** of 46%. Moreover, there were positive genetic correlations between nature orientation and frequency of visits to public nature space and gardens. These data support a genetic component in people's nature orientation and experience [8]. However, a heritability estimate is valid only for the specific population under study [9]. It is likely that interactions between genes and environmental factors (including physical and social environments) vary between populations and different societies, which means that heritability estimates probably vary, and thus further studies are needed.

In the present study, environmental influences, including complex interactions with level of urbanisation, were substantial and explained over 50% of individual variation in nature experiences [8]. Thus, the third question regarding intrinsic factors that govern the individual response to nature can be safely answered as a combination of inherited and environmental factors. Therefore, we tentatively suggest nature orientation as a proxy for an individual level of Biophilia.

### Nature *and* nurture

All **phenotypes** are a combination of nature *and* nurture (with a few known exceptions), especially for highly polygenic traits such as human behaviour [9]. Taken together, the Japanese study [7] and the twin study [8] suggest that Biophilia at the population level can be analysed using the methods to partition causes of variation in biological beings. For any quantitative trait (e.g., height, blood pressure, running speed), the phenotypic variance has both genetic and environmental causes that might interact [9]. Although exact calculations of each type of variance are extremely difficult to obtain, this approach may be used as a framework.

However, the picture is complex as the influence of genes and environment at the individual level depends on the unique genotype that interacts with idiosyncratic factors [9], such as development during childhood. In general, nature attachment is high in young children but declines during adolescence, then rises again and slowly stabilises in the late 20s [10]. Also, the type of nature experienced when growing up might be important. For instance, a study of adolescents in the UK showed that high daily exposure to woodland, but not grassland, decreased the risk of emotional and behavioural problems, after taking confounding variables into account [11]. This suggests that the environmental factor contributes to the resulting phenotype.

Multiple studies show that exposure to nature can improve mental health at the population level [1], but few studies highlight the interplay between many variables at the individual level. People who consider themselves as highly nature oriented experience more positive health effects from nature exposure than less nature oriented people [12]. But the relationships are complex. For instance, strong self-identification with nature could lead to increasing mental health problems if natural environments are threatened [12]. Furthermore, the genetic component of nature orientation may also contribute to mental health. Another twin study revealed a lower risk of depression with access to more greenery for identical twins but not nonidentical twins [13], suggesting a genetic influence.

The relationship to nature by factors linked to societal and cultural contexts is often examined in confined circumstances, and rather few investigations are truly cross-cultural. A study of physiological and psychological responses in Japanese and Canadian students on different garden styles revealed differences for both gender and nationality [14]. This highlights the need for more cross-cultural studies.

### Successful urban green space planning

Knowledge about the interplay between nature *and* nurture governing individual response to green space is pivotal for future successful urban planning and management for human health. There are still multiple issues that are poorly known. A special focus on individuals who are less nature oriented might be fruitful. Moreover, physiological and psychological investigations using a twin design would be very valuable. We argue that biologists and health and social scientists should cooperate closely to investigate the health benefits of multiple types of nature experiences in cities. Knowledge gaps might be closed by the use of large and random samples, including both



**Trends In Ecology & Evolution**

**Figure 1. Urban greenery: unmanaged woodland (left), manicured nature (right).** Both pictured sites are part of the Gothenburg Botanical Garden, Sweden. Urban green spaces should contain multiple types of nature to meet the needs of people with different nature orientations. For instance, unmanaged woodland (left) rich in indigenous biodiversity can benefit people who are highly nature oriented by recreational activities promoting both physical and mental health. Manicured nature with ornamental plantings (right) can benefit people who are less nature oriented by decreasing stress symptoms via serenity and relaxation. (Photo: Bengt Gunnarsson.)

subjective and objective measurements, and preferably with a cross-cultural study design. Thus, multidisciplinary teams of scientists will be needed.

The current evidence supports an ‘updated Biophilia hypothesis.’ Nature exposure is beneficial because it elicits an unconscious positive response in many people. These findings have implications for urban planning: provide city dwellers with green spaces nearby their residence, including street trees and bushes, green walls, and rooftop. The ‘3–30–300 rule’ might be helpful, that is, see three trees from every home, 30% canopy cover in every neighbourhood, and less than 300 m to the nearest green space [15]. But

everyone is not positive toward nature. Inheritance and environmental influence in combination govern individual responses that cover a wide range. Thus, we suggest an additional rule: avoid uniform urban green spaces and plan for variety in size, configuration, and biodiversity (Figure 1). Making urban planners aware of Biophilia variation in people could potentially lead to optimised health benefits if city inhabitants are able to select their own favourite green space.

#### Acknowledgements

We thank D. Blomqvist, B. Wheeler, and the reviewers for comments and the subject group Landscape Management at the Department of Urban and Rural Development for support.

#### Declaration of interests

The authors have no interests to declare.

<sup>1</sup>Department of Biological and Environmental Sciences, University of Gothenburg, SE 405 30 Göteborg, Sweden

<sup>2</sup>Gothenburg Global Biodiversity Centre, University of Gothenburg, SE 405 30 Göteborg, Sweden

<sup>3</sup>Department of Urban and Rural Development, Swedish University of Agricultural Sciences, SE 750 07 Uppsala, Sweden

\*Correspondence:

bengt.gunnarsson@bioenv.gu.se (B. Gunnarsson).

<https://doi.org/10.1016/j.tree.2023.06.002>

© 2023 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

#### References

1. Bratman, G.N. *et al.* (2019) Nature and mental health: an ecosystem service perspective. *Sci. Adv.* 5, eaax0903
2. Wilson, E.O. (1984) *Biophilia*. Harvard University Press
3. Soga, M. *et al.* (2023) The vicious cycle of biophobia. *Trends Ecol. Evol.* 38, 512–520
4. Joye, Y. and de Block, A. (2011) ‘Nature and I are two’: a critical examination of the Biophilia hypothesis. *Environ. Values* 20, 189–215
5. Schiebel, T. *et al.* (2022) Testing the Biophilia theory: automatic approach tendencies towards nature. *J. Environ. Psychol.* 79, 101725
6. Koivisto, M. and Grassini, S. (2022) Affective responses to urban but not to natural scenes depend on inter-individual differences in childhood nature exposure. *J. Environ. Psychol.* 82, 101840
7. Kobayashi, H. *et al.* (2018) Forest walking affects autonomic nervous activity: a population-based study. *Front. Public Health* 6, 278
8. Chang, C. *et al.* (2022) People’s desire to be in nature and how they experience it are partially heritable. *PLoS Biol.* 20, e3001500
9. Hosken, D.J. *et al.*, eds (2019) *Genes and Behaviour: Beyond Nature-Nurture*. John Wiley & Sons
10. Hughes, J. *et al.* (2019) Age and connection to nature: when is engagement critical? *Front. Ecol. Environ.* 17, 265–269
11. Meas, M.J.A. *et al.* (2021) Benefit of woodland and other natural environments for adolescents’ cognition and mental health. *Nat. Sustain.* 4, 851–858
12. Dean, J.H. *et al.* (2018) Is nature relatedness associated with better mental and physical health? *Int. J. Environ. Res. Public Health* 15, 1371
13. Cohen-Cline, H. *et al.* (2015) Access to green space, physical activity and mental health: a twin study. *J. Epidemiol. Community Health* 69, 523–529
14. Elsadek, M. *et al.* (2019) Cross-cultural comparison of physiological and psychological responses to different garden styles. *Urban For. Urban Green.* 38, 74–83
15. Konijnendijk, C. (2023) Evidence-based guidelines for greener, healthier, more resilient neighbourhoods: introducing the 3-30-300 rule. *J. For. Res.* 34, 821–830