

Biophilic Design: Nine ways to enhance physical and psychological health and wellbeing in our built environments.

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Abstract

Biophilic Design is an applied science that takes into account the most recent findings on the relationship between human beings and Nature to render artificial spaces more coherent with innate human biophilia. It is well known that the application of Biophilic Design reduces stress, stimulates creativity and clear thinking, improves physical and psychological wellbeing and accelerates healing. Considering the relentless process of global urbanization, these benefits will become increasingly important in the design of our urban spaces, buildings and interiors. The aim of the present study is to develop a conceptual framework for Biophilic Design, reducing the gap between scientific research and its translation into functional applications.

Keywords: Biophilia; Biophobia; Biophilic Design Characteristics; Biophilic Design Elements.

Introduction

Biophilic Design is an applied science, aimed at planning artificial spaces that reflect the innate tendency of human beings to seek connections with Nature. It is well known that the application of Biophilic Design reduces stress, stimulates creativity and clear thinking, improves physical and psychological wellbeing and accelerates healing (for a review, see Barbiero and Berto, 2016).

Biophilia

Biophilia is “the innately emotional affiliation of human beings to other living organisms” (Wilson, 1993, p. 31). It covers a variety of attitudes (Kellert and Wilson, 1993), emotions (Barbiero and Marconato, 2016) and values (Kellert, 1997) which, collectively, constitute our relationship with Nature.

Biophilia and biophobia

According to E.O. Wilson, “biophilia is not a single instinct but a complex of learning rules that can be teased apart and analyzed individually. The feelings molded by the learning rules fall along several emotional spectra: from attraction to aversion” (Wilson, 1993, p. 31). Attraction is biophilia, aversion is biophobia (Ulrich, 1993). During evolution, humankind had to face the hostile forces of Nature in wilderness environments. The learning rules of biophilia and biophobia rooted themselves in the genetic heritage of our species, according to the contribution they made to improving human efficiency in seeking resources and refuges. Wilderness environments trigger two types of physiological reaction: (1) the ‘fight-or-flight’ response, which translates into a hyperactivity of one of the branches of the autonomic nervous system, usually the over-expression of the sympathetic nervous system (Shimuzu and Okabe, 2007), which was linked to the concept of biophobia (e.g. Ulrich, 1993); and (2) the ‘rest-and-digest’ response, which manifests as the cooperation of both branches of the autonomic nervous system, with a prevalent influence of the parasympathetic nervous system. This assures better long-term resilience of the individual (Harvard Medical School, 2018), as it reduces stress (Ulrich, 1993) and enhances cognitive functions (Kaplan, 1995; Berto et al., 2015b). Although various scholars consider biophobia to be part of the biophilic system (e.g. Wilson, 1984; Ulrich, 1993), for the purposes of studying Biophilic Design, it would be more convenient to maintain a distinction between the two concepts of biophobia and biophilia (Barbiero and Berto, 2018). A reasonable objective of Biophilic Design could be to construct environments that can stimulate biophilia (Barbiero, 2011) and reduce the stress induced by biophobia: in other words, environments that can sustain and improve the equilibrium of the autonomic nervous system.

An evolutionary history of biophilia

Biophilia developed in the Palaeolithic period. For approximately 95% of their evolutionary history, human beings survived by adopting a nomadic hunter-gatherer lifestyle. Humans have thus perfected a set of responses adapted to the various wilderness environments – mainly the savannah (Orians and Heerwagen, 1992) – aimed at recognizing the quality of an environment in terms of resources and refuges. Some of the environmental preferences which incorporated into Biophilic Design are based on innate learning rules derived from our ancestors' survival, and even today they form the primary, deepest core of our biophilia (Berto et al., 2015a). After farming was invented, approximately 14,000 years ago (Arranz-Otaegui et al. 2018), most of the human population became sedentary. Human beings started to distinguish the domestic from the wilderness environment. Their refuges became permanent, and the first human clusters were formed: villages and then towns and cities (Diamond, 1998). In this period, which covers approximately 5% of the evolutionary history of humankind, the biophilia structured in the Palaeolithic period was adapted to the new cultural requirements. One example is proxemics. In the Palaeolithic period, groups of *Homo sapiens* were few, and meetings between humans were rare, outside of their own clan. During the Neolithic period, village life required a level of socialization that imposed a hitherto unknown physical proximity, to which we have never fully adapted. This explains, for example, why many people seek outdoor spaces in Nature in which the human presence is rare. Finally, over the past 250 years – an irrelevant period from an evolutionary point of view: less than 0.2% of the evolutionary history of humankind – human beings developed their inclination to transform their environment permanently and irreversibly (Crutzen, 2006). During this period, human clusters gradually became larger and denser. Compared to the wilderness environments in which humans evolved, towns and cities – now home to 53% of the world's population (Worldbank, 2018) – are characterized by a lack of green spaces, large crowds, and artificial lighting (Beatley, 2011). The lack of natural stimuli atrophied biophilia (Wilson, 1993; Berto and Barbiero, 2017a). After the industrial revolution, detachment from Nature became even more pronounced. This detachment was so hard that many people feel the need to restore their biophilia by immersing themselves in Nature during their free time.

From biophilia to Biophilic Design

“Biophilic Design is the deliberate attempt to translate an understanding of the inherent human affinity to affiliate with natural systems and processes – known as biophilia – into the design of the built environment” (Kellert, 2008, p. 3). “Biophilic Design is not about greening our buildings or simply increasing their aesthetic appeal through inserting trees and shrubs. Much more, it is about humanity’s place in nature, and the natural world’s place in human society, a space where mutuality, respect, and enriching relation can and should exist at all levels and emerge as a norm rather than the exception” (Kellert and Heerwagen, 2008, p. vii). These definitions come from Stephen R. Kellert (1943-2016), Tweedy/Ordway Professor of Social Ecology at Yale University. Kellert, together with E.O. Wilson, is the author of *Biophilia Hypothesis* (Kellert and Wilson, 1993). Like Wilson, Kellert is also an ecologist, who gradually developed an interest in artificial environments, culminating in the book *Biophilic Design* in which Kellert et al. (2008) collected the experiences of biologists, psychologists and architects joined by their common interest in artificial environments that respect human biophilia. The first chapter of this book (Kellert, 2008) continues to be a reference work for studies on Biophilic Design even today (Söderlund, 2019).

Design by Nature: the legacy of Stephen Kellert

The goal of Biophilic Design is only apparently simple. Kellert saw two limitations that hamper the introduction of effective Biophilic Design: “the limitations of our understanding of the biology of the human inclination to attach value to Nature, and the limitations of our ability to transfer this understanding into specific approaches for designing the built environment” (Kellert, 2008, p.3). Therefore, Kellert recognized two dimensions of Biophilic Design. The first was an *organic* or *naturalistic dimension*, inspired by the biophilia that established itself genetically during the Palaeolithic period. The second was a *vernacular dimension*, which developed after the Neolithic period. Kellert correlated these two dimensions to 72 characteristics of Biophilic Design and systematized them according to six ‘elements’: Environmental features, Natural shapes and forms, Natural patterns and processes, Light and space, Place-based relationships, and

Evolved human-Nature relationships (Kellert, 2008). The 72 characteristics provided a foundation for the *Biophilic Quality Index* by Berto and Barbiero (2017b). Kellert's research was interrupted prematurely in 2016. In the book *Nature by Design* (Kellert, 2018), published posthumously by his wife Cilla, Kellert sought to systematize Biophilic Design according to three categories: Direct Experience of Nature; Indirect Experience of Nature, and Experience of Space and Place, which led to a series of suggestions aimed at helping designers to incorporate the human affinity with Nature into the built environment. If used appropriately and specifically, instead of as a checklist applied indiscriminately, these suggestions, or alternatively the 72 characteristics published in Kellert (2008), offer a series of options for using Biophilic Design in an effective way (Kellert, 2018, pp. viii-ix).

The 15 Patterns of Biophilic Design by Terrapin Bright Green

A pragmatic approach to Biophilic Design has been proposed by the consulting firm Terrapin Bright Green (TBG), founded by Bill Browning and Cook&Fox Architects. TBG's proposal is based on a systematic collation of environmental psychology literature, concerning the effects of the built environment on human beings. TBG's aim was to identify patterns which have both a scientific foundation and a feasible application by architects in Biophilic Design (Browning et al., 2014; Browning and Ryan, 2020). Particularly significant is the fact that the entire 'Nature of the space' dimension – which includes patterns 11 to 15 – raises the issue of considering, within Biophilic Design, environments that can support and improve the equilibrium of the autonomic nervous system which, as we have seen, is the biological root of biophilia. The 15th "awe" pattern was recently added by Browning and Ryan, (2020) to the original 14 models (Browning et al., 2014). 'Awe' can be traced back to the penultimate of Kellert's 72 characteristics, 'Fear and awe' (Kellert, 2008, p.14). This is an item that still need to be improved, including the related Immanuel Kant's meaning of 'sublime' ("das Erhabene"; Kant, 1790).

Thirteen years of Biophilic Design theories: a comparative analysis

We compared the features of Biophilic Design described in the most scientifically relevant publications (Kellert, 2008; Browning et al.,

2014; Kellert, 2018; Browning and Ryan, 2020) in order to identify the issues that the authors unanimously considered to be basic to Biophilic Design (Table 1). We noted that the first four attributes (Light; Protection and Control; Air; Views) are considered in Evolutionary Psychology to be essential in the search for refuge, while the next three (Greenery; Curiosity; Biophilic Materials) are essential in the search for resources. It is not surprising that the characteristics of Biophilic Design considered to be universal follow the adaptive models that were developed by our species in its search for a habitat with reliable refuges and resources. It is also unsurprising that the top places are held by the issues most closely linked to our biology (the senses), and the cultural, experiential issues are lower down. Finally, we were quite amazed to note that issue of 'Quiet' is never considered. In our view, this issue would deserve greater attention (Barbiero et al., 2014; Berto and Barbiero, 2014). Since biophilia depends on the balance of the autonomic nervous system, we believe it is important to add two categories related to the 'Quiet' issue: Sounds and Smells. Sounds and Smells seem to be good indicators of a rest-and-digest state (Kreibig, 2010) and can be part of both finding refuge and seeking resources (Buss, 2019, pp. 70-93).

Kellert (2008)	Browning et al. (2014, 2020)	Kellert (2018)	Our summary
Natural light	Dynamic and diffuse light	Natural light	Light
Prospect and refuge	Prospect and refuge	Prospect and refuge	Protection and Control
Air	Thermal and airflow variability	Air	Air
Views and vistas	Visual connection with nature	Views	Views
Plants	Visual connection with nature	Plants	Greenery
Curiosity and enticement	Mystery	-	Curiosity
Natural materials	Material connection with nature	Materials	Biophilic Materials
-	-	-	Sounds
-	-	-	Smells

Table 1. Comparison of the most important features of Biophilic Design according to the most relevant studies. The final column on the right contains a summary of our proposal.

The future of the Biophilic Design

In the future, empirical attempts to test Biophilic Design ‘in the field’, as has happened in recent years, will no longer be sufficient (for a review, see Kellert, 2018, p. 111-188). We think that there is a need to go beyond the list of ‘suggestions for designers’ on what is important for proper Biophilic Design (Kellert, 2018, p. viii-ix). The aim of Biophilic Design is to design artificial environments that have a positive effect on individual health and wellbeing. These positive effects need to be measurable. To guarantee that the biophilic quality of projects continues to improve, in the future we will need to establish guidelines derived directly from the results of appropriate tests, conducted according to scientific criteria. In the next phase, these guidelines could then be converted into a handbook to assist designers in ensuring the success of their work, and this could be personalized and optimized for each specific case. Finally, in our view it is important to reconnect human beings with Nature (Kellert, 2018, p.14-16) rather than “bringing

nature into the built space” (Browning et al. 2014). The practice of Biophilic Design touches on very deep parts of the human psyche, which are linked to the need, felt by many people, to rediscover an affinity with Nature and feel at one with it again (Barbiero and Berto, 2018). This also entails an acceptance of the dangerous side of Nature, which arouses biophobic reactions in us. Reconnecting with Nature does not mean returning to the Palaeolithic hunter-gatherer lifestyle but knowing and valuing those aspects that allow us to recover our physical and mental equilibrium more quickly and efficiently. This will be the test bench for Biophilic Design.

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References

- Arranz-Otaegui, A., Gonzalez Carretero, L., Ramsey, M.N., Fuller, D.Q. Richter, T. (2018) Archaeobotanical evidence reveals the origins of bread 14,400 years ago in northeastern Jordan. *PNAS*. DOI: 10.1073/pnas.1801071115
- Barbiero, G. (2011) Biophilia and Gaia. Two Hypotheses for an Affective Ecology. *J. Biourbanism*, 1, 11–27.
- Barbiero, G., Berto, R. (2016) *Introduzione alla Biofilia*. Roma, IT: Carocci.
- Barbiero, G., Berto, R. (2018) From Biophilia to Naturalist Intelligence Passing Through Perceived Restorativeness and Connection to Nature. *Ann Rev Research*, 3(1): 555604.
- Barbiero, G., Berto R., Freire, D.D., Ferrando, M., Camino, E. (2014). Unveiling biophilia in children using active silence training: an experimental approach. *Vis Sustain* 1, 31-38
- Barbiero, G., Marconato, C. (2016) Biophilia as emotion. *Vis Sustain* 6, 45-51
- Beatley, T. (2011) Biophilic Cities: What Are They? In: *Biophilic Cities*. Washington DC, Island Press, pp. 45-81.
- Berto, R., Barbiero, G. (2014) Mindful silence produces long lasting attentional performance in children. *Vis. Sustain.*, 2, 49-60.

- Berto, R., Barbiero, G. (2017a) How the psychological benefits associated with exposure to Nature can affect pro-environmental behaviour. *Ann. Cogn. Sci.* 1: 16-20
- Berto, R., Barbiero, G. (2017b) The Biophilic Quality Index: A Tool to Improve a Building from “Green” to Restorative. *Vis. Sustain.*, 8, 38-45
- Berto, R., Barbiero, G., Barbiero, P., Senes, G. (2018) Individual’s Connection to Nature Can Affect Perceived Restorativeness of Natural Environments. Some Observations about Biophilia. *Behav. Sci.* 8, 34.
- Berto, R., Barbiero, G., Pasini, M., Unema, P. (2015a) Biophilic Design Triggers Fascination and Enhances Psychological Restoration in the Urban Environment. *J. Biourbanism*, 1, 26–35.
- Berto, R., Pasini, M., Barbiero, G. (2015b) How Does Psychological Restoration Work in Children? An Exploratory Study. *J Child Adolesc Behav*, 3, 1–9.
- Browning, W.D., Ryan, C.O., Clancy, J.O. (2014). *14 Patterns of Biophilic Design*. New York, Terrapin Bright Green, LLC.
- Browning, W.D., Ryan, C.O. (2020). *Nature Inside: A biophilic design guide*. London, RIBA Publishing.
- Buss, D. (2019). *Evolutionary psychology: The new science of the mind*. 6th edition. New York, Taylor and Frances, Routledge.
- Crutzen, P.J. (2006) The “Anthropocene”. In: Ehlers E., Krafft T. (eds) *Earth System Science in the Anthropocene*. Berlin, Heidelberg, Springer, pp. 13-18
- Diamond, J. (1998) *Guns, germs and steel: a short history of everybody for the last 13,000 years*. New York, Vintage.
- Harvard Medical School (2018) Understanding the stress response. Chronic activation of this survival mechanism impairs health: <https://www.health.harvard.edu/staying-healthy/understanding-the-stress-response>. Visited 28th, July, 2020.
- Kant, I. (1790) *Kritik der Urteilskraft*. Berlin und Libau, Verlag Lagarde und Friedrich.
- Kaplan, S. (1995) The restorative effects of nature: Toward an integrative framework. *J. Env. Psy.* 15: 169-182.
- Kellert, S (1997) *Kinship to Mastery. Biophilia in Human Evolution and Development*. Washington, DC, Island Press.

Kellert, S. (2008) Dimensions, Elements and Attributes of Biophilic Design. In *Biophilic Design*, eds. S.R. Kellert, J. Heerwagen, P., Mador. Hoboken, NJ, John Wiley & Sons, pp. 3-19.

Kellert, S. (2018) *Nature by Design*. New Haven: Yale University Press.

Kellert, S. and Heerwagen, J., (2008) *Preface*. In *Biophilic Design*, eds. S.R. Kellert, J. Heerwagen, P., Mador. Hoboken, NJ, John Wiley & Sons, pp. vii-ix.

Kellert, S., Heerwagen, J., Mador, P., eds. (2008) *Biophilic Design. The Theory, Science, and Practice of Bringing Buildings to Life*. Hoboken, NJ: John Wiley & Sons.

Kellert, S., Wilson, E.O. eds. (1993) *The Biophilia Hypothesis*. Washington DC, Island Press.

Kreibig, S.D. (2010). Autonomic nervous system activity in emotion: A review. *Biological psychology*, 84(3), 394-421.

Orians, G.H., Heerwagen, J.H. (1992) Evolved Responses to Landscapes. In *The Adapted Mind: Evolutionary Psychology and the Generation of Culture*; Barkow, J.H., Cosmides, L., Tooby, J., Eds.; Oxford University Press, New York pp. 555–579.

Shimizu, H., Okabe, M (2007) Evolutionary origin of autonomic regulation of physiological activities in vertebrate phyla. *J Comp Physiol A* 193:1013–1019

Söderlund, J. (2019) *The Emergence of Biophilic Design; Cities and Nature*. Springer Nature, Switzerland AG

Ulrich, R. (1993) Biophilia, Biophobia and Natural Landscapes. In eds. *The Biophilia Hypothesis*, ed. Kellert, S., Wilson, E.O. Washington DC, Island Press, pp. 73-137.

Wilson, E.O. (1984) *Biophilia*. Cambridge, MA, Harvard University Press,

Wilson, E.O. (1993) Biophilia and the Conservation Ethic. In *The Biophilia Hypothesis*, ed. Kellert, S., Wilson, E.O. Washington DC, Island Press, pp. 31-41.

Worldbank (2018) <https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS>