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Biophilic Design: How 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 Man 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 well-being and accelerates healing. Considering the relentless process of global urbanization, these benefits will become increasingly important in the design of our urban spaces, architecture 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.

Key words: Biophilia; Biophobia; Biophilic Design; Vernacular Design.

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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 well-being 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 adversion" (Wilson, 1993, p. 31). Attraction is biophilia, adversion 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 Paleolithic 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 Paleolithic period was adapted to the new cultural requirements. One example is proxemics. In the Paleolithic 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, our 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". This definition comes 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.

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 a *naturalistic* dimension, inspired by the biophilia that established itself genetically during the Paleolithic period. The second was a *vernacular* dimension, which developed after the Neolithic period. Kellert correlated these two dimensions to 72 characteristics of Biophilic Design (Kellert, 2008). These 72 characteristics has been implemented almost in their entirety into the *Living Building Challenge* certification system (Sturgeon, 2017) and 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 offer a series of options for using Biophilic Design in an effective way (Kellert, 2018, pp. viii-ix).

The 14 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). Particularly significant is the fact that the entire 'Nature of the space' dimension – which includes patterns 11 to 14 – 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.

Ten 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; Sturgeon, 2017; Kellert, 2018) 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; Materials and Finishing and Colors) 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 the issue of 'quiet and silence' is never considered: this is an issue that in our view would deserve greater attention (Berto and Barbiero, 2014).

Kellert, 2008	Browning et al., 2014	Sturgeon, 2017	Kellert, 2018	OUR SUMMARY
Natural light	Dynamic & diffuse light	Natural light	Natural light	**Light**
Prospect & refuge	Prospect & refuge	Prospect & refuge	Prospect & refuge	**Protection & Control**
Air	Thermal and airflow variability	Air	Air	**Air**
Views & vistas	Visual connection with nature	Views & vistas	Views	**Views**
Plants	Visual connection with nature	Plants	Plants	**Greenery**
Curiosity & enticement	Mystery	Curiosity & enticement	-	**Curiosity**
Natural materials	Material connection with nature	Natural materials	Materials	**Materials & Finishings & Colors**

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 Paleolithic 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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