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The Biophilic Quality Index. A Tool to Improve a Building from "Green" to Restorative.

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Abstract.

Despite the name, current "green architecture pays exclusive attention to being environmental friendly rather than being biophilic as well. Disregarding Nature in design is not just a matter of aesthetics but concerns also the quality of people's lives. In order to achieve this, there is a need for a paradigm shift from "green" to "restorative" in order to really accomplish biophilic design. In the light of our experience in Human-Environment research we have devised the *Biophilic Quality Index* (BQI), a reliable instrument that allows us to calculate to what extent a building is biophilic. The rationale behind the BQI is simple: Biophilia is innate and affects attention through a proper operationalization of restorativeness and biophilic design is good when it enhances a restorative environment. The BQI can be used both as a guide to follow for a building-to-be, and as a rating system for an existing building, where the final score represents the space for improvement. The BQI will help architects integrate Nature in design and promote understanding that to plan restorative environments is not only an aesthetic need but a necessity for human being's efficient cognitive functioning.

Key words. biophilia · biophilic design · biophilic quality index · cognitive sustainability · environmental sustainability · nature design deficit disorder

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Introduction

Ecology and Environmental Psychology are the theoretical frameworks of this short communication which aims to highlight the importance of integrating Nature in design for human's wellbeing and proposes a tool able to quantify how biophilic an artificial environment is. The positive effect of Nature on human wellbeing must be introduced first in order to encompass the rationale behind the proposed tool.

Humans are considered as organisms evolving over two hundred thousand years in their natural environments, growing and organizing in response to them and indeed becoming fascinated by them (Berrill, 1955; Kaplan, 1977; Ulrich, 1977). In order to survive humans had to assimilate information about these natural environments and to develop expectations about them; since humans are genetically programmed for operation in natural environments they cannot operate effectively in non-natural environments (Knopf, 1987). In fact, humans are more likely to function effectively in those environments that possess attributes similar to the settings in which they evolved and there is also evidence for genetically-determined biases that affect environmental preference (Kaplan, 1977; Balling & Falk, 1982). One such attribute of natural environments is *legibility* (Kaplan, 1976), that is the easiness to grasp information: people prefer settings that serve their need to easily comprehend and predict (Kaplan & Kaplan, 1989). Another attribute is *mystery* (Kaplan, 1977), that is preference for settings that promise new information, which are intriguing and encourage exploration. Another attribute is *refuge* (Appleton, 1975): people prefer settings that maximize security and seclusion, providing shelter from elements of the environment that threatened comfort and survival. Moreover, because of the sensory mechanisms developed solely in response to natural environments, humans have also an innate preference for the particular patterns that natural settings carry: the curvilinear forms and edges, the continuous gradations of shape and color, the blending of textures, the lunar and seasonal cycles, and the other features that distinguish natural from artificial environments (Wohlwill, 1983).

However, Nature is not only appreciated for its aesthetical characteristics, it is also a useful resource for people (Ulrich, 1983). (1) Nature facilitates competence building heightening the individual's sense of control and esteem (Houston, 1968; Lewis, 1977). (2) Nature carries symbols that affirm culture and/or the self and emanates the meaning of life Itself. (3) Nature offers a shift in the stimulus field inherently pleasing to an organism fueled by a need to investigate. It injects diversity into urban experience, offering respite from overly complex, chaotic stimulation in everyday life spaces. (4) Nature restores. As far as the last point is concerned, most natural environments meet all the requirements to be "restorative environments" (Kaplan, 1995). Natural environments are distinct settings, either physically or conceptually from everyday environments (*being-away*); they contain patterns that hold one's attention effortlessly (*fascination*); they have scope and coherence that engage the mind and promote exploration in time and space (*extent*); and they fit with and support one's inclinations or purposes (*compatibility*).

Understanding of transactions between people and restorative environments has accumulated, and a large body of data shows that contact with Nature is especially beneficial for urban dwellers whereas low levels of Nature may be a factor in the higher rates of certain pathologies observed for urban populations as compared to rural groups (for a review, see Berto, 2014). Restorative environments research has been dominated by two theoretical positions, one emphasizing stress reduction (*Stress Recovery Theory*; Ulrich et al., 1991), the other one concerned with the recovery of the capacity to focus attention (*Attention Restoration Theory*; Kaplan, 1995). Though the theories differ in the antecedent condition that leads a person to a restorative environment, both emphasize that

the exposure to Nature can positively affect human functioning, and natural environments are preferred over urban environments because Nature holds attention without mental effort, blocking out the demands of daily work and urban living and can mitigate stress and prevent it through aiding in the recovery of the essential psycho-physiological resources.

Environmental and cognitive sustainability

The term "green building" has been around for quite some time and interpreted variously. For the public in general it is a building with a lot of landscape and/or water features. Strictly speaking, "green" means sustainable or environment friendly. Technically speaking, the *Green Building* is meant to alter as little as possible Gaian biogeochemical cycles (Barbiero, 2011; Smith & Smith, 2015; Barbiero, 2017, pp. 43-60), striving therefore to an "outer" sustainability, whose final aim is the "impact zero" building. To this end, various green building planning paradigms have been created across South East Asia and the USA, with the prominent LEED®, BREAMS®, WELL®, LBC® and GREEN MARK® extending their influence across the developing new paradigms. While there is nothing intrinsically wrong with these parameters defining high energy performance buildings, there is however a lack of acknowledgment of the real reason for integrating natural features in design. The sustainability indexes underrate the psycho-physiological benefits deriving from the exposure to Nature, basically neglecting the fact that natural features are more than a simple visual pleasure element (Berto, 2005; Berto et al., 2008; Berto, 2011; Berto et al., 2015).

Environment-friendly design can be impressive and good (see for example, Guz Architects' design in Singapore), but very often even though such design is sustainable and seems to be very Nature-associated, it is very rigid and man-made and does not reflect what Nature really has to offer. Sustainability does not really push architects to go beyond form and scale design to encompass the wellbeing and quality of life of users, which should be among the most important architectural considerations today. Nature's restorative value should be considered the most important factor to take into account in biophilic design (Barbiero, 2011; Barbiero, 2014; Berto et al., 2015). In this regard, biophilic design is the way to accomplish "inner" sustainability, whose final aim is a building perceived as highly restorative where it is possible to make the most of human nature. This is the problem we are facing as an ecologist and an environmental psychologist. We have a lot of buildings with "Nature deficit *design* disorder" and we want to help engineering buildings to bring occupants closer to the regenerative power of Nature.

Biophilic design can help. The core of biophilic design (otherwise called biophilic architecture, ecological design or restorative environmental design) is to bridge the gap between human beings and Nature, by taking evolutionary biology, ecology and environmental psychology as the basis for design (Barbiero, Berto & Callegari, 2016). From the biological/ecological standpoint, biophilic stems from biophilia (Wilson, 1984; Kellert, 2008). The experience of real or reproduced Nature has psychological and physiological restorative effects (Berto, 2014; Barbiero & Berto, 2016). However, biophilic design is not just an exotic garden outside the building or a piece of vertical landscape purely for aesthetic reasons, but rather a holistic "restorative" design that does not alienate people, as the environment-friendly technological buildings very often do. Biophilic design is "cognitive sustainable" design (Berto, 2011) and can be applied at all levels of scale, creating interior and exterior revolutionary forms, private and public buildings, landscapes, and whole cities. This transformation from green to restorative requires panoramic, trans-disciplinary thinking and coordinated actions, because the cost of disregarding Nature in design is not just a matter of aesthetics but also extends to the quality of people's lives.

The biophilic quality index

The Malaysian architect K. Yeang (2008), one of the pioneers in ecological/biophilic architecture, has offered a set of principles for designing "with Nature" (see Table 1). Yeang's suggestions are significant, even though they can sound *intangible* to someone who is approaching biophilic design, together with the first conceptual framework for biophilic design laid out by Cramer and Browning (2008) where three categories were developed to define biophilic buildings. More recently, Ryan et al. (2014) articulated from these categories a list of 14 Nature-based patterns (see Table 2). While it is more *tangible* and with a wide range of application, Ryan et al.'s list doesn't fill completely the gap between theory and practice. We are aware that biophilic design is not a "formula", but our belief is that in the designer's toolkit there is room for another tool specifically meant to guide and assist in the biophilic design process. In the light of our experience as researchers in the field of Human-Environment interaction and after a careful analysis of the effect flaws in design can have on human's physiological, psychological, emotional and behavioral responses, we have devised the *Biophilic Quality Index* (BQI) to help architects to address biophilic design. The BQI establishes more robust *quantitative* rather than *qualitative* parameters in biophilic design and measures and tracks variable efficacy in the environment in order to capture the restorative benefits offered by biophilic design. The BQI originates from a set of research studies where the environmental psychology paradigms were verified within the evolutionary biology framework and the relationships between perceived restorativeness, connection to Nature, environmental preference and environmental features were carefully addressed (Barbiero et al., 2014; Berto & Barbiero, 2014; Berto, Pasini & Barbiero, 2015). In addition, the BQI validity and reliability were also observed in the field where the biophilic assessment was correlated with the energetic certification (PassivHaus®, Minergie®, CasaClima®) and the individual's perception of restorativeness of Biosphera 2.0 (Ravotto et al., in press).

The BQI allows us to calculate to what extent a building is biophilic, and it can be used both as a guide to follow for a building-to-be or as a rating system for an existing building where the final score (a percentage value) represents the room for improvement. The BQI is made up of five different sections in order to assess the building in its context (e.g. in the case of a public building) and each single space within the building (see Table 3). Each section presents a list of environment characteristics whose presence or absence have to be assessed in order to label a building as "biophilic". From our point of view, a biophilic building is a single or a network of individually designed spaces that would provide a *restorative* experience for those living/working in it, and for people viewing the building. To this end, each space within the biophilic building has to be specifically designed to foster human wellbeing and a sense of *here-ness*, by providing a restorative environment which allows recovery from urban stress and mental fatigue, and configured in such a way as to allow the experience of relaxation, fascination and interaction with the environment. The BQI allows assessing environment's *enclosure*, *separation from distractions*, *environmental stimulation*, *coherence*, *complexity*, *affordances*, opportunities for *visual contact with Nature* and the presence of *biomorphic patterns,* characteristics that have to be carefully assessed in a building in order to be biophilic. When biophilic design comes to a public space, it has to facilitate the sense of *there-ness*; meaningful public spaces have to allow people to make strong connections between the place, their personal lives and the larger world. Since restorative public places are relevant for people by enriching their lives, the BQI allows assessing the presence of *detractors*, the *façade* characteristics, the *location* and the *provision of access,* i.e. the characteristics to be assessed for a public space to be biophilic.

Conclusions

Architecture is the profession of designing the built environment, but to properly accomplish biophilic design and to plan environments/buildings/cities in harmony with their ecosystems, architects should include the contributions from researchers in related fields like environmental psychology and ecology because each one has a significant role in restoring the balance between architecture and our biological/ecological/psychological inventory.

Since the Biophilic Quality Index has proved reliable on the field, they can help architects not only to translate theory into practice, but also to make comparisons between buildings with different level of perceived restorativeness. In this respect, it would seem reasonable to suggest the inclusion of the Biophilic Quality Index within construction paradigms to pave the way for a shift of the WELL® and LBC® certifications from qualitative to quantitative protocols, because even biophilia can be objectively measured, thereby bypassing reliance on the architect's sensitivity to the topic and/or people's perception in a Post Occupancy Evaluation (late) assessment.

Endnote

The *Biophilic Quality Index* (BQI) is r egistered at Società Italiana Autori ed Editori (SIAE), Rome, Italy, n° 2017000273.

References

Appleton, J. (1975). *The Experience of Landscape*. New York: Wiley.

Balling, J.D., & Falk, J.H. (1982). Development of visual preference for natural environments. *Environment and Behavior*, 14(1), 5-28.

Barbiero, G. (2011). Biophilia and Gaia: two hypotheses for an Affective Ecology. *Journal of Biourbanism*, 1, 11-27. Available online: http://journalofbiourbanism.org/2013/01/20/biophilia-and-gaia-two-hypotheses for-an-affective -ecology/

Barbiero, G. (2014). Affective Ecology for Sustainability. *Visions for Sustainability*, 1, 20-30. Available online: http://dx.doi.org/10.13135/2384-8677/1419

Barbiero, G. (2017). *Ecologia Affettiva. Come trarre benessere fisico e mentale dal contatto con la Natura*. Milano: Mondadori.

Barbiero, G., & Berto, R. (2016). *Introduzione alla biofilia. La relazione con la Natura tra genetica e psicologia*. Roma: Carocci.

Barbiero, G., Berto, R., & Callegari, G. (2016). Biophilic design to address human needs for Nature in daily artificial environments. Primo congresso congiunto della Società Italiana di Ecologia, Unione Zoologica Italiana, Società Italiana di Biogeografia, Università di Milano-Bicocca, 30 Agosto -2 Settembre 2016, Milano

Barbiero, G., Berto, R., Freire, D.D., Ferrando, M., Camino, E. (2014). Unveiling biophilia in children using active silence training: an experimental approach. *Visions for Sustainability*, 1, 31-38 DOI: http://dx.doi.org/10.13135/2384-8677/1420

Berrill, N.J. (1955). *Man's Emerging Mind*. New York: Dodd, Mead.

Berto, R. (2005). Exposure to restorative environments helps restore attentional capacity. *Journal of Environmental Psychology*, 25, 249-259.

Berto, R. (2011). The Attentional Vantage Offered by Perceiving Fascinating Patterns in the Environment. In Daniels, J.A. (ed.), *Advances in Environmental Research*, vol. 6, 4th quarter. New York: Nova Science Publishers, pp. 503-516.

Berto, R. (2014). The role of Nature in coping with psycho-physiological stress. A literature review of restorativeness. *Behavioral Science, special issue: Advances in Environmental Psychology*, 4, 394–409 DOI: 10.3390/bs4040394.

Berto, R. & Barbiero, G. (2014) Mindful silence produces long lasting attentional performance in children. *Visions for Sustainability*, 2, 49-60 DOI: http://dx.doi.org/10.13135/2384-8677/1427

Berto, R., Barbiero, G., Pasini, M. & Unema, P. (2015). Biophilic design triggers fascination and enhances psychological restoration in the urban environment. *Journal of Biourbanism*, 1, 26-35.

Berto, R., Massaccesi, S., & Pasini, M. (2008). Do eye movements measured across high and low fascination photographs differ? Addressing Kaplan's fascination hypothesis. *Journal of Environmental Psychology*, 28, 185-191.

Berto, R., Pasini, M., & Barbiero, G. (2015). How does Psychological Restoration Work in Children? An Exploratory Study. *Journal of Child and Adolescent Behaviour*, 3, 1-9. Available on line: http://dx.doi.org/10.4172/2375-4494.10002000

Browning B. (2012). *The Economics of Biophilia*, Terrapin Bright Green LLC New York NY, Washington. Available online: https://www.terrapinbrightgreen.com/reports/the-economics-of-biophilia/ (visited March 14th, 2017).

Cramer, J.S., & Browning, W.D. (2008). Transforming Building Practices Through Biophilic Design. In S. F. Kellert, J. H. Heerwagen, & M. L. Mador (Eds.), *Biophilic Design*. Hoboken, NJ: Wiley, pp. 335-346.

Houston, C.S. (1968). The Last Blue Mountain. In S.Z. Klausner (Ed.), *Why Man Takes Chances*. New York: Doubleday, pp. 52-58.

Kaplan R., & Kaplan, R. (1989). *The Experience of Nature: A Psychological Perspective*. New York: Cambridge University Press.

Kaplan, S. (1976). Adaptation, Structure and Knowledge. In G.T. Moore, & R.G. Golledge (Eds.), *Environmental Knowing: Theories, Research and Knowledge*. Stroudsbourg, PA: Dowden, Hutchinson, & Ross, pp. 32-45.

Kaplan, S. (1977). Tranquillity and challenge in the natural environment. In *Children, Nature and the Urban Environment*,), (General Tech. Rep. No NE-30). Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeastern Experiment Station, pp 181-186.

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

Kellert, S.R. (2008). Dimensions, Elements, Attributes of Biophilic Design. In S. R. Kellert, J. H. Heerwagen, & M. L. Mador (Eds.), *Biophilic Design*. Hoboken, NJ: Wiley. pp. 3–19.

Knopf, R.C. (1987). Human Behavior, Cognition and Affect in the Natural Environment. In D. Stokols, & I. Altman (Eds.), *Handbook of Environmental Psychology*, vol. 1, pp. 783-825.

Lewis, C.A. (1977). Human Perspective in Horticulture. In *Children, Nature, and the Urban Environment*, (General Tech. Rep. No NE-30). Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeastern Experiment Station, pp. 187-192.

Ravotto, G., Sabia, S., Berto, R., Barbiero G., Callegari, G. (in press) Scientific Biophilic Design. Human-Nature connection in the Biosphera 2.0 project. *Visions for Sustainability*, 8, in press.

Ryan, C., Browning, W.D., Clancy, J.O., Andrews, S.L., & Kallianpurkar, N.B. (2014). Biophilic design patterns. Emerging Nature-based parameters for health and well-being in the built environment. *International Journal of Architectural Research*, 8(2), 62-76.

Smith, T.M., & Smith, R.L. (2015). Elements of Ecology. Chapter 22: *Biogeochemical Cycles*. 9th edition, London: Pearson Education.

Ulrich, R.S. (1977). Visual landscape preference: a model and application. *Man-Environment Systems*, 7, 279-293.

Ulrich, R.S. (1983). Aesthetic and Affective Response to Natural Environment, in I. Altman, & J.F. Wohlwill (Eds.), *Behavior and The Natural Environment*, Plenum, New York, pp. 85-125.

Ulrich, R.S., Simons, R.F., Losito, B.D., Fiorito, E., Miles, M.A., & Zelson, M. (1991). Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology*, 11, 201-230.

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

Wohlwill, J.F. (1983). The Concept of Nature: A Psychologist's View. In I. Altman & J.F. Wohlwill (Eds.), *Human Behavior and the Environment* (vol. 6): *Behavior and the Natural Environment* (pp. 1-34). New York: Plenum.

Yeang, K. (2008). Ecoskyscrapers and Ecomimesis: New tall building typologies, CTBUH 8th World Congress.

Table 1 Yeang's principles for designing "with Nature"

1-The ecological approach to design is about environmental bio-integration. 2- Our built forms and systems need to imitate Nature's processes, structure, and functions, as in its ecosystems. 3- The process of designing to imitate ecosystems is Ecomimesis. This is the fundamental premise for eco design. 4- There is much misperception about what is ecological design. We must not be misled and seduced by technology. 5- The other common misperception is that if our building gets a high notch in a green-rating system, then all is well. 6- Ecosystems in the biosphere are definable units containing both biotic and abiotic constituents acting together as a whole.

Table 2: Cramer and Browning's conceptual categories (left column), and Ryan et al.'s biophilic conditions (right column) for biophilic design.

Conceptual category	Biophilic conditions
Nature in space	Visual connection with Nature Non-visual connection with Nature Non-rhythmic sensory stimuli Access to thermal and airflow variability Presence of water Dynamic and diffuse light Connection with natural systems
Natural analogues	Biomorphic forms and patterns, Material connection with Nature Complexity and order
Nature of the space	Prospect Refuge Mystery Risk/peril

Table 3: Sections and a few examples from the sub-sections making up Berto and Barbiero's Biophilic Quality Index.

Section 1	The network (the building in the context; 6 sub-sections) e.g. sub-section "façade": • novelty • transparency • …
Section 2	The individual spaces within the building (8 sub-sections) e.g. sub-section "enclosure": • strategic placement and/or orientation of the building/spaces • physical boundaries • …
Section 3A	Opportunities for visual contact with Nature (3sub-sections) e.g. sub-section "indoor plants/ecosystems" …
Section 3B	If a garden/backyard/terrace/patio is present (3 sub-sections) e.g. sub-section "trees" …
Section 4	Non-visual contact with Nature (1 sub-section) e.g. sub-section: "biomorphic forms and patterns and natural materials"
Section 5	Sustainability (2 sub-sections) e.g. sub-section "design" …