Biophilic Design Triggers Fascination and Enhances Psychological Restoration in the Urban Environment

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ABSTRACT

This brief communication wants to draw greater attention to the role of physical environment in the psychological restoration process. Given the benefits deriving from contact with Nature, urban designers should also attend the human need for psychological restoration. According to the *Attention Restoration Theory*, performance, mood and well-being benefit from exposure to environments attracting effortless involuntary attention and demanding little voluntary attention; this process called *fascination*, mostly occurs in natural environments though our exploratory studies showed that also urban settings/buildings can be high on fascination. Using knowledge of our affinity for Nature, experiences of well-being can also be generated through the environments we create (biophilic architecture). Fascination with Nature is derived not only from natural elements, but also from the *qualities* and *attributes* of Nature people find appealing and aesthetically pleasing when reproduced in the built environment as well. "Cognitive comfort" resides primarily in the relationship among natural and built landscape elements rather than intrinsically in the elements themselves. To know that also urban settings may be highly fascinating can be of great help to city planners to promote psychological well-being as one aspect of public health. Urban environments should not compromise people's need for psychological restoration whereas contribute to providing an opportunity for physical, cognitive and emotional restoration from environmental stress.

***Keywords*:** Attention Restoration Theory; Biophilic Design; Lempel-Ziv Welch Lossless Compression Algorithm; Perceived Restoration Scale.

The purpose of Environmental Psychology is to understand the complex relations between people and the environments around them; though interest in human transactions with the natural world remains a priority, concern for optimizing human relations with the built environment is growing (Gifford, 2009). Since *design* requires knowledge about how the physical environment affects people's preferences, behavior, moods, etc. there is a direct connection between the needs of designers and the work of environmental psychologists. However, within its own domain, designers have struggled with the proper role of design since the mid-twentieth century (see Hoppenfeld, 1960); the tension revolves around two different notions: design as a physically oriented search for ideal urban form, versus design as a more process-oriented discipline. To some extent, the concern for design has been replaced by a concern for *place* (Johnson, 2009), although the two notions are difficult to disassociate. Thus designers might be engaged in an effort to discover how physical aspects of places affect human feeling, thoughts, and behavior (Nasar, 1997; Lund, 2003; Rodriguez, Khattak & Evenson, 2006; Dumbaugh & Rae, 2009), or whether design matters at all (Ryan & Weber, 2007). Researchers have shown that people make inferences from the physical appearances of places and these inferences are often accurate. A visual feature, such as grilles on windows for instance, serve as a useful probabilistic cue for a non-visual attribute of a place, such as fear of crime (Craik & Appleyard, 1980). This process helped our predecessors to survive: they had to be able to recognize what it is, evaluate it, and act on that evaluation. Visual-formal qualities refer to physical properties and relations, such as shape, proportion, scale, and complexity, to which humans respond quickly and "for their own sake" (Lang, 1987). Observers would notice formal qualities that may benefit or injure them or that may support or interfere with their activities (Gibson, 1979).

In Western society people are often overwhelmed by a wide variety and large amount of sensory information (Lipowski, 1970), which can cognitively overload their limited processing capacity. Information overload can have negative consequences on behavior: to process too much information often results in stress-related diseases and mental fatigue, i.e. confusion, distraction, cognitive strain and other dysfunctional or unfavorable conditions (for a review see Berto, 2014). To prevent this, modern urban environments should be more "cognitively sustainable", i.e. to serve psychological restoration playing a role in coping with *mental fatigue* (Berto, 2011). Actually, using knowledge of our affinity for Nature[1], adapted and refined over millions of years, we can generate experiences of health and well-being through the environments we create (Barbiero, 2011). The experience of Nature through human evolution has left its mark on our minds, our behavioral patterns, our physiological functioning, in what we pay attention to in the environment, how we respond, and what that experience means to us (Barbiero, 2014). The *biophilia hypothesis* and supporting research tell us that, as a species, we still respond strongly to Nature's forms, processes, and patterns (Kellert & Wilson, 1993; Kellert, Heerwagen & Mador, 2008). A number of studies have demonstrated that attentional performance improves through exposure to natural as compared to urban scenes (Tennessen & Cimprich, 1995; Hartig et al., 2003; Berto, 2005): thanks to their content, natural scenes do not overload the attentional system, further undermining cognitive performance, unlike urban scenes. According to the *Attention Restoration Theory* (ART; Kaplan, 1995), performance benefits from exposure to environments that attract effortless involuntary attention, known as *fascination*, which demand little voluntary attention. Environments perceived as natural tend to trigger more *fascination* than environments perceived to be urban or artificial; artificial environments containing natural analogues or biomorphic ornaments can also trigger fascination, but not to as great an extent of "restorativeness" (see e.g. Herzog et al., 1997; Hartig et al., 2003; Staats, Kieviet & Hartig, 2003; Purcell, Peron & Berto, 2001), and a few have forwarded hypotheses about how the process may work (see e.g. Berto, 2005; Berman, Jonides & Kaplan, 2008; Berto et al., 2015).

[1] In this paper we will use "Nature" with the capital "N" to indicate the biosphere and the abiotic matrices (soil, air, water) where it flourishes, to avoid confusion with the "nature" understood as the intrinsic quality of a certain creature or certain phenomenon.

Succinctly, mental fatigue is associated with effortful voluntary attention and occurs because it takes considerable effort to stay focused. In contrast *fascination* is based on interest, resulting from *process* or *content* and it can be conceptualized along a dimension, from *hard* to *soft*: *hard fascination* is mainly concerned with activities, events, etc. whereas *soft fascination* has to do with environments, places; in both cases fascinating stimuli attract people and keep them from getting bored (Kaplan & Kaplan, 1989, p. 184). Unfortunately, everyday settings call for voluntary attention and the price paid is mental fatigue, which is the manifestation of the cumulative effect of distractions that must be inhibited for voluntary attention to function efficiently; mental fatigue indicates that the inhibitory mechanism is fatigued. By contrast, fascinating settings/patterns are inherently gripping and people do not spend energy in suppressing distracting stimuli because they do not have to pay attention to less than interesting stimuli.

Berto, Massaccesi and Pasini (2008) showed that images of natural scenes with a high level of *fascination* (rated on the *Perceived Restorativeness Scale*) are characterized by a different pattern of eye movements than images of built environments with low *fascination*. This study provided initial evidence that in watching fascinating scenes people shift effortlessly from one feature to another, although results did not make clear whether the voluntary vs. involuntary attention was engaged by the naturalness category or by *fascination* itself, i.e. from *content* or *process*. Berto et al. (2010) focused on the possible relationship between human need for attentional recovery and patterns of stimulation provided by the environment. They showed that in mentally fatigued participants, the cost of performing an *ad hoc* attention-orienting task in the "high fascination" condition (i.e. viewing scenes of natural and built environments that engage effortless attention) is smaller than in the "low fascination" condition (i.e. viewing scenes of natural and built environments that engage effortful attention). Only in the high fascination condition, where people can function in the involuntary mode, participants showed a benefit (in terms of reaction time reduction) from shifting attention between trials, independently of the environmental category. From Berto et al.'s study (2010) it turned out that in certain cases the particular combination of natural and built elements is more important than the amount of visible natural environment (see also Zacharias, 1999), and *fascination* is a process that can take place in attending both natural and urban scenes. Accordingly, the involuntary process can also be engaged in viewing urban scenes if *environmental information is fascinating*, i.e. if it does not overload the attentional system (see also Kaplan & Kaplan, 1981). Actually, scenes high on *fascination* have in common the engagement of a process that affords psychological restoration.

To verify whether *fascination* is linked to the amount of information to be processed in a scene independently from the environmental category, we tried to address this question at a basic level using a simple method that allows the quantifying of image information: the Lempel-Ziv Welch lossless compression algorithm (LZW). The LZW-algorithm has practically become the standard compression procedure (commonly referred to as "zip"), and constitutes a simple but reliable method of comparing image information. By removing *redundancy*, compression leaves the compressed file with only the actual information content; images often contain quite some redundant information, or have multiple sections containing identical information. The LZW algorithm determines the amount of unique information in the information source (for more details see Unema et al., 2005; Itti, 2006). The compression *ratio* is expressed as a percentage; the higher the ratio, the more *redundancy* the image contains. The compression ratio was calculated for the thirty-eight scenes used in Berto et al.'s study (2010) because those images depict both "high" and "low" *fascination* scenes (nineteen each) spanning the entire naturalness range (from totally built to totally natural). Since the LZW algorithm does not take into account any pre-existing knowledge about the world, it can be safely assumed that the procedure of compression affected all images similarly. From our analysis it turned out that ratio predicts *fascination*, with

less redundant scenes (lower ratio) being rated more fascinating. Scene naturalness also weighed in on the prediction of *fascination*, with nature scenes showing the highest *fascination* score; nevertheless, the naturalness category alone was not enough to explain *fascination*.

In fact, the perception of *fascination* does not rely on *naturalness* only, on the contrary it depends on a series of "sensorial semiotic aesthetic attributes" such as *openness*, *mystery*, *complexity*, *order*, *vegetation*, *maintenance*, *style* and *perceived use* (Nasar, 1994, 1997). There is some evidence of preferences for certain building and skyline arrangements (Smith, Health & Lim, 1995): people have clear preferences for combinations of building shape, color and arrangement, etc., and they may also have preferences for certain combinations of buildings and natural elements (Zacharias, 1999). Actually, our *fascination* with Nature is derived not just from natural elements, but also from the *qualities* and *attributes* of natural settings that people find particularly appealing and aesthetically pleasing when reproduced in built environment as well. Wohlwill (1983) suggested that the difference in preference between natural and built environments might arise from *formal* differences between them; he theorized that built/artificial environments have "regular lines, rectilinear edges, sharp discontinuities, abrupt transitions, and highly regular, smooth surfaces", whereas natural environments are characterized by "irregular lines and irregular, rough textures". Exactly this combination turns into *fascination, that is not engaged merely by random sequences of interesting objects, but it is connected to a larger framework otherwise it would be only a momentary diversion or distraction* (Kaplan & Kaplan, 1989, p. 185). However the restoration process is a mixture of *fascination* and pleasure, not only settings that encourage *fascination* have an important aesthetic component involved, but environmental preference and psychological restoration are also strongly related (Kaplan & Kaplan, 1989; Hernandez et al., 2001; Purcell, Peron & Berto, 2001).

The goal of biophilic design is to create settings imbued with positive emotional experiences, enjoyment, pleasure, interest, *fascination* and wonder, which are the precursors of human attachment to and caring for place (Kellert, Heerwagen & Mador, 2008). The goal can be achieved including actual Nature or symbolically referring to Nature in architectural environments, this will inspire interest in and appreciation of Nature, while an effective way to obtain restoration from mental fatigue (Kellert, 2005; Joye, 2007; Van den Berg, Hartig & Staats, 2007). To this end, we wanted to verify the relationship between psychological restoration, the so-called *perceived restorativeness*, environmental preference and the presence of several physical-aesthetic attributes (see Hidalgo et al., 2006) across buildings with different degrees of biophilic design (low-medium-high). Perceived restorativeness was assessed on the *Perceived Restorativeness Scale*-11 (PRS-11; Pasini et al., 2014) that measures the individual perception of four restorative factors: *being-away* (a setting that allows physical and/or psychological distance from demands on directed attention), *fascination* (the type of attention assumed to be effortless and without capacity limitations drawn by interesting objects, namely a setting that allows an individual to be curious about and fascinated by things), *coherence* (a setting where activities and items are ordered and organized), *scope* (a setting large enough with no restrictions to movements, a sort of world of its own). Though all buildings were characterized by the presence of vegetation, only for the "high biophilic design buildings" there was a positive relationship between *vegetation* and attributes like *visual complexity* and *distinctiveness*, which in turn were correlated with environmental preference and perceived restorativeness. High biophilic design buildings were the most preferred and scored higher on the PRS-11, in particular on *being-away*, *scope* and *fascination*. By contrast the "low biophilic design building" scored higher only on the forth restorative factor *coherence*, which was positively related to attributes like *order* and *congruency* and negatively with *distinctiveness*; moreover the low biophilic design buildings turned out to be the most familiar and least preferred among buildings.

To know that urban settings/buildings can also be highly fascinating is of great interest to city planners in order to promote psychological well-being as one aspect of public health. Urban environments should not compromise people's need for psychological restoration. Research shows that urban design can be employed as a tool to improve human health (see Gesler, 2005; Van den Berg, Hartig & Staats, 2007), though most of this research has focused on hospitals and health facilities and to a lesser extent to everyday urban design (Verlade, Fry & Tveit, 2007). Urban environments/buildings have an impact on people perceiving them, affecting aesthetic appreciation, psycho-physiological well-being and mental fatigue. "Cognitive comfort" resides primarily in the relationship among natural and built landscape elements rather than intrinsically in the elements themselves (Zacharias, 1999; Berto et al., 2010). The question therefore is not whether the concomitant depletion (or presence) of natural elements has only a negative (or positive) impact on mental restoration, but to design urban environments that are "cognitively sustainable", i.e. that do not put a person at risk of experiencing mental fatigue or environmental stress (Berto, 2011). Appreciation for urban settings relies on the relationship between buildings and psychological wellbeing, i.e. on urban settings that, like Nature, do not overload the attentional system. In modern living environments, opportunities to experience psychological and physiological well-being are often in decline, therefore to reconcile Nature with architecture by integrating real Nature and/or natural forms/elements into the built environment and architectural design can make information processing less cognitive demanding and enhance *fascination*.

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