Abstract

According to Duxbury and Higgins, 57% of full time office employees reported high levels of stress. Stress impacts the productivity, health and well-being of individuals, and the bottom line of employers. A growing body of research suggests that exposure to nature mitigates stress stimuli and therefore has restorative effects on memory and attention resulting in health, well-being and productivity benefits. This paper summarizes the findings of a 2015 MID thesis study that brings together information drawn from the neurosciences and environmental psychology including: attention restoration theory (ART), psycho-evolutionary theory, biophilic design, survival-advantageous characteristics, current case studies, and experience drawn from design practice. In this review, the authors highlight six key biophilic design strategies for stress reduction in office knowledge workers: locating in or near nature, movement in nature, maximizing daylight and views to nature, use of natural materials, plants and natural scents. These strategies focus particularly on providing workers with the most direct and indirect exposure to nature and, therefore, are likely to have the strongest impact on mitigating the stress response. Each strategy is shown in current applications in existing workplaces, where they are used in combination or independent of each other, depending on site conditions and opportunities.

Keywords: workplace design, biophilia, biophilic design, interior design, knowledge workers, stress reduction, plants, nature-based features, office workers, well-being, health
1. INTRODUCTION

Stress is negatively impacting the productivity, the health and well-being of employees and the bottom line of employers. According to a Canadian study of 25,000 full-time employees 57% reported high levels of stress [1]. It is estimated Canadian employers lose $20 billion per year due to stress-related illness [2]. Stress causes a loss of productivity and chronic stress can cause long term health issues [3].

A growing body of evidence suggests exposure to nature and nature-based or biophilic features may offer a solution to reducing stress in the workplace [4]. This paper summarizes some of the findings from a 2015 thesis study [5] that includes a comprehensive literature review on the topic drawn from the neurosciences, environmental psychology, and examples in design practice. The purpose of the study was to determine strategies that would provide design practitioners with cost effective and straightforward ways of integrating nature-based features into workplace design to enhance well-being and reduce stress.

2. THE BRAIN AND THE NEUROSCIENCE OF STRESS

People are largely unaware of the stress stimuli they experience day to day, since the majority of sensory impulses are sorted in our sub-conscious. Neurosurgeon, Dr. Norman Hill describes that the brain, even during sleep, is constantly responding to sensory stimuli, endlessly coordinating all the chemical and electrical impulses, (N. Hill, personal communication, April 13, 2015 in [5] p. 7-9). The brain has evolved to place particular priority on sensory impulses to pass that are necessary to gain information about one’s immediate environment to perform a specific task, typically related to survival.

Neuroscientist, Dr. Matt Hill, explains that, unfortunately, our response to stressors has not evolved to suit our modern-day workplace environment [6]. Our response to life threatening and dangerous situations in the wild is physiologically similar to our emotional response to non-life threatening work pressures and physical characteristics of workplace environments (e.g. high stimulation). When external sensory stimuli trigger an alarm response in our brains, the neurotransmitter cortisol is released, producing a short term increased physiological function or what is commonly known as a flight or fight response.

What was appropriate and effective metabolic response for survival when early humans where faced with a saber-tooth tiger, is very problematic when it is being reproduced by stimuli in modern workplace environments. This is because cortisol thins out dendrites that form the connections between our brain cells [3]. Limiting the ability for one cell to speak to other cells effects short term memory. Memory is a key component in learning and cognition. It is theorized that these chemical and structural changes in the brain are the reason that individuals who are stressed experience memory loss and related mental and physical health problems. According to Posen, [3], chronic stress can lead to depression. Others have identified stress as a risk factor for Alzheimer’s [7].

With advances in information technology, office workers are now working longer hours and spending more time indoors than workers did during the Industrial Revolution, which means they are being exposed to increasing levels of stress stimuli. Stress is a natural and useful biological response, but long-term stress can have dire consequences. While it is not possible, or even desirable, to attempt to block all of the billions of sensory stimuli received by the human body, designers may, according to environmental design theory and research, be able to mitigate worker stress by incorporating more natural, or biophilic, stimuli into workplace design.
3. ATTENTION RESTORATION THEORY AND BIOPHILIC DESIGN

If the human brain is not designed for the modern workplace, what is it designed for? According to acoustic ecologist Gordon Hempton, the ear, one of the brain’s sensory receptors, is particularly attuned to better hear certain frequencies of sound (2-5 HZ) that communicate information about the natural environment and events in it relevant to survival [8]. Our vision system is similarly attuned to process daylight. E.O. Wilson’s Biophilia Hypothesis suggests humans have a certain innate affiliation or love of other living things [9], which makes sense given how easily we comprehend and communicate in it. Because humans are equipped with the perfectly designed biological receptors for processing relevant natural information means that we can do it effortlessly and without attention. In contrast, focused or directed attention towards something like a work-task or human-made environment requires a great deal of effort and can even overload our sensory receptors, causing mental fatigue and stress.

Thirty years ago, environmental psychologists Rachel and Stephen Kaplan developed Attention Restoration Theory or ART, suggesting that involuntary and effortless attention to nature rests the brain and thereby helps to restore memory and concentration [11][12]. Kaplans' theory has been repeatedly tested and supported by numerous studies, with over 2046 citations currently in Google Scholar, including one in Li and Sullivan’s recent 2016 study revealing the importance of views, over exposure to daylight alone, of school landscapes on recovery from stress in high school students [13].

Roger Ulrich’s [14][15] own experiments suggest stress recovery during exposure to nature are derived from psycho-evolutionary theory related to positive emotional state and physiological changes, rather than involuntary attention, which Ulrich et al. was able to elicit with non-nature-based stimuli. Although Kaplans and Ulrich et al. provide us with different explanations of what happens during the restorative process, both (and many other researchers) found that views of nature, versus human made settings, account for cognitive recuperation and increased perceptual capacity [16].

In 2008, social ecologist, Stephen Kellert began translating biophilia, ART, and psycho-evolutionary theory into a framework for biophilic design [17]. As a work in progress, Kellert’s many different levels consisting of two dimensions, six elements and 70 attributes, can be difficult to follow and keep straight [5] (p. 17). The attributes overlap and there are varying levels of detail within the elements. Architect and historian, Grant Hildebrand has proposed a similar nature-based design framework, but it is much smaller in organizational scale. Hildebrand’s theoretical framework consists of five preferred architectural characteristics that emulate natural settings useful or advantageous to human survival. For example, Hildebrand references Jay Appleton’s “prospect and refuge” [18], a location offering a view of resources from a “protective place of concealment”[19][20]. Although still mainly theoretical, both Kellert and Hildebrand’s work to organize key ideas emerging from environmental design research has made it easier for designers to apply in actual design solutions.

In biophilic design, it is important to note that Kellert [17] differentiates between three types of exposure to nature. The first is direct biophilic experience or self-sustaining features such as: plants, woods, gardens, daylight, views, landscapes and scents. Indirect biophilic experience is nature that requires on-going human intervention to survive, such as potted plants, which require watering and other maintenance. A third is symbolic represented in natural motifs such as leaves on column capitals or organic shapes on finish materials or images. Research by Kahn, et al., [21] found that direct and indirect experiences with nature have greater potential for stress reduction. Interacting with images of nature, or technological nature, provides some, but not all, the enjoyments and benefits of interacting with actual nature [22], (p 41).
4. BIOPHILIC WORKPLACE DESIGN STRATEGIES IN PRACTICE

Biophilic workplace design is still relatively new, with relatively few examples, and of these, very little performance-based evaluation research has been done. While there are potentially many approaches to induce stress recovery through exposure to nature into workplace design, the following is a list of six practical design strategies drawn from a sample of seven biophilic workplace designs, along with additional related literature research. All six strategies focus on providing direct or indirect exposure to nature, or a combination of both.

4.1. Locating in or adjacent to nature

Locating work environments in natural areas provides opportunities for direct experience of nature immediately adjacent to, and usable as, a work environments. The Pond Studios, designed by Elva Rubio in a rural area near Lagrange, Georgia is a 15,000 ft² building extended over a large pond, providing a panoramic view of the surrounding nature. Several expansive decks encourage movement and use of outdoor spaces during office hours [23].

In the case of SC3 Offices, the multidisciplinary design firm’s building is located within an urban location (Winnipeg, MB) between two highways, a light industrial, and suburban residential neighbourhood [24] (see also Figure 1, Figure 2, Figure 3). Here the designers enhanced existing nature on the urban site, preserving and adding to a stand of spruce trees on the north side of the building and working with the local Municipal government to re-introduce a native prairie grassland along the south side of the site facing, and thereby mitigating sound from, the busy roadway. Walking paths, shared with the adjacent neighbourhood, are designed throughout. A broad, forest-sheltered exterior deck, fitted out with appropriate furnishings to minimize relocation time, extends the studio space into the new urban forest as a place for employees to unwind as well as undertake work tasks and meetings (see Figure 6).
4.2. Moving in nature

Several research studies [4][25] support the restorative benefits of not only viewing nature, but moving through it on vegetated paths and in urban parks and forests, compared to walking in urban settings without green
Making nature both readily accessible, and possibly unavoidable, is a design strategy intended to build healthier workplaces. In the case of the proposed Google Campus in San Francisco Bay, California, designed by Architects NBBJ, a series of linked outdoor spaces and rooftops promote scooter-riding, jogging, biking, yoga classes all created from data on how employees work and relate in order to maximize “casual collisions of the workforce” [26].

4.3. Daylight and views

Probably one of the most well-known and applied biophilic design strategies is the provision of natural daylight and view. As mentioned earlier in this paper, some research suggests that restorative benefits are more likely to be attributed to natural views, than to daylight, although both are important to human well-being and biological circadian function. Exterior glazing for daylight and view provides an additional opportunity to include operable windows for natural ventilation and improved indoor air quality and control.

The Selgas Cano architectural office provides its workers with an unusual ground level view of nature (Figure 4). It is also an example of maximizing daylight and views by moving enclosed offices off glazed exterior walls and into the interior of the building floor plate, low (under 42 or 48”) or no partitions and overhead storage units, and the incorporation of light color furnishings and finishes to maximize day light penetration. SC3 uses similar strategies, including full floor to ceiling windows to optimize daylight and vegetated views (Figure 5). Glazed interior partitions and light shelves are also effective strategies for maximizing daylight and view.
4.4 Natural materials: Wood

Tactile and visual stimulation provided by natural materials in indoor environments, and in particular, wood, has been shown to impact stress and relaxation responses. Researchers, Tsunetsugu et al [27] suggest that the ideal proportion of wood as an interior finish on walls and floors is between 30% to 45% of the combined surface area of a living space. Path, designed by Geremia Design in 2011, is a social networking application company’s office located in a dense urban site in San Francisco. Path’s office space cannot provide direct experience of nature, so the designers provide an indirect experience of nature through the use of well-placed plants, wood and other natural materials. Confronted with a similar dense urban location, Google’s Tel Aviv’s office designers’ use spatial planning to create an interior park like setting with materials such: as wood benches, crates, flooring and natural tree trunks.

4.5 Plants

Another well-known and easily applied biophilic design strategy is the inclusion of plants in the workplace. Research studies by Raanaas et al [28] and Shibata & Suzuki [29] suggest between one and five plants within the sight of the worker for stress reduction and improved health and well-being. On the ninth floor of its building in London, England, Goggle offers indirect nature in the form of gardening boxes on its decks and balconies, so popular there is a waiting list. Google Tel Aviv and Path’s office areas also use the indirect nature of potted plants as discussed in 4.4 above.

4.6 Natural scents

Environmental psychologist, Sally Augustin suggests certain natural scents can reduce stress, promote relaxation (lavender) and can improve brain functions such as memory (rosemary), creativity (cinnamon-vanilla), and alertness (peppermint) [30]. The health benefits of the Japanese practice of shinrin yoku, or forest bathing, is supported by research that finds the scents, or essential oils, emitted by evergreen trees are associated with improvements to the immune system and production of natural killer cells [31]. SC3’s location within a spruce wood forest provides an opportunity for workers to benefit from such essential oils, which also permeate into the indoor office space (Figure 6).

The introduction of scents inside buildings, sometimes referred to as environmental fragrancing, as in the Fredric’s office building in Philadelphia, is intended to boost productivity of employees [32]. Scents, especially ones from artificial or chemical sources, however, can be problematic for people with sensitives. Moreover, the efficacy of scents is inconclusive. According to environmental psychologist, Susan Knasko, five out of eleven published studies, including her own, showed no effect of scents on task performance [32]. Interestingly,
congruency (how much an introduced scent matches its setting) has been shown to impact consumer behaviour in retail settings [33].

Figure 6 - SC3 and surrounding deck area set in urban forest, natural spruce scent permeates indoor and outdoor spaces (with permission Giles, 2014).

5. CONCLUSION

Stress is a natural human response to dangerous or threatening situations, but according to neuroscience, the human biological response has not appropriately adapted to sources of stress stimuli found in today’s work environments, contributing to the rise of chronic stress and its related health problems. A growing body of environmental design research suggests that the introduction of nature-based stimuli, or biophilic design, might help to recover from stress through restorative attention or by inducing positive emotional state.

The literature research from the MID thesis study summarized in this paper highlights how including nature and nature-based features in workplaces could potentially have a significant impact on worker health and well-being. An important finding drawn from the literature was that direct and indirect exposure to nature has the greatest impact over symbolic nature experiences. The implication of this finding is that designers should prioritize strategies that provide direct contact. Four examples provided include locating workspaces adjacent to or in, nature, maximize movement in nature, exposure to scents in nature and optimize the provision of daylight and vegetated views. Where direct contact is not possible, exposure to indirect nature is recommended. Two strategies identified include the use of natural materials (wood), interior landscaping and potted plants. The case studies show how these various biophilic design strategies have been be applied in practice.
The authors note that biophilic workplace design is relatively new and that additional building performance evaluation research of buildings employing it is required to determine its impact on reducing worker stress. With a growing interest in promoting human health and wellness in buildings, biophilic design is now being integrated into green building rating systems such as Leadership in Energy and Environmental Design (LEED), Living Building Challenge (LBC) and the Well Building Standard, which likely will transform how future buildings are located and built. Rating systems, along with more multidisciplinary approaches to design delivery, will provide an excellent opportunity to integrate environmental design research with lessons-learned from measurement and monitoring of buildings employing biophilic design strategies.

6. REFERENCES


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