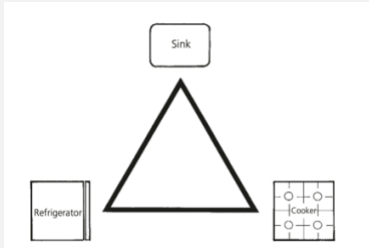



Title	Quote	Additional Info	Citation	Reference
<p>Architects Pocket Book of Kitchen Design</p> <p>(BOOK)</p> <p>1</p>	<p>“The dictionary definition of <i>ergonomics</i> is defined as ‘the study of man in relation to the environment and the adaptation of machines and general conditions to fit individuals, so that they may work to maximum efficiency’” (page 36)</p> <p>“Low light levels can cause fatigue and depression” (page 46)</p>	<p>The Work Triangle – the relationship between the Sink, Cooker and Fridge in the kitchen space</p> 	<p>(Baden-Powell, 2005)</p>	<p>Baden-Powell, C. (2005) <i>Architect's Pocket Book of Kitchen Design</i>. Z-Library. Architectural Press Available at: https://b-ok.cc/book/1000132/149698</p>
<p>The Practice of Biophilic Design</p> <p>(ARTICLE)</p> <p>2</p>	<p>“Biophilia is the inherent human inclination to affiliate with nature that even in the modern world continues to be critical to people’s physical and mental health and well being” (Wilson, 1986) (page 3)</p> <p>Subjects were subliminally exposed to pictures of snakes, spiders, frayed wires and guns – Almost all study participants aversively responded to the revealed images of snakes and spiders but indifferent to the wires or handguns - Arne Öhman (1986) (page 3)</p> <p>“humans may have evolved in the natural world, the “natural habitat” of contemporary people has largely become the indoor built environment where we now spend 90% of our time” (page 5)</p> <p>“inadequate contact with natural light, ventilation, materials, vegetation, views, natural shapes and forms”(page 5)</p> <p>“Biomimicry refers to forms and functions found in nature, especially among other species, whose properties have been adopted or suggest solutions to human needs and problems” (page 18)</p>	<p>Arne Ohman’s study shows us how people respond to nature over human created/man-made elements.</p> <p>Application of BD results in;</p> <p>Physical – lower blood press., increased comfort, improved health</p> <p>Behavioural – Better coping and mastery skills, attention, concentration, improved social interaction</p> <p>Mental – less stress n anxiety, improved problem solving and creativity</p> <p>3 kinds of experiences of nature:</p> <ol style="list-style-type: none"> 1. Direct experience of nature (light, air, plants) 2. Indirect experience of nature (pattern, shape, form) 3. Experience of space and place (prospect, refuge) 	<p>(Kellert and Calabrese, 2015)</p>	<p>Kellert, S., and Calabrese, E. (2015) <i>The Practice of Biophilic Design</i>. Available at: https://www.biophilic-design.com.</p>

		<p style="text-align: center;">Experiences and Attributes of Biophilic Design</p>  <table border="0" style="width: 100%; text-align: center;"> <tr> <td style="width: 33%; background-color: #4CAF50; color: white; padding: 2px;">DIRECT EXPERIENCE OF NATURE</td> <td style="width: 33%; background-color: #00796B; color: white; padding: 2px;">INDIRECT EXPERIENCE OF NATURE</td> <td style="width: 33%; background-color: #FF9800; color: white; padding: 2px;">EXPERIENCE OF SPACE AND PLACE</td> </tr> <tr> <td style="font-size: 8px;"> <ul style="list-style-type: none"> • Light • Air • Water • Plants • Animals • Weather • Natural landscapes and ecosystems • Fire </td> <td style="font-size: 8px;"> <ul style="list-style-type: none"> • Images of nature • Natural materials • Natural colors • Stimulating natural light and air • Naturalistic shapes and forms • Evoking nature • Information richness • Age, change, and the patina of time • Natural geometries • Biomimicry </td> <td style="font-size: 8px;"> <ul style="list-style-type: none"> • Prospect and refuge • Organized complexity • Integration of parts to wholes • Transitional spaces • Mobility and wayfinding • Cultural and ecological attachment to place </td> </tr> </table>	DIRECT EXPERIENCE OF NATURE	INDIRECT EXPERIENCE OF NATURE	EXPERIENCE OF SPACE AND PLACE	<ul style="list-style-type: none"> • Light • Air • Water • Plants • Animals • Weather • Natural landscapes and ecosystems • Fire 	<ul style="list-style-type: none"> • Images of nature • Natural materials • Natural colors • Stimulating natural light and air • Naturalistic shapes and forms • Evoking nature • Information richness • Age, change, and the patina of time • Natural geometries • Biomimicry 	<ul style="list-style-type: none"> • Prospect and refuge • Organized complexity • Integration of parts to wholes • Transitional spaces • Mobility and wayfinding • Cultural and ecological attachment to place 		
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<p>Biophilic Design: the theory, science, and practice of bringing buildings to life</p> <p>3</p>	<p>“Some biophilic architects consider that neurological nourishment comes strictly from living biological forms. In their view, ornamented forms and surfaces are derivative of natural forms, and thus provide only a secondhand (i.e., vicarious) experience” (page 64)</p> <p>“human alienation from nature” (page 5)</p> <p>“This new design paradigm is called here “restorative environmental design,” an approach that aims at both a low-environmental-impact strategy that minimizes and mitigates adverse impacts on the natural environment, and a positive environmental impact or biophilic design approach that fosters beneficial contact between people and nature in modern buildings and landscapes” (page 5)</p> <p>“Biophilic design is, thus, viewed as the largely missing link in prevailing approaches to sustainable design. Low-environmental-impact and biophilic design must, therefore, work in complementary relation to achieve true and lasting sustainability” (page 5)</p>	<p>Discusses claims rather than conduct data collection:</p> <ul style="list-style-type: none"> • “Reducing air pollutants, especially ozone, nitrogen dioxide, and to a lesser extent particulate matter (McPherson et al. 1997)” (page 115) • “Reducing the demand for air conditioning during warm weather by shading buildings” (page 115) <p>Conclusion to ‘evidence base chapter’:</p> <p>“Anecdotal experience, common sense, evolutionary theory, and even some empirical evidence suggest that contact with nature confers health benefits. But there is very little rigorous evidence of this association” (page 116)</p>	<p>(Kellert et al., 2008)</p>	<p>Kellert, S. R., Heerwagen, J. H., and Mador, M. L. (2008) <i>Biophilic Design: the theory, science, and practice of bringing buildings to life. Choice Reviews Online</i>. John Wiley & Sons, Inc Available at: https://book.cc/book/3600058/ede228</p>						

	<p>“Biomimicry is the act of learning from nature, borrowing designs and strategies that have worked in place for billions of years” (page 28)</p> <p>“Biomimicry is not a style of building, nor is it an identifiable design product. It is, rather, a design process” (page 29)</p> <p>“<i>Building for Life</i>, Stephen Kellert says the goal of biophilic design is to “reestablish positive connections between people and nature in the built environment”” (page 32)</p> <p>“the importance of <i>indoor</i> daylight or sunshine for human health and performance, there seems to be a growing consensus that access to a view of nature is significant. Beginning with the seminal work of Roger Ulrich (1984), then Mendell (1991), Heschong Mahone Group (2003), and now Kellert (2005), seated views of nature and proximity to windows are being linked to reduced length of stay after surgery, reduced sick building syndrome (SBS), increased performance at task, and overall improved emotional health.” (page 119-120)</p> <p>“Since every opening in a building has the potential to connect humans as well as nature, the importance of those connections should be equally addressed” (page 129)</p>			
<p>Biomimicry in Architecture (BOOK)</p> <p>4</p>	<p>“Biomimicry is concerned with functional solutions, and is not necessarily an aesthetic position” (page 2)</p> <p>“‘Biomorphic’ is generally understood to mean design based on biological forms” (page 3)</p> <p>“‘Bio-utilisation’ refers to the direct use of nature for beneficial purposes, such as incorporating planting in and around buildings to produce evaporative cooling” (page 3)</p> <p>“The principle for architecture that emerges from observing is: less materials, more design” (page 9)</p>	<p>Discusses how some buildings look towards bamboo for its rigidity and strength over a vertical height of 40m whilst retaining a slim structure – thanks to the nodes between bamboo, it’s able to reach 40m+ and the same ‘breakpoints’ are introduced in buildings to reach their heights.</p> <p>Could bio-utilisation link to creating spaces that benefit the individual user better? For example as Kellert and Calabrese (2015) have reinforced the positive effect BD has on the users</p>	<p>(Pawlyn, 2016)</p>	<p>Pawlyn, M. (2016) <i>Biomimicry in Architecture</i>. 2nd Edn. Newcastle Upon Tyne: RIBA Publishing Available at: https://book.cc/book/5335560/0e37a7</p>

“Biomimicry works at all scales of architecture and can even be extended to scales beyond the reach of conventional architecture. It is ultimately a systemic approach” (page 125)

behavioural, mental and physical attributes, could BD help individuals suffering from ADHD etc and live at home alone, using the kitchen space.

14 Patterns of Biophilic Design (WEB)

5

“a garden view can enhance our creativity; why shadows and heights instill fascination and fear” (page 4)

“14 PATTERNS OF BIOPHILIC DESIGN

Nature in the Space Patterns

1. Visual Connection with Nature
2. Non-Visual Connection with Nature
3. Non-Rhythmic Sensory Stimuli
4. Thermal & Airflow Variability
5. Presence of Water
6. Dynamic & Diffuse Light
7. Connection with Natural Systems

Natural Analogues Patterns

8. Biomorphic Forms & Patterns
9. Material Connection with Nature
10. Complexity & Order

Nature of the Space Patterns

11. Prospect
12. Refuge
13. Mystery
14. Risk/Peril” (page 5)

“sunlight and a view to nature was believed to be important, as can be seen at St. Elizabeth’s in Washington, D.C. Designed in the 1850s to the concepts of Dr. Thomas Kirkbride, who “...believed that the beautiful setting...restored patients to a more natural balance of the senses” (Sternberg, 2009)” (page 6)

2 connotations of nature

1. “Nature is only that which can be classified as a living organism unaffected

TABLE 1. BIOPHILIC DESIGN PATTERNS & BIOLOGICAL RESPONSES

Table 1 illustrates the functions of each of the 14 Patterns in supporting stress reduction, cognitive performance, emotion and mood enhancement and the human body. Patterns that are supported by more rigorous empirical data are marked with up to three asterisks (+++), indicating that the quantity and quality of available peer-reviewed evidence is robust and the potential for impact is great, and no asterisk indicates that there is minimal research to support the biological relationship between health and design, but the anecdotal information is compelling and adequate for hypothesizing its potential impact and importance as a unique pattern.

14 PATTERNS	STRESS REDUCTION	COGNITIVE PERFORMANCE	EMOTION, MOOD & PREFERENCE
NATURE IN THE SPACE			
Visual Connection with Nature	• Lowered blood pressure and heart rate (Grim, Stanton & Gaddard, 2013; van den Berg, Hertz, & Staats, 2007; Turrenig & Muzicchi, 2005)	Improved mental engagement/ attentiveness (Bridgerman & Weisz, 2008)	Positively impacted attitude and overall happiness (Barton & Potts, 2012)
Non-Visual Connection with Nature	• Reduced systolic blood pressure and stress hormones (Park et al., 2009; Wang, Cui, Janer et al., 2010; Chappell et al., 2008; Ulrich et al., 1991)	Positively impacted cognitive performance (Barton, Zhu & Chinn, 2012; Langford, Hilly, & Lunderstein, 2004)	Perceived improvements in mental health and tranquility (Li et al., 2012; Johnson et al., 2011; Turrenig, Park, & Muzicchi, 2010; Kim, Kim, & Forring, 2007; Roggenbom & Sorens, 2003)
Non-Rhythmic Sensory Stimuli	• Positively impacted heart rate, systolic blood pressure and sympathetic nervous system activity (Li, 2010; Park et al., 2008; Kahn et al., 2006; Renscher et al., 2002; Ulrich et al., 1991)	Observed and quantified behavioral measures of attention and exploration (Windhager et al., 2011)	
Thermal & Airflow Variability	• Positively impacted comfort, well-being and productivity (Hargrave, 2006; Han & Wilson, 2005; Wigg, 2005)	Positively impacted concentration (Fang et al., 2010; Wang et al., 1991; K. Kaplan & Kaplan, 1989)	Improved perception of temporal and spatial pleasure (aesthetics) (Parkinson, de Dear & Grando, 2012; Zhang, Aron, Hwang & Han, 2010; Aron, Hwang & Hwang, 2008; Wang, 2007; de Dear & Brager, 2002; Heeding, 1979)
Presence of Water	• Reduced stress, increased feelings of tranquility, lower heart rate and blood pressure (Chen, Wang, & Wilson, 2002; Pleasant et al., 2010; Beckerman & Veisel, 2002)	Improved concentration and memory restoration (Chen et al., 2010; Beckerman & Veisel, 2002)	Observed preferences and positive emotional responses (Windhager, 2011; Kaplan & Frye, 2010; Miller et al., 2010; Kahnava & Harnett, 2008; Beckerman & Veisel, 2002; Hwang & Chan, 1993; Russ & Alexander, 2003; Ulrich, 1983)
Dynamic & Diffuse Light	• Positively impacted circadian system functioning (Fajardo et al., 2011; Beckert & Rubin, 2008)	Increased visual comfort (Eisenack, 2012; Kim & Kim, 2007)	
Connection with Natural Systems			Enhanced positive health responses; Shifted perception of environment (Kabat et al., 2008)
NATURAL ANALOGUES			
Biomorphic Forms & Patterns			Observed view preference (Neuhart, 2012; Joyce, 2007)
Material Connection with Nature		Decreased diastolic blood pressure (Thompson, Morrell & Sato, 2007)	Improved comfort (Thompson, Morrell & Sato, 2007)
Complexity & Order	• Positively impacted perceptual and physiological responses (Gargano, 2012; Zhai, 2007; Taylor, 2006; S. Kaplan, 1988)	Improved creative performance (Susterfeld et al., 2012)	Observed view preference (Hwang, 2012; Hwang et al., 2008; Hagenhoff, Parnitzke, & Taylor, 2004; Taylor, 2006)
NATURE OF THE SPACE			
Prospect	• Reduced stress (Egan & Dipolstein, 2010)	Reduced boredom, irritation, fatigue (Kearwater & Cox, 1991)	Improved comfort and perceived safety (Hwang & Byrne, 2007; Wang & Taylor, 2008; Veith, 2002)
Refuge		Improved concentration, attention and perception of safety (Egan & Dipolstein, 2010; Ulrich et al., 1991; Wang & Taylor, 2008; Pelech, 2008)	
Mystery			Induced strong pleasure response (Beckerman, 2012; Saha et al., 2011; Hays, 2010; Wilson & Sorens, 2001)
Risk/Peril			Resulted in strong dopamine or pleasure responses (Barton et al., 2012; Wang & Tsun, 2011; Zaki et al., 2008)

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(Browning et al., 2014)

Browning, W., Ryan, C., and Clancy, J. (/2014)

14 Patterns of Biophilic Design. *Terrapin Bright Green*.

Available at:
<https://www.terrapinbrightgreen.com/wp-content/uploads/2020/05/14-Patterns-of-Biophilic-Design-Terrapin-2014e.pdf>

by anthropogenic impacts on the environment” (page 8)

2. “everything, including all that humans design and make, is natural and a part of nature because they are each extensions of our phenotype. This perspective inevitably includes everything from paperback books and plastic chairs” (page 8)

“Biophilic design can be organized into three categories – Nature in the Space, Natural Analogues, and Nature of the Space” (page 9)

Nature in the Space – direct, physical and ephemeral presence of nature in a space

“Nature in the Space encompasses seven biophilic design patterns:

1. **Visual Connection with Nature.** A view to elements of nature, living systems and natural processes.
2. **Non-Visual Connection with Nature.** Auditory, haptic, olfactory, or gustatory stimuli that engender a deliberate and positive reference to nature, living systems or natural processes.
3. **Non-Rhythmic Sensory Stimuli.** Stochastic and ephemeral connections with nature that may be analyzed statistically but may not be predicted precisely.
4. **Thermal & Airflow Variability.** Subtle changes in air temperature, relative humidity, airflow across the skin, and surface temperatures that mimic natural environments.
5. **Presence of Water.** A condition that enhances the experience of a place through seeing, hearing or touching water.
6. **Dynamic & Diffuse Light.** Leverages varying intensities of light and shadow that change over time to create conditions that occur in nature.
7. **Connection with Natural Systems.** Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem”

Natural Analogues – “Addresses organic, non-living and indirect evocations of nature. Objects, materials, colours, shapes, sequences and patterns found in nature”

“Mimicry of shells and leaves, furniture with organic shapes, and natural materials that have been processed or extensively altered (e.g., wood planks, granite tabletops), each provide an indirect connection with nature: while they are real, they are only analogous of the items in their ‘natural’ state” (page 10)

“Natural Analogues encompasses three patterns of biophilic design:

1. **Biomorphic Forms & Patterns.** Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature.
2. **Material Connection with Nature.** Materials and elements from nature that, through minimal processing, reflect the local ecology or geology and create a distinct sense of place.
3. **Complexity & Order.** Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature.” (page 10)

Nature of the Space – Addresses spatial configurations in nature. Able to see beyond our immediate surroundings with the slightly dangerous or unknown; obscured views.

Nature of the Space encompasses four biophilic design patterns:

1. **Prospect.** An unimpeded view over a distance, for surveillance and planning.
2. **Refuge.** A place for withdrawal from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead.
3. **Mystery.** The promise of more information, achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment.
4. **Risk/Peril.** An identifiable threat coupled with a reliable safeguard.” (page 10)

	<p>“Biophilia can be linked to 3 overarching mind-body systems – cognitive, psychological and physiological” (page 11)</p> <p>Cognitive – mental agility and memory – repetitive task like paper work – “Directed attention is energy intensive, and over time can result in mental fatigue and depleted cognitive resources (e.g., Kellert et al., 2008” (pg 11) – “strong or routine connections with nature can provide opportunities for mental restoration”</p> <p>Psychological responses – adaptability, alertness, emotion and mood</p> <p>Physiological responses – musculoskeletal, respiratory and overall physical comfort – “Short term stress that increases heart rate and stress hormone levels, such as from encountering an unknown but complex and information-rich space, or looking over a banister to 8 stories below, are suggested to be beneficial to regulating physiological health (Kandel et al., 2013)” (page 11)</p>			
<p>Application of biophilic architecture in apartment design</p> <p>(PDF)</p> <p>6</p>	<p>“Globally, the construction sector consumes 50% of natural resources, 40% of energy and 16% of water. Besides transportation and construction also contribute the most CO2 emissions, which is 182.5 tons per year and 45% of course the best solution is not to stop development, but to build more wisely, one of them is by applying biophilic architecture.</p>	<p>Discusses how a particular apartment building could improve the health and well-being of guests through different design implementations focusing on the 14 patterns of biophilic design by terrapin llc</p>	<p>(Ardiani <i>et al.</i> , 2020)</p>	<p>Ardiani, Y. M., Prawata, A. G., and Sholihin, A. (2020) Application of biophilic architecture in apartment design. <i>IOP Conference Series: Earth and Environmental Science</i> 426 012105. https://doi.org/10.10</p>

				88/1755-1315/426/1/012105
<p>Nature inside (BOOK)</p> <p>7</p>	<p>“This innate biological connection between people and nature is referred to as ‘biophilia” (page 12)</p> <p>Excerpt From Nature Inside William D. Browning</p> <p>This material may be protected by copyright.</p> <p>Biophilic evidence base:</p> <p>““How the brain processes experiences of nature is quite interesting. As images trigger responses in the rods and cones on the retina of the human eye, they are transmitted by the optical nerve to the visual cortex of the brain. This funnel-shaped portion of the brain does the initial processing before the images move to different parts of the brain for interpretation. As an image travels further into the funnel the cross-section of the visual cortex increases and more neurons are triggered, in particular mu opioid receptors, which leads to a more pleasurable response”. (page 36)</p> <p>““In the Biederman-Vessel study,⁶ an image of a plain grey wall was processed at the start of the funnel, while images of a pile of bricks and a lamp post beside a building were each processed further into the cortex. Finally an image of a rolling Japanese garden with water made it furthest into the cortex, triggering the strongest pleasure response of all” (page 37)</p> <p>““As far back as the 1800s there was a theory that the brain operates differently while experiencing nature.¹⁴ It was thought that when out in nature, the brain operates on a level of 'soft fascination'. This eventually became the basis for attention restoration theory (ART),^{15 16} which</p>		(Browning <i>et al.</i> , 2020)	<p>Browning, W. D., Ryan, C. O., and Heatherwick, T. (2020) <i>Nature inside. A biophilic design guide.</i> London: RIBA Publishing</p> <p>Available at: https://books.google.co.uk/books?hl=en&lr=&id=7QcCEAAQBAJ&oi=fnd&pg=PT6&dq=nature+inside&ots=cU9HQaK6Dn&sig=QXA7MUxKdGQXgIyYrxPv6yate0Q&redir_esc=y#v=onepage&q=nature%20inside&f=false</p>

posited that portions of the prefrontal cortex quiet down while experiencing nature. After this mental pause, we have better cognitive capacity” (page 41) (Rachel Kaplan & Stephen Kaplan, *The Experience of Nature: A Psychological Perspective*, Cambridge University Press, Cambridge, 1989)

Biophilia in the design process:

““Principles of biophilic design are 'fundamental conditions for the effective practice of biophilic design'¹ communicating a vision of health and wellbeing in symbiosis with nature. The principles support an adaptable methodology for realising that vision. Biophilic design requires repeated and sustained engagement with nature.

Biophilic design focuses on human adaptations to the natural world that over evolutionary time have advanced people's health, fitness and well-being.

Biophilic design encourages an emotional attachment to particular settings and places.” (page 53) (“Stephen R. Kellert and Elizabeth F. Calabrese, 'The Practice of Biophilic Design', <http://www.biophilic-design.com>, 2015, pp. 6-7 (accessed 23 March 2020)

““As the efficacy of a biophilic design solution is not easily measured by a checklist or performance modelling, successful biophilic design planning depends upon alignment of desired health outcomes and experiences with design opportunities” (page 63)

““Not all products are created equally. At the interiors fit-out scale, the issue is not necessarily one of cost but of informed decision-making. For any project destined to have a carpet or rug, furniture, textiles, hardware or similar goods (Figure 3.2), biophilic design presents a lens and filter both for narrowing down the pool of goods and materials to select from and for coordinating a unified

vision for the occupant experience. Finding the right balance of these components is essential to reaching a biophilic interior solution (Figure 3.16); the balance may be perceived as achieving ‘authenticity’, while avoiding tchotchkes that offer little to no experiential value or, in an extreme case, lead to visual toxicity” (page 91)

““Hardware naturally offers both a haptic experience of texture, form and radiant temperature, and a visual experience of form, complexity and order, affordance and implied strength. Hinges and hooks, knobs and handles, keyhole and switch plates, vent grilles and other architectural and decorative ironworks (Figure 3.5) can each help thread a coherent vision through a biophilic design concept”(page 108)

““Stephen Kellert, in his Kinship to Mastery (1997), observed that there is a progression in the nature bonding process. Pre-schoolers focus on attraction, desire, fear and aversion experiences with nature; children aged 6–9 transition to a more emotional relationship with nature; and at about 10 years old and onward, the relationship with nature becomes increasingly intellectual” (page 152-153) (“Stephen R. Kellert, Kinship to Mastery, Island Press, Washington DC, 1997, pp. 166-167)

Closing thoughts:

““Biophilic design brings a new level of intention to design — a lens through which the scope of design expands beyond function and beauty. Knowing that biophilic design can measurably support positive psychological and physiological conditions presents a new frontier of responsibility and purpose to the profession.

Biophilic design is one of many components of a holistic approach to buildings and places. It can be a powerful

	<p>tool to support human health and well-being in the built environment. There are many other things that support our health and well-being, and they need to be addressed as well. Hopefully biophilic experiences in buildings will also engender an awareness and desire to nurture natural environments.</p> <p>While bringing nature inside can help to create meaningful and enduring experiences of the built environment, ultimately the most important suggestion we can make is to get outdoors and directly engage with nature” (page 347)</p>			
<p>Physiological and cognitive performance of exposure to biophilic indoor environment (ARTICLE)</p> <p>8</p>	<p>“According to participants' responses for the BIDI questionnaire in the space survey, the office common area was generally rated as “biophilic environment” (mean BIDI score = 27 (out of 54)), while the classroom was generally rated as “non-biophilic environment” (mean BIDI score = 3). The reception room is also a non-biophilic place (mean BIDI score = 0).” (Page 258-259)</p> <p>“Our findings indicate that including natural elements in the design of indoor spaces has “calming” effects as seen in the changes to blood pressure and skin conductance, as well as positive impacts on short-term memory” (page 260)</p> <p>“Our cognitive results suggest that participants in the biophilic indoor environment performed better, especially for the short-term memory, after controlling for caffeine intake, sleep quality, general</p>	<p>Biophilic environment improves short-term memory by 14%, decreases neg. emotions & increase pos. emotions</p> <p>28 participants in an office environment studied to quantify the effects physiological and cognitive responses to natural elements. Able to deduce that the exposure to nature resulted in 3.6mmHG lower diastolic blood pressure and the above stats mentioned</p> <p>BIDI – “Biophilic Interior Design Index (BIDI), was developed based on the 14 patterns of biophilic design proposed by Terrapin Bright Green LLC (page 257). We designed a questionnaire asking participants' perception of the biophilic features in the study environment such as plants, water, air-flow, light, materials, biomorphic patterns, long-distance view. Their responses of these questions were used to calculate the score of the BIDI.”</p>	<p>(Yin <i>et al.</i> , 2018)</p>	<p>Yin, J., Zhu, S., MacNaughton, P., Allen, J. G., and Spengler, J. D. (2018) Physiological and cognitive performance of exposure to biophilic indoor environment. <i>Buildi ng and Environment</i> 132 255–262. https://doi.org/10.1016/j.buildenv.2018.01.006</p>

	<p>stress level and time of visit. These findings along with improved emotional affect are consistent with the Attention Restoration Theory (ART) [18,34,50] (page 261)</p> <p>Conclusion: “We found that even short exposure to a biophilic indoor environment was associated with lower systolic and diastolic blood pressure and skin conductance level in comparison to their baseline measures. In addition, participants in biophilic environment had 14% better performance in short-term memory and improved emotions compare to their performance in the non-biophilic environment. These results may be partially explained by both the Stress Recovery Theory and the Attention Restoration Theory. Biophilic indoor environment may play an important role in improving population health and cognitive function yet have been overlooked” (page 262)</p>			
<p>Bridging biophilic design and environmentally sustainable design: A critical review (ARTICLE)</p> <p>9</p>	<p>“upward trend increased by 25% in 2008 and by 50% in 2019, indicating that the potential of BD is becoming more widely Recognised” (page 11)</p>		<p>(Wijesooriya and Brambilla, 2021)</p>	<p>Wijesooriya, N., and Brambilla, A. (2021) Bridging biophilic design and environmentally sustainable design: A critical review. <i>Journal of Cleaner Production</i> 283 124591. https://doi.org/10.1016/j.jclepro.2020.124591</p>

<p>A quantitative study for indoor workplace biophilic design to improve health and productivity performance (ARTICLE)</p> <p>10</p>	<p>“Specifically, 12% green coverage ratio is identified as the optimal greenery dose for the office after integrating the results on psychological, physiological, and productivity performance” (page 7)</p> <p>“The total power of Alpha wave (EEG results), which indicates relaxed status, was significantly increased in Case 4 and Case 5 (the cases with 12% and 20% greenery ratio). The total powers were increased 28.33 dB from Case 1b to Case 4, and increased 94.91 dB from Case 1b to Case 5, respectively. It means that the high greenery ratio in Case 4 and Case 5 made participants more relaxed and vigilant” (page 7)</p> <p>“visual contact with greenery is the main cause of health benefits (Kellert and Calabrese, 2015)” (page 9) (practice of biophilic design)</p>	<p>12% optimum greenery ratio</p>	<p>(Lei <i>et al.</i> , 2021)</p>	<p>Lei, Q., Yuan, C., and Lau, S. S. Y. (2021) A quantitative study for indoor workplace biophilic design to improve health and productivity performance. <i>Journal of Cleaner Production</i> 324 129168. https://doi.org/10.1016/j.jclepro.2021.129168</p>																				
<p>Are Biophilic-Designed Site Office Buildings Linked to Health Benefits and High Performing Occupants? (ARTICLE)</p> <p>11</p>	<p>Conclusion: “positive psychological effects, such as improved work satisfaction and higher morale” (page 12218)</p>	<p>Table 1. A typology of values of nature [35].</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Definition</th> </tr> </thead> <tbody> <tr> <td>Aesthetic</td> <td>Physical attraction and appeal of nature</td> </tr> <tr> <td>Dominionistic</td> <td>Mastery and control of nature</td> </tr> <tr> <td>Humanistic</td> <td>Emotional bonding with nature</td> </tr> <tr> <td>Moralistic</td> <td>Ethical and spiritual relation to nature</td> </tr> <tr> <td>Naturalistic</td> <td>Exploration and discovery of nature</td> </tr> <tr> <td>Negativistic</td> <td>Fear and aversion of nature</td> </tr> <tr> <td>Scientific</td> <td>Knowledge and understanding of nature</td> </tr> <tr> <td>Symbolic</td> <td>Nature as a source of language and imagination</td> </tr> <tr> <td>Utilitarian</td> <td>Nature as a source of material and physical benefit</td> </tr> </tbody> </table> <p>Note: Adapted from Kellert, by Meltzer and colleagues [35].</p>	Value	Definition	Aesthetic	Physical attraction and appeal of nature	Dominionistic	Mastery and control of nature	Humanistic	Emotional bonding with nature	Moralistic	Ethical and spiritual relation to nature	Naturalistic	Exploration and discovery of nature	Negativistic	Fear and aversion of nature	Scientific	Knowledge and understanding of nature	Symbolic	Nature as a source of language and imagination	Utilitarian	Nature as a source of material and physical benefit	<p>(Gray and Birrell, 2014)</p>	<p>Gray, T., and Birrell, C. (2014) Are Biophilic-Designed Site Office Buildings Linked to Health Benefits and High Performing Occupants? <i>International Journal of Environmental Research and Public Health</i> 11, (12) 12204–12222.</p>
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Design for healthy ageing – the relationship between design, well-being, and quality of life: a review (ARTICLE)

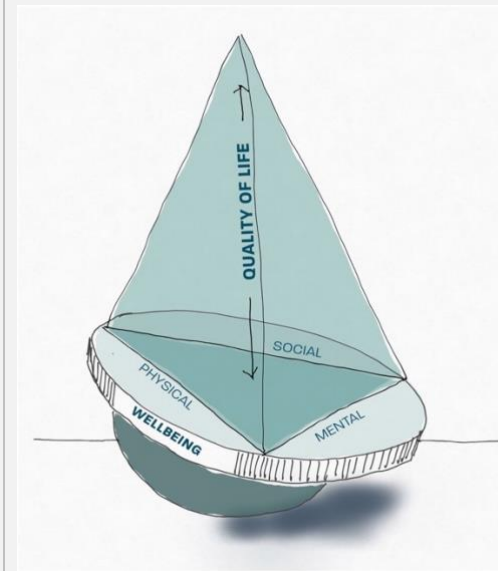
13

“One can consider QoL as comprised of three factors of well-being (physical, social and mental)” (page 20)

“a conceptual model, where these factors, arranged in a triangular pyramid on top of a balance board, act as dynamic forces – the higher the pyramid, the better the QoL (Figure 1). When all three forces act in unison, the base is balanced, enabling QoL to be high and healthy ageing to be good. However, if forces are unequal, the balance board becomes askew and QoL is decreased” (page 20)

“With people spending so much time inside buildings, the issue of Indoor Environmental Quality (IEQ) becomes particularly important. IEQ includes a range of parameters, such as thermal comfort, noise, light, and air quality. In addition to the need to satisfy occupants’ comfort requirements, inadequate IEQ can negatively influence the occupants’ quality of life and health status.” (page 25)

Figure 1. Conceptual model of the relationship between the tri- angle of well-being in healthy ageing and QoL (Engelen et al, 2021)



“Riemersma-van Der Lek et al. (2008) conducted a 5-year double-blind, placebo-controlled, randomized study with 189 older adults (most of them with a dementia diagnosis) across 12 residential aged care facilities in the Netherlands. They introduced bright light (1000 lux) during the day time (9:00– 18:00), followed by lower light levels in the evenings in six residential aged care facilities during 15–40 months. The six control facilities retained the standard light levels of 200–300 lux. The residents of the intervention facilities showed slower cognitive decline and less depressive symptoms than residents in the control facilities” (page 26)

(Engelen *et al.* , 2021)

(Riemersma-van der Lek *et al.*, 2008)

Engelen, L., Rahmann, M., and de Jong, E. (2021) Design for healthy ageing – the relationship between design, well-being, and quality of life: a review. *Building Research & Information* 50, (1-2) 19–35.

<https://doi.org/10.1080/09613218.2021.1984867>

Riemersma-van der Lek, R. F., Swaab, D. F., Twisk, J., Hol, E. M., Hoogendijk, W. J. G., and Van Someren, E. J. W. (2008) Effect of Bright Light and Melatonin on Cognitive and Noncognitive Function in Elderly Residents of Group Care Facilities. *JAMA* 299, (22) 2642. <https://doi.org/10.1001/jama.299.22.2642>

<p>Nature connectedness and biophilic design (ARTICLE)</p> <p>14</p>	<p>“There is growing evidence that nurturing positive connections with nature benefits people’s well-being (Capaldi et al., 2014)” (page 36)</p> <p>“Nature connectedness refers to the way we relate to and experience nature. A high level of nature connectedness means feeling a close relationship or an emotional attachment to our natural surroundings.” (page 36)</p> <p>“increasing disconnect between humans and the rest of the natural world.” (page 36)</p> <p>“Greater nature connectedness delivers better mental health (Capaldi et al., 2014)” (page 36)</p>	<p>Links to “affection” biophilic values</p>	<p>(Richardson and Butler, 2021)</p>	<p>Richardson, M., and Butler, C. W. (2021) Nature connectedness and biophilic design. <i>Building Research & Information</i> 50, (1-2) 36–42. https://doi.org/10.1080/09613218.2021.2006594</p>
<p>Making Healthy Places: Designing and Building for Health, Well-being, and Sustainability (BOOK)</p> <p>15</p>			<p>(Dannenberg et al. , 2011)</p>	<p>Dannenberg, A. L., Frumkin, H., and Jackson, R. J. (2011) “<i>Making healthy places : designing and building for health, well-being, and sustainability.</i>” Island Press Available at: https://books.google.co.uk/books?hl=en&lr=&id=ITbVtSBwmM8C&oi=fnd&pg=PR2&dq=making+healthy+places&ots=YQU4r2fhq6&sig=od73gos7nHkLTfJySSSjcbWk6DU&r</p>

				edir_esc=y#v=onepage&q=making%20healthy%20places&f=false
Sustainable Development Goals (PDF) 16	“Goal 3. Ensure healthy lives and promote well-being for all at all ages”	Doesn’t explicitly mention about redesigning homes or focusing on the biophilic framework – however, biophilia and improving an individuals nature connectedness will ‘promote well-being for all at all ages’ The United Nations (2015) confirms that As stated in (United Nations, 2015)	(United Nations, 2015)	United Nations (/2015) Transforming our world: the 2030 Agenda for Sustainable Development. <i>United Nations</i> . United Nations Available at: https://sdgs.un.org/2030agenda .
Biophilic Design: For The First Optimum Performance Home (PDF) 17	“While most built environments provide somewhat shallow and limited sensory experiences as compared to nature, biophilic design deeply engages all of the senses–in much the same way as sitting near the ocean, walking through the forest, climbing a mountain, or working in the garden” (page 39)		(Stewart-Pollack, 2006)	Stewart-Pollack, J. (2006) Biophilic Design: For The First Optimum Performance Home. <i>Green Build</i> (04). Available at: https://www.ultimatohomedesign.com/oph/uhd04gb02.pdf
The National Human Activity Pattern Survey (NHAPS): a resource for	“NHAPS respondents reported spending an average of 87% of their time in enclosed buildings”	Report is based on US statistics across 9386 respondents – number can’t be far of for UK stats	(Klepeis <i>et al.</i> , 2001)	KLEPEIS, N. E., NELSON, W. C., OTT, W. R., ROBINSON, J. P., TSANG, A. M., SWITZER, P., BEHAR, J. V.,

<p>assessing exposure to environmental pollutants (article)</p> <p>18</p>				<p>HERN, S. C., and ENGELMANN, W. H. (2001) The National Human Activity Pattern Survey (NHAPS): a resource for assessing exposure to environmental pollutants. <i>Journal of Exposure Science & Environmental Epidemiology</i> 11, (3) 231–252. https://doi.org/10.1038/sj.jea.7500165</p>
<p>The nourishing soil of the soul’: The role of horticultural therapy in promoting well-being in community-dwelling people with dementia</p> <p>19</p>	<p>“63.3% of people with dementia are living at home; however, community-based support for those living with the condition is inadequate, with little peer support and limited opportunities for people with dementia to continue to participate in everyday activities such as gardening (Knapp et al., 2007)” (page 898)</p> <p>“World Health Organisation’s definition of health as ‘a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity’ (World Health Organisation, 2006, p. 1)” (page 899)</p> <p>“Attention Restoration Theory (Kaplan & Kaplan, 1989) asserts that concentration and attention spans can be improved by interaction with nature, whether through active engagement or exposure to views of natural environments.” (page 900)</p>	<p>BD is beneficial for patients affected by dementia</p>	<p>(Noone <i>et al.</i>, 2015)</p> <p>(Caruth Chalfont, 2007)</p>	<p>Noone, S., Innes, A., Kelly, F., and Mayers, A. (2015) ‘The nourishing soil of the soul’: The role of horticultural therapy in promoting well-being in community-dwelling people with dementia. <i>Dementia</i> 16, (7) 897–910. https://doi.org/10.1177/1471301215623889</p>

Interaction with, or exposure to, nature elicits profound physical, psychological and emotional responses, highlighting a fundamental interconnectedness between human beings and the natural world (Bossen, 2010)” (page 900)

“Chalfont (2007) stated that engagement in outdoor activity can contribute to improved mood, behaviour and cognition, increased motor function and stimulation of senses and may even assist people with dementia in creating new memories through exposure to sensory stimuli” (page 902)

Caruth Chalfont
(2007) *Design for nature in dementia care*. London: Jessica Kingsley

Birthright: People and nature in the modern world (BOOK)
20

“But biophilia as Wilson and I have shaped the term is a complex process encompassing an array of values and qualities that constitute a broader affiliation with nature. Biophilia reflects fundamental ways we attach meaning to and derive benefit from the natural world. These include:...” (p. XII)

Please see table to right →

“Our inborn affinity for the natural world is, in effect, a birthright that must be cultivated and earned. For a creature of learning and free will, this is not a hard-wired outcome, but one that requires conscious and sustained engagement.” (p. xiii)

“To become adaptive and beneficial, our biophilic tendencies must be learned through experience and be supported by others. Too little contact with the natural world and our biophilic values atrophy” (p. xiii)

Figure 1: A typology of biophilic values

Value	Definition
Attraction	Appreciation of the aesthetic appeal of nature, from a superficial sense of the pretty to a profound realization of beauty
Reason	The desire to know and intellectually comprehend the world, from basic facts to more complex understanding
Aversion	Antipathy toward and sometimes fearful avoidance of nature
Exploitation	The desire to utilize and materially exploit the natural world
Affection	Emotional attachment, including a love of nature
Dominion	The urge to master and control the natural environment
Spirituality	The pursuit of meaning and purpose through connection to the world beyond our selves
Symbolism	The symbolic representation of nature through image, language, and design

(Kellert, S. R., 2012)

(Kellert, S. R., 2012)

Kellert, S. R. (2012) *Birthright: people and nature in the modern world*. New Haven: Yale University Press

		These values are to be thought of as a trait, for example I believe I express Reason for affiliating myself to nature whereas someone else may just like the aesthetics																						
<p>The effect of an outdoor orientation program on participants' biophilic expressions (article)</p> <p>21</p>	<p>“In addition to omitting the naturalistic expression, the most-recent articulation of the biophilic expressions has them renamed with the following terms: <i>attraction</i> (aesthetic), <i>reason</i> (scientific), <i>aversion</i> (negativistic), <i>exploitation</i> (utilitarian), <i>affection</i> (humanistic), <i>dominion</i> (dominionistic), <i>spirituality</i> (moralistic), and <i>symbolism</i> (symbolic) (Kellert, 2012). See Table 2 for Kellert’s revised terminology and condensed taxonomy of biophilic expressions”(page 34)</p> <p>Overall, one’s pattern of biophilic expression gives insight into how one relates to the natural world. Specifically, biophilia is believed to be comprised of a set of “weak learning rules,” which channel one’s interactions with the natural world to bring about the various biophilic expressions (Wilson, 1993, p. 33)” (page 35)</p>	<p>Table 1 <i>A Typology of Values of Nature</i></p> <table border="1"> <thead> <tr> <th>Value</th> <th>Definition</th> </tr> </thead> <tbody> <tr> <td>Aesthetic</td> <td>Physical attraction and appeal of nature</td> </tr> <tr> <td>Dominionistic</td> <td>Mastery and control of nature</td> </tr> <tr> <td>Humanistic</td> <td>Emotional bonding with nature</td> </tr> <tr> <td>Moralistic</td> <td>Ethical and spiritual relation to nature</td> </tr> <tr> <td>Naturalistic</td> <td>Exploration and discovery of nature</td> </tr> <tr> <td>Negativistic</td> <td>Fear and aversion of nature</td> </tr> <tr> <td>Scientific</td> <td>Knowledge and understanding of nature</td> </tr> <tr> <td>Symbolic</td> <td>Nature as a source of language and imagination</td> </tr> <tr> <td>Utilitarian</td> <td>Nature as a source of material and physical benefit</td> </tr> </tbody> </table> <p><small>Note. Adapted from Kellert, 2002, p. 130</small></p> <p>Kellert (2012) which is the updated version, removed Naturalistic from the biophilic values for easier understanding</p>	Value	Definition	Aesthetic	Physical attraction and appeal of nature	Dominionistic	Mastery and control of nature	Humanistic	Emotional bonding with nature	Moralistic	Ethical and spiritual relation to nature	Naturalistic	Exploration and discovery of nature	Negativistic	Fear and aversion of nature	Scientific	Knowledge and understanding of nature	Symbolic	Nature as a source of language and imagination	Utilitarian	Nature as a source of material and physical benefit	(Meltzer <i>et al.</i> , 2018)	<p>Meltzer, N. W., Bobilya, A. J., Faircloth, W. B., Mitten, D., and Chandler, R. M. (2018) The effect of an outdoor orientation program on participants’ biophilic expressions. <i>Journal of Outdoor and Environmental Education</i> 21, (2) 187–205. https://doi.org/10.1007/s42322-018-0013-x</p>
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<p>Children and nature: psychological, sociocultural, and evolutionary investigations</p> <p>22</p>	<p>“The <i>aesthetic</i> value reflects the physical attraction and appeal of nature. Its development is viewed as instrumental in a child’s emerging capacity for perceiving and recognizing order and organization, for developing ideas of harmony, balance, and symmetry, and for evoking and stimulating curiosity, imagination, and discovery.</p>	<p>3-6 yrs old = focus on “satisfying the child’s material and physical needs” (Kellert, 2002, p.132) – Utilitarian, dominionistic and negativistic expressions are being formed (Kellert, 2002)) (page 36)</p> <p>6-12yrs old = “become more comfortable, familiar, and appreciative of</p>	(Kellert, 2002)	<p>Kellert, S. R. (2002) Children and nature : psychological, sociocultural, and evolutionary investigations. Ed. by Kahn, P. H.</p>																				

<p>The <i>dominionistic</i> value reflects the urge to master and control nature. Adaptive benefits associated with this value include safety and protection, independence and autonomy, the urge to explore and confront the unknown, and the willingness to take risks, be resourceful, and show courage.</p> <p>The <i>humanistic</i> value emphasizes strong affection and emotional attachment for nature. Bonding with elements of the natural world is viewed as instrumental in developing intimacy, companionship, trust, capacities for social relationship, and affiliation and in enhancing self-confidence and self-esteem through giving, receiving, and sharing affection.</p> <p>The <i>moralistic</i> value reflects an ethical and spiritual affinity for nature. Adaptive benefits associated with the formation of this value include a sense of underlying meaning, order, and purpose, the inclination to protect and treat nature with kindness and respect, and enhanced sociability from shared moral and spiritual conviction.</p> <p>The <i>naturalistic</i> value expresses the desire for close contact and immersion in nature. Functional benefits stemming from this value include inclinations for exploration, discovery, curiosity, inquisitiveness, and imagination, enhanced self-confidence and self-esteem by demonstrating competence and adaptability in nature, and greater calm and coping capacities through heightened temporal awareness and spatial involvement.</p> <p>A <i>negativistic</i> value reflects the avoidance, fear, and rejection of nature. Functional and adaptive benefits of this value include avoiding harm and injury, minimizing risk and uncertainty, and respect and awe of nature through recognizing its power to humble and destroy.</p>	<p>other creatures and natural settings” (Kellert, 2002, p. 133) – Humanistic, aesthetic and symbolic expressions being developed here (page 36)</p> <p>13-17yrs old = Moralistic, scientific and naturalistic being developed in this period as their understanding becomes more “systematic” and “abstract” (Kellert, 2002:p. 136)</p>		<p>Estados Unidos: The Mit Press</p>
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	<p>A <i>scientific</i> value emphasizes the empirical and systematic study and understanding of nature. Functional advantages of developing this value include intellectual competence, critical thinking, problem-solving abilities, enhanced capacities for empirical observation and analysis, and respect and appreciation for natural process and diversity.</p> <p>The <i>symbolic</i> value indicates nature’s role in shaping and assisting human communication and thought. Adaptive benefits of this value include classifying and labelling abilities instrumental in language and counting, resolution of difficult aspects of psychosocial development through story and fantasy, and enhanced communication and discourse through the use of imagery and symbol.</p> <p>Finally, a <i>utilitarian</i> value reflects the material and commodity attraction of the natural world. Several advantages of this value include physical and material security, self-confidence and self-esteem through demonstrating craft and skill in nature, and recognition of human physical dependence on natural systems and processes” (page130-131)</p>			
<p>The psychological benefits of indoor plants: A critical review of the experimental literature</p> <p>23</p>	<p>“Plants have a beneficial effect on stress reduction and pain tolerance (Bringslimark <i>et al.</i>, 2009)” cited in Gillis & Gatersleben (2015) (page 953)</p>		<p>(Bringslimark <i>et al.</i>, 2009)</p>	<p>Bringslimark, T., Hartig, T., and Patil, G. G. (2009) The psychological benefits of indoor plants: A critical review of the experimental literature. <i>Journal of Environmental Psychology</i> 29, (4) 422–433. https://doi.org/10.10</p>

				16/j.jenvp.2009.05.001
<p>HUMAN SPACES: The Global Impact of Biophilic Design in the Workplace</p> <p>24</p>	<p>“Biophilia, a concept first popularized by Edward O. Wilson in 1984, describes the innate relationship between humans and nature, and concerns the need we have to be continually connected to nature.” (page 7)</p> <p>People prefer nature over urban characteristics – “For example, in a 2004 study, when asked to describe their ideal city, people more often chose non-urban characteristics, greenery in particular.” (Félonneau, 2004) (page 7)</p> <p>“research tells us that being connected to nature, is in fact, an adaptive human function that allows for, and assists with, psychological restoration” (Van De Berg et al., 2007) (page 7)</p> <p>“Interest in biophilia has grown substantially over the last decade, largely due to the rapid urbanization of the modern world” (page 7)</p> <p>“Biophilic design is a method of designing the places in which we live and work in such a way that satisfies our deep and fundamental need to be connected with nature.” (page 7)</p> <p>“Our analysis has shown that perceptions of well-being can increase by up to 15% when people work in surroundings that incorporate natural elements” (page 19)</p> <p>“workspaces that incorporate nature provide more tranquil settings that allow for</p>	<div data-bbox="1108 252 1585 826" style="border: 1px solid black; padding: 5px;"> <p>Global Key Findings</p> <ul style="list-style-type: none"> • A third (33%) of office workers say that the design of an office would affect their decision to work at a company. • Only 42% report having live plants in the office and an alarming 47% report having no natural light in their office. • Almost a fifth (19%) of respondents report that there are no natural elements present in their office. • Just under half (47%) of all respondents agree that they have felt stressed in their workplace within the last three months. This finding emphasizes the importance of identifying and enforcing practices that can improve well-being at work – such as biophilic design. • Two thirds (67%) of respondents report feeling happy when walking into bright office environments accented with green, yellow or blue colors. • 24% of respondents say that their workplace does not provide them with a sense of light and space. • 39% of workers felt most productive at their own desk in a private office. Others said they felt most productive at their own desk in an open plan office (36%). • 28% of respondents report that they do not have a quiet space to work in their office. <hr/> <p>GLOBAL RESEARCH FINDINGS</p> <p><i>Natural elements positively linked to well-being at work -</i></p> <p><i>Nature views: Having no window view was significantly related to greater levels of reported stress. In contrast, window views of greenery and water were linked with lower levels of stress.</i></p> <p><i>Accent colors: Employee well-being is positively impacted by offices that incorporate nature-resembling colors such as green, blue and brown. It was also found that the use of gray colors within the workspace had a significant negative impact on employees' levels of stress.</i></p> <p><i>Nature within the workspace: Across the world, those who work in offices that provide natural light, live plants and greenery along with water features, report significantly higher levels of well-being than those who work in environments devoid of nature.</i></p> <p><i>Light and spacious workspaces: Those who report that their work environment provides a sense of light and space report greater levels of well-being in comparison to those who do not feel that their work environment is light and spacious.</i></p> </div> <p>the UK, the Netherlands and the Philippines, it was found that the presence of indoor plants was positively associated with productivity. In contrast, workers’ productivity in India and Indonesia was linked to the presence of green office colors. In Germany there was less focus on office color, instead it was the use of stone elements that was most strongly linked to employees’ performance. In Australia, it was the use of wood within the office design – may be interesting to ask about this in the interview</p>	<p>(Interface, 2015)</p> <p>(van den Berg et al., 2007)</p> <p>(Kaplan and Kaplan, 1989)</p> <p>(Kaplan, S., 1995)</p>	<p>Interface (2015) <i>Human Spaces: The Global Impact of Biophilic Design in the Workplace. Interface</i>. Available at: http://interfaceinc.scene7.com/is/content/InterfaceInc/Interface/EMEA/eCatalogs/Brochures/Human%20Spaces%20report/English/ec_eu-globalhumanspacesreport-enpdf.pdf</p> <p>van den Berg, A. E., Hartig, T., and Staats, H. (2007) Preference for Nature in Urbanized Societies: Stress, Restoration, and the Pursuit of Sustainability. <i>Journal of Social Issues</i> 63, (1) 79–96. https://doi.org/10.1111/j.1540-4560.2007.00497.x</p>

more effortless attention that is less mentally draining and may indeed restore - rather than deplete - our mental capacity²². In academia, this is referred to as Attention Restoration Theory²³, which posits that viewing and experiencing nature engages a different part of the brain from that used in high attentional focus.” (page 20)

“However, as research shows us that it is the variation in patterns, textures and colors of nature that brings us pleasure, we can take this knowledge and think about how

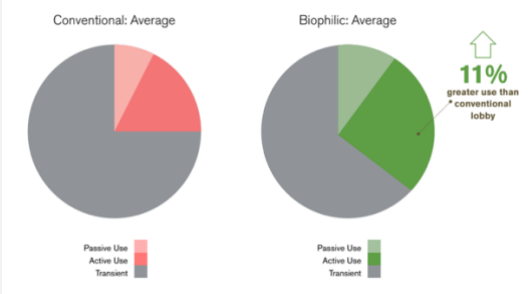
we might re-create this within the indoor environment when access to a window is not feasible.” (page 23)

“plants make them feel calmer and more relaxed, frequently stating that an office with plants makes it a more desirable place to work. (Grinde & Patil, 2009) (page 26)

Kaplan, R., and Kaplan, S. (1989) *The experience of nature : a psychological perspective*. Cambridge ; New York: Cambridge University Press
Available at:
https://books.google.co.uk/books?hl=en&lr=&id=7180AAA AIAAJ&oi=fnd&pg=PR7&dq=The+experience+of+nature:+a+psychological+perspective&ots=TqMXQH062j&sig=Qo-zhJ2KFhN1t1pYP6cj6BeY3c8&redir_esc=y#v=onepage&q=The%20experience%20of%20nature%20%3A%20a%20psychological%20perspective&f=false

Kaplan, S. (1995) The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental*

				<p><i>Psychology</i> 15, (3) 169–182. https://doi.org/10.1016/0272-4944(95)90001-2</p>
<p>The Nature of Wood, an Exploration of the Science on Biophilic Responses to Wood</p> <p>25</p>	<p>“Humans subconsciously sort between naturally occurring and anthropogenic creations, and seem to prefer those that are nature-made.” (Vessel et al., 2018) (page 5)</p> <p>“Wood is often described by research participants as being “warm, comfortable, relaxing, natural, and inviting”” (Rice et al., 2006) (page 5)</p> <p>“In a room with white walls, the addition of wood surfaces has shown to lower stress more effectively than the addition of a few plants.” (Fell, 2010) (page 5)</p> <p>“In other research, rooms with (about 45% of the) surfaces being wood have shown to boost perceptions of comfort and lower blood pressure” (Herz, 2004) (page 5)</p> <p>“placed their palm on a panel of stainless steel, tile, marble or white oak; touching the oak panel led to increases in activity of the parasympathetic (rest and calming) portion of the nervous system that did not occur with the other materials.” (Ikei et al., 2017) (page 6)</p>	<p>These results may be due to wood having lower thermal conductance than metal or stone, and therefore feels closer to the perceived ambient temperature of a space.</p> <p>“One possible explanation for our biophilic response to wood is that the brain makes a series of associations—what is sometimes referred to as semantic processing. In other words, the brain subconsciously links wood to trees, trees to life and nature and, thus, a biophilic response is triggered.” (Vessel, 2012) (page 10)</p>	<p>(Browning et al., 2022)</p>	<p>Browning, W. D., Ryan, C. O., and DeMarco, C. (2022) <i>The Nature of Wood, an Exploration of the Science on Biophilic Responses to Wood</i>. New York: Terrapin Bright Green Available at: http://www.terrapinbrightgreen.com/wp-content/uploads/2022/01/The-Nature-of-Wood_Terrapin_2022-01.pdf</p>

<p>COEUR D'ALENE RESORT & CASINO</p> <p>26</p>	<p>“The timber motif continues in the materials selection for the lobby and other hotel amenities, creating a warm and inviting environment.” (page 3)</p> <p>“For the Coeur d’Alene Resort and Casino, biophilic design wasn’t a premeditated strategy, but a tool to create a culturally and ecologically significant space. Such a design demonstrates how effective intuitive biophilic design communicates the uniqueness of place and culture for a memorable guest experience and beloved space.” (page 4)</p>	<p>Project Type: Hospitality</p> <p>Renovation and expansion of the Coeur d’alene casino/resort</p> <p>Visual Connection to Nature: Vegetated parking lot, full height glass windows and covered walkway</p> <p>Dynamic and diffuse light: Takes adv. of natural light based on when the space will be most used</p> <p>Connection to natural systems: Walkways move through the landscape and rainwater is captured and retention in the courtyard</p> <p>Material connection to nature: Timber construction and reclaimed tree trunks line the entrance</p>	<p>(Terrapin Bright Green, 2016)</p>	<p>Terrapin Bright Green (2016) <i>COEUR D’ALENE RESORT & CASINO. Terrapin Bright Green.</i> Terrapin Bright Green Available at: https://www.terrapinbrightgreen.com/wp-content/uploads/2015/11/Coeur-dAlene-Spring-16F.pdf</p>
<p>Human Spaces. 2.0: Biophilic Design in Hospitality</p> <p>27</p>		 <p>(page 22)</p> <p>This shows lobbies with biophilic attributes have guest actively and passively using the space more over than conventional lobbies with limited natural features</p>	<p>(Interface, 2017)</p>	<p>Interface (2017) <i>Human Spaces 2.0: Biophilic Design in Hospitality. Interface.</i> Available at: http://interfaceinc.scene7.com/is/content/InterfaceInc/Interface/EMEA/eCatalogs/Brochures/Human%20Spaces%20Hospitality%20Report/EN/ec_eu-</p>

		-36% of users active or passively using biophilic lobbies -25% using conventional lobbies		humanspaceshospitalityreport-en.pdf
Windhover Contemplative Center & Art Gallery 28	<p>“much of the design focuses on the refuge pattern.” (page 2)</p> <p>“the prevalence and complexity of student mental health issues has grown in recent years both nationally and at Stanford.” (page 4)</p> <p>“While none of these mental health issues can be solved with the built environment alone, many studies show that an individual’s environment can play a key role in their wellbeing.” (page 4)</p>	<p>Project Type: Hospitality</p> <p>Public gallery on Stanford’s campus designed to be a spiritual refuge for the community</p> <hr/> <p>[P1] Visual Connection to Nature. Lower blood pressure and heart rate, improved mental engagement/attentiveness, positively impacted attitude and overall happiness</p> <hr/> <p>[P6] Dynamic and Diffuse Light. Positively impacted circadian system functioning, increased visual comfort.</p> <hr/> <p>[P9] Material Connection with Nature. Decreased diastolic blood pressure, improved creative performance, improved comfort.</p> <hr/> <p>[P12] Refuge. Improved concentration, attention and perception of safety.</p>	(Nestor, C. and Terrapin Bright Green, 2015)	<p>Nestor, C., and Terrapin Bright Green <i>(2015) Windhover Contemplative Center & Art Gallery. Terrapin Bright Green.</i></p> <p>Available at: https://www.terrapinbrightgreen.com/wp-content/uploads/2015/11/Windhover CaseStudy_Fall15.pdf</p>
Cookfox Architecture Studio	<p>“need for additional refuge conditions throughout the office, with only one zone reporting “satisfied” and two high traffic zones reporting “highly unsatisfied.” Refuge conditions have been shown to improve concentration, attention and perception of safety while also reducing irritation and fatigue” (page 4)</p>	<p>Project Type: Office/commercial</p> <p>Renovation of office space of the former Crawford Simpson Department Store</p>	(Clancy, J. <i>et al.</i> , 2015)	<p>Clancy, J., Nestor, C., and Terrapin Bright Green <i>(2015) Cookfox</i></p>

<p>29</p>		<p>12,121 sq ft office space 3,600 sq ft greenroof</p> <p>P1,2,3,4,6,7,8,9,10,11,12 of the 14 patterns</p> <hr/> <p>[P1] Visual Connection to Nature. Lower blood pressure and heart rate, improved mental engagement/attentiveness, positively impacted attitude and overall happiness.</p> <hr/> <p>[P3] Non-Rhythmic Sensory Stimuli. Positively impacted heart rate, systolic blood pressure and sympathetic nervous system activity, observed and quantified behavioral measures of attention and exploration.</p> <hr/> <p>[P8] Biomorphic Forms & Patterns. Observed view preference.</p> <hr/> <p>[P11] Prospect. Reduced stress, reduced boredom, irritation, and fatigue, improved comfort and perceived safety.</p>		<p><i>Architecture Studio. Terrapin Bright Green.</i> Available at: https://www.terrapinbrightgreen.com/wp-content/uploads/2015/11/641-Case-Study-Fall15.pdf</p>
<p>Kickstarter Commercial Headquarters</p> <p>30</p>	<p>“Research shows refuge spaces increase concentration, attention, and perception of safety, while prospect spaces reduce stress, boredom and fatigue, and improve comfort and perceived safety. Having a balance between the two patterns is suggested to be more important than the size or frequency of the feature. By incorporating both refuge and prospect spaces in their new headquarters, Kickstarter ensures that their employees have places to do a variety of work activities comfortably and effectively” (page 4)</p>	<p>Office</p> <p>29,00ft</p> <p>P3,7,9,11,12</p>	<p>(Nestor and Terrapin Bright Green, 2016)</p>	<p>Nestor, C., and Terrapin Bright Green (2016) <i>Kickstarter Commercial Headquarters. Terrapin Bright Green.</i> Available at: https://www.terrapinbrightgreen.com/wp-content/uploads/2015/11/Kickstarter-Spring-16F.pdf</p>

		<p>[P3] Non-Rhythmic Sensory Stimuli. Native landscaping sets the stage for non-rhythmic sensory stimuli, with occupants on each floor with direct view of native landscaping</p> <p>[P4] Access to Thermal & Airflow Variability. Glass garage door connecting sunroom and greenroof porch, operable windows in the office</p> <p>[P5] Presence of Water. Weather responsive water retention courtyard and downspout</p> <p>[P6] Dynamic & Diffuse Light. Natural light from the courtyard, sunroom, and exterior refurbished windows</p> <p>[P7] Connection with Natural Systems. The central courtyard and greenroof's native landscaping rainwater capture and retention in the courtyard</p> <p>NATURAL ANALOGUES</p> <p>[P8] Biomorphic Forms & Patterns. Fractal patterns in the reclaimed heart pine finishes</p> <p>[P9] Material Connection with Nature. Interior doors and details as well as desks and seating are made of salvaged or local materials</p> <p>[P10] Complexity & Order. Library bookshelves</p> <p>NATURE OF THE SPACE</p> <p>[P11] Prospect. Views into the central courtyard and over the greenroof provide prospect conditions with focal ranges greater than 20 feet</p> <p>[P12] Refuge. Reading nooks, cubbies, and high-backed chairs</p>		
<p>Creating Positive Spaces Using Biophilic Design</p> <p>31</p>	<p>“Studies have shown that 10% of employee absence can be attributed to working in environments with no connection to nature.” (Elzeyadi, 2011) (page 20)</p>	<p>Ecological Valence Theory²³ This theory explains our colour preferences and responses to them. We seek colours that are reminiscent of nature when it is thriving²⁴, for example:</p> <p>Blue: clear sky or clean water – calming and relaxing</p> <p>Green: healthy vegetation – calming and restorative</p> <p>Yellow: warmth and sunshine – happy and welcoming</p> <p>Red: healthy ripe fruits – energising and exciting</p> <p>(page 16)</p>	<p>(Heath <i>et al.</i>, 2018)</p>	<p>Heath, O., Jackson, V., and Goode, E. (2018) <i>Creating Positive Spaces Using Biophilic Design</i>. Global Wellness Institute. Available at: https://globalwellnessinstitute.org/wp-content/uploads/2018/12/biophilicdesignguide-en.pdf</p>

<p>An ecological valence theory of human color preference</p> <p>32</p>	<p>“ecological valence theory in which color preferences arise from people’s average affective responses to color-associated objects.” (page 8877)</p> <p>“People like colors strongly associated with objects they like (e.g., blues with clear skies and clean water) and dislike colors strongly associated with objects they dislike (e.g., browns with feces and rotten food)” (page 8877)</p>		<p>(Palmer and Schloss, 2010)</p>	<p>Palmer, S. E., and Schloss, K. B. (2010) An ecological valence theory of human color preference. <i>Proceedings of the National Academy of Sciences</i> 107, (19) 8877–8882. https://doi.org/10.1073/pnas.0906172107</p>
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Biophilic Design Strategies in Long-Term Residential Care Environments for Persons with Dementia

33

“Opportunities for nature engagement in indoor and outdoor environments contributes to reduced sensory deprivation and can contribute significantly to the wellbeing of individuals with dementia, as well as their carers (Rappe & Lindén, 2004) (page 9)

“Biophilic-inspired design can lead to better quality of life for residents of LTC homes” (page 24)

LTC – Long term Care

“Natural daylighting can enhance occupants’ well-being and satisfaction in LTC residential environments by enlivening interior spaces while affording views of nature-landscape and the broad exterior realm” (page 24)

Sick-building syndrome

34

“SBS has been reported with increasing frequency since the 1970s, as older, naturally ventilated buildings have been replaced by more energy-efficient, “airtight” buildings.” (page 1013)

Table 1. Summary of recent relevant research relating to biophilic design and long term care environments.

Patterns	Researchers/Setting	Research design, sample, setting and results	Measures of wellbeing	Key environmental features
1. Biophilic Design Pattern: Visual Connection with Nature. Rappe et al., 2004 as “A view to elements of nature, living systems and natural processes.”	Rappe & Lindén, 2004, Helsinki, Finland.	Study based on survey of 65 staff from 10 dementia care homes. Results showed plants can contribute to the well-being of individuals with dementia.	Effect of plants on sensory deprivation	Indoor and Outdoor plants
2. Biophilic Connection with Nature Pattern identified by Browning et al., 2019 as “A view to olfactory or gustatory stimuli that engender a deliberate and positive reference to nature, natural processes.”	Kaplan, 2001, Michigan, USA Yin et al., 2018, Boston, USA Wheat et al., 2014* Dewelder et al., 2012,b	Study of apartment residents using a survey with both verbal and visual material. Results showed that natural elements in a view from the window improved attention, lessening of stress, improvement in mood, lowering of medications and reduction of falls. Comparison of blood pressure, and reported emotions, of people in real and Virtual Reality (VR) environments with and without biophilic elements. Systematic review of databases and organizations, showed spending time in gardens to reduce stress. Literature review reported benefits of horticultural therapy and garden settings in reduction of pain, improvement in attention, lessening of stress, and reduction of falls.	Influence of natural views from windows on restoration Health benefits of real and virtual biophilic environments Effects of multisensory engagement on dementia residents Benefits of touch and horticulture therapy in improving well-being of aging residents	Viewing environmental and built content from windows Indoor biophilic environment and VR biophilic environments
3. Biophilic design pattern: non-rhythmic connection with nature identified by Browning et al., 2019 as “Stochastic and ephemeral connections with nature that may be analyzed statistically but may not be predicted precisely.”	Ratcliffe et al., 2013, South East England, UK Tappen et al., 2008, Florida, USA Ottosson and Grahn, 2005, Lund, Sweden. Jonvaux et al., 2013, Nancy, France.	Semi-structured interviews with 20 adults aged 22-74 years. Results showed birding most commonly associated with restorative experiences. Study of 65 participants with dementia randomly assigned to the treatment group in a nursing home. Results showed assisted walking with their favorite indoor room. Results showed greater concentration, blood pressure, and heart rate measured before and after rest in a garden or in their favorite indoor room. Results showed greater well-being in a garden. Study of 68 Alzheimer’s patients, visitors, and health care workers in a hospital healing garden. Findings showed sensory elements such as varied colors, sounds, smells, and textures help fight against sensory deprivation.	Positive influence of auditory natural stimuli on stress and attention fatigue. Effects of walking-conversation and mobility in residents. Influence of nature and green space on cognitive ability of elderly populations The role of sensory stimuli in improving mental and physical well-being in healthcare environments.	Outdoor gardens with auditory, haptic and olfactory stimuli Literature review Interview transcripts with choice questions on natural preferences 30 Minute either walking, talking, and walking-talking Resting in an outdoor garden versus resting indoors Pre and post evaluation of a healing garden

(Peters and Verderber, 2021)

Peters, T., and Verderber, S. (2021) Biophilic Design Strategies in Long-Term Residential Care Environments for Persons with Dementia. *Journal of Aging and Environment* 1–29. <https://doi.org/10.1080/26892618.2021.1918815>

(Redlich et al., 1997)

Redlich, C. A., Sparer, J., and Cullen, M. R. (1997) Sick-building syndrome. *The Lancet* 349, (9057) 1013–1016. [https://doi.org/10.1016/S0140-6736\(96\)07220-0](https://doi.org/10.1016/S0140-6736(96)07220-0)

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1. <https://b-ok.cc/book/1000132/149698>
2. <https://www.biophilic-design.com>
3. <https://b-ok.cc/book/3600058/ede228>
4. <https://b-ok.cc/book/5335560/0e37a7>
5. <https://www.terrabinbrightgreen.com/wp-content/uploads/2020/05/14-Patterns-of-Biophilic-Design-Terrapin-2014e.pdf>
6. <https://www.proquest.com/docview/2555101619?pq-origsite=primo&parentSessionId=GMAC0%2BDXUeLjIR%2B%2FhgF7PBxEsEkt%2F36sdGSVva%2FEb6g%3D>
7. https://books.google.co.uk/books?hl=en&lr=&id=7QcCEAAQBAJ&oi=fnd&pg=PT6&dq=nature+inside&ots=cU9HQaK6Dn&sig=QXA7MUxKdGOXglyYrxPv6yate0Q&redir_esc=y#v=onepage&q=nature%20inside&f=false
8. <https://www.sciencedirect.com/science/article/pii/S0360132318300064>
9. <https://www.sciencedirect.com/science/article/pii/S0959652620346357>
10. <https://www.sciencedirect.com/science/article/pii/S0959652621033540>
11. <https://www.mdpi.com/1660-4601/11/12/12204>
12. <https://www.proquest.com/docview/1721941096/E359060D71F4080PQ/1>
13. <https://www.tandfonline.com/doi/full/10.1080/09613218.2021.1984867>
14. <https://www.tandfonline.com/doi/full/10.1080/09613218.2021.2006594>
15. https://books.google.co.uk/books?hl=en&lr=&id=ITbVtSBwmM8C&oi=fnd&pg=PR2&dq=making+healthy+places&ots=YQU4r2fhq6&sig=od73gos7nHkLTFjySSSjcbWk6DU&redir_esc=y#v=onepage&q=making%20healthy%20places&f=false
16. <https://sdgs.un.org/goals>
17. <https://www.ultimatehomedesign.com/oph/uhd04gb02.pdf>
18. <https://web.s.ebscohost.com/ehost/pdfviewer/pdfviewer?vid=0&sid=f08c3466-5523-4650-8097-4169e991be4c%40redis>
19. <https://doi.org/10.1177/1471301215623889>
20. <https://b-ok.cc/book/2344893/ee8f50>
21. <https://link.springer.com/article/10.1007/s42322-018-0013-x>
22. <https://b-ok.cc/book/1072307/d5d12c>
23. <https://doi.org/10.1016/j.jenvp.2009.05.001>
24. http://interfaceinc.scene7.com/is/content/InterfaceInc/Interface/EMEA/eCatalogs/Brochures/Human%20Spaces%20report/English/ec_eu-globalhumanspacesreport-enpdf.pdf
25. http://www.terrabinbrightgreen.com/wp-content/uploads/2022/01/The-Nature-of-Wood_Terrapin_2022-01.pdf
26. <https://www.terrabinbrightgreen.com/wp-content/uploads/2015/11/Coeur-dAlene-Spring-16F.pdf>
27. http://interfaceinc.scene7.com/is/content/InterfaceInc/Interface/EMEA/eCatalogs/Brochures/Human%20Spaces%20Hospitality%20Report/EN/ec_eu-humanspaceshospitalityreport-en.pdf
28. https://www.terrabinbrightgreen.com/wp-content/uploads/2015/11/Windhover_CaseStudy_Fall15.pdf
29. <https://www.terrabinbrightgreen.com/wp-content/uploads/2015/11/641-Case-Study-Fall15.pdf>
30. <https://www.terrabinbrightgreen.com/wp-content/uploads/2015/11/Kickstarter-Spring-16F.pdf>
31. <https://globalwellnessinstitute.org/wp-content/uploads/2018/12/biophilicdesignguide-en.pdf>
32. <https://www.pnas.org/doi/pdf/10.1073/pnas.0906172107>
33. <https://www.tandfonline.com/doi/pdf/10.1080/26892618.2021.1918815>