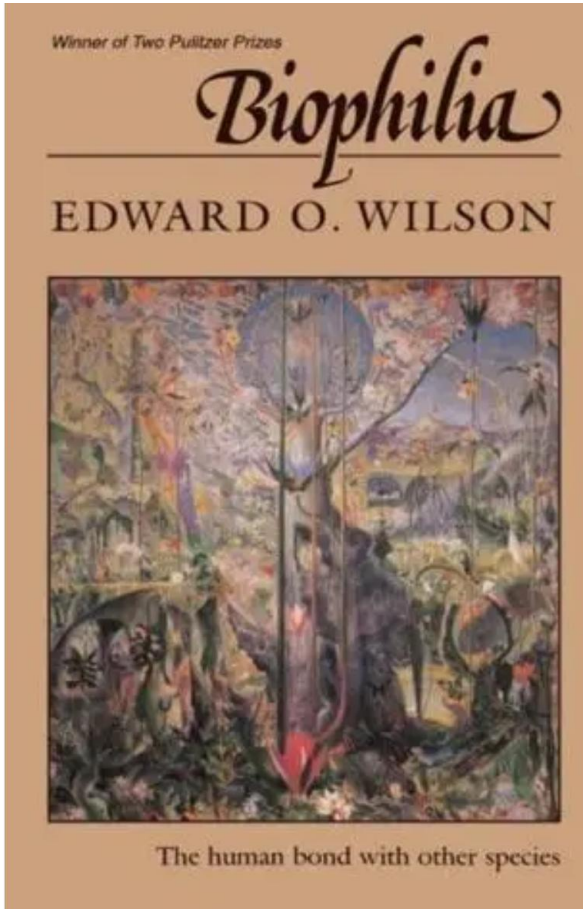
From Biophilic Design to Biophilic Cities

How to Improve People's Health and Well-Being in the Urban Environment

Yves Kazemi, Monday 29 April 2024

Biophilia: The Human Bond with Other Species (Wilson, Edward O., 1984)

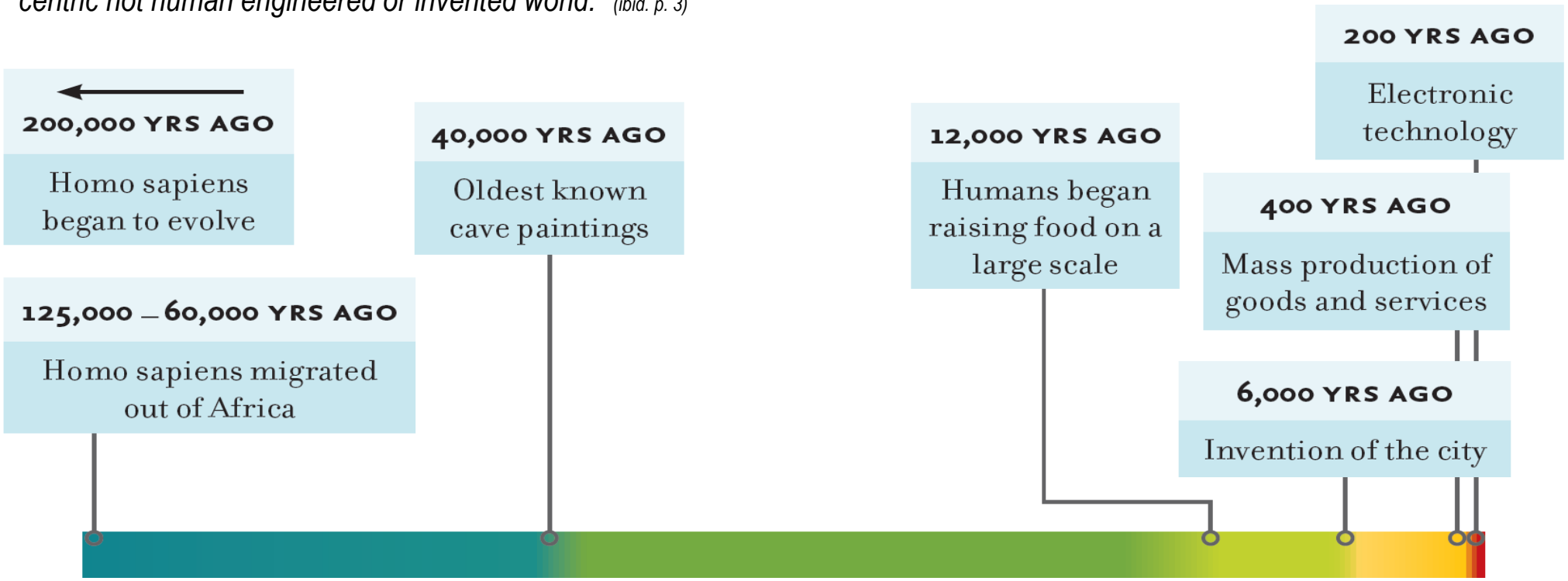


- "Biophilia is the inherent human inclination to affiliate with nature that even in the modern world continues to be critical to people's physical and mental health and wellbeing."
- "For more than 99 % of human history people have lived in hunter–gatherer bands totally and intimately involved with other organisms.
- "During this period of deep history, and still further back, they depended on an exact learned knowledge of crucial aspects of natural history."
- "In short, the brain evolved in a biocentric world, not a machine-regulated world."
- "It would be therefore quite extraordinary to find that all learning rules related to that world have been erased in a few thousand years."
- Even in the tiny minority of peoples who have existed for more than one or two generations in wholly urban environments."

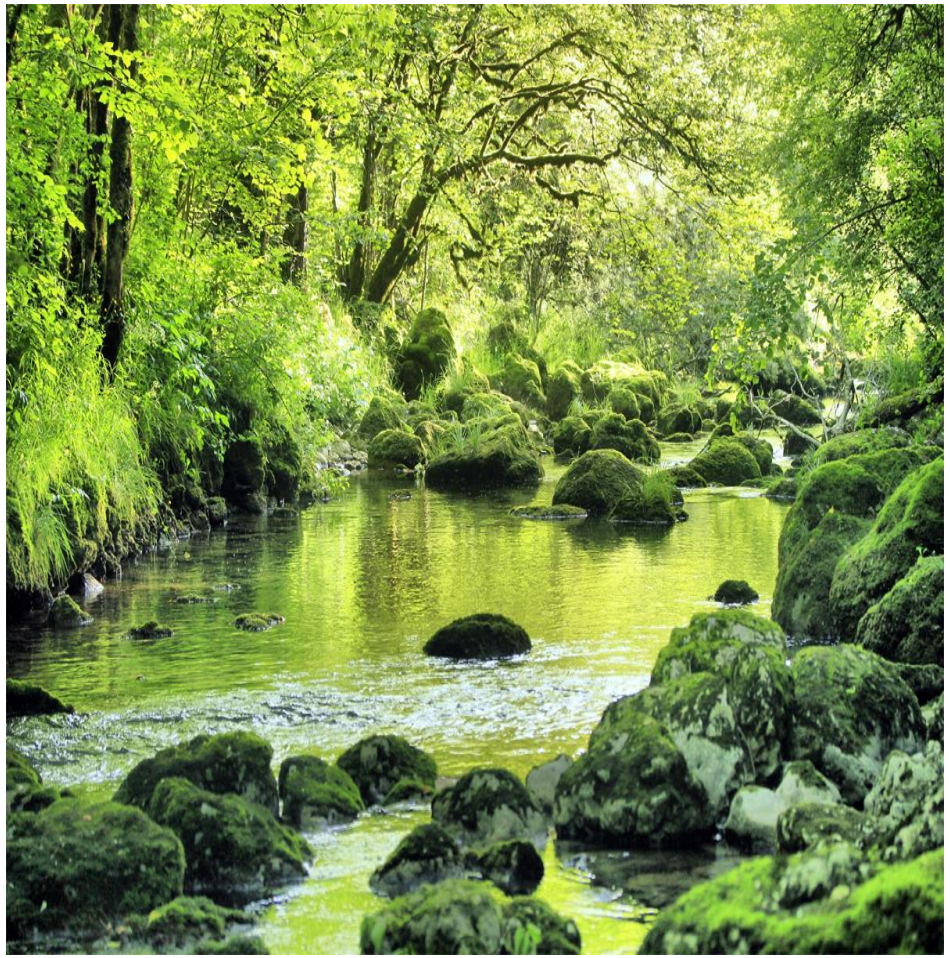
[Kellert and Wilson, The Biophilia Hypothesis, 1993, p. 32, in Beatley Timoty, Biophilic Cities, 2011, p. 3.]

“The idea of **biophilia** originates in an understanding of human evolution, where for more than 99% of our species history we biologically developed in adaptive response to natural not artificial or human created forces” (Kellert and Calabrese, 2015, p. 3)

“Most of what we regard as normal today is of relatively recent origin (…). The human body, mind, and senses evolved in a bio-centric not human engineered or invented world.” (ibid. p. 3)

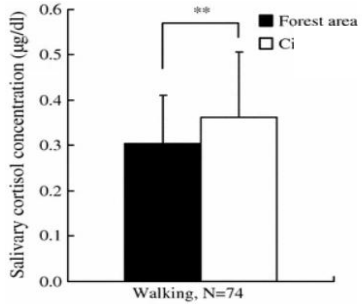


Nature's Effects on Metabolism and Biomarkers of Stress

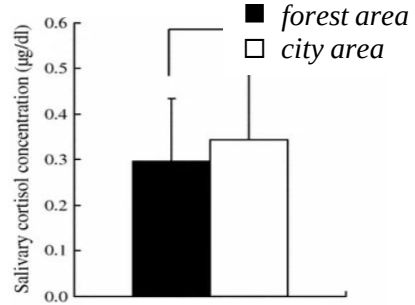


E.g. Change in salivary cortisol concentration and in pulse rate after forest walking and viewing (Bum Jin Park et al. 2009)

cortisol

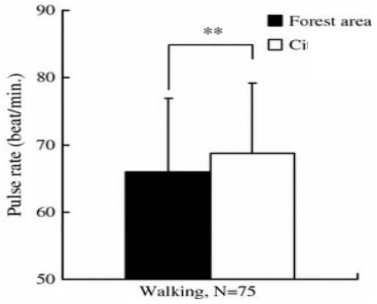


walking n=74

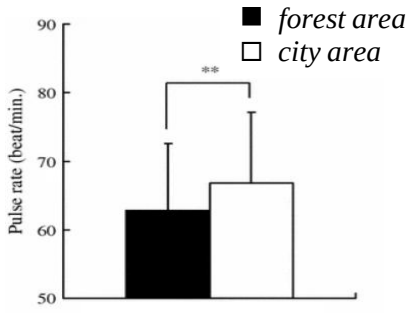


viewing n=260

pulse rate



walking n=75



viewing n=268

Why are green spaces improving human Health and Well-Being ?

BIOPHILIA

Direct effects of nature on the brain

LESS BAD THINGS

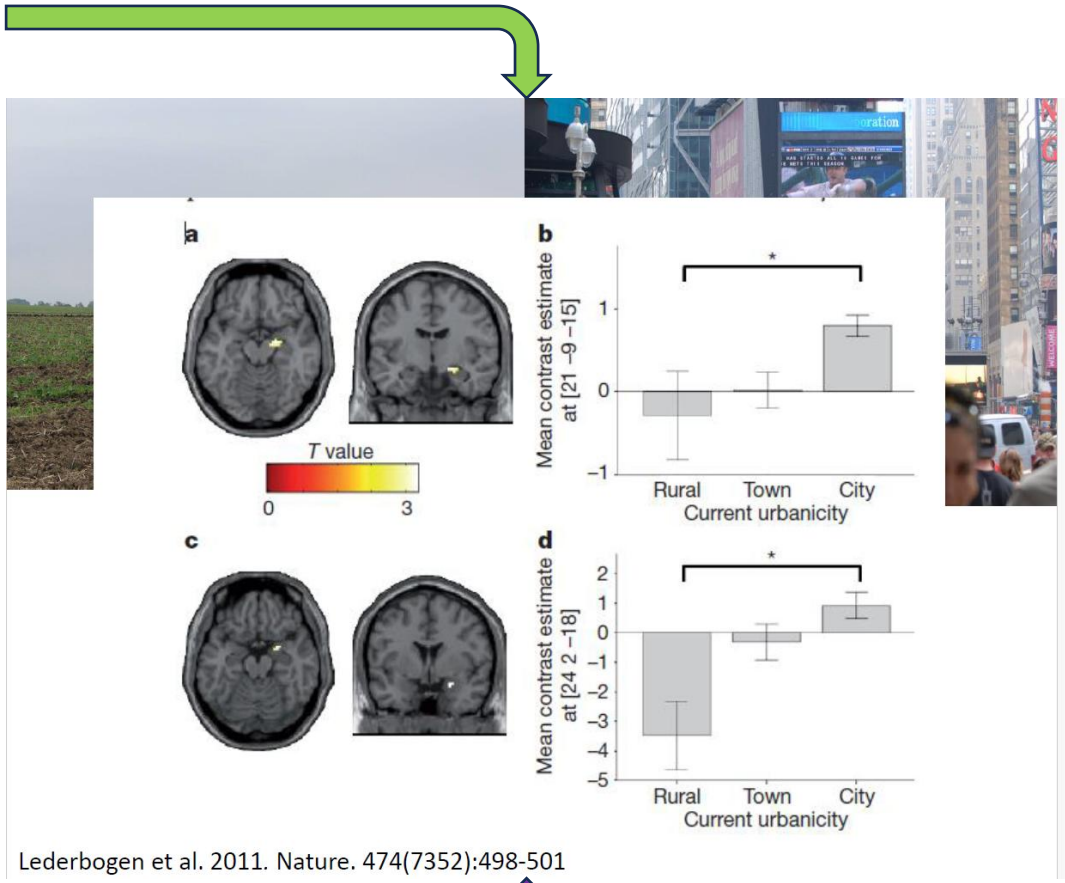
Noise, pollution, excess heat, etc.

MORE GOOD THING

Physical activities, social interaction

DIRECT EFFECTS ON THE BRAIN

Neural processing, fractal patterns



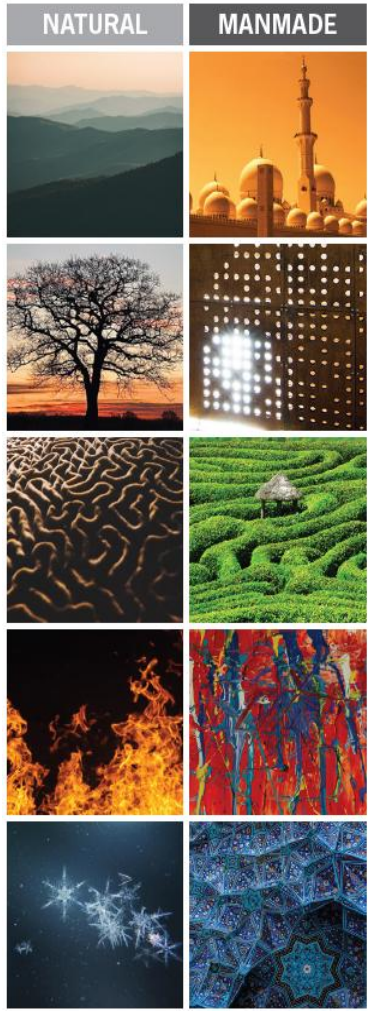
Lederbogen et al. 2011. Nature. 474(7352):498-501

[Adapted from Dr Matilda van den Bosch , UFOR 200, UBC, 2017]

Definition and Influence of Fractals on Human Health and Well-Being

Definition (Trombin, 2020, p.10)

- Fractals are self-similar patterns over a range of magnification scales.
- They are characterised as being either statistical or exact:
  - Statistical fractals are found in nature, displaying randomness and an organic signature.
  - Exact fractals are created by humans, displaying cleanliness, symmetry and scaled replication.



Influence of Natural Fractals (Trombin, 2020, p.5)

- Quantifiable health benefits, e.g. , reduced stress, improved cognitive functioning, enhanced creativity and problem-solving, heightened appreciation for nature and positive emotions.
- The benefits of fractals specifically, and of nature more generally, have been shown to occur within minutes, even seconds. (Smith et al., 2020; Lee et al., 2015)
- In urban landscapes, people become increasingly disconnected from nature's fractals and its stress-reduction qualities.

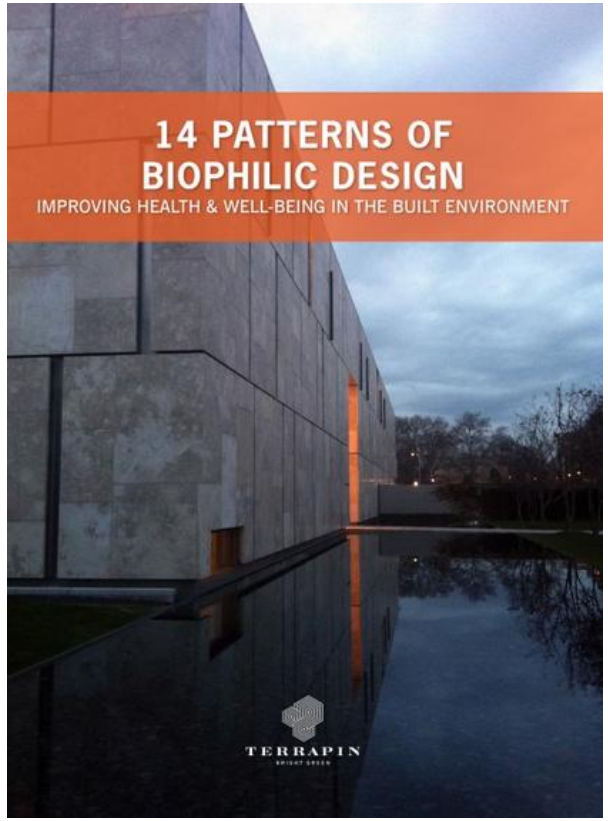
Health benefits associated with mid-complexity fractal patterns (Trombin, 2020, p.11)

STRESS REDUCTION	COGNITIVE PERFORMANCE	EMOTION, MOOD & PREFERENCE
Reduced stress up to 60% and positively impacted heart rate, blood pressure and galvanic skin responses particularly for statistical fractals TAYLOR, 2006; JOYE, 2007	**Induced state of alertness; enhanced ability to concentrate and hold attention** (particularly fractals *D*=1.3; peak in brain beta response in parietal area) HÄGERHÄLL ET AL., 2008, 2015	**Superior ability and ease in navigating through the environment; liveability and vitality** JULIANI ET AL., 2016; MEHAFFY & SALINGAROS, 2015
Induced stress-reducing, restorative experience, wakefully relaxed state. Deep relaxation, daydreaming and light mediation state (particularly for statistical fractals *D*=1.3) peak in brain alpha response in frontal lobes) TAYLOR ET AL., 2016, 2017; HÄGERHÄLL ET AL., 2008, 2015	**Effortless looking' characterised by increased engagement and prolonged concentration** SMITH ET AL., 2020	**Balances between relaxation and excitement, especially compared to Euclidean patterns** ABBOUSHI ET AL., 2019
	Reduced cognitive effort JULIANI ET AL., 2016	**Increased visual preference and performance, regardless of the generation method** (i.e. among naturally occurring, computer-generated and man-made fractals) TAYLOR ET AL., 2018; TAYLOR & SPEHAR, 2016; SPEHAR ET AL., 2015; SALINGAROS, 2012; HÄGERHÄLL ET AL., 2004; SPEHAR ET AL., 2003; TAYLOR, 1998; AKS & SPROTT, 1996
	Increased pattern recognition abilities TAYLOR ET AL., 2018, 2017A, 2017B	
	Enhanced performance in visual tasks TAYLOR & SPEHAR, 2016; TAYLOR ET AL., 2018	

TABLE 2. Summary of health benefits associated with mid-complexity fractal patterns. Results are primarily from early research based on computer screens.

14 Patterns of Biophilic Design (Browning and Clancy, 2014)

"Biophilic architectural design" can reduce stress, improve cognitive function and creativity, increase our well-being, and speed up healings



NATURE IN THE SPACE

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

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

NATURE OF THE SPACE

11. Prospect
12. Refuge
13. Mystery
14. Risk/Peril

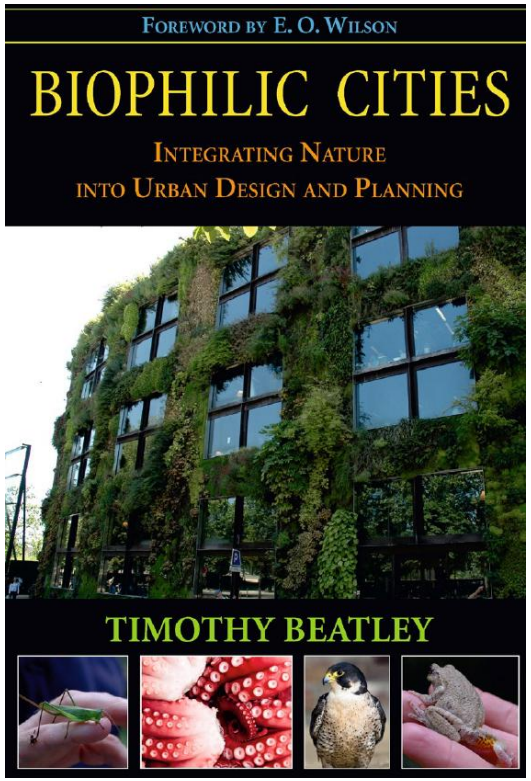
TABLE 1. BIOPHILIC DESIGN PATTERNS & BIOLOGICAL RESPONSES (**Browning and Clancy,**, 2014, p.12)

14 PATTERNS		*	STRESS REDUCTION	COGNITIVE PERFORMANCE	EMOTION, MOOD & PREFERENCE
NATURE IN THE SPACE	**Visual Connection with Nature**	* * *	**Lowered blood pressure and heart rate** (Brown, Barton & Gladwell, 2013; van den Berg, Hartig, & Staats, 2007; Tsunetsugu & Miyazaki, 2005)	**Improved mental engagement/ attentiveness** (Biederman & Vessel, 2006)	**Positively impacted attitude and overall happiness** (Barton & Pretty, 2010)
	Non-Visual Connection with Nature	* *	**Reduced systolic blood pressure and stress hormones** (Park, Tsunetsugu, Kasetani et al., 2009; Hartig, Evans, Jamner et al., 2003; Orsega-Smith, Mowen, Payne et al., 2004; Ulrich, Simons, Losito et al., 1991)	**Positively impacted on cognitive performance** (Mehta, Zhu & Cheema, 2012; Ljungberg, Neely, & Lundström, 2004)	**Perceived improvements in mental health and tranquility** (Li, Kobayashi, Inagaki et al., 2012; Jahncke, et al., 2011; Tsunetsugu, Park, & Miyazaki, 2010; Kim, Ren, & Fielding, 2007; Stigsdotter & Grahn, 2003)
	Non-Rhythmic Sensory Stimuli	* *	**Positively impacted on heart rate, systolic blood pressure and sympathetic nervous system activity** (Li, 2009; Park et al, 2008; Kahn et al., 2008; Beauchamp, et al., 2003; 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** (Heerwagen, 2006; Tham & Willem, 2005; Wigö, 2005)	**Positively impacted concentration** (Hartig et al., 2003; Hartig et al., 1991; R. Kaplan & Kaplan, 1989)	**Improved perception of temporal and spatial pleasure (alliesthesia)** (Parkinson, de Dear & Candido, 2012; Zhang, Arens, Huizenga & Han, 2010; Arens, Zhang & Huizenga, 2006; Zhang, 2003; de Dear & Brager, 2002; Heschong, 1979)
	Presence of Water	* *	**Reduced stress, increased feelings of tranquility, lower heart rate and blood pressure** (Alvarsson, Wiens, & Nilsson, 2010; Pheasant, Fisher, Watts et al., 2010; Biederman & Vessel, 2006)	**Improved concentration and memory restoration** (Alvarsson et al., 2010; Biederman & Vessel, 2006) **Enhanced perception and psychological responsiveness** (Alvarsson et al., 2010; Hunter et al., 2010)	**Observed preferences and positive emotional responses** (Windhager, 2011; Barton & Pretty, 2010; White, Smith, Humphryes et al., 2010; Karmanov & Hamel, 2008; Biederman & Vessel, 2006; Heerwagen & Orians, 1993; Ruso & Atzwanger, 2003; Ulrich, 1983)
	Dynamic & Diffuse Light	* *	**Positively impacted circadian system functioning** (Figueiro, Brons, Plitnick et al., 2011; Beckett & Roden, 2009) **Increased visual comfort** (Elyezadi, 2012; Kim & Kim, 2007)		
	Connection with Natural Systems				**Enhanced positive health responses; Shifted perception of environment** (Kellert et al., 2008)

[*] – Quantity and quality of empirical evidence supporting biophilic concepts (maximum = [***])

Biophilic Cities: Integrating Nature into Urban Design and Planning (Beatley 2011)

Biophilic cities and urbanism recognize the essential need for daily human contact with nature as well as the many environmental and economic values provided by nature and natural systems



Biophilic Urban Design and Planning

- Restore large interconnected green system
- Trees, parks and forests within 100m of where people live
- Insert nature and biodiversity in urban interstice
- Protect and restore natural urban hydrology
- Design biophilic urban streets and infrastructure
- Grow food and develop agriculture in the city
- Green retrofit existing urban neighbourhoods
- Creates safe spaces for walking and biking
- Promote healthy building and working environment
- Green the vertical dimension (Walls/Rooftops)