The Mountain Refuge ®

HUMAN SUSTAINABILITY REPORT

2022/2023

SYNSĒA

HUMAN SUSTAINABILITY REPORT

When designing buildings, it is essential to consider not only environmental sustainability, but also sustainability intended as the compatibility of space with users' neurophysiological, cognitive, and emotional needs.
In this way, architecture can become a mean towards a healthier environment, and healthier humans.

Synsēa's Human Sustainability Report (HSR) performs a "post-hoc analysis" with the aim of evaluating the qualitative components of the design, and the way these positively interact with human requirements; hence, to what extent the space can be considered sustainable in relation to users' experience.

Each project is unique, and the variables that are taken into account greatly vary. Our cluster analysis and variables selection ranges from large scale factors to small scale architectural choices. The report focuses on design features that are studied in neuroscientific research for being the most influential and interfering with our nervous system and sensorial responses.

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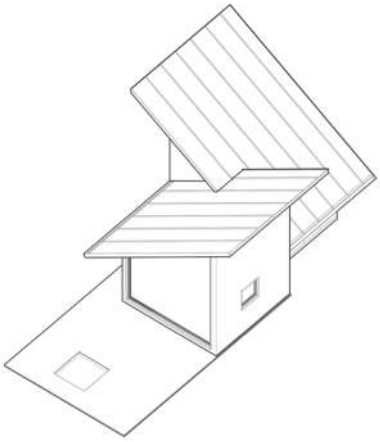
THE MOUNTAIN REFUGE

The Mountain Refuge® is a tiny-house designed by Italian architects Massimo Gnocchi and Paolo Danesi.

The project acts as a contemporary interpretation of traditional mountain refuges, bringing in architectural character and spatial quality.
A space in which human's essence, a connection with nature and history can be experienced.

The Mountain Refuge aims to find a balance between sustainability and design, yet it does not want to become a design item, nor a technological system.

The Mountain Refuge is modular, so the design could stand alone as one 24 square-meter space, or include an optional second module to add 12 square metres of floor space.



THE MOUNTAIN REFUGE

The clusters of analysis can be divided into two main domains. One large-scale outdoor space, which refers to the outer environment where The Mountain Refuge is designed to be placed. The other is intended as the indoor area.

OUTDOOR SPACE

MOUNTAINS
HILLS
LAKES

INDOOR SPACE

DAY AREA
NIGHT AREA

OUTDOOR SPACE: BIOPHILIA

Biophilia, or the innate attraction to natural living organisms, has been shown to have positive effects on our nervous system, as its exposure has been found to decrease stress, improve mood, and increase cognitive function.

One of the main mechanisms through which exposure to natural environments affects our nervous system is through the activation of the parasympathetic nervous system. This is responsible for regulating the body's "rest and digest" response, which helps to reduce stress and promote relaxation. Studies have found that exposure to natural environments, such as parks or forests, can increase parasympathetic activity and decrease sympathetic activity, leading to a reduction in stress.

Exposure to natural environments has also been found to increase activity in the prefrontal cortex, a region of the brain involved in cognitive function and decision-making. This increase in prefrontal cortex activity has been linked to improvements in attention and working memory.

In addition, presence of biophilic stimuli has been shown to increase the production of endorphins, neurotransmitters that promote feelings of pleasure and well-being. This increase in endorphin production may help to explain the positive mood effects associated with exposure to natural environments.

OUTDOOR SPACE: BIOPHILIA

The Mountain Refuge is conceived to be placed within various biophilic settings.
The house structure allows it to be compatible with high altitudes, mountains, hills, forests and lakes.

This freedom of placement implies that the types of nature surrounding the house can vary, according to its location.




OUTDOOR SPACE: BIOPHILIC VARIABLES

AUDITORY POLLUTION

OLFACTORY STIMULI

GREEN EXERCISE

LANDSCAPE VIEW

NATURAL LIGHT

OUTDOOR SPACE: AUDITORY POLLUTION

Auditory pollution refers to unwanted or excessive noise, such as traffic noise or loud music, that can have negative effects on our health and well-being. Exposure to such noise has been linked to a variety of health problems, including hypertension, cardiovascular disease, and sleep disturbance.

In contrast, being in nature provides a quiet and peaceful environment that can have restorative effects on the brain. Research has shown that even short-term exposure to nature can have positive effects on cognitive function, such as improving attention and working memory.

Neuroscientific studies have further demonstrated the benefits of natural sounds on brain activity. For example, functional magnetic resonance imaging (fMRI) studies have shown that exposure to natural sounds activates brain regions involved in attention and emotion regulation. Moreover, natural sounds can modulate the activity of the autonomic nervous system, leading to physiological changes such as reduced heart rate and increased parasympathetic activity.

ECOLOGICAL SPACE: OLFACOTRY STIMULI

One aspect of nature that has been studied extensively in recent years is the olfactory experience of being in the woods, which can have significant neurophysiological benefits.

Exposure to natural scents in forest environments can have a calming effect on the brain and body. For example, one study found that inhaling the scent of Hinoki cypress, a type of tree found in Japanese forests, led to a decrease in sympathetic nervous system activity and an increase in parasympathetic nervous system activity, which is associated with relaxation. Another study found that exposure to the scent of pine trees led to a decrease in cortisol levels, a hormone associated with stress.

In addition to its calming effects, exposure to natural scents in the woods may also have cognitive benefits. For example, exposure to the scent of plants has been found to improve cognitive performance in tasks related to working memory and attention. Another study found that exposure to the scent of cedar wood improved creativity in a word association task.

The neurophysiological benefits of smelling nature in the woods may be due to the effects of phytoncides, which are organic compounds released by trees and plants. Phytoncides have been shown to have antibacterial and antifungal properties, and may also have positive effects on human immune function and stress response.

OUTDOOR SPACE: GREEN EXERCISE

There is increasing evidence to suggest that engaging in physical activity in natural environments, or "green exercise", can lead to enhanced cognitive and emotional benefits compared to exercising in indoor or urban environments. This effect has been observed across different age groups and populations, from children to older adults, and from healthy individuals to those with mental health conditions.

Research has shown that exposure to natural environments during exercise can lead to improvements in mood, attention, and cognitive performance, as well as reduced levels of stress and anxiety. One proposed mechanism for these benefits is the restorative effect of nature on the brain, which can help to reduce mental fatigue and restore attentional capacity.
In addition, engaging in physical activity in natural environments can also lead to greater engagement with the exercise itself, potentially leading to increased levels of physical activity and greater adherence to exercise programs over time.

Neuroscientific studies have suggested that exposure to natural environments during exercise can lead to changes in brain activity, including increased activation in areas associated with attention and cognitive control, and reduced activation in areas associated with rumination and negative affect. These changes in brain activity are thought to underlie the observed improvements in cognitive and emotional functioning.

OUTDOOR SPACE: LANDSCAPE VIEW

When compared to viewing urban landscapes or cityscapes, natural landscapes such as forests, mountains, and bodies of water, can have numerous neurophysiological benefits.

One study used functional magnetic resonance imaging (fMRI) to examine brain activity in participants who viewed natural versus urban landscapes. The results showed that viewing natural landscapes resulted in increased activity in the brain regions associated with attentional and emotional processing, such as the anterior cingulate cortex and the insula, while viewing urban landscapes resulted in increased activity in regions associated with stress and anxiety, such as the amygdala and the hypothalamus.

As previously discussed, spending time in nature can improve cognitive function, including attention and working memory. Researchers found that spending just 50 minutes in a natural setting led to improvements in performance on cognitive tests compared to spending the same amount of time in an urban setting.

Equally importantly, viewing natural landscapes can reduce physiological markers of stress, such as heart rate and cortisol levels, compared to viewing urban landscapes.

OUTDOOR SPACE: NATURAL LIGHT

Exposure to natural lighting has numerous neurophysiological benefits, and respecting circadian rhythms can lead to positive outcomes for health and wellbeing.

It has been largely studied and proven that natural lighting can improve mood, alertness, and cognitive function. Exposure to natural lighting can also help regulate circadian rhythms, the body's internal biological clock that controls sleep-wake cycles, hormone production, and other physiological processes. When the circadian rhythm is disrupted, it can lead to negative health outcomes, including sleep disorders, obesity, and depression.

Indeed, studies have also shown that exposure to natural lighting during the day and reduced exposure to artificial lighting at night can improve sleep quality and duration. This is because natural lighting helps regulate the release of melatonin, a hormone that plays a key role in sleep-wake cycles. Exposure to artificial lighting at night, particularly from electronic devices, can disrupt the circadian rhythm and reduce the release of melatonin, leading to difficulty falling asleep and poor sleep quality.

INDOOR SPACE: THE VARIABLES

LAYOUT

LIGHTING

ENERGY

MATERIALS

ATMOSPHERE AND NEUROAESTHETICS

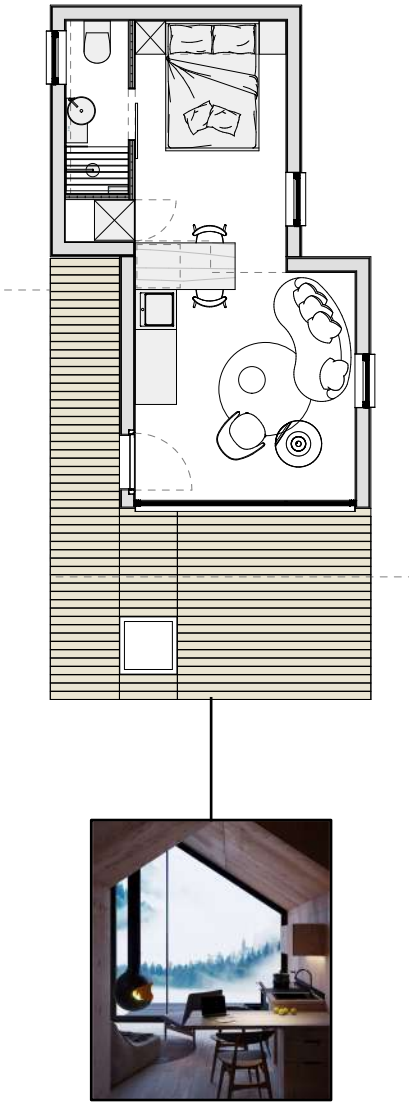
INDOOR SPACE: LAYOUT

PROSPECT REFUGE THEORY

One of The Mountain Refuge's most admirable features is its large front window in the day area, allowing a boundless visual of the natural surroundings whilst feeling safe and "having your back covered".

The Prospect-Refuge Theory (PRT) proposes that humans have a preference for environments that provide both open views (prospect) and places of safety or shelter (refuge). This theory has been applied to urban design and architecture, and there is evidence to suggest that exposure to environments that adhere to the principles of PRT can have noticeable positive effects on the human nervous system.

The mechanisms are still unclear, however it may be due to the fact that humans evolved in natural environments and therefore have an innate preference for environments that provide both open views and shelter.



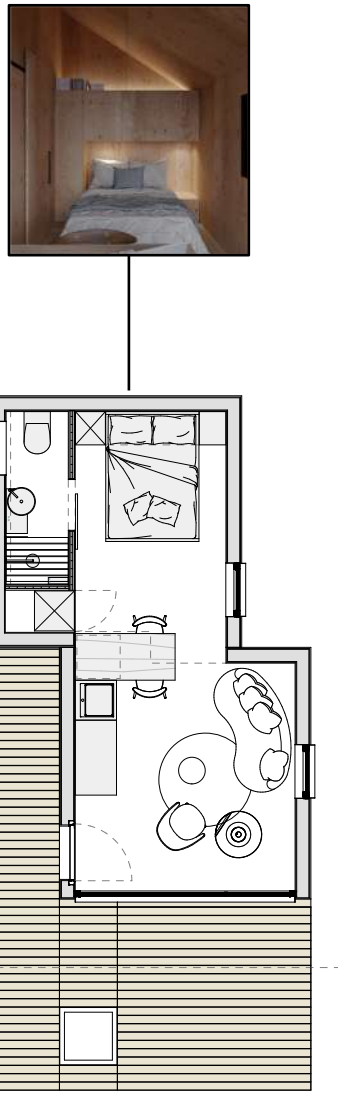
INDOOR SPACE: LAYOUT

NIGHT AREA

The Mountain Refuge's night area is the representaton of the perfect safe have, thanks to a perfectly balanced combination of ceiling height and shape. Some studies have investigated the effects of enclosed spaces on the brain and body, which may shed some light on why people find sleeping in such environments enjoyable.

One theory is that the feeling of being enclosed and secure may activate the parasympathetic nervous system, which is responsible for the body's "rest and digest" response. This may result in a feeling of deep relaxation and tranquility, making it easier to fall asleep and stay asleep throughout the night.

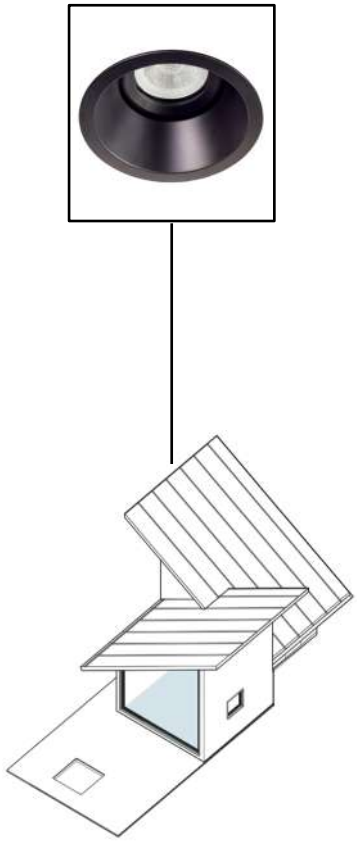
The feeling of safety could also activate the release of dopamine, a neurotransmitter associated with pleasure and reward, which may enhance feelings of comfort and well-being.



INDOOR SPACE: ARTIFICIAL LIGHTING

3000 K – WARM WHITE

Warm white light with a colour temperature of 3000K, as chosen by The Mountain Refuge, has been shown to have a positive impact on the human nervous system. This is due to the fact that warm light has a calming effect on the brain, which can help reduce stress and anxiety. The mechanism through which this occurs is related to the impact that light has on the production of certain neurotransmitters, including serotonin and melatonin. Serotonin is a neurotransmitter that is involved in regulating mood, appetite, and sleep, and studies have shown that exposure to warm white light can increase the production of serotonin. Melatonin is a hormone that is produced by the pineal gland in response to darkness, and it is involved in regulating the sleep-wake cycle. Warm white light has been shown to have a less disruptive effect on melatonin production, which can help promote better sleep.

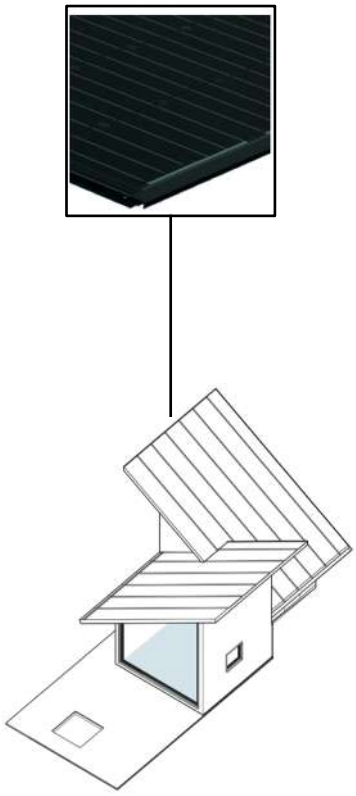


INDOOR SPACE: ENERGY

PHOTOVOLTAIC PANELS

The Mountain Refuge is an energetically self-sufficient space thanks to the use of photovoltaic panels. While their primary benefit is the environmental impact, there may also be positive effects on humans' nervous system.

One potential benefit of PV panels is their ability to reduce exposure to electromagnetic fields (EMFs). Traditional electricity sources, such as power lines and electrical devices, emit EMFs that have been associated with adverse health effects, including changes in brain function and behaviour. By contrast, PV panels do not emit significant EMFs, which may have a positive impact on human neurophysiology. Moreover, sunlight exposure stimulates the production of serotonin, a neurotransmitter that regulates mood and behaviour. PV panels can provide a source of clean, renewable energy that allows individuals to harness the power of the sun without the harmful effects of UV radiation.

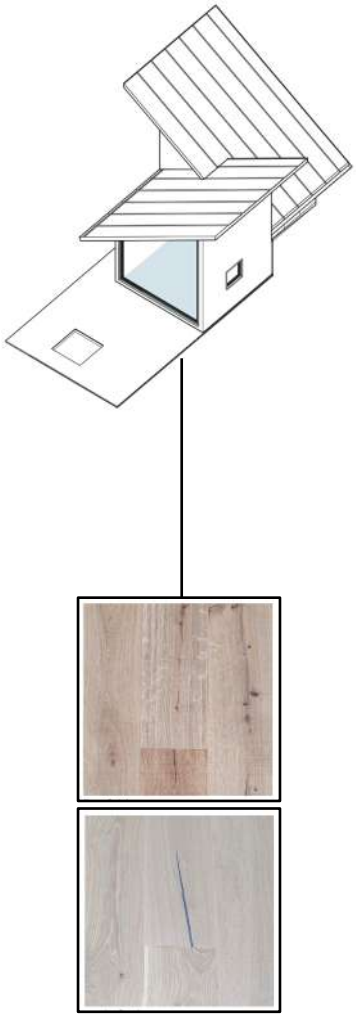


INDOOR SPACE: MATERIALS

FLOORING: OAK WOOD

For its indoor area, he Mountain Refuges offers two shades of oak wood flooring.

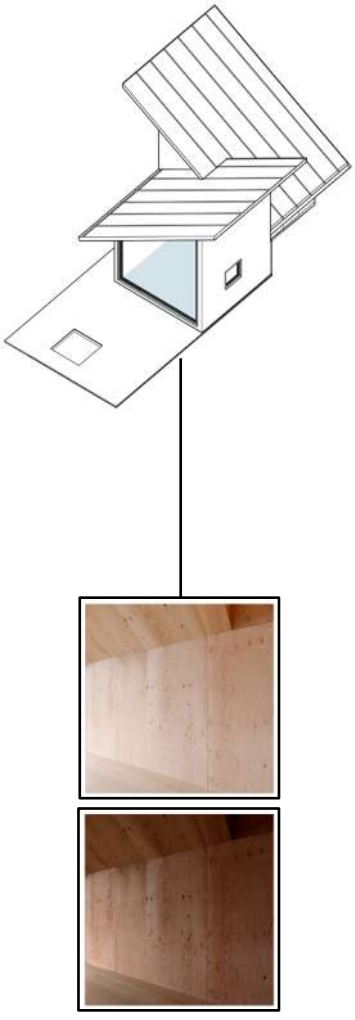
Exposure to this type of wood, which is rich in volatile organic compounds, has been shown to have specific neurophysiological and cognitive benefits. A study published in Frontiers in Psychology found that exposure to oak wood activated brain regions associated with positive emotional processing, such as the prefrontal cortex and the anterior cingulate cortex. Similarly, another study published in the International Journal of Environmental Research and Public Health, found that exposure to oak wood resulted in increased parasympathetic nervous system activity, which is associated with relaxation and reduced stress levels. The study also found improvements in cognitive function, including increased attention and working memory.



INDOOR SPACE: MATERIALS

INTERIOR AND CEILING FINISH:
SPRUCE PLYWOOD

The chosen material for The Mountain Refuge's ceiling finish and indoor features is spruce plywood, in two different shades. Spruce wood emits a volatile organic compound called alpha-pinene, which has been found to increase activity in certain areas of the brain and promote relaxation and stress reduction.
Exposure to alpha-pinene from spruce wood can increase activity in the parasympathetic nervous system, again leading to decreased heart rate, reduced blood pressure, and increased feelings of calmness and relaxation. Furthermore, exposure to spruce wood has also been associated with decreased levels of cortisol, a hormone released in response to stress. Lower levels of cortisol have been linked to improved immune function and reduced risk of various chronic diseases.



INDOOR SPACE: NEUROAESTHETICS

The concluding note, which binds all the previously mentioned qualities of the project, is the elegant approach to the design of The Mountain Refuge, thus creating not only a perfectly functional but al so beautiful space.

Neuroaesthetics is the study of the neural basis of aesthetic experience. Beautiful spaces can have a significant impact on our nervous system by activating neural networks associated with pleasure, reward, and positive emotional states. This can lead to reduced stress levels, improved mood, and increased cognitive function.

Research in neuroscience has shown that exposure to visually appealing environments can enhance the release of dopamine, a neurotransmitter involved in the reward system of the brain. Dopamine release can promote positive affective states and improve motivation and learning.

Moreover, aesthetic experiences activates brain regions associated with emotion, perception, and cognitive processing, such as the prefrontal cortex, anterior cingulate cortex, and insula. These regions are involved in attentional control, decision-making, and memory formation, among other cognitive functions. Therefore, exposure to beautiful spaces may also enhance cognitive performance and productivity.

REFERENCES

World Health Organization. (2011). Burden of disease from environmental noise: Quantification of healthy life years lost in Europe.

Alvarsson, J. J., Wiens, S., & Nilsson, M. E. (2010). Stress recovery during exposure to nature sound and environmental noise. International Journal of Environmental Research and Public Health, 7(3), 1036-1046.

Berman, M. G., Jonides, J., & Kaplan, S. (2008). The cognitive benefits of interacting with nature. Psychological Science, 19(12), 1207-1212.

Vernet, M., Martel, M., Lafontaine, M. P., & Fiset, P. (2019). Natural sounds enhance the neural coding of speech in adverse listening conditions. NeuroImage, 185, 369-379.

Lee, J., Lee, Y., Lee, J., & Park, D. (2015). Nature therapy and preventive medicine. Public Health in East and Southeast Asia, 3(2), 17-24.

Brunekreef, B., & Holgate, S. T. (2002). Air pollution and health. The Lancet, 360(9341), 1233-1242.

Li, Q., Kobayashi, M., Wakayama, Y., Inagaki, H., Katsumata, M., Hirata, Y., ... & Kawada, T. (2011). Effect of phytoncide from trees on human natural killer cell function. International Journal of Immunopathology and Pharmacology, 24(3), 683-691.

Fu, C. W., Chen, Y. Y., & Yang, Y. H. (2018). Association of urbanicity with cognitive function among middle-aged and older adults in Taiwan. International Journal of Environmental Research and Public Health, 15(3), 412.

Park, B. J., Tsunetsugu, Y., Kasetani, T., Kagawa, T., & Miyazaki, Y. (2010). The physiological effects of Shinrin-yoku (taking in the forest atmosphere or forest bathing): evidence from field experiments in 24 forests across Japan. Environmental Health and Preventive Medicine, 15(1), 18-26.

Nowak, D. J., Hirabayashi, S., Bodine, A., & Hoehn, R. (2013). Modeled PM2.5 removal by trees in ten US cities and associated health effects. Environmental Pollution, 178, 395-402.

Song, C., et al. (2018). Psychological and physiological effects of forest therapy on middle-aged males with high-normal blood pressure. International Journal of Environmental Research and Public Health, 15(12), 2795.

Carmona, R. (2010). Healing spaces: The science of place and well-being. John Wiley & Sons.

Kuo, F. E., & Sullivan, W. C. (2001). Aggression and violence in the inner city: Effects of environment via mental fatigue. Environment and Behavior, 33(4), 543-571.

REFERENCES

Tsunetsugu, Y., Lee, J., Park, B. J., Tyrväinen, L., Kagawa, T., & Miyazaki, Y. (2018). Physiological and psychological effects of viewing a Japanese garden: results from a field experiment in 24 settings. Landscape and Urban Planning, 170, 24-32.

Li, Q., Morimoto, K., Nakadai, A., Inagaki, H., Katsumata, M., Shimizu, T., & Hirata, Y. (2007). Forest bathing enhances human natural killer activity and expression of anti-cancer proteins. International Journal of Immunopathology and Pharmacology, 20(2_suppl), 3-8.

Herz, R. S., & Inzlicht, M. (2002). Cognitive effects of the scent of fresh pine: Pinus sylvestris as a cognitive booster. Journal of Environmental Psychology, 22(3), 265-272.

Seo, H. S., Lee, C., & Choi, J. (2013). The influence of scent on cognitive function. The Korean Journal of Psychology: General, 32(4), 905-922.

Park, B. J., Tsunetsugu, Y., Kasetani, T., Kagawa, T., & Miyazaki, Y. (2010). The physiological effects of Shinrin-yoku (taking in the forest atmosphere or forest bathing): evidence from field experiments in 24 forests across Japan. Environmental Health and Preventive Medicine, 15(1), 18-26.

Barton, J., & Pretty, J. (2010). What is the best dose of nature and green exercise for improving mental health? A multi-study analysis. Environmental science & technology, 44(10), 3947-3955.

Ohly, H., White, M. P., Wheeler, B. W., Bethel, A., Ukoumunne, O. C., Nikolaou, V., & Garside, R. (2016). Attention restoration theory: A systematic review of the attention restoration potential of exposure to natural environments. Journal of Toxicology and Environmental Health, Part B, 19(7), 305-343.

Ward Thompson, C., Roe, J., Aspinall, P., Mitchell, R., Clow, A., & Miller, D. (2012). More green space is linked to less stress in deprived communities: Evidence from salivary cortisol patterns. Landscape and urban planning, 105(3), 221-229.

Bratman, G. N., Hamilton, J. P., & Daily, G. C. (2015). The impacts of nature experience on human cognitive function and mental health. Annals of the New York Academy of Sciences, 1352(1), 1-9.

Miyazaki, Y., et al. (2012). Physiological and psychological effects of forest therapy on middle-aged males with high-normal blood pressure. International Journal of Environmental Research and Public Health, 9(8), 2767-2785.

Park, B. J., et al. (2010). The physiological effects of Shinrin-yoku (taking in the forest atmosphere or forest bathing): evidence from field experiments in 24 forests across Japan. Environmental Health and Preventive Medicine, 15(1), 18-26.

REFERENCES

Berman, M. G., Jonides, J., & Kaplan, S. (2008). The cognitive benefits of interacting with nature. Psychological Science, 19(12), 1207-1212.

Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., & Zelson, M. (1991). Stress recovery during exposure to natural and urban environments. Journal of Environmental Psychology, 11(3), 201-230.

Chang, A. M., Aeschbach, D., Duffy, J. F., & Czeisler, C. A. (2015). Evening use of light-emitting eReaders negatively affects sleep, circadian timing, and next-morning alertness. Proceedings of the National Academy of Sciences, 112(4), 1232-1237.

Takahashi, J. S., Hong, H. K., Ko, C. H., & McDearmon, E. L. (2018). The genetics of mammalian circadian order and disorder: implications for physiology and disease. Nature Reviews Genetics, 19(10), 595-606.

Vetter, C., Juda, M., Lang, D., Wojtysiak-Wojcicka, M., Roenneberg, T. (2016). Blue-enriched office light competes with natural light as a zeitgeber. Scandinavian Journal of Work, Environment & Health, 42(4), 347-356.

Bratman, G. N., Hamilton, J. P., & Daily, G. C. (2012). The impacts of nature experience on human cognitive function and mental health. Annals of the New York Academy of Sciences, 1249(1), 118-136.

Kaplan, R., & Kaplan, S. (1989). The experience of nature: A psychological perspective. Cambridge University Press.

Kuo, F. E. (2015). How might contact with nature promote human health? Promising mechanisms and a possible central pathway. Frontiers in psychology, 6, 1093.

Tennessen, C. M., & Cimprich, B. (1995). Views to nature: Effects on attention. Journal of Environmental Psychology, 15(1), 77-85.

Kawakami, K., et al. (2013). Effects of phytoncides on blood pressure under stress. Journal of Physiological Anthropology, 32(1), 8.

Kwon, Y. J., et al. (2014). Effects of aromatherapy on the anxiety, vital signs, and sleep quality of percutaneous coronary intervention patients in intensive care units. Evidence-Based Complementary and Alternative Medicine, 2014.

Lee, J., et al. (2018). The psychological effects of forest therapy on elderly patients with mild cognitive impairment. International Journal of Environmental Research and Public Health, 15(3), 617.

Li, Q., et al. (2009). Forest bathing enhances human natural killer activity and expression of anti-cancer proteins. International Journal of Immunopathology and Pharmacology, 22(4), 827-833.

Li, Q., et al. (2010). Acute effects of walking in forest environments on cardiovascular and metabolic parameters. European Journal of Applied Physiology, 111(11), 2845-2853.

REFERENCES

Belyaev, I., Dean, A., Eger, H., Hubmann, G., Jandrisovits, R., Johansson, O., ... & Mosgöller, W. (2015). EUROPAEM EMF guideline 2015 for the prevention, diagnosis and treatment of EMF-related health problems and illnesses. Reviews on Environmental Health, 30(4), 337-371.

Lambert, G. W., Reid, C., Kaye, D. M., Jennings, G. L., & Esler, M. D. (2002). Effect of sunlight and season on serotonin turnover in the brain. The Lancet, 360(9348), 1840-1842.

Bratman, G. N., Hamilton, J. P., & Daily, G. C. (2012). The impacts of nature experience on human cognitive function and mental health. Annals of the New York Academy of Sciences, 1249(1), 118-136.

Cajochen, C., & Chellappa, S. L. (2019). The role of naturalistic light and the gut–brain axis in promoting health and wellbeing. Proceedings of the Nutrition Society, 78(4), 328-336.

Phillips, A. J., Vidafar, P., Burns, A. C., McGlashan, E. M., Anderson, C., Rajaratnam, S. M., ... & Lockley, S. W. (2019). High sensitivity and interindividual variability in the response of the human circadian system to evening light. Proceedings of the National Academy of Sciences, 116(24), 12019-12024.

Vandewalle, G., Schwartz, S., Grandjean, D., Wuillaume, C., Balteau, E., Degueldre, C., ... & Maquet, P. (2010). Spectral quality of light modulates emotional brain responses in humans. Proceedings of the National Academy of Sciences, 107(45), 19549-19554.

Smolders K, de Kort YAW. Bright light therapy: improved sensitivity to color contrast in the visual system. PLoS One. 2014;9(1):e86468. doi:10.1371/journal.pone.0086468

Navara KJ, Nelson RJ. The dark side of light at night: physiological, epidemiological, and ecological consequences. J Pineal Res. 2007;43(3):215-224. doi:10.1111/j.1600-079x.2007.00473.x

Ulrich RS. View through a window may influence recovery from surgery. Science. 1984;224(4647):420-421. doi:10.1126/science.6143402

Marmot M. Social determinants of health inequalities. Lancet. 2005;365(9464):1099-1104. doi:10.1016/S0140-6736(05)71146-6

Appleton, J. (1975). The experience of landscape. New York: John Wiley & Sons.

Herzog, T. R. (1985). A cognitive analysis of preference for waterscapes. Journal of Environmental Psychology, 5(3), 225-241.

Ulrich, R. S. (1984). View through a window may influence recovery from surgery. Science, 224(4647), 420-421.

Ulrich, R. S., Zimring, C., Zhu, X., DuBose, J., Seo, H. B., Choi, Y. S., ... & Joseph, A. (2008). A review of the research literature on evidence-based healthcare design. HERD: Health Environments Research & Design Journal, 1(3), 61-125.

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www.synsea.it
info@synsea.it