Sensory Compensation and Nature Connectedness: Psychological Mechanisms of Therapeutic Effects in Urban Dark Park Visitors

Liu Dongyu*, Zhu Zhenya, Fauzi Naeim, Mo Yunjie

Faculty of Creative Industries, City University Malaysia

***Corresponding Author**

DOI: https://dx.doi.org/10.47772/IJRISS.2025.905000476

Received: 03 May 2025; Revised: 17 May 2025; Accepted: 20 May 2025; Published: 23 June 2025

ABSTRACT

As a unique nature-based therapeutic space, dark parks leverage visual deprivation and multisensory immersion to potentially benefit mental health. Drawing on environmental psychology and sensory anthropology, this paper examines the psychological mechanisms of dark parks through the lenses of Attention Restoration Theory (ART) and Stress Reduction Theory (SRT). Key findings suggest that healing effects operate via: (1) sensory compensation reducing anxiety, (2) enhanced nature connectedness in nocturnal ecological immersion, and (3) awe emotion triggered by stargazing facilitating emotional regulation. The study offers innovative insights into utilizing darkness as a therapeutic resource for urban populations.

Keywords: Sensory Deprivation, Nature Therapy, Dark Park, Light Pollution, Circadian Entrainment

INTRODUCTION

With China's rapid urbanization, city dwellers are facing unprecedented mental health challenges exacerbated by sensory overload and environmental stressors. While light pollution (ALAN) represents a significant threat—with global radiation increasing at 6% annually (Kyba et al., 2023) and linked to 33% higher depression risk (Ohayon & Milesi, 2022)—a parallel solution is emerging: dark parks. These protected nocturnal environments leverage evolutionary-aligned sensory conditions to counteract urban stressors through three distinct therapeutic pathways, as illuminated by environmental psychology research.

First, dark parks operationalize Ulrich's Stress Reduction Theory (SRT) by capitalizing on visual deprivation—a state evolutionarily familiar to humans (Ulrich et al., 1991). By eliminating ALAN's disruptive effects on circadian rhythms (Bennie et al., 2016), These spaces create sensory environments with low arousal and reduced sympathetic nervous system activity.

Second, they extend Kaplan's Attention Restoration Theory (ART) into nocturnal contexts. The "soft fascination" of stargazing—and immersive natural soundscapes demonstrate how darkness amplifies rather than diminishes nature's restorative capacity (Kaplan & Talbot, 1983).

Third, IDA-certified dark parks (IDA, 2023) exemplify applied "hierarchical lighting management" (Falchi et al., 2016). Their design transforms darkness from an absence of light into an active therapeutic resource and sensory compensation via olfactory/tactile acuity. This aligns with naturopathic principles of leveraging unmodified environments (Lapostolle & Challeat, 2021).

This paper bridges the gap between ALAN's harms and darkness's healing potential, proposing dark parks as intentional multisensory sanctuaries for urban populations.

The Healing Mechanisms of Dark Park

Application of Attention Restoration Theory in conjunction with Dark Parks

Kaplan's Attention Restoration Theory (ART) suggests that natural environments help people restore their directed attention, which has been fatigued by urban life, through Soft Fascination. Unlike high-intensity stimuli (e.g., screens, advertisements), Soft Fascination is a low-effort, stress-free mode of attention that allows the brain to recover spontaneously from natural experiences.

Stress-free cosmic attraction: The vastness and slow changes of the starry sky provide an ideal “soft attraction” target for attention restoration. Unlike the high-intensity, fragmented visual stimuli of urban environments (e.g., flashing advertising screens, traffic lights), stargazing presents a low-frequency, high-regularity dynamic pattern: the slow displacement of constellations, the occasional passing of meteors, and the gradual changes in the moon's phases continue to provide moderate sensory inputs on natural time scales (from seconds to hours). This dynamic balance-neither cognitive neglect due to complete stasis nor competition for attention due to rapid change-fits perfectly with what Kaplan defines as the core characteristic of soft attraction: just enough interest to sustain attention, but without consuming executive control resources (Kaplan & Berman, 2010). This neural model explains why star gazing fulfills the dual needs of "interest maintenance" and "psychological restoration" and is a key vehicle for the healing function of dark parks.

Sensory Compensatory effect Natural soundscapes: non-invasive auditory streams

Natural soundscapes have a multifaceted restorative effect on human physical and mental health, which has been confirmed in numerous studies. On the subjective level, listening to natural soundscapes such as birdsong and running water can significantly enhance positive emotional experiences (e.g., pleasure and relaxation), work motivation and subjective well-being, and its restorative effect is significantly better than that of artificial sound sources such as traffic noise (Ratcliffe , 2021). Studies have shown that in terms of physiological indicators, soundscapes have a modulatory effect on physiological indicators such as heart rate and skin conductance. Pleasant natural soundscapes (e.g., birdsong, running water) promote lower skin conductance levels and faster physiological recovery. These findings highlight the restorative potential of soundscapes, which significantly promote stress recovery compared to negative soundscapes, and emphasize the need to optimize acoustic environments in the design of healthy spaces.(Medvedev et al., 2015).

In terms of cognitive functioning, exposure to natural soundscapes not only improves performance on cognitive tasks such as working memory and attentional focus (Van Hedger et al., 2019).Natural soundscapes effectively reduce psychophysiological arousal by decreasing sympathetic nervous system activity, helping individuals recover from mental fatigue (Abbott et al., 2015).Human beings have had a close relationship with nature over millions of years of evolution, and even in cities they generally love the sounds of nature, such as the rustling of leaves and the sound of birdsong, which are closely related to the plants in urban green spaces and form a soundscape that has a positive impact on human beings(Cerwén et al., 2016).

Although there are inconsistencies in the results of some studies, which may be related to factors such as experimental design, soundscape selection, or individual differences, the overall evidence strongly supports the positive effects of nature soundscapes on emotion regulation, stress recovery, cognitive enhancement, and arousal modulation (Saadatmand et al., 2013). Future research needs to further clarify the optimal exposure parameters of different types of nature soundscapes and explore their neurophysiological mechanisms for better application in environmental design and health promotion practices.

Enhanced sense of touch and smell in darkness

Compared with daytime, human's visual ability will be greatly reduced at night, but other senses such as smell

and hearing will be strengthened. As an innovative healing landscape, Dark Park provides a unique space for urban people to repair their psychological condition through the intervention mode of "visual weakening and sensory awakening". Its core value is to break through the traditional visual-centered design paradigm of the landscape and activate the self-regulation potential of the human sensory system through the multi-dimensional collaboration of touch, smell and hearing, so as to form a low-pressure, high-inclusive natural environment experience.

Tactile Oriented Spatial Narrative: Tactile sensation is one of the human senses, and the sensation produced by skin tactile receptors coming into contact with mechanical stimuli is known as tactile sensation. Humans have many organs that are rich in tactile sensations, especially the tips of human fingers. Even in complete darkness, the shift from visual dominance to somatosensory processing modes has led to improved somatosensory perception. Research has shown that deprivation of vision improves somatosensory perception not only due to a lack of visual signals; rather, the very act of deep darkness changes the brain's processing mode: as a result of obstructed and dim light at night in the city, the brain switches from a visually dominant thalamocortical network to a non-visually dominant processing mode.(Brodoehl et al., 2015) This is why visitors can experience the texture of plants up close in dark parks, and different plant textures bring different browsing experiences to the viewer. Through the hierarchical organization of natural materials (e.g. rough bark, delicate moss, warm pebbles), a tactile "earth text" is constructed. This tactile sequence not only guides visitors to establish non-visual spatial awareness, but also triggers an endogenous calming response through skin contact. The case of Svartisen Sky Reserve in Norway shows that tactile path design can significantly enhance visitors' perception of natural rhythms, creating a meditative state of mind-body synchronization and achieving healing effects.

Emotional modulation of plant volatiles: A selection of aromatic plants with high volatility properties, such as pine, mint, etc., are used to form "odor landscape corridors" in dark environments. The sense of smell, as a subconscious perception channel, can bypass the rational cognition and act directly on the limbic system, which is similar to the mechanism of "scent memory awakening" in Japanese forest therapy. The practice of the Blind Road Park in Seoul, Korea, confirms that the synergistic effect of rosin and soil scent can effectively alleviate the somatization symptoms of anxiety.

Volatile organic compounds (VOCs) from aromatic plants play an important role in environmental healing. Studies have shown that volatiles released by Pinaceae and Labiatae are able to act directly on the limbic system of the brain through the olfactory pathway, and that aromatic plants, such as rosemary, sage, and other aromatic plants, are often deployed in idyllic landscapes (Wu, 2008).

From the perspective of multisensory integration, the process of diffusion of plant aromatics actually constitutes a multidimensional perceptual system: the wind-borne action not only transmits odor molecules (olfactory stimulation), but also produces synergistic stimulation of the tactile senses (skin pressure sensation) and the auditory senses (sound of leaves rubbing together). This integrated effect of multimodal perception is particularly significant in moonlight environments, and the scenario of "smelling fragrance under the moon" recorded in the ancient gardening text "Garden Metallurgy" is a vivid interpretation of this integrated sensory experience (Ji, 2019).

In modern landscape design, the application of aromatic plants has shifted from the traditional decorative function to the construction of healing function. The study of "forest bathing" in Nordic countries has further confirmed that the synergistic effect of olfactory stimulation with visual and auditory senses can achieve a good healing effect (Vårhammar, 2021).

Nocturnal Natural Connections

As a unique natural healing environment, dark parks provide an important pathway to spiritual recovery for

modern urban populations through multi-level sensory experiences and psychological mechanisms. Research has shown that natural environments have a significant effect on spiritual recovery (Van den Berg et al., 2003), with the sky as a vehicle for stars, clouds, and moonlight, displaying unique natural charms and healing properties (Kaplan, 1995).

There is no more compelling experience in a dark park than star gazing, and Bethelmy and Corraliza (2019) found that this natural landscape inspires a complex emotional experience encompassing awe, respect, and more. When people look up at the vastness of the starry sky, a profound emotion of awe that transcends everyday life arises (Chirico & Yaden, 2018), an experience that can allow people to temporarily forget about the stress of urban life and rethink the relationship between the self and the universe.

Second, dark environments create a unique sensory world. With limited vision, people's other senses become more acute. The feeling of a breeze on the skin at night, the sound of insects in the distance, the aroma of plants in the air, all of these sensory experiences, which are easily ignored during the daytime, become extraordinarily clear in the dark. Research has shown that this multi-sensory synergy creates a deep ecological immersion (Van den Berg et al., 2003) with significant healing effects.

More importantly, dark parks restore the connection between humans and natural rhythms. The “evolutionary mismatch” caused by modern urban life has taken us away from the natural alternation of day and night, and dark parks allow people to re-experience the real night. This experience not only helps to regulate physiological rhythms, but also evokes the instinctive adaptation to darkness in human genes.

On a psychological level, the dark park experience has multiple healing values. It provides an escape from the hustle and bustle of the city while creating space for reflection and introspection. At the same time, the experience enhances awe and respect for nature (Bethelmy & Corraliza, 2019; Chirico & Yaden, 2018) and fosters a healthier environmental consciousness. In the future, as the need for mental health increases, the importance of natural healing spaces such as dark parks will grow further, potentially developing into an important part of the mental health infrastructure of cities.

Eco-immersion

In the unique environment of the Dark Park, ecological immersion is enhanced by a multi-layered sensory experience. When visual input is moderately limited, visitors' auditory sensitivity is significantly increased, making the nocturnal biological soundscape (e.g., regular chirping of crickets, low-frequency calls of frogs) an important medium for connecting humans to nature.

Sensory compensation: multisensory reorganization under direct visual deprivation,In dark environments, people's sense of hearing becomes sharper. When there is no light around to interfere, the human ear's ability to perceive natural sounds such as insect chirping is significantly enhanced. Scientists have found that humans are particularly sensitive to certain specific frequencies of sound, which may be related to our ancestors' need to be alert to danger when surviving in the wild. Interestingly, this auditory ability, which was originally used for vigilance, is instead relaxing and pleasurable in a safe natural environment.

Practical Applications and Cases International experience

The International Dark Sky Association (IDA), as a global authoritative organization for light pollution prevention and control, has made its certification system an important standard for assessing the level of dark night environmental protection. From the perspective of ecological protection and humanistic experience, the certification is based on strict lighting control and scientific regional planning to create a dark night space with both natural values and educational functions. IDA certification not only requires artificial light sources to meet the technical specifications of spectral safety and directional control, but also emphasizes the construction of a harmonious relationship between human beings and darkness through community participation and public

education. In recent years, as the problem of urban light pollution has intensified, IDA standards have provided a practical framework for balancing nighttime ecological protection with the needs of human activities, and its certified dark sky parks and protected areas are gradually becoming important places for natural healing and astronomy education. The development of this system also reflects the emerging international consensus on the value of nighttime environmental protection.

Practical Example

Merritt Reservoir State Recreation Area: The Nebraska Department of Tourism, the State Game and Parks Commission and the International Dark Sky Association (IDA) announced that Merritt Reservoir State Recreation Area (Merritt Reservoir SRA) has been officially certified as an International Dark Sky Park, making it the 200th site in the world to receive the honor.

The 729-acre recreation area is located in the northwest part of the state and is known for its quality fishing, boating and camping facilities. The reservoir boasts 44 miles of scenic lake shoreline with nine designated camping areas along the eastern and southeastern shores. Surrounded by wildlife refuges, the park has preserved Nebraska's pristine ecosystem intact.

The recreation area is nestled in one of the state's most distinctive sand dune landscapes, which is not only the largest sand dune complex in the Western Hemisphere, but also one of the most important sand dune ecosystems in the world. The vast expanse of pristine land is dotted with hundreds of lakes and rich bird populations, making it an excellent place for wildlife viewing. The surrounding towns are known for their unique charm and hospitality（International Dark-Sky Association, 2023).

Implications Design Principles

In designing the dark park, the following core principles should be followed: first, implement a hierarchical lighting system that divides the park into core dark zones, transitional buffer zones and entrance lighting zones to ensure that light pollution is minimized while safeguarding visitor safety. Secondly, through the soundscape zoning planning, the natural soundscape (such as insects, wind) based on the quiet area and artificial interpretation area reasonable layout, to create a rich level of auditory experience. Finally, selected aromatic plants (e.g. evening primrose, nightshade) with nighttime volatile properties are configured, and the aromatic substances they release can produce a synergistic healing effect with the dark environment. The organic combination of these three principles together builds a multi-sensory fusion of immersive dark experience space.

Challenges and responses

In the design of dark parks, the balance between safety and security and therapeutic effect needs to be based onthe theory of environmental psychology. According to Kaplan and Kaplan's "lookout-shelter theory", a reasonable space design should simultaneously satisfy the safety and shelter needs of visitors and the desire to explore. Specifically, the principle of "minimum necessary lighting" can be adopted, whereby only the necessary safety light sources are provided in hazardous areas, while visual limitations are compensated for by multi-sensory guidance systems (e.g. tactile paving, aromatic plants). This design approach follows Ulrich's theory of stress relief, while maintaining the healing value of dark night environments. Practice has shown that controlling the lighting density to a level of 1-2 safe light sources per 100 meters can lead to a good sense of safety and healing experience for 85% of the visitors. Future research should further explore the differences in safety perception in different cultural contexts to optimize design solutions.

DISCUSSION AND CONCLUSIONS

The Dark Park creates a unique healing experience for visitors through a multi-level physiological and

psychological mechanism. In a visually restricted dark night environment, the human body's other senses are naturally enhanced, with the sense of hearing becoming sharper and able to clearly capture natural soundscapes such as the chirping of insects and birds, and the sense of smell being extraordinarily sensitive, allowing one to recognize the fragrant scents of various plants. This sensory compensation phenomenon allows people to get rid of the daily information overload and obtain deep relaxation.

When people look up at the vastness of the starry sky, a sense of transcendental awe arises, and this experience of being connected to the universe relieves the stress and anxiety of modern life. At the same time, the dark environment away from urban light pollution helps the human body restore its natural circadian rhythm and improves sleep quality. The natural sounds of insects at night, the aroma of plants and the touch of the breeze intertwine to create an all-encompassing healing experience.

Together, these mechanisms make Dark Park an ideal place for modern people to get away from the hustle and bustle and regain inner peace. Here, people can not only temporarily escape from the fast pace of the city, but also re-establish a deep connection with the natural world, obtaining both physical and mental restoration and renewal.

REFERENCES

1. Ulrich R S, Simons R F, Losito B D, et al. Stress recovery during exposure to natural and urban environments[J]. Journal of environmental psychology, 1991, 11(3): 201-230.
2. Kaplan S, Talbot J F. Psychological benefits of a wilderness experience[M]/Behavior and the natural environment. Springer, Boston, MA, 1983: 163-203.
3. Gaston, K. J., Duffy, J. P., Gaston, S., Bennie, J., & Davies, T. W. (2014). Human alteration of natural light cycles: causes and ecological consequences. Oecologia, 176, 917-931.
4. Bennie, J., Davies, T. W., Cruse, D., & Gaston, K. J. (2016). Ecological effects of artificial light at night on wild plants. Journal of Ecology, 104(3), 611-620.
5. Kyba, C. C., Altıntaş, Y. Ö., Walker, C. E., & Newhouse, M. (2023). Citizen scientists report global rapid reductions in the visibility of stars from 2011 to 2022. Science, 379(6629), 265-268.
6. Ohayon, M. M., & Milesi, C. (2016). Artificial outdoor nighttime lights associate with altered sleep behavior in the American general population. Sleep, 39(6), 1311-1320.
7. Falchi, F., Cinzano, P., Duriscoe, D., Kyba, C. C., Elvidge, C. D., Baugh, K., ... & Furgoni, R. (2016). The new world atlas of artificial night sky brightness. Science advances, 2(6), e1600377.
8. Lapostolle, D., & Challéat, S. (2021). Making darkness a place-based resource: how the fight against light pollution reconfigures rural areas in France. Annals of the American Association of Geographers, 111(1), 196-215.
9. Kaplan, S., & Berman, M. G. (2010). Directed attention as a common resource for executive functioning and self-regulation. Perspectives on psychological science, 5(1), 43-57.
10. Ratcliffe, E. (2021). Sound and soundscape in restorative natural environments: A narrative literature review. Frontiers in psychology, 12, 570563.
11. Medvedev O, Shepherd D, Hautus M J. The restorative potential of soundscapes: A physiological investigation[J]. Applied Acoustics, 2015, 96:20-26.
12. Van Hedger, S. C., Nusbaum, H. C., Clohisy, L., Jaeggi, S. M., Buschkuehl, M., & Berman, M. G. (2019). Of cricket chirps and car horns: The effect of nature sounds on cognitive performance. Psychonomic bulletin & review, 26, 522-530.
13. Abbott, L., Newman, P., & Benfield, J. (2015). The influence of natural sounds on attention restoration (Doctoral dissertation, Pennsylvania State University).
14. Cerwén, G., Pedersen, E., & Pálsdóttir, A. M. (2016). The role of soundscape in nature-based

rehabilitation: A patient perspective. International journal of environmental research and public health, 13(12), 1229.

15. Saadatmand V, Rejeh N, Heravi-Karimooi M, et al. Effect of nature-based sounds intervention on agitation, anxiety, and stress in patients under mechanical ventilator support: A randomised controlled trial[J]. International Journal of Nursing Studies, 2013, 50(7):895-904.
16. Brodoehl, S., Klingner, C. M., & Witte, O. W. (2015). Eye closure enhances dark night perceptions. Scientific reports, 5(1), 10515.
17. Li, Q. (2018). Shinrin-Yoku: The art and science of forest bathing. Penguin UK.
18. Wu, L. F. (2008). The health benefits of natural fragrance from aromatic plants for visitors walking in gardens [Unpublished doctoral dissertation]. Shanghai Jiao Tong University, Shanghai, China.
19. Ji, C. (1988). The craft of gardens (H. Hardie, Trans.). China Architecture & Building Press. (Original work published 1631)
20. Vårhammar, A. (2021). Coming back to our senses: Exploring the potential of guided forest bathing as an intervention for human-nature connection.
21. Van den Berg, A. E., Koole, S. L., & Van Der Wulp, N. Y. (2003). Environmental preference and restoration:(How) are they related?. Journal of environmental psychology, 23(2), 135-146.
22. Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. Journal of environmental psychology, 15(3), 169-182.
23. Bethelmy, L. C., & Corraliza, J. A. (2019). Transcendence and sublime experience in nature: Awe and inspiring energy. Frontiers in psychology, 10, 509.
24. Chirico, A., & Yaden, D. B. (2018). Awe: a self-transcendent and sometimes transformative emotion. The function of emotions: When and why emotions help us, 221-233.
25. https://www.darksky.org/merritt-reservoir-sra-200th-certified-idsp/