

# From Environmental Neuroscience to Multisensory Landscape Perception

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## ABSTRACT

Landscape, as an area of human perception, results from the interplay between nature and human activity. In this process, external environmental information is filtered and processed through the sensory system, ultimately forming perception and driving higher levels of cognition. Recent advancements in neurocognitive science have deepened our understanding of sensory perception mechanisms, particularly in the context of landscape experiences. The interaction of sensory dimensions such as visual, auditory, and olfactory perceptions in landscape experiences does not simply add up, but results from multi-layered information processing. For example, *Impression, Sunrise*, Claude Monet's Impressionist work, reveals the neurological principles behind how the brain processes landscapes through the clever use of color and light contrast. Research included in this edition focuses on the multisensory influences in landscape

experience, exploring how they shape human behaviors, emotions, and health, particularly in urban green spaces and historical areas. While focusing on how urban construction should meet humans' needs, the research also emphasizes ecological diversity to promote harmonious coexistence between humans and nature.

## KEYWORDS

Landscape Experience; Multisensory Perception; Environmental Neuroscience; Environmental Psychology; Landscape Cognition; Landsenses Ecology

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Landscape is an area perceived by people, shaped by the action and interaction of natural and human factors. In the process of perceiving and interpreting the surrounding environment, external environmental information is filtered and processed through the senses, forming perceptions that promote high-level

cognition. Over the past half-century, with the rapid development of neurocognitive science, humans have gradually uncovered the mysteries of sensory perception processing, deeply influencing our understanding of landscape experience and landscape design.

Landscape experience is not simply a sum of multidimensional sensory inputs from the environment, and an increase in sensory dimensions does not necessarily lead to a stronger experience. Perhaps we have all had the experience of encountering a breathtaking view, then rushing to take a photo, but only to find that the image fails to capture the beauty of the scene we perceive. The beauty we perceive in a landscape is not a direct reflection of the objective world, but rather the result of complex information processing involving sensory filtering, selective perception, and reinforcement through high-level cognition.

In this sense, artists often rely on intuition to pursue the “reality” that may be influenced by hidden neuroscientific mechanisms. For example, in French Impressionist painter Claude Monet’s *Impression, Sunrise*, the red sun appears to flicker and come alive on the canvas. In visual cognition, the occipital lobe’s visual cortex processes color and light-dark information separately. The information is then transmitted to higher processing areas through the “what” pathway and a “where” pathway: the “what” pathway, which leads to the temporal lobe responsible for object recognition, processes color information; while the “where” pathway, leading to the parietal lobe (that determines position and movement), retains only light-dark information by omitting color to maintain higher temporal resolution. Monet’s painting exploits this distinction, creating a visual illusion. The red sun and the background differ only in hue, not in lightness or darkness. As a result, the “where” pathway cannot distinguish the relative position of the red sun against the background, yet the “what” pathway can identify the red sun. In other words, the brain perceives the sun but struggles to accurately locate it and identify its movement, thus the illusion of a subtly trembling red sun is created, which captures our full attention.

Then, what are the neurological mysteries behind different sensory dimensions of perception? How is multisensory information combined in specific scenes? And how do they shape our landscape experience and other high-level cognition? In response, this edition explores the complex mechanisms of human-landscape interaction, drawing on theories from fields such as environmental psychology, landscape ecology, behavior setting, and affordance. It presents new approaches to landscape creation of high-quality landscapes. Research in this edition covers urban green spaces, historical districts, etc., examining how sensory dimensions—such as vision, hearing, and smell—affect human behaviors, emotions, and health. In

the context of promoting the idea of natural community that comprises humans, the research not only focuses on the urban development to fulfill the demand for high-quality spaces, but also prioritizes ecological diversity for the harmonious coexistence between humans and nature.

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**Competing interests** | The authors declare that they have no competing interests.

# 从环境神经科学到景观的多维感知

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## 摘要

景观作为人类感知的区域, 是自然和人类活动交织作用的结果。在这一过程中, 外界环境信息通过感官系统被筛选、加工, 最终形成知觉, 并推动更高层次的认知。近年来, 神经认知科学的发展帮助我们深入了解了感官知觉背后的机制, 及其在景观体验中的作用。视觉、听觉和嗅觉等感官维度在景观体验中的交互作用并非简单的叠加, 而是多层次信息处理的结果。例如, 莫奈的印象派作品《印象·日出》通过巧妙的色彩与明暗对比, 为探索大脑在处理景观时的神经学原理提供了启发。本期研究围绕多维感官, 探讨它们如何塑造人类行为、情感和健康, 特别是在城市绿色空间、历史街区等场所中的作用。在关注城市建设如何满足人类对空间的需求的同时, 强调生态多样性, 以推动人与自然的和谐共生。

## 关键词

景观体验; 多维感知; 环境神经科学; 环境心理学; 景观认知; 景感生态学

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景观是指人类所感知的一个区域, 其是自然因素与人类因素作用及相互作用的结果。在人类感知和解读周围环境的过程中, 外界的环境信息通过感官被筛选、加工, 形成知觉, 并进一步促进高级认知的产生。在过去的半个世纪里, 随着神经认知科学的飞速发展, 人类逐渐揭示了感官知觉加工的奥秘, 这深刻影响了我们对景观体验及景观设计的理解。

景观体验并非环境多维感官信息的简单叠加, 感官维度的增加也

不一定能直接导致更强烈的体验。或许我们都曾有过这样的经历: 猛然看到一片令人惊叹的美景, 急忙拿出相机, 但拍下的照片却显得平平无奇, 未能捕捉到眼前景色的美丽。我们感受到的景观之美, 并非对客观世界的简单复制, 而是在感官筛选、知觉选择性加工和高级认知强化的复杂信息处理下形成的结果。

艺术家常常依赖直觉去追求这种真实, 而这种“真实”背后可能蕴藏着不为人知的神经科学机制。以法国印象派画家克劳德·莫奈及其著名作品《日出·印象》为例, 画中的那轮红日似乎具有某种魔力, 跳动、跃然纸上, 宛如有生命一般。在视觉认知过程中, 枕叶的视皮层对色彩与明暗信息进行分别处理。分开加工的信息进一步传递到高级加工区域, 在这一过程中, 只有通向颞叶的负责物体认知的“what”通路处理色彩信息, 通向顶叶的负责判断位置与运动的“where”通路则为了保证较高的时间分辨率而省略了色彩信息, 只保留明暗信息。莫奈的画作正是基于这一神经生物学原理, 创造了一种视错觉。画中的红日与背景的区别仅体现在色相上, 明暗上并无差异。这使得“where”通路无法分辨红日与背景的相对位置, 而只有“what”通路能够识别红日。换句话说, 大脑知道存在一颗红日, 但却难以准确判断它的位置或与其他物体的运动关系, 从而产生了一种红日微微颤抖的动态错觉, 使我们的注意力完全集中于红日。

那么, 不同维度的感知在神经学上究竟蕴含怎样的奥秘? 在具体场景中, 多维感官信息是如何叠加的? 它们又如何影响我们的景观体验以及其他高级认知? 带着这些疑问, 本期聚焦景观体验中人与景观交互的复杂机制, 以环境心理学、景感生态学、行为背景与可供性理论等理论框架为基础, 探讨以高品质景观为核心的景感营造新思路。本期文章涵盖的研究区域包括城市绿地、历史街区等, 研究主题涉及视觉、听觉、嗅觉等多个感官维度对人群行为、心理与健康的影响。在倡导人与自然生命共同体理念的时代背景下, 本期研究不仅关注能够满足人类对高品质空间需求的城市建设, 还强调了生态多样性, 旨在促进人与自然的和谐共生。