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Supravisual Perception: Crossmodal Correspondences in Architectural Design from a Cognitive Perspective

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ABSTRACT

Research Problem

Architecture, as a discipline, has evolved beyond the mere act of construction, emerging as a multifaceted process that seamlessly integrates form, function, and aesthetics to shape human experiences within built environments. Historically, this evolution has been heavily influenced by Western architectural traditions, particularly since the Renaissance, which prioritized visual perception as the dominant sensory mode, focusing on symmetry, proportion, and aesthetic appeal while often sidelining the rich interplay of auditory, tactile, olfactory, and gustatory experiences. This visual-centric paradigm, reinforced by industrial advancements and modernist movements in the 20th century, has created a significant knowledge gap in understanding how multisensory interactions influence human behavior, comfort, and well-being. The rise of cognitive neuroscience over the past few decades has illuminated the complexity of multisensory perception and crossmodal interactions, demonstrating that the human brain integrates sensory inputs into a cohesive environmental experience rather than processing them in isolation. Despite these scientific breakthroughs, the practical application of such findings in architectural design remains underdeveloped, leading to built environments that may be visually harmonious yet functionally inadequate or stressful for occupants. This research addresses the problem of sensory misalignment, particularly in the integration of lighting and acoustics, and examines how these deficiencies impact spatial perception, safety perceptions, emotional states, and physiological responses across diverse cultural and climatic contexts. By bridging cognitive science and architectural practice, this study seeks to redefine design paradigms to create environments that resonate with human sensory capacities on a global scale.

Research Question

The central research question driving this study is: How does the strategic coordination of sensory inputs, specifically lighting and acoustics, shape human perception, comfort, and well-being within architectural settings? This is supported by several sub-questions: (1) To what extent do congruent sensory conditions (e.g., warm lighting with nature sounds) enhance spatial perception, comfort, and safety compared to incongruent conditions (e.g., cool lighting with traffic noise) across different demographic groups? (2) How do multisensory interactions influence physiological responses, such as heart rate, as reliable indicators of stress reduction or relaxation, and can these effects vary by cultural background? (3) Can a multisensory design approach, grounded in cognitive neuroscience, offer a scalable and culturally adaptable framework for developing architectural spaces that promote cognitive development, emotional resilience, and social engagement among users in varied global settings? These questions aim to uncover the mechanisms of sensory coherence, providing empirical evidence to guide design practices and

encouraging a culturally sensitive reevaluation of how architects conceptualize spaces for diverse populations, including urban dwellers, rural communities, and individuals with sensory impairments.

Research Method

This study employs a dual-methodological framework to provide a comprehensive analysis of the research problem. A systematic literature review was conducted, synthesizing a wide array of peer-reviewed articles, seminal books, and theoretical frameworks from cognitive neuroscience, environmental psychology, and architectural design, spanning publications from 1970 to 2024. This review identified key trends, such as the growing recognition of multisensory integration, its neurological basis, and its relevance to architectural contexts, while also exploring historical shifts in design philosophy. The experimental phase involved 40 participants (20 females and 20 males, aged 25-35), selected to represent a diverse yet controlled demographic, including variations in sensory sensitivity and cultural exposure, who were exposed to controlled conditions in a 4×4-meter room designed to simulate architectural settings. The experiment featured two distinct conditions: (1) a congruent setting with warm lighting (2700 Kelvin) and nature sounds (50 dB) to evoke a calming atmosphere, inspired by biophilic design principles; (2) an incongruent setting with cool lighting (6500 Kelvin) and traffic noise (50 dB) to mimic urban stress. Each condition lasted 15 minutes, with a 10-minute break between sessions to minimize carryover effects and ensure participant well-being. Responses were gathered using a 5-point Likert scale questionnaire comprising six items (comfort, spatial perception, safety, lighting quality, sound pleasantness, ease) and supplemented by continuous heart rate monitoring with wearable devices calibrated for accuracy. Data analysis employed independent t-tests and exploratory factor analysis to assess significant differences and underlying sensory patterns, ensuring robust, replicable, and nuanced outcomes.

The Most Important Results and Conclusion

The experimental results demonstrated marked improvements in the congruent condition compared to the incongruent one. Participants reported significantly higher levels of comfort (mean 4.1 vs. 2.7), lighting pleasantness (4.2 vs. 2.6), sound pleasantness (4.3 vs. 2.5), and ease (4.1 vs. 2.8) on the Likert scale ($p < 0.05$), reflecting a clear preference for sensory harmony across the sample. Additionally, 65% of participants perceived the space as larger in the congruent setting compared to 30% in the incongruent condition, suggesting a perceptual expansion linked to sensory coherence that may enhance usability in confined spaces. Physiologically, the congruent condition reduced average heart rate to 72 bpm from 78 bpm in the incongruent setting, indicating a stress-reducing effect that could have implications for mental health in high-stress environments. These findings highlight the critical role of sensory integration in enhancing spatial experience, well-being, and potential therapeutic benefits. The study concludes that multisensory design, informed by cognitive neuroscience, is indispensable for creating adaptive, user-centered architectural spaces. It advocates for a paradigm shift in design practices, proposing that architects reevaluate sensory convergence frameworks to integrate multisensory principles, tailored to cultural and contextual needs. This approach not only elevates the quality of spatial experiences but also holds substantial potential to foster cognitive development, emotional stability, and social connectivity among users. Practical applications include designing sensory-rich public spaces, healthcare facilities with reduced stress, and urban planning strategies that prioritize human well-being, ultimately leading to environments that enhance quality of life and leave an enduring positive legacy.

KEYWORDS

Multisensory Design, Sensory Architecture, Cognitive Sciences, Spatial Perception, Sensory Interactions