The Application of Emotional in Spatial Layout Design

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Abstract. Recent spatial design increasingly emphasizes emotional expression alongside functionality. However, most studies still examine individual design elements in isolation and lack systematic analysis of how multiple factors evoke emotions through physiological and psychological mechanisms. This study builds a user-centered evaluation framework linking spatial layout, physiological responses, and emotional experience. By combining neuroaesthetics with indicators such as electroencephalography (EEG) and galvanic skin response (GSR), and applying spatial syntax, it reveals how spatial structures influence cognition and affect. Taking the "Pierre Bonnard: Designed by India Mahdavi" exhibition as an example, the study shows how multisensory elements construct emotional atmospheres. Results demonstrate that scale, color, and lighting can induce measurable physiological responses related to psychological perception, supporting biofeedback-informed design principles. Integrating physiological signals with behavioral analysis can help establish a scientific and adaptable method for emotional spatial design [1,2].

Keywords: Emotional expression, Spatial layout design, User experience, Physiological and psychological responses, Evaluation criteria

1. Introduction

Emotional communication has become a key focus in contemporary spatial design, moving beyond purely functional concerns. Mahdavi's exhibition at the Victoria and Albert Museum exemplifies this shift. While prior studies have discussed emotional effects of single elements like color and spatial relations, few have analyzed how multiple factors jointly trigger specific emotional states [1,3]. This study proposes a user-centered framework to examine links among spatial layout, physiological responses, and emotional resonance. By combining EEG and GSR data with neuroaesthetic interpretation [1,4] and spatial syntax analysis [5], the research integrates objective measurement with theoretical insight, offering a basis for evidence-based emotional spatial design.

2. Theoretical and conceptual interpretation

2.1. Theoretical framework of affective spatial experience

The formation mechanism of affective spatial experience can be systematically explained through a neuro-environmental model. Building on Norman's three-level emotional design theory, this section proposes that spatial configurations elicit affective responses through multisensory channels within a

neuro-environmental framework. In particular, the user experience in a given space constitutes a multi-layered neuro-affective response system. Environmental elements interact via physiological perception (e.g., thermal comfort, spatial scale), behavioral efficiency (e.g., circulation layout), and cultural symbolism (e.g., decorative semantics) to shape users' psychological and emotional states.

In addition, this theoretical framework provides a methodological basis for the measurement and optimization of affective spaces. For example, Mahdavi's NGV exhibition shows multi-dimensional intervention by adjusting color saturation to affect physiological responses, optimizing circulation routes to boost behavioral efficiency, and embedding artistic symbols to convey cultural meaning. Tschacher et al. further confirm that color saturation correlates with reduced galvanic skin response (GSR) in art exhibitions, supporting the model's validity in affective modulation [6]. Thus, while this model reveals general mechanisms, its practical application manifests in diverse typological patterns, which will be elaborated through empirical cases in the following sections.

2.2. Typological manifestations in spatial practicethe mechanism of affective spatial experience appears across typologies

- In public spaces, the Helsinki Central Library uses wooden vaulted ceilings and radial layouts to improve comfort and circulation, encouraging exploratory behavior and social interaction [7].

- In commercial spaces, Apple flagship stores use transparent facades and interactive product islands to promote engagement and unplanned purchases, enhancing excitement and dopamine release [8].

- In residential settings, Beijing's siheyuan courtyards provide shading and symmetry, enhancing relaxation and belonging [9].These cases illustrate how physiological, behavioral, and cultural strategies produce distinct emotional effects.

2.3. Reference and criticism of hume's views

Hume proposed that art evaluation requires "standards and excellent critics" [3], offering both semiotic and ethical inspiration for spatial design. Today, space is no longer a passive object of judgment but a sign system carrying multiple meanings. Mahdavi's exhibition for Pierre Bonnard illustrates this by turning Provençal light and color into material symbols: a peach-colored wall suggests joy, pottery textures evoke painting gestures, and curved walls imply intimacy [6]. This approach moves beyond formalism and invites visitors to find personal meaning through movement and sensory engagement.

Such semiotic practice also reflects a shift in critical ethics. When single-voice interpretations are replaced by multi-voice guides, and fixed seating by movable stands, spatial design redistributes power between critics and users. At the Venice Biennale's "Shared Kitchen," varying utensil heights hint at cultural power structures, while communal dining enacts spatial democracy. These examples show that spatial evaluation should both decode emotional semiotics and ensure inclusive participation.

Mahdavi's openness embodies this dual awareness. Unlabeled decorations allow diverse readings, letting visitors see them as pure forms or personal memories. This design intelligence responds to Hume's call for "delicate taste," challenging elitist tendencies and fostering critical sensibility, where standards emerge through embodied encounters rather than authority.

3. Key factors influencing emotional expression

3.1. Spatial scale and proportion

Spatial scale and proportion shape how users emotionally and cognitively experience space. Bollnow's Shelter Theory notes that moderate enclosure enhances comfort, and in Ando Tadao's Row House, narrow corridors contrast with open areas to strengthen intimacy. Altman's territoriality theory shows that flexible partitions in micro-apartments help residents manage boundaries and reduce stress. Pallasmaa argues spaces feel right when scale aligns with the body [10]; for instance, the Church of the Light's vertical cross opening evokes elevation and introspection [11]. Research such as Coburn's eye-tracking studies indicates harmonious scale maintains attention and engagement [12], and Eberhard links proportion to emotional centers for mood stability [13]. Cultural context also matters: Nisbett observes Western layouts favor symmetry, while East Asian designs value fluid, context-sensitive spaces [14].

3.2. Color in emotional expression

Color modulates atmosphere through contrast, saturation, and harmony [4]. High-contrast tones like black–white or red–green create excitement, often used in commercial or performance spaces, while muted tones like beige or gray convey calm, fitting for residential or therapeutic settings. Mahdavi's Bonnard exhibition integrates vivid colors to heighten perception and evoke joy [6]. Bright saturated colors can stimulate dopamine [8], but meanings vary culturally—red signals vitality in Eastern contexts but urgency in Western ones [15]. Color choices must align with cultural symbolism and emotional expectations.

3.3. Lighting design and emotional atmosphere

Lighting shapes emotion via intensity, temperature, direction, and dynamics [16]. Bright white light promotes alertness in offices, while warm low light fosters intimacy in homes or restaurants. Dynamic effects like dimming and color transitions build narrative and emotional rhythm [15]. Color temperature also matters: cooler tones above 5000K aid focus, warmer tones below 3000K create warmth. Designers often mix these to suit different zones, balancing technical needs with emotional intent.

3.4. Display and decorative elements

Displays and decorations guide attention and evoke memory [17]. In the Bonnard exhibition, motifs were abstracted into sculptures to spark curiosity and playfulness, engaging the brain's reward system. Plants, textiles, and tactile materials evoke memory and identity [18], while biophilic elements improve comfort and well-being. These elements act as both aesthetic highlights and psychological interfaces, strengthening emotional connections between space and users.

4. Spatial layout design strategies based on user experience

4.1. User-driven design

User-driven approaches align design with needs and emotional expectations through interviews, surveys, and observation [18]. In senior apartments, continuous handrails, warm lighting, and wide

circulation emerged from empathy-driven research. Similar methods guided the Sharjah Art Center Theatre design, where shaded social zones and environmental simulations informed layout choices [19].

4.2. Practical approaches to emotional design

Emotional design shapes spatial form and interactivity into experiential stories [2]. For example, the "Forest Fairy Tale" playroom uses low arches, soft textures, and soundscapes to evoke security and imagination. Emotional effects can be evaluated via mapping, behavior tracking, and structured interviews [20]. In the Sharjah open-air theater, references to Bedouin tents and climate-responsive structures created diverse spatial atmospheres and cultural resonance [19].

4.3. Integration and application of interdisciplinary strategies

Effective design draws from psychology, sociology, environmental science, and aesthetics. Psychology maps spatial features to emotional states [21]; sociology examines cultural and group behaviors [22]. Neuroaesthetics links visual characteristics to neural reward mechanisms, as seen in Mahdavi's use of color and warmth to evoke domestic comfort [1]. Environmental science and material engineering enhance comfort and cultural identity, while digital tools like parametric modeling and simulations align emotional goals with technical performance [23].

5. User-based physiological and psychological evaluation criteria

5.1. Quantification of physiological indicators

Quantifying physiological data clarifies how spatial elements trigger brain regions tied to perception and emotion. Building on Zeki’s neuroaesthetics [1,11], research shows elements such as light, proportion, and symmetry can activate areas like the prefrontal cortex and amygdala, linking design with feelings of awe and comfort. For example, Ando’s Church of the Light demonstrates how light and shadow shape spiritual perception. Simple metrics like galvanic skin response (GSR) detect relaxation when users touch natural materials, and heart rate variability (HRV) reflects stress changes under different scales. Designers can focus on clear visual elements while leaving space for interpretation, guided by evidence such as golden ratio effects on neural networks and natural light rhythms on melatonin [22].

5.2. Evaluation methods of psychological states

Assessing psychological states combines surveys, interviews, and behavioral tracking with physiological tools. Eye-tracking maps visual focus and navigation [24], while EEG detects emotional arousal and relaxation levels. Though fMRI is less practical, it shows how spatial cues activate regions linked to pleasure and salience [25]. These combined methods provide a solid evidence base for linking spatial features with users’ cognitive and emotional responses.

5.3. Development of a practical "rule book"

A rational rule book translates these insights into adaptable guidelines for various spaces [26]. Offices benefit from 300–500 lux lighting, cooler tones around 4000–5000K, and ceiling heights below 3.2 m to enhance alertness and reduce fatigue. Residential stress-relief areas favor low-

saturation warm tones like beige or terracotta to help reduce cortisol. Cultural spaces, as shown in Mahdavi's Bonnard exhibition, use vivid colors and textures to boost mood and memory [21]. Warm light gradients can enrich art perception and immersion [27]. This flexible, evidence-based rule book integrates physiological data and psychological feedback to inform design decisions that meet diverse user needs.

6. Conclusion

This study examined how spatial elements such as scale, color, lighting, and furnishings evoke physiological and psychological responses, illustrated through theoretical analysis and case studies. It proposed methods integrating emotional design, interdisciplinary tools, and cognitive-behavioral assessment. Future work should consider cultural and individual differences and explore technologies like AI-based emotion recognition and adaptive environmental controls [26]. Establishing standardized yet flexible evaluation systems will support evidence-based innovation in emotional spatial design.

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