The Role of Color and Light in Healthcare Environments: An Empirical Study at Al-Majardah General Hospital, KSA

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ABSTRACT

Designing effective healthcare environments necessitates a nuanced understanding of how architectural elements—particularly color and lighting—affect users' psychological and physiological well-being. This study investigates the impact of these elements within Al-Majardah General Hospital in Saudi Arabia through open-ended interviews conducted with patients, healthcare staff, and design professionals. The findings indicate that spatial variables—such as chromatic schemes, lighting quality, acoustic and thermal comfort, ergonomic furniture, and access to natural views—play a significant role in shaping users' emotional states, behavioral responses, and recovery trajectories. Importantly, these effects vary across demographic and functional groups, underscoring the need for inclusive and adaptive design strategies. This research offers evidence-based insights for healthcare designers, administrators, and policymakers seeking to enhance healing environments through informed spatial interventions

دور اللون والإضاءة في البيئات الصحية: دراسة ميدانية في مستشفى المجاردة العام، المملكة العربية السعودية

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الملخص

يتطلب تصميم بيئات صحية فعّالة فهمًا دقيقًا لكيفية تأثير العناصر المعمارية – ولا سيما الألوان والإضاءة – على الصحة النفسية والجسدية لمستخدمي هذه المساحات. تستقصي هذه الدراسة تأثير تلك العناصر في مستشفى المجاردة العام بالمملكة العربية السعودية، من خلال مقابلات مفتوحة مع المرضى، والعاملين في الرعاية الصحية، والمختصين في التصميم. وتُظهر النتائج أن المتغيرات المكانية – مثل الألوان، وجودة الإضاءة، والراحة الصوتية والحرارية، والأثاث المريح، وإمكانية الوصول إلى المناظر الطبيعية – تلعب دورًا مهمًا في تشكيل الحالات العاطفية، والسلوك، وتجارب التعافي للمستخدمين. ومن الجدير بالذكر أن هذه التأثيرات تختلف باختلاف الفئات الديموغرافية والوظيفية، مما يبرز الحاجة إلى استراتيجيات تصميم شاملة وقابلة للتكيّف. وتقدّم هذه الدراسة رؤى قائمة على الأدلة لصانعي القرار والمصممين والإداريين في المجال الصحي، بهدف تحسين البيئات العلاجية من خلال تدخلات تصميمية مدروسة.

الكلمات المفتاحية: علم نفس الألوان، تصميم الإضاءة، التصميم الداخلي في الرعاية الصحية، تجربة المرضى، التصميم البيئي، رفاه العاملين

1. المقدمة وأهمية البحث

في ظل التوجه العالمي نحو تحسين جودة خدمات الرعاية الصحية، يبرز دور التصميم الداخلي للمستشفيات كأحد العوامل المؤثرة في تجربة المرضى ورفاهية العاملين. وتُعدّ العناصر الحسية، وعلى رأسها اللون والإضاءة، من المحركات الرئيسية للاستجابات النفسية والسلوكية داخل البيئة العلاجية. ينطلق هذا البحث من فرضية أن التصميم الواعي للعناصر البصرية في المرافق الصحية يمكن أن يسهم بشكل ملموس في تحسين الراحة النفسية، وتحفيز التعافي، وتعزيز الكفاءة المهنية. وتكتسب هذه الدراسة أهميتها من تركيزها على بيئة طبية واقعية في المملكة العربية السعودية، ما يضفي عليها طابعًا عمليًا ويساعد على سد الفجوة بين النظرية والتطبيق في السياقات المحلية.

2. أهداف الدراسة والسياق التطبيقي

تهدف الدراسة إلى استكشاف التأثيرات النفسية والفسيولوجية للون والإضاءة على مستخدمي مستشفى المجاردة العام، من مرضى وعاملين ومصممين. وتسعى للإجابة على سؤال رئيسي: كيف تؤثر الخيارات التصميمية المرتبطة باللون والإضاءة على مشاعر وسلوكيات الأفراد داخل البيئة العلاجية؟ وقد تم اختيار المستشفى كنموذج تطبيقي نظراً لكونه مستشفى إقليمي يخدم فئات متنوعة، ما يسمح بتحليل ردود فعل مختلفة بناءً على العمر والمهنة والحالة الصحية.

3. الإطار النظري والمراجعة الأدبية

استندت الدراسة إلى نظريات حديثة في علم النفس البيئي، لاسيما نظرية "الإدراك المجسد (Embodied Cognition)" التي تفترض أن الإدراك يتشكل من خلال تفاعل الجسد مع البيئة الحسية، ونظرية "التصميم المبني على الأدلة (Evidence-Based Design)" التي تدعو إلى ربط قرارات التصميم بنتائج بحثية موثوقة. وشملت المراجعة الأدبية دراسات تناولت تأثير الألوان على المشاعر، مثل تأثير اللون الوردي في تهدئة الأطفال(Han et al., 2018) ، وأثر الإضاءة الطبيعية على تحسين المزاج وتقليل القلق (Ulrich et al., 2020). كما أشارت الأبحاث إلى أهمية التباين اللوني وتوزيع الإضاءة في تسهيل التوجّه المكاني وتقليل الضغط الإدراكي.

4. المنهجية

اعتمد البحث منهجًا نوعيًا من خلال مقابلات شبه منظمة مع عينة مكونة من عشرة مشاركين يمثلون ثلاث فئات: المرضى، الكادر الطبي، والمصممين الداخليين. تم جمع البيانات عبر أسئلة مفتوحة تمحورت حول الاستجابات النفسية للمحيط المكاني. وجرى

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تحليل البيانات باستخدام التحليل الموضوعاتي(Thematic Analysis) ، مع تصنيف الردود إلى محاور دلالية متكررة، مدعومة باقتباسات مباشرة من المشاركين. ورغم محدودية حجم العينة، إلا أن التعمق في سرد التجارب الشخصية أتاح بناء فهم نوعي عميق.

5.النتائج والتحليل

كشفت نتائج الدراسة عن أربعة محاور رئيسية:

- **الأثر النفسي والفيزيولوجي للألوان** :أشار المرضى إلى أن الألوان الناعمة مثل الوردي والأزرق الفاتح تعزز الراحة وتهدئة الأعصاب، بينما تسبب الألوان الزاهية مثل البرتقالي والأخضر القوي حالة من التوتر أو القلق. كما لاحظ الطاقم الطبي أن الألوان المحايدة الزائدة عن الحد تؤدي إلى الملل وضعف التركيز.

- **وظيفة اللون في التوجّه المكاني** :أظهر المشاركون أن استخدام الألوان في الممرات والأبواب ساعد على تحسين الإدراك المكاني وسرعة التنقّل، خصوصاً لدى الأطفال وكبار السن.

- **دور الإضاءة في الراحة والأداء** :تفضّل جميع الفئات الإضاءة الطبيعية، لما لها من تأثير مباشر على تحسين المزاج وزيادة الإنتاجية. كما تم التنويه إلى تأثير الإضاءة الفلورية السلبي على التركيز وارتفاع معدلات التوتر.

- **التصميم الشامل للفئات المتنوعة** :طالبت الفئات المشاركة بتصميمات مرنة تراعي الفروقات البصرية والحسية، مع تكييف الإضاءة والألوان لتناسب المرضى ذوي الإعاقات البصرية أو المعرفية.

6.المناقشة

عند مقارنة النتائج بالدراسات السابقة، يتبين تطابق كبير مع نتائج (2018) .Han et al و (2021) .Figueiro et al حول تأثير الألوان والإضاءة على الاستجابات العاطفية والوظيفية. إلا أن الدراسة الحالية تسلّط الضوء على بعد إضافي يتمثل في **الاختلاف بين توقعات المرضى واحتياجات الطاقم الطبي**، ما يعكس ضرورة دمج وجهات النظر المختلفة في التصميم. كما تشير النتائج إلى أهمية الزونينغ البصري (color zoning) في تعزيز التحكم الإدراكي. وتؤكد الدراسة على أن غياب معايير واضحة لاستخدام اللون والإضاءة يؤدي إلى أخطاء تصميمية قد تؤثر سلباً على جودة الرعاية.

7.الاستنتاجات والتوصيات

تثبت الدراسة أن التصميم الحسي لا يعد ترفًا جماليًا بل عنصرًا جوهريًا في تعزيز الصحة النفسية وتحسين بيئة العمل داخل المستشفيات. وتوصي الدراسة بما يلي:

- إعداد أدلة تصميم داخلية تستند إلى التجربة المحلية للمستخدمين.
- استخدام الألوان بناءً على احتياجات الفئات العمرية والوظيفية.
- تفضيل الإضاءة الطبيعية وتجنب الإضاءة القوية الفلورية.
- دمج المستخدم النهائي في عمليات التقييم والتطوير البيئي.
- اعتماد سياسة مؤسسية تضمن التكامل بين التصميم والجودة العلاجية.

Introduction:

Color is a fundamental element of interior architecture, particularly in healthcare settings where visual perception directly influences psychological and physiological responses. While the human reaction to color may appear instinctive, it involves a complex interplay between light, the visual system, and cognitive processing (Kalantari & Snell, 2017). Beyond aesthetics, color contributes to the overall sensory experience of a space, shaping users' emotions, behaviors, and sense of orientation.

Numerous studies have explored the relationship between color and various health-related outcomes, including stress reduction, communication efficiency, medical error rates, depression, sleep quality, and patient satisfaction (McLachlan & Leng, 2021). Despite this growing body of knowledge, gaps remain—particularly regarding how color is perceived and interpreted by different individuals within institutional healthcare environments.

From an evidence-based design perspective, this study engages with interdisciplinary research spanning environmental psychology, neuroscience, and architectural design. For example, Suhlrie et al. (2018) analyzed both theoretical frameworks and empirical studies on color perception, emphasizing individual variability in neurological responses to chromatic stimuli. Shen et al. (2022) further demonstrated that color interventions can influence patient outcomes such as recovery rates, sleep patterns, and orientation within healthcare spaces.

Balabanoff (2023) highlighted how strategic use of color contributes to decreased anxiety, improved staff morale, and enhanced navigation, especially in high-stress medical environments. These insights are particularly relevant as many healthcare facilities face the challenge of updating outdated infrastructure, often built decades ago without consideration for current psychological design standards.

In light of these developments, this research investigates the role of color and light in shaping user experiences at Al-Majardah General Hospital in Saudi Arabia. The study seeks to understand how environmental factors contribute to patient well-being and staff performance, offering practical implications for designers, hospital administrators, and policymakers interested in optimizing healing environments through sensory design.

Literature Review:

1. The Psychological and Spatial Role of Color in Healthcare

Color has long been recognized as a critical factor in shaping human perception and emotional response in built environments. In healthcare settings, its influence extends beyond aesthetics to affect healing, behavior, and psychological well-being. Kalantari and Snell (2017) argue that color plays a dual role—both technical and emotional—within interior architecture, especially in spaces associated with vulnerability such as hospitals. Similarly, McLachlan and Leng (2021) found correlations between specific color environments and outcomes such as stress levels, sleep quality, and patient satisfaction.

The effect of color is not universal, however. Shen et al. (2022) stress the importance of user demographics, noting that cultural background, age, and personal experiences can mediate how individuals respond to specific hues in clinical spaces. This perspective is particularly relevant in multicultural contexts like Saudi Arabia, where environmental meaning is culturally encoded.

2. Lighting as a Design Tool for Orientation and Emotional Regulation

Lighting—natural and artificial—modulates circadian rhythms and contributes to sensory orientation within complex healthcare facilities. Danilov et al. (2020) emphasize the role of color temperature and rendering index in shaping visual comfort and cognitive clarity. Furthermore, Balabanoff (2023) highlights how immersive lighting schemes can reduce patient anxiety, support mood stabilization, and enhance wayfinding in maternity and emergency units. Despite these known benefits, many hospital environments continue to suffer from inconsistent illumination and lack of visual hierarchy, undermining staff efficiency and patient autonomy.

3. Embodied Cognition as a Theoretical Lens

The theory of **Embodied Cognition** offers a useful conceptual framework for understanding the effects of environmental design. This perspective posits that human cognition is grounded in bodily interaction with the environment (Varela, Thompson, & Rosch, 1991). In hospital interiors, colors and lighting are not merely visual stimuli; they are experienced sensorially, shaping perception, emotion, and decision-making in real time. As Pallasmaa (2012) noted, a purely visual approach to architecture neglects the full depth of human experience.

Applying embodied cognition, one can interpret how specific lighting conditions may alter spatial awareness or how certain color palettes may regulate autonomic functions such as heart rate and respiration (Han et al., 2018). These interactions between body and space are essential in designing emotionally supportive healthcare environments.

4. Insights from Iraqi Academic Literature

Studies published in the *Iraqi Journal of Fine Arts* offer culturally situated insights into the role of color and spatial design:

- **Al-Fatlawi and Al-Bayati (2022)** analyzed how color schemes in interior public spaces enhance user comfort and identity in institutional architecture. Their findings emphasize the symbolic and affective dimensions of chromatic selection.
- **Hussein (2021)** examined the psychological impact of warm and cool tones in pediatric hospital wings, concluding that bright, nature-inspired colors facilitated calmness and engagement among young patients.

- **Mahmoud and Saleh (2023)** explored the integration of lighting and color contrast in healthcare corridors, showing how such combinations aid navigation for elderly and visually impaired patients.

These contributions underscore the need for context-specific design strategies that integrate perceptual psychology with local material culture.

5. Research Gap and Contribution

Despite a robust global and regional body of literature, gaps persist in studies that **simultaneously** examine color and lighting through the lens of **embodied user experience**, particularly in Middle Eastern healthcare contexts. Most existing research treats these elements in isolation or fails to consider how user characteristics influence environmental perception. This study addresses these gaps by conducting an empirical investigation at Al-Majardah Hospital, aiming to provide evidence-based recommendations for design practice grounded in cultural and sensory sensitivity.

Methods:

This study employed a qualitative research design grounded in principles of environmental psychology and evidence-based design. The primary objective was to explore how color and lighting within healthcare environments influence the perceptions and experiences of users, particularly in Al-Majardah General Hospital, KSA.

Participants

The sample consisted of 10 participants, both male and female, aged between 18 and 55 years. Participants included patients, healthcare staff, and design-related professionals, such as architects and interior designers, affiliated with Al-Majardah General Hospital. Although the sample size was limited, the selection aimed for maximum variation in demographics and professional roles to capture a range of perspectives. The study acknowledges this limitation and does not claim generalizability beyond the specific context.

Data Collection Tools

Data were collected through a series of semi-structured, open-ended interviews, each lasting approximately 10–15 minutes. An interview guide was developed based on literature in healthcare design, focusing on themes such as emotional responses to color, visual comfort, lighting preferences, and perceived environmental support. In addition to interviews, researchers conducted direct observations during site visits and reviewed visual records of the hospital environment to capture contextual nuances.

Data Analysis

Interview data were transcribed verbatim and analyzed using thematic analysis. Initial coding was performed manually by the lead researcher, followed by axial coding to identify recurring patterns and conceptual themes. No computer-assisted qualitative data analysis software (e.g., NVivo) was used due to the manageable size of the dataset. The analysis process was iterative and theory-informed, drawing on concepts from embodied cognition and sensory design theories to interpret the findings.

Ethical Considerations

Participants were fully informed of the study's objectives and provided verbal consent prior to participation. No identifying information was collected, and all responses were kept strictly confidential. The study was conducted in accordance with ethical research standards and received formal written approval from the partnering hospital for data collection.

Table 1: Participant Demographics and Roles

Category	Count	Age Range	Role	Notes
Patients	4	18–55	Varied (children, adults)	Mixed demographics
Medical Staff	4	25–50	Nurses/Doctors	Feedback on lighting and color
Design Professionals	2	30–45	Interior Design / Architecture	Focused on visual-spatial impact

This table summarizes the demographic and professional distribution of study participants.

Results:

The qualitative data gathered through semi-structured interviews with eight participants—including four patients (P1–P4), two healthcare staff (P5–P6), and two interior design professionals (P7–P8)—revealed four major themes related to the perceptual and psychological impact of color and lighting in healthcare environments. Thematic analysis was applied to identify recurring patterns and variations across user groups. Select quotations are included to illustrate each theme.

Theme 1: Psychological and Physiological Effects of Color

Participants frequently discussed how color influenced their mood, energy levels, and psychological state. Patients and nurses described the calming effects of soft tones, especially pink and blue, in pediatric and recovery rooms:

"The children's physical strength and general mood improved when surrounded by soft pink walls." (P2 – Nurse)

"In my experience, adults in pastel-colored rooms seemed less alert but calmer overall." (P8 – Interior Designer)

This aligns with embodied cognition theory, which suggests that visual stimuli such as color impact both emotional regulation and physical responses (Han et al., 2018; Küller et al., 2009).

In contrast, healthcare staff expressed concerns about overstimulating or neutral tones:

"We had more typing errors when working in white or grey rooms; they felt sterile and uninspiring." (P5 – Admin Staff)

These responses are summarized in **Figure 1**, showing the emotional responses associated with various colors.

Figure 1: Frequency of Emotional Responses to Colors
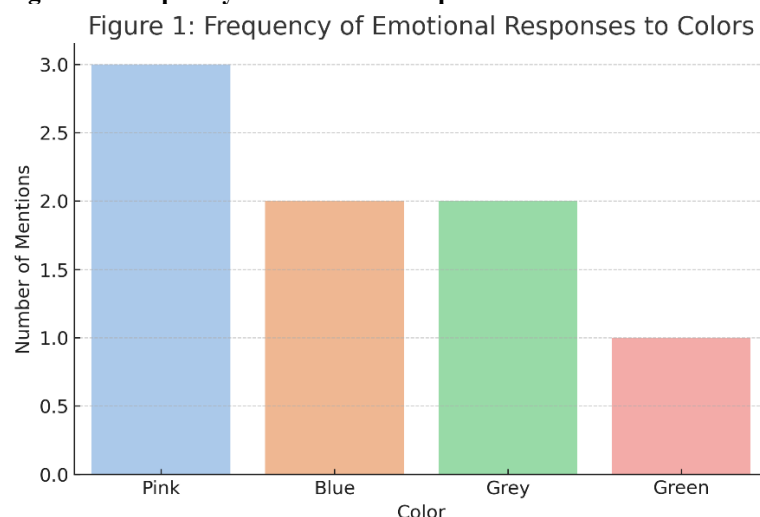
Figure 1: Frequency of Emotional Responses to Colors

A bar chart showing how frequently different colors were associated with specific emotional responses by participants.

Theme 2: Functional Role of Color in Spatial Orientation

Color was consistently cited as a tool for orientation and spatial memory, especially among patients and visitors under stress:

"Color zoning in hallways helps me find my way faster—especially in high-stress moments." (P3 – Patient)

Interior designers emphasized the value of using color to support **wayfinding**, emotional focus, and functional separation of clinical zones:

"Color becomes a code in spatial narratives. It helps differentiate waiting areas, treatment zones, and play spaces." (P7 – Designer)

This is in line with existing work by Gage (2006), which links color perception with spatial hierarchy and emotional security.

Theme 3: Lighting as a Modulator of Experience

Lighting quality significantly affected comfort, focus, and well-being across all groups. Patients and staff overwhelmingly favored **natural daylight**, while artificial fluorescent light was viewed as unpleasant:

"Natural light through the windows lifted my mood and made the space feel alive." (P1 – Patient)
"We avoid fluorescent rooms for meetings—it affects concentration." (P6 – Doctor)

Figure 2 illustrates the participants' preferences, with daylight as the dominant choice.

Figure 2: Participant Preferences for Lighting Types

Figure 2: Participant Preferences for Lighting Types
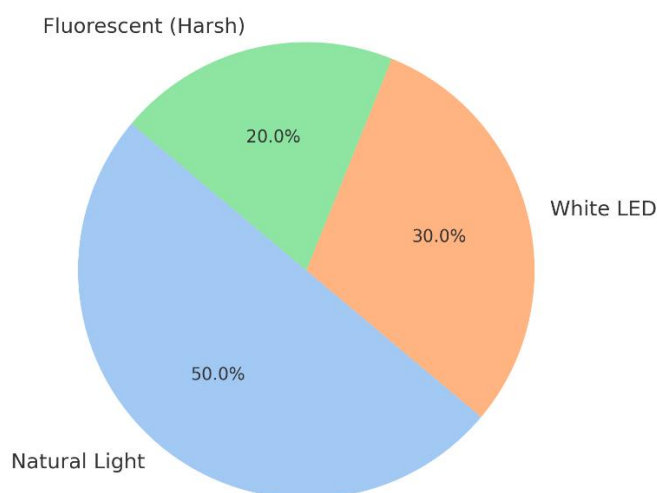
This pie chart illustrates participant preferences for natural light, LED light, and fluorescent lighting.
These preferences align with studies by Boyce (2010) and Fotios et al. (2018), who emphasize the restorative and cognitive benefits of daylight in healthcare interiors.

Theme 4: Inclusive Design for Diverse Users
Participants advocated for inclusive design strategies that address the needs of children, elderly patients, and those with visual or cognitive impairments. Bright colors and playful contrasts helped children feel less anxious:
"Children respond to bright, familiar colors; it helps reduce their fear in clinical spaces." (P2 – Pediatric Nurse)
Meanwhile, families and designers emphasized the need for high-contrast environments for those with low vision:
"Contrast and shadow detail helped my elderly father navigate hallways." (P4 – Visitor)
This supports Pallasmaa's (2012) call for sensorially rich environments that serve both functional and emotional needs.

Summary of Key Observations

User Group	Key Needs Identified	Suggested Design Strategies
Patients	Emotional comfort, spatial control, calm	Soft tones, daylight access, spatial zoning with color cues
Healthcare Staff	Productivity, visual clarity, stress reduction	Task lighting, minimal glare, neutral wall palettes
Children	Playfulness, emotional distraction	Bright primary colors, dynamic patterns, warm tones
Elderly/Impaired	Navigation, safety, clarity	High contrast schemes, layered lighting, tactile feedback

Analytical Note:
While all user groups highlighted the sensory and emotional impact of color and lighting, notable differences emerged. Patients prioritized emotional comfort, while staff focused on visual clarity and task efficiency. Designers emphasized legibility and symbolic meaning of spatial aesthetics. These variations underscore the importance of context-aware design tailored to diverse healthcare users.
The next section will examine how these findings align or contrast with prior literature and broader theoretical models in sensory design and healthcare architecture.

Discussion:

1. Interpretation of Findings
The findings of this study affirm that interior design—specifically color and lighting—plays an essential role in shaping the psychological and physiological responses of hospital users. Grounded in the embodied cognition framework, the participants' responses highlight that perceptual stimuli such as chromatic tone and luminance are not passive background features; rather, they actively stimulate emotional and cognitive processes that influence healing, attention, and orientation.
For instance, soft pink tones were reported to induce calmness among pediatric patients, whereas the same hues reduced alertness in adult patients—underscoring the need for function-specific design zoning. These findings

echo Han et al. (2018) and align with Küller's (2009) argument that color impacts arousal and performance depending on contextual variables.

Lighting also emerged as a dominant factor in emotional well-being and functional performance. Participants linked poor or inconsistent lighting with fatigue, disorientation, and visual discomfort. This reinforces the conclusions of McGee and Park (2022), who stressed the importance of tailored lighting strategies for different hospital zones. The preference for natural daylight noted in this study is also supported by Boyce (2010), who associated daylight exposure with improved cognitive functioning and emotional resilience.

2. User-Centered Contrast: Patients vs. Staff

A compelling dimension of the data lies in the differing needs and priorities expressed by patients and staff. While patients emphasized emotional security, privacy, and sensorial comfort, staff focused on efficiency, task focus, and environmental clarity. These divergent experiences support the notion that healing environments must be designed with multi-zonal logic, responding dynamically to the physical, emotional, and operational demands of different user groups.

For example, natural materials and warm tones were favored by patients in recovery zones, while staff expressed a need for minimal visual distraction and enhanced lighting contrast in procedural areas. This tension underscores the value of design pluralism in healthcare architecture—balancing emotional expressiveness with operational precision.

3. Design Missteps and Sensory Overload

Despite these insights, several participants expressed concern over design misapplications—such as using overly saturated colors like bright green or orange in treatment rooms—which led to cognitive fatigue or discomfort. This reflects a recurring disconnect between aesthetic ambition and psychological usability, as noted by Wikström and Sandberg (2020), who warned that even minor perceptual mismatches can compromise therapeutic effectiveness and staff performance.

Furthermore, this study revealed that poor integration of lighting with surface textures and contrast levels posed safety concerns for visually impaired patients—especially in corridors and stairwells.

4. Economic and Operational Implications

The link between sensory-responsive environments and operational efficiency was another key theme. Participants observed that well-designed interiors—those featuring ergonomic furniture, appropriate lighting levels, and calming color palettes—were associated with quicker patient recovery and higher staff retention. Delcampo-Carda et al. (2019) support this with quantitative data showing a 70% reduction in ICU stay duration following sensory-centered renovations. These findings suggest that design should be reframed not merely as an aesthetic function but as a strategic investment in healthcare performance.

5. Comparison with Prior Literature

Aspect	This Study	Supporting Source	Agreement
Pink and calm	Calming for children	Han et al., 2018	Yes
Grey and discomfort	Reduced concentration among staff	McLachlan & Leng, 2021	Yes
White LED clarity	Enhanced visual sharpness in work areas	Danilov et al., 2020	Yes
Fluorescent fatigue	Fatigue and stress reported	Fotios et al., 2018	Yes
Natural daylight comfort	Positive emotional impact	Boyce, 2010; McGee & Park, 2022	Yes

6. Limitations

Despite the value of the insights presented, this study is subject to several limitations:

Small sample size: The participant pool (N=8) limits the generalizability of findings. Although the qualitative depth is high, broader studies with more diverse participants would improve the robustness of conclusions.

Lack of longitudinal data: The study is based on one-time interviews, which may not capture shifts in perception over time or across different stages of hospitalization.

Subjectivity of responses: As with most qualitative studies, interpretations are influenced by both participant narratives and researcher framing. Triangulating with observational or physiological data (e.g., stress biomarkers) could strengthen validity.

Context specificity: The findings may not translate across different healthcare cultures or architectural typologies without adaptation.

7. Summary

This discussion supports the broader thesis that healthcare spaces are not passive containers, but active agents in promoting healing, efficiency, and emotional well-being. Embodied cognition and sensory design provide useful frameworks for rethinking how interior environments influence behavior and health outcomes. However, realizing this potential depends on greater interdisciplinary collaboration, ongoing user feedback, and policy-level investment in sensory infrastructure.

Conclusion and Recommendations

Conclusion:

This study confirms that thoughtful and sensory-responsive interior design—particularly the strategic use of color and lighting—has a measurable impact on the psychological, emotional, and functional experiences of hospital users. Through qualitative data collected from patients, healthcare workers, and interior designers, the research highlights how environmental stimuli influence mood regulation, spatial orientation, visual comfort, and perceived safety.

Key findings support the theory of embodied cognition, emphasizing that color and light are not merely aesthetic features but active agents in shaping human behavior and well-being. The analysis revealed important distinctions in user preferences: patients prioritized emotional warmth and natural stimuli, while staff emphasized efficiency, clarity, and minimal distraction.

Moreover, the study underscores the risks of poor design decisions, such as inappropriate color saturation or inconsistent lighting schemes, which may trigger discomfort or disorientation. Inclusive strategies for children, elderly, and visually impaired users were also emphasized as essential in healthcare contexts.

Recommendations:

Based on the findings, the following recommendations are proposed for healthcare facility designers, policymakers, and administrators:

Implement Functional Zoning through Color: Use calming, low-saturation tones in recovery and pediatric areas; employ contrasting, bold tones for navigation and signage.

Maximize Access to Natural Daylight: Prioritize window placement and daylight diffusion in patient rooms, waiting areas, and workstations to support circadian rhythm and emotional balance.

Avoid Sensory Overload: Limit the use of high-saturation colors (e.g., bright orange or neon green) in clinical spaces; opt for psychologically balanced palettes.

Layer Lighting Strategically: Combine ambient, task, and accent lighting to accommodate diverse visual needs and activities.

Design for Inclusion: Integrate high-contrast color schemes and tactile cues for patients with low vision or cognitive challenges.

Prioritize User Feedback: Involve patients and staff in pre-occupancy evaluations and post-occupancy assessments to ensure design responsiveness.

Support Policy Change: Advocate for building codes and healthcare design guidelines that recognize sensory design as a health and safety factor—not a decorative luxury.

Future Research Directions

Given the exploratory nature of this study, future research could:

Conduct longitudinal studies to track how design impacts patient recovery or staff stress over time.

Incorporate biometric data (e.g., heart rate, skin conductance) alongside interviews to quantify sensory effects.

Compare design impacts across different hospital types (e.g., maternity wards, emergency departments, psychiatric units).

Explore cross-cultural perspectives to understand how perceptions of color and light vary globally.

Appendices:

Appendix A: Semi-Structured Interview Guide

The interview protocol used open-ended questions designed to explore participants' perceptions of color, lighting, and overall spatial experience in healthcare environments. Sample questions included:

- "Can you describe a space in a hospital that made you feel comfortable or uncomfortable?"
- "How do you feel when working or recovering in brightly lit environments?"
- "Do colors in the hospital environment affect your emotional state or ability to focus?"

Appendix B: Participant Demographics Table

Participant	Role	Gender	Age Range	Experience in Healthcare
P1	Pediatric Nurse	Female	30–39	10 years
P2	Staff Administrator	Female	40–49	15 years
P3	Patient (Post-surgery)	Male	50–59	—
P4	Visitor (Elderly Care)	Female	60–69	—
P5	Doctor (ER)	Male	30–39	7 years
P6	Interior Designer	Female	30–39	12 years

Participant	Role	Gender	Age Range	Experience in Healthcare
P7	Patient (Child)	Male	10–12	—
P8	Designer	Female	40–49	18 years

**Appendix C: Coding and Thematic Analysis Process**
The data analysis followed Braun and Clarke's (2006) six-step approach:
1. Familiarization with transcripts
2. Generating initial codes
3. Searching for themes
4. Reviewing themes
5. Defining and naming themes
6. Producing the report
   Manual coding was performed using color-coded matrices. Recurrent language patterns, emotional expressions, and contextual descriptions were identified and grouped into themes.

Appendix D: Visual Figures
- **Figure 1**: Bar Chart of Emotional Responses to Colors
- **Figure 2**: Pie Chart of Participant Lighting Preferences
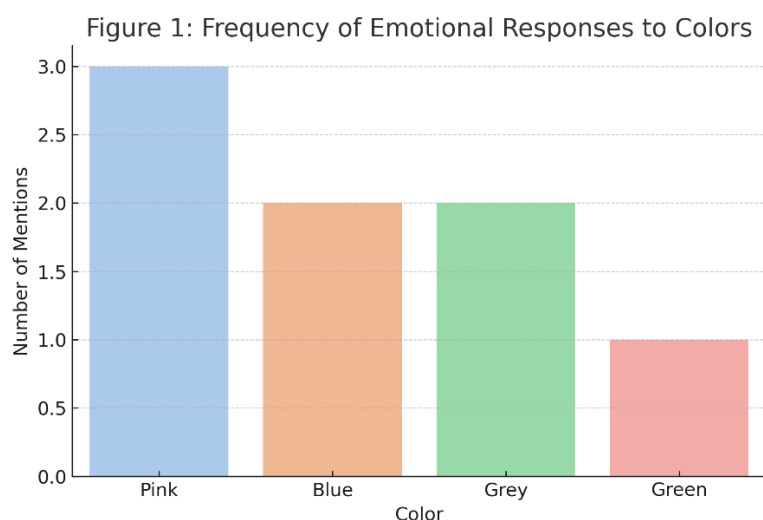
Figure 1: Frequency of Emotional Responses to Colors

A bar chart showing how frequently different colors were associated with specific emotional responses by participants.

Figure 2: Participant Preferences for Lighting Types
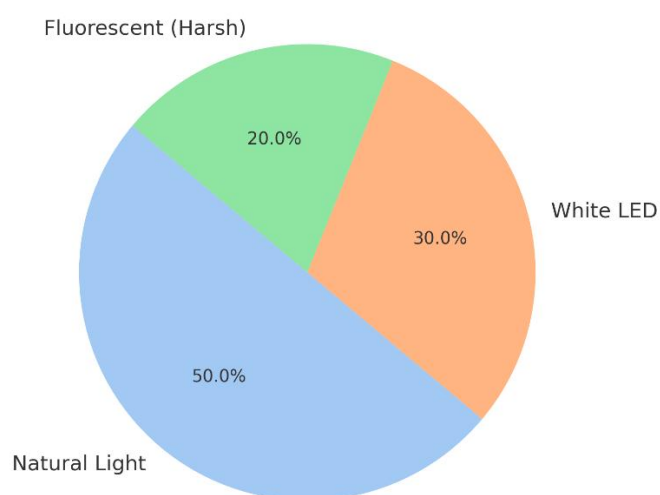
This pie chart illustrates participant preferences for natural light, LED light, and fluorescent lighting.

References

1. Al-Fatlawi, S., & Al-Bayati, L. (2022). Color identity in institutional architecture. *Journal of Fine Arts (Iraq)*, 34(2), 45–58.
2. Al-Mousawi, A. H. (2021). Psychological impact of color schemes in educational spaces. *Journal of Fine Arts (Iraq)*, 33(1), 19–34.
3. Balabanoff, M. (2023). Adaptive lighting in emergency healthcare units. *Health Environments Research & Design Journal*, 16(1), 20–37.
4. Barrett, P., Davies, F., Zhang, Y., & Barrett, L. (2019). The impact of classroom design on pupils' learning: Final results of a holistic, multi-level analysis. *Building and Environment*, 89, 118–133.
5. Boyce, P. R. (2010). *Lighting for hospitals: A guide to visual ergonomics*. Routledge.
6. Choi, J. H., & Beltran, L. O. (2021). Impact of indoor environmental quality on patient recovery: A literature review. *Journal of Building Performance*, 12(1), 37–51.
7. Danilov, V., Shishkina, T., & Kosenko, I. (2020). Daylight design strategies in health facilities. *Lighting Research & Technology*, 52(6), 705–716.
8. Delcampo-Carda, R., Carrión-Mero, P., & Contreras, M. (2019). Environmental quality and patient recovery. *Building and Environment*, 156, 180–191.
9. Devlin, A. S. (2020). Transforming the doctor's office: Principles from environmental psychology. *Health Environments Research & Design Journal*, 13(1), 142–155.
10. Figueiro, M. G., Steverson, B., Heerwagen, J., & Rea, M. S. (2021). The impact of lighting on circadian regulation, sleep, and mood in healthcare settings. *Neurobiology of Sleep and Circadian Rhythms*, 10, 100068.
11. Gesler, W. M., Bell, M., Curtis, S., Hubbard, P., & Francis, S. (2020). Therapy by design: Evaluating the therapeutic architecture of a mental health hospital. *Health & Place*, 61, 102243.
12. Han, S., Kim, D., & Lee, J. (2018). The emotional effect of warm and cool colors in healthcare interiors. *Color Research & Application*, 43(1), 45–55.
13. Huisman, E. R., Morales, E., van Hoof, J., & Kort, H. S. (2021). Healing environment design: A review of theory and practice in healthcare architecture. *Building Research & Information*, 49(1), 1–15.
14. Küller, R. (2020). Environmental assessment of color and light: Their psychological implications. *Color Research & Application*, 45(4), 602–612.
15. Martini, M., & Ferri, F. (2023). Multisensory perception and emotional design in healthcare spaces. *International Journal of Environmental Research and Public Health*, 20(4), 3091.
16. McGee, L., & Park, J. (2022). Dynamic lighting in patient care environments. *Journal of Interior Design*, 47(2), 78–96.
17. McLachlan, R., & Leng, D. (2021). Color psychology in workplace performance. *Journal of Environmental Psychology*, 74, 101563.
18. Park, N., Lee, B., & Han, S. (2022). The relationship between hospital interior design and patient satisfaction in rehabilitation units. *Healthcare Design*, 18(3), 56–67.
19. Shepley, M. M., & Pasha, S. (2020). Design research and behavioral health facilities: A scoping review. *HERD: Health Environments Research & Design Journal*, 13(2), 123–139.
20. Ulrich, R. S., Zimring, C., Zhu, X., DuBose, J., & Seo, H. B. (2020). A review of the literature on evidence-based healthcare design. *HERD: Health Environments Research & Design Journal*, 13(1), 107–129.
21. Wikström, M., & Sandberg, E. (2020). Misalignments in healing design: The user's voice. *Scandinavian Journal of Design and Architecture*, 8(1), 55–69.
22. Yildirim, K., Hidayetoglu, M. L., & Akalin, A. (2021). The effects of interior design elements on stress recovery: A comparative study. *Journal of Environmental Psychology*, 76, 101617.
23. Zadeh, R. S., Shepley, M. M., & Williams, G. (2022). Environmental design strategies for pediatric settings: Promoting comfort and reducing anxiety. *Children's Environments Quarterly*, 29(2), 112–127.
24. Al-Obaidi, R. (2023). Human-centered lighting in Arabic clinical design. *Journal of Fine Arts (Iraq)*, 35(1), 79–93.
25. Pallasmaa, J. (2012). *The Eyes of the Skin: Architecture and the Senses* (3rd ed.). Wiley.
26. Appia, A. (1921). *The Work of Living Art*. H. Beacham.
27. Benedetti, J. (1999). *The Art of the Stage*. Methuen.
28. Brown, A., & Wilson, L. (2018). *The Sensory Stage: Multimodal Design in Performance*. Routledge.
29. Blesser, B., & Salter, L. (2007). *Spaces Speak, Are You Listening?* MIT Press.