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Review

Bounded, Affective, and Heuristic Decision-Making in Interior Built Environments: A Narrative Review and Conceptual Framework for Human-Centered Building Design

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Abstract

Interior built environments influence user behavior through more than deliberate rational evaluation. They shape attention, movement, affective comfort, perceived safety, wayfinding, and well-being through bounded cognition, affective appraisal, heuristics, embodied perception, and automatic approach–avoidance processes. The research gap addressed in this review concerns the fact that prior work on interior environments, wayfinding, indoor environmental quality, neuroarchitecture, atmospherics, and behavioral decision-making remains fragmented across separate studies, and existing reviews rarely explain how these mechanisms can be organized into a design-usable framework for interior built environments. This narrative review synthesizes foundational and recent literature across building design, environmental psychology, neuroarchitecture, virtual reality, indoor environmental quality, wayfinding, and behavioral decision-making to clarify how decision mechanisms translate into interior design variables such as lighting, color, spatial organization, materiality, form, sensory atmosphere, environmental legibility, thermal comfort, and controllability. The review distinguishes bounded rationality, heuristics and biases, dual-process accounts, affective and atmospheric processing, prospect–refuge dynamics, mere exposure, and room-effect research rather than treating them as a single "non-rational" category. It proposes an integrative framework in which interior cues are processed through perceptual and affective appraisal; moderated by individual, cultural, contextual, temporal, and ethical factors; and expressed through behavioral outcomes such as navigation, approach or withdrawal, dwell time, perceived quality, usability, stress regulation, and well-being. The paper contributes to human-centered building design by formalizing a mechanism-based account of how interior environments can support behavior without reducing users to passive recipients of environmental manipulation. It concludes with practical implications for design briefing, post-occupancy evaluation, VR-based testing, healthcare and workplace audits, safety-critical settings, and future longitudinal validation.

Keywords: interior built environments; human-centered building design; narrative review; conceptual framework; environmental psychology; bounded rationality; heuristics; neuroarchitecture; indoor environmental quality; evidence strength; ethical design

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1. Introduction

Interior built environments are not neutral containers for human activity. They organize perception, attention, emotion, movement, social interaction, and decision-making through light, color, layout, enclosure, materiality, acoustics, thermal conditions, spatial

rhythm, and sensory atmosphere. In everyday interiors, users rarely pause to conduct explicit cost–benefit analyses of spatial options. Instead, they often respond through rapid appraisal, embodied familiarity, affective comfort or discomfort, cognitive shortcuts, visual salience, and perceived safety. This makes interior design a psychologically consequential domain within human-centered building design and environmental psychology [1–3].

The term "non-rational decision-making" can be useful for signaling a move away from purely rationalist assumptions, but it also risks conceptual overextension. Bounded rationality is not equivalent to irrationality; heuristics can be adaptive rather than defective; affective appraisal may support rather than undermine judgment; and dual-process theory cannot be treated as a direct synonym for prospect theory, atmosphere theory, or approach–avoidance motivation. The present review therefore uses the more precise formulation "bounded, affective, and heuristic decision-making" while retaining "non-rational" only as a limited umbrella term when necessary [4–6].

The central argument of this review is that interior built-environment research benefits from a mechanism-based account of user behavior. Such an account does not ask only whether a design element is attractive or functional. It asks how specific interior cues are perceived, how they shape affective and cognitive appraisal, which decision mechanisms are activated, which moderators alter their effect, and which behavioral or psychological outcomes follow. This approach is important because the same design cue can have different effects depending on user characteristics, cultural expectations, task demands, setting type, prior exposure, sensory sensitivity, and ethical context [7–9].

Recent empirical work has strengthened the case for such an approach. Studies in neuroarchitecture and environmental neuroscience show that architectural interiors can evoke psychological and neural responses associated with coherence, fascination, hominess, body-based appraisal, affective state, and approach–avoidance tendencies. Virtual reality and mobile EEG methods have made it possible to study spatial experience with greater ecological validity. At the same time, systematic reviews of indoor environmental quality demonstrate that lighting, thermal comfort, acoustics, air quality, and non-light visual factors can influence physiological and brain-related responses. These developments move the field beyond speculative claims and toward more testable models of interior experience [10–14].

The aim of this paper is to provide a narrative, critical, and application-oriented review of bounded, affective, and heuristic decision-making in interior built environments. It clarifies key theoretical distinctions, maps them onto interior design variables, evaluates recent empirical developments, formalizes an integrative framework, and identifies methodological and ethical boundaries for future research and practice.

Primary Contribution and Novelty

The primary contribution of this article is not a systematic evidence map and not a claim that all interior variables have equally established causal effects. Rather, the contribution is a mechanism-based conceptual framework for interior built-environment research. The framework links four elements that are often discussed separately: (1) interior cues and affordances such as lighting, layout, acoustics, materiality, views, density, signage, and controllability; (2) perceptual and affective appraisal processes such as salience, coherence, familiarity, safety, arousal, sensory load, and perceived control; (3) decision mechanisms such as bounded rationality, heuristics, dual-process interaction, affective appraisal, approach–avoidance, mere exposure, and room-effect processes; and (4) behavioral and experiential outcomes such as navigation, approach or withdrawal, dwell time, perceived quality, stress regulation, usability, dignity, and well-being. This contribution is

sharpened by explicitly qualifying the evidentiary status of each design implication and by identifying where empirical validation is still required.

This contribution responds to a specific gap in existing review literature. Prior reviews have examined wayfinding in interior environments, indoor environmental quality and brain/body responses, neuroarchitectural methods, and room-product effects, but these bodies of work tend to remain separated by method or domain. The present review advances the literature by integrating these strands into one organizing model that distinguishes mechanisms, grades evidence strength, and translates findings into design-evaluation questions for interior built environments. The framework is therefore intended to help researchers ask not only whether an interior cue has an effect but which mechanism is being proposed, what level of evidence supports it, what moderators may alter it, and how it could be tested in future building research.

2. Narrative Review Positioning and Source Selection Strategy

This article is positioned as a narrative review and conceptual framework article rather than as a formal systematic review, meta-analysis, or PRISMA-ScR scoping review. This positioning is deliberate. The objective is conceptual clarification, interdisciplinary synthesis, framework development, and identification of research gaps. A formal PRISMA-ScR evidence map would require a separately executed protocol, reproducible database strings, numerical screening counts, duplicate screening procedures, and a flow diagram. Because this article does not claim to estimate effect sizes or exhaustively map all available evidence, it is presented as a narrative conceptual review informed by transparency principles rather than as a full systematic review.

The source-selection strategy combined theory-led sampling with targeted literature searching across building design, environmental psychology, behavioral decision-making, interior design, architecture, spatial cognition, neuroarchitecture, wayfinding, virtual reality, indoor environmental quality, room-effect research, and ethical behavioral design. Searches and citation tracing were conducted during manuscript preparation and updated during revision in May–June 2026. Sources were identified through Scopus, Web of Science, Google Scholar, PubMed, publisher databases, and backward and forward citation searching from key articles. Search phrases combined terms such as “interior environment”, “interior design”, “built environment”, “human-centered building design”, “environmental psychology”, “bounded rationality”, “heuristics”, “decision-making”, “dual-process”, “affective appraisal”, “approach avoidance”, “atmospherics”, “prospect refuge”, “wayfinding”, “neuroarchitecture”, “virtual reality”, “EEG”, “post-occupancy evaluation”, “indoor environmental quality”, “room-effect”, and “room-product-effect”.

The working source pool was approximate rather than a formal database log. Across initial preparation and revision, approximately 110–130 candidate sources were inspected at title, abstract, or full-text level, and 57 published scholarly sources were retained in the final cited source set. Sources were prioritized when they had foundational relevance to decision-making theory or environmental psychology; direct empirical relevance to interior built environments, wayfinding, healthcare, workplace, retail, hospitality, educational, residential, or safety-critical interiors; methodological relevance to VR, EEG, physiological sensing, or neuroarchitecture; or critical relevance to ethics, reproducibility, boundary conditions, and evidence strength. Sources were excluded when they focused exclusively on outdoor urban scale without implications for interiors, were not in English, relied on unsupported practitioner claims without peer-reviewed evidence, or lacked relevance to bounded, affective, heuristic, or embodied decision-making in relation to interior built environments.

The literature was analyzed through thematic and mechanism-based synthesis. Concepts and findings were coded into five analytical categories: (1) decision mechanism;

(2) interior design variable or environmental cue; (3) behavioral, emotional, or experiential outcome; (4) context or moderator; and (5) evidence status. This procedure was used to move from a descriptive review of theories and studies toward the five-level framework presented in Section 6. Table 1 summarizes the source-selection categories and their role in the synthesis; Table 2 then translates the key conceptual distinctions into interior built-environment terms.

Table 1. Source categories, selection scope, and use in the narrative synthesis.

Source Category	Selection Scope	Role in Synthesis	Evidence-Status Use
Foundational theory	Bounded rationality, heuristics, dual-process accounts, affective appraisal, prospect–refuge, mere exposure	Clarified concepts that are often conflated in design discourse	Foundational theory; not treated as direct design proof
Interior and building-design evidence	Wayfinding, healthcare interiors, workplaces, retail/service environments, residential and safety-critical interiors	Linked mechanisms to interior cues such as layout, lighting, signage, materiality, acoustics and controllability	Field/POE evidence when conducted in real settings; otherwise indirect
IEQ and body/brain evidence	Lighting, thermal comfort, acoustics, air quality, physiological state, VR and EEG studies	Explained how environmental parameters may affect comfort, cognitive load and appraisal	Systematic/review, laboratory/VR, or physiological evidence depending on method
Critical and ethical literature	Nudging, manipulation, autonomy, reproducibility, cultural and individual variability	Established boundary conditions and ethical limits for behavioral design	Critical synthesis; used to qualify practical implications

Table 2. Conceptual distinctions, interior translations, boundary conditions, and evidence status.

Mechanism	Core Logic	Interior Built-Environment Translation	Boundary Condition	Evidence Status
Bounded rationality	Users decide under limited time, information, attention, and cognitive capacity.	Legible layouts, clear zoning, intuitive circulation, and coherent signage reduce cognitive burden.	Not irrationality; it is constrained adaptation.	Foundational theory; supported by wayfinding and cognitive-load literature.
Heuristics and biases	People use shortcuts such as availability, recognition, anchoring, and representativeness.	First impressions, visible quality cues, familiar materials, and salient landmarks shape judgment.	Heuristics can be useful or misleading depending on context.	Foundational cognitive theory; design application is context-dependent.
Dual-process accounts	Fast automatic processing and slower reflective processing interact.	Atmosphere, color, form, and texture engage rapid appraisal; maps and instructions support reflection.	The two systems are not independent modules and should not be oversimplified.	Foundational cognitive theory; indirect support from multisensory and environmental behavior studies.
Affective appraisal and atmospherics	Environmental cues evoke pleasure, arousal, dominance, stress, calmness, or threat.	Lighting, sound, color, enclosure, texture, and scent influence mood and behavior.	Responses vary across cultures, individuals, and tasks.	Environmental psychology and atmospherics evidence; moderate support.
Approach–avoidance motivation	Cues elicit attraction, exploration, withdrawal, or avoidance.	Curved forms, openness, refuge, lighting softness, and density influence willingness to enter or stay.	Approach is not universally positive; avoidance can be adaptive in unsafe contexts.	Motivational theory plus lab/VR evidence; context-dependent.

Table 2. *Cont.*

Mechanism	Core Logic	Interior Built-Environment Translation	Boundary Condition	Evidence Status
Mere exposure and familiarity	Repeated exposure can increase comfort, preference, and attachment.	Recurring spatial rhythms, consistent materials, and familiar typologies support orientation and belonging.	Over-familiarity can also produce boredom or reduce attention.	Foundational social psychology; interior application needs longitudinal testing.
Prospect–refuge and reference dependence	People evaluate space relative to safety, visibility, enclosure, and perceived loss or gain.	Open sightlines, refuge zones, transitions, and control over exposure influence perceived safety.	Prospect–refuge is distinct from economic Prospect Theory.	Environmental preference theory; interior application plausible but setting-dependent.

3. Conceptual Clarification: From "Non-Rational" to Bounded, Affective, and Heuristic Processes

The term "non-rational" is potentially misleading if used to imply error, irrationality, or an absence of reasoning. In behavioral economics and cognitive psychology, much behavior is better described as bounded, adaptive, heuristic, affective, automatic, or embodied. These terms overlap but are not interchangeable. Bounded rationality emphasizes the limits of information, time, attention, and computational capacity. Heuristics refer to simplified strategies used under uncertainty. Affective appraisal refers to rapid evaluative responses that help users interpret environmental meaning. Dual-process accounts distinguish fast automatic processing from slower reflective processing. Approach–avoidance motivation concerns orientation toward or away from stimuli. Mere exposure and familiarity describe preference formation through repeated contact. Atmospherics concerns emotion-laden evaluation of environmental qualities [4,7,15,16].

These distinctions matter for interior design. A user who chooses a clear corridor over a confusing one may be acting under bounded rationality, not irrationality. A patient who feels calmer in a room with natural imagery may be responding through affective appraisal and stress regulation, not merely aesthetic preference. A shopper who attributes quality to a product because of a prestigious interior setting may be influenced by a room-effect or environmental framing mechanism. A person who avoids an angular or harshly lit room may be responding through approach–avoidance dynamics. Treating all these mechanisms as one category would weaken theoretical precision and reduce the practical value of the framework [2,17,18]. Table 2 summarizes these distinctions, their interior translations, boundary conditions, and evidence status.

4. Theoretical Lineages and Relevance to Interior Built Environments

4.1. Bounded Rationality and Spatial Legibility

Bounded rationality begins from the premise that decision-makers rarely optimize across all possible alternatives. Instead, they operate under informational, temporal, perceptual, and cognitive constraints. In interiors, this is visible in wayfinding, spatial categorization, task performance, and the interpretation of institutional environments. Users often rely on spatial affordances, landmarks, signage, lighting gradients, and familiar organizational patterns rather than analytical interpretation of plans or instructions [4,15,19,20].

Interior wayfinding research is especially relevant because complex facilities such as hospitals, airports, universities, and offices place users under cognitive load. Wayfinding difficulties can generate stress, delay, frustration, and reduced usability. A bounded-rationality approach therefore supports design strategies that reduce unnecessary cognitive

burden: clear zoning, coherent circulation hierarchies, visual access, landmark differentiation, consistent color coding, and predictable transitions [18,21,22].

4.2. Heuristics, First Impressions, and Environmental Judgment

Heuristics are simplified judgment strategies that allow for rapid decisions under uncertainty. In interior environments, users often infer cleanliness, professionalism, safety, luxury, warmth, or institutional quality from salient visual and material cues. Availability, anchoring, recognition, representativeness, and take-the-best heuristics can operate through lighting emphasis, reception-area design, material quality, spatial order, and immediate sensory impressions [5,6,23].

The implication is not that designers should exploit bias but that they should understand how limited information is converted into evaluative judgment. A poorly lit corridor may anchor perceptions of danger even when objectively safe; a coherent clinic entrance may support trust; a visibly high-quality material palette may bias judgments of service quality. Such mechanisms are especially relevant in healthcare, hospitality, retail, education, and public-service interiors where trust and orientation are central [24–26].

4.3. Dual-Process Accounts and Multisensory Interiors

Dual-process theory is often used to distinguish rapid automatic processing from slower reflective processing. Interior environments frequently engage rapid appraisal through visual, tactile, auditory, thermal, and olfactory cues. Users may feel calm, exposed, tense, curious, or confused before they can articulate why. At the same time, reflective processing becomes important when users must interpret instructions, compare options, follow safety procedures, or navigate unfamiliar settings [3,7,27].

The practical design implication is that emotionally supportive atmosphere and informational clarity should not be separated. A space may be pleasant but illegible, or legible but stressful. Effective behavioral and emotional design requires integration: sensory conditions that support affective comfort, and cognitive structures that support orientation, comprehension, and agency [2,28].

4.4. Affective Atmospheres, PAD Theory, and Embodied Appraisal

Environmental psychology has long treated interiors as affective settings. The pleasure–arousal–dominance model and store atmospherics research show that environmental qualities can influence emotion, approach behavior, dwell time, and satisfaction. For interior built environments, this means that atmosphere is not a decorative residue; it is a mechanism through which lighting, color, texture, density, acoustics, and spatial configuration shape behavioral orientation [2,29–31].

Recent neuroarchitectural work strengthens this claim by linking interior form, perceived coherence, fascination, hominess, and affective evaluation to psychological and neural responses. These findings do not imply deterministic design effects, but they justify treating interiors as psychologically active environments whose effects should be empirically tested rather than assumed [10,11,13,32].

4.5. Approach–Avoidance Motivation, Form, and Spatial Curvature

Approach–avoidance motivation is highly relevant for interior design because many design problems involve decisions to enter, stay, explore, retreat, queue, engage, rest, or seek help. Research on contour and curvature suggests that curved environments and objects are often preferred over angular alternatives and may influence approach behavior. Recent work using virtual reality and reaction-time paradigms has extended this question directly to interior stimuli [33–35].

Curvature, however, should not be treated as a universal design rule. The effect of angularity or curvature depends on task, cultural meaning, brand identity, safety expectations, spatial scale, and user differences. In some contexts, angular forms can communicate precision, authority, or urgency. The framework therefore treats curvature as one cue within a broader appraisal system rather than as an isolated prescription [12,36].

4.6. Prospect–Refuge, Perceived Safety, and Control

Prospect–refuge theory explains environmental preference partly through the balance between visual access and shelter. At the interior scale, prospect and refuge appear in waiting areas, classrooms, workplaces, hotel lobbies, psychiatric settings, restaurants, and domestic rooms. Users often prefer spaces that allow for awareness of surroundings while offering protection, privacy, and a sense of control [37–40].

This line of theory should not be confused with economic Prospect Theory. Economic Prospect Theory concerns reference dependence, loss aversion, and decision-making under risk. Prospect–refuge theory concerns environmental preference, visibility, and perceived safety. Both can inform interior design, but they operate at different conceptual levels and should be explicitly distinguished [41,42].

4.7. Mere Exposure, Familiarity, and Room-Effect Research

Repeated exposure can build familiarity, ease, attachment, and preference. In interiors, this is relevant to residential design, institutional design, branded environments, hospitality, and healthcare spaces where repeated contact changes user appraisal over time. Familiar layouts and materials can reduce cognitive effort and support belonging, but excessive repetition can also reduce novelty and engagement [25,43].

Room-effect and room-product-effect research adds another dimension: spaces can frame the way people, products, and activities are perceived. The desirability of a product or the social evaluation of a person can be influenced by the room context in which they are encountered. This provides a useful bridge between environmental psychology, product evaluation, retail design, and interior atmosphere [24,44,45].

5. Recent Empirical Developments: From Theory to Interior Built-Environment Evidence

A central aim of this manuscript is the stronger integration of recent empirical work. Foundational sources remain necessary, but they are no longer treated as sufficient. Several lines of recent evidence are particularly important for advancing interior built-environment research. The evidence-to-design relationships synthesized from these strands are summarized in Table 3.

Table 3. Evidence-to-design synthesis across mechanisms, interior variables, outcomes, and strength of evidence.

Design Variable	Decision Mechanism	Typical Interior Cues	Likely Outcomes	Critical Qualification	Evidence Status/Strength
Lighting and visual access	Affective appraisal, attention, prospect–refuge, circadian and physiological pathways	Daylight, glare control, contrast, indirect light, visibility, window views, dynamic lighting transitions, and visual focal points	Mood regulation, perceived safety, recovery support, orientation, stress modulation, and intuitive navigation support	Effects depend on task, timing, clinical status, culture, and visual comfort.	Moderate to strong: IEQ reviews, healthcare/restorative evidence, and field studies; dynamic lighting and focal-point claims require task-specific validation.

Table 3. *Cont.*

Design Variable	Decision Mechanism	Typical Interior Cues	Likely Outcomes	Critical Qualification	Evidence Status/Strength
Color and visual atmosphere	Affective appraisal, anchoring, identity, room-effect	Warm/cool palettes, saturation, contrast, institutional colors, brand or care identity	Comfort, arousal modulation, perceived quality, social meaning	Color effects are highly contextual and cannot be reduced to universal rules.	Tentative to moderate: environmental psychology and atmospherics evidence; highly context- and culture-dependent.
Layout and spatial organization	Bounded rationality, wayfinding heuristics, cognitive load, dual-process interaction	Zoning, circulation hierarchy, landmarks, signage, sightlines, thresholds, focal points, and lighting gradients	Faster navigation, reduced confusion, perceived control, safer movement, and stronger route confidence	Legibility must be balanced with privacy, security, and social function.	Moderate to strong: wayfinding, legibility, and post-occupancy research; causal strength varies by setting.
Materiality, texture, and form	Embodied appraisal, approach–avoidance, familiarity, representativeness	Natural materials, tactile finishes, curvature, enclosure, furniture form, surface quality	Approach, dwell time, perceived warmth, trust, comfort, attachment	Material meaning varies by culture, maintenance, cost, and institutional norms.	Tentative to moderate: lab/VR and material-perception studies; needs field validation.
Acoustics, density, and sensory load	Arousal regulation, stress appraisal, bounded attention	Noise control, crowding, reverberation, sensory zoning, quiet rooms	Reduced stress, improved concentration, better emotional regulation	Under-stimulation can be problematic; users differ in sensory needs.	Moderate: IEQ and workplace/learning evidence; user sensitivity differs.
Environmental framing and room-effect	Anchoring, representativeness, social attribution, room-product-effect	Contextual prestige, room congruence, display settings, social staging	Perceived quality, desirability, credibility, behavioral engagement	Ethical concerns increase when framing is opaque or manipulative.	Moderate in retail/service settings; tentative when translated to healthcare, education, or public interiors.

First, neuroarchitecture and environmental neuroscience show that spatial features can be studied using behavioral ratings, neuroimaging, EEG, mobile brain/body imaging, virtual reality, and physiological measures. Studies of architectural interiors indicate that subjective dimensions such as coherence, fascination, and hominess are not merely stylistic preferences; they can correspond with measurable psychological and neural responses. Virtual reality studies also allow researchers to manipulate form, proportion, curvature, lighting, and color while preserving a sense of spatial immersion [10,11,13,32].

These methods, however, require careful qualification. VR improves experimental control and spatial immersion, but it cannot fully reproduce long-term occupancy, smell, social meaning, maintenance, real risk, institutional power relations, or everyday routines. EEG and physiological sensing can register correlates of arousal, attention, workload, or bodily state, but they do not directly reveal design preference, moral value, dignity, or well-being. Neuroarchitectural measures therefore require triangulation with behavior, self-report, post-occupancy evidence, and contextual interpretation. Without such triangulation, the field risks construct validity problems, sample limitations, weak ecological validity, overinterpretation of neural signals, and neuro-reductionism [10–14,32,46].

Across the reviewed literature, the strongest agreement concerns the need to triangulate spatial experience rather than infer it from a single indicator. There is moderate-to-strong evidence that legibility, visual access, IEQ conditions, and signage quality influence comfort, wayfinding, perceived safety, and task performance in specific settings. Evidence

is weaker when broad design prescriptions are transferred across contexts, for example from retail atmospherics to healthcare waiting or from short VR exposure to long-term occupancy. Contradictions usually arise when the same cue has different meanings across task demands, cultures, stress states, or user groups. For this reason, design implications in this review are framed as mechanism-based hypotheses rather than universal causal rules.

Second, indoor environmental quality research shows that the body and brain respond to environmental variables beyond visual aesthetics. Thermal comfort, air quality, acoustics, lighting, and non-light visual factors influence comfort, health, productivity, emotion, and physiological state. This supports a broader conception of interior decision-making in which sensory and bodily conditions shape cognition and behavior [3,14,46]. Psychological thermal comfort and perceived IEQ are especially relevant for complex wayfinding because heat, glare, air quality concerns, acoustic disturbance, and crowding can increase cognitive load, reduce attentional capacity, and alter affective appraisal during navigation. In this sense, wayfinding should not be treated only as a signage or spatial-configuration problem; it is also shaped by the bodily conditions under which users search, decide, and move.

Third, healthcare and psychiatric-environment studies indicate that interior design is consequential in high-stress settings. Evidence from restorative healthcare design, nature views, psychiatric seclusion-room redesign, and therapeutic-environment research suggests that perceived safety, restfulness, sensory load, dignity, and autonomy are central design concerns. These settings make the ethical dimension especially visible: design should reduce distress and support agency rather than simply steer behavior [17,47,48].

Fourth, retail, service, and room-product-effect research shows that interiors influence evaluation, approach behavior, and perceived quality. These studies are valuable not because retail design should become the default model for all interiors but because they demonstrate how environmental framing can shape judgment. The same principle can be translated cautiously to educational, institutional, workplace, and care environments [29,31,44,49].

6. Conceptual Framework

The framework formalizes the relationship between interior design variables and behavioral or emotional outcomes across five linked levels. The first level consists of interior cues and affordances: lighting, color, layout, materiality, acoustics, thermal conditions, spatial density, signage, furniture, and views. The second level is perceptual and affective appraisal: salience, coherence, familiarity, arousal, safety, refuge, sensory load, and perceived control. The third level is decision mechanism: bounded rationality, heuristics, dual-process processing, affective appraisal, approach–avoidance, and familiarity effects. The fourth level is behavioral response: navigation, approach or withdrawal, dwell time, task focus, help-seeking, purchasing, compliance, or social engagement. The fifth level is outcome: comfort, reduced stress, usability, recovery, perceived quality, well-being, and ethical engagement [1,2,4].

The framework was developed by cross-mapping the thematic synthesis categories from Section 2. First, theories were grouped by mechanism: bounded cognition, heuristics, affective appraisal, embodied appraisal, familiarity, and environmental safety appraisal. Second, interior variables were grouped by cue type: spatial organization, lighting and visual access, materiality and form, acoustics and sensory load, signage and landmarks, IEQ parameters, and environmental controllability. Third, outcomes were grouped as navigation, approach–withdrawal, perceived safety, comfort, stress regulation, trust, and well-being. This mapping produced the five framework levels rather than treating the framework as a purely illustrative diagram.

The framework adds to existing models in three ways. Compared with the pleasure–arousal–dominance and atmospherics tradition, it specifies decision mechanisms rather than focusing only on affective state. Compared with choice architecture and nudge theory, it emphasizes sensory, spatial, and material conditions specific to interior environments rather than abstract choice presentation. Compared with wayfinding and architectural legibility models, it integrates affective, embodied, and ethical dimensions beyond navigation alone [2,8,9,24].

The framework also introduces explicit moderators. User age, culture, neurodiversity, prior exposure, health status, sensory sensitivity, spatial literacy, and task goals can alter the same cue–response relationship. Context also matters: a lighting strategy appropriate for retail may be inappropriate for psychiatric care; a corridor designed for evacuation may require different cues than a hotel corridor designed for comfort. The framework therefore avoids universal prescriptions and instead supports context-sensitive hypotheses [3,39,50]. The model should also be read as a simplified first-order conceptual model rather than a fully dynamic behavioral model. In lived interiors, feedback loops are expected: repeated wayfinding success or failure, accumulated familiarity, crowding episodes, thermal discomfort, perceived reliability of signage, and prior emotional states may reshape later perception, trust, appraisal, and route choice. Future empirical studies should therefore test both immediate cue–response effects and temporal feedback effects across repeated occupancy. Figure 1 presents this simplified mechanism-based framework and its moderators.

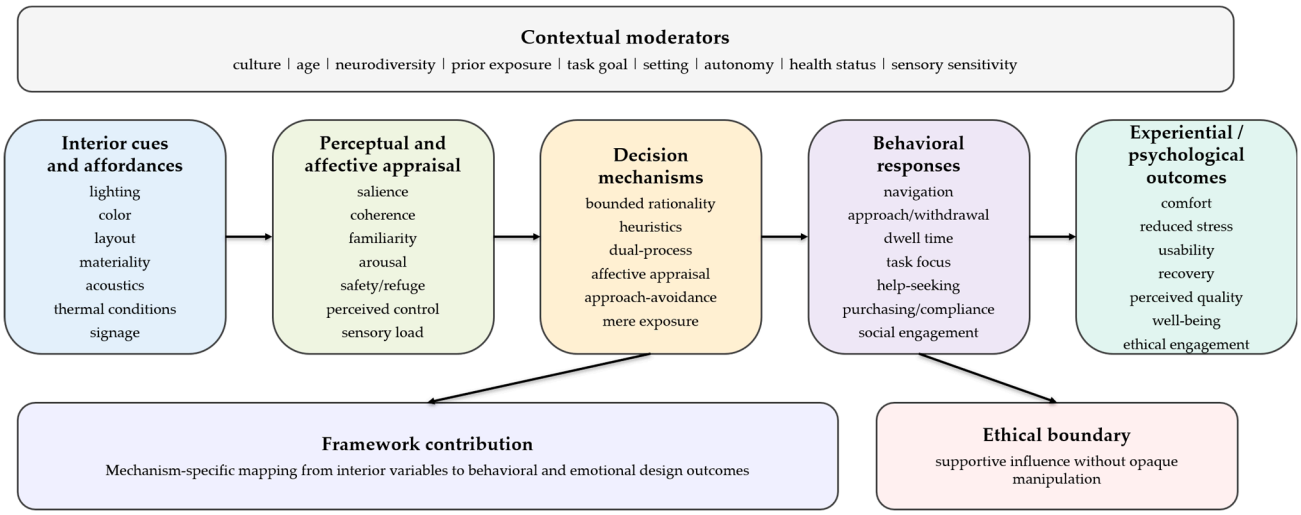

Figure 1. Conceptual framework linking interior built-environment cues to bounded, affective, and heuristic decision-making processes, with contextual moderators and ethical boundaries.

7. Context-Specific Applications

The value of the framework lies in its ability to organize design decisions around mechanisms and outcomes. The following applications illustrate how bounded, affective, and heuristic decision-making can be translated into interior built-environment research and practice without reducing design to deterministic behavioral control. Because the evidence base differs by context, these applications are presented as representative use cases rather than as equally validated prescriptions. Table 4 links selected settings to mechanisms, design applications, testable predictions, methods, and evidence cautions.

Table 4. Application matrix, evidence status, and testable future research directions.

Context	Primary Mechanism	Design Application	Testable Prediction	Suggested Method	Evidence Status/Caution
Healthcare waiting areas	Affective appraisal and prospect–refuge	Calm lighting, natural views, visual control, reduced crowding	Perceived safety and lower anxiety increase when users have both visual access and refuge.	Field experiment; patient-reported stress; physiological measures	Moderate healthcare/restorative evidence; requires population-specific validation.
Psychiatric/ seclusion rooms	Sensory load and autonomy	Non-overwhelming wall design, soft lighting, acoustic control, dignity-preserving features	Restfulness improves when sensory stimulation is calming and controllable.	Mixed-methods pre-evaluation; lived-experience panels	Emerging mixed-methods evidence; strong ethical safeguards required.
Workplace interiors	Bounded rationality and cognitive load	Clear zones, acoustic gradients, task lighting, visual coherence	Cognitive fatigue decreases when spatial organization reduces unnecessary decisions.	Post-occupancy evaluation; ecological momentary assessment	Moderate workplace/POE evidence; organizational context is a major moderator.
Retail/ hospitality	Room-effect, heuristics, atmospherics	Material congruence, lighting hierarchy, coherent brand atmosphere	Perceived quality increases when environmental cues are congruent with product/service identity.	VR experiment; behavioral tracking; ethical acceptability survey	Relatively strong retail/atmospherics evidence; ethical risk increases with commercial steering.
Schools/ universities	Wayfinding heuristics and familiarity	Landmarks, consistent color coding, intuitive circulation	Navigation time and stress decrease when landmarks and zoning are consistent.	Wayfinding task; eye tracking; route-choice analysis	Moderate wayfinding evidence; findings may vary by age, disability, and cultural signage conventions.
Residential settings	Mere exposure and attachment	Familiar materials, flexible zones, identity-supportive personalization	Attachment and perceived restoration increase when users can personalize repeated-use spaces.	Longitudinal post-occupancy study	Tentative: supported by familiarity and attachment theory; longitudinal evidence needed.
Airports and complex public facilities	Wayfinding heuristics, perceived reliability, and trust transfer	Consistent routine signage, dynamic lighting gradients, focal points, and clearly differentiated emergency cues	Trust in emergency guidance increases when everyday wayfinding cues are visible, legible, consistent, and correct.	Wayfinding simulation; field POE; emergency-preparedness survey; route-choice and compliance-intention measures	Emerging empirical evidence from airport wayfinding; requires real-world validation and ethical emergency-design safeguards.

7.1. Healthcare and Psychiatric Settings

In healthcare interiors, stress, uncertainty, pain, waiting, vulnerability, and reduced autonomy intensify the importance of perceived safety, legibility, sensory comfort, and dignity. Evidence on nature views, restorative settings, seclusion-room redesign, and indoor environmental quality suggests that lighting, wall design, views, acoustic control, and

spatial organization can influence restfulness, overwhelm, anxiety, and perceived control. A bounded-rationality perspective supports intuitive wayfinding; an affective-appraisal perspective supports calming sensory conditions; an ethical perspective requires patient dignity and transparency [17,47,48]. In these settings, commercial framing strategies should not be imported uncritically; behavioral influence is acceptable only when it supports comprehension, dignity, care access, and user welfare.

7.2. Workplace and Learning Environments

Workplaces and classrooms require sustained attention, social coordination, privacy regulation, and recovery from cognitive load. Clear zoning, acoustic control, access to daylight, task-appropriate lighting, spatial predictability, and environmental controllability can support concentration and well-being. The framework predicts that designs reducing unnecessary sensory and navigational load will improve subjective usability and reduce stress, particularly under high workload [3,14,48].

7.3. Retail, Hospitality, and Service Environments

Retail and hospitality interiors frequently use atmosphere, material cues, lighting, display, and room-effect mechanisms to shape perceived quality and dwell time. This is a legitimate area of environmental psychology, but it also raises ethical questions when influence becomes opaque manipulation. The framework suggests that such environments should be evaluated not only by sales or engagement but also by transparency, user autonomy, and long-term experience [24,30,44,49].

7.4. Residential and Domestic Environments

Residential interiors are strongly shaped by familiarity, identity, attachment, privacy regulation, and repeated exposure. Design strategies that support belonging, sensory comfort, and flexibility may influence well-being over time. However, domestic preference is deeply personal and culturally situated; generalized prescriptions should be treated cautiously [39,43].

7.5. High-Stress and Safety-Critical Interiors

Emergency departments, evacuation routes, crisis rooms, airports, and complex public facilities require rapid comprehension under stress. Here, bounded rationality and heuristics are especially relevant: users need salient landmarks, clear decision points, visual access, and non-ambiguous cues. The goal is not to manipulate behavior but to reduce cognitive burden when reflective processing is compromised [18,21,28,51]. Dynamic lighting variables, architectural focal points, and salient landmarks may function as intuitive navigation cues when they remain consistent, legible, and non-competing. A recent airport-terminal study on the halo effect of wayfinding signage suggests that perceived reliability of routine signage can transfer to perceived reliability of emergency exit signage and willingness to comply, illustrating how everyday interior cues may shape emergency preparedness through trust and heuristic transfer [52].

8. Practical Use for Buildings Research and Design Practice

For the readership of Buildings, the framework is intended as a research and design tool rather than a checklist of universal prescriptions. It can be used by building researchers to formulate mechanism-specific hypotheses, by interior designers and architects to structure design briefs, by facility managers to organize post-occupancy evaluation, and by healthcare, workplace, learning, hospitality, and public-building teams to identify whether an intervention is aimed at legibility, stress reduction, perceived safety, dwell time, comfort, dignity, or user agency. During early programming, contextual moderators can be weighted

by five practical criteria: user vulnerability, task criticality, exposure duration, reversibility of harm, and evidence uncertainty. High weights should be assigned when users are stressed, ill, neurodivergent, older, unfamiliar with the building, or performing safety-critical tasks; lower weights may be appropriate for low-risk, voluntary, short-duration settings. Mood state should be treated as a measured contextual covariate rather than a universal correction factor: brief baseline affect or stress measures can be used in POE or VR studies to interpret navigation, comfort, and appraisal outcomes.

In design briefing, the framework can help teams ask which mechanism a proposed intervention is intended to activate and what evidence supports that claim. For example, a lighting intervention may be justified through IEQ and visual-comfort evidence, a signage and zoning intervention through wayfinding and bounded rationality, a refuge-zone intervention through prospect–refuge and safety appraisal, and a room-atmosphere intervention through affective appraisal and room-effect research. In post-occupancy evaluation, the same logic can guide measurement by linking design variables to behavioral outcomes such as navigation time, dwell time, stress ratings, perceived safety, or usability.

In virtual-reality-based occupancy testing, the framework can support controlled manipulation of spatial variables before construction or renovation. It also provides an ethical review lens: proposed design interventions should be evaluated not only for behavioral effectiveness but also for transparency, accessibility, dignity, proportionality, and alignment with user welfare. This applied orientation strengthens the manuscript's relevance to building design, facility performance, and human-centered built-environment research. Figure 2 illustrates a practical workflow for coupling physiological metrics with post-occupancy evaluation without treating biometric signals as self-sufficient evidence.

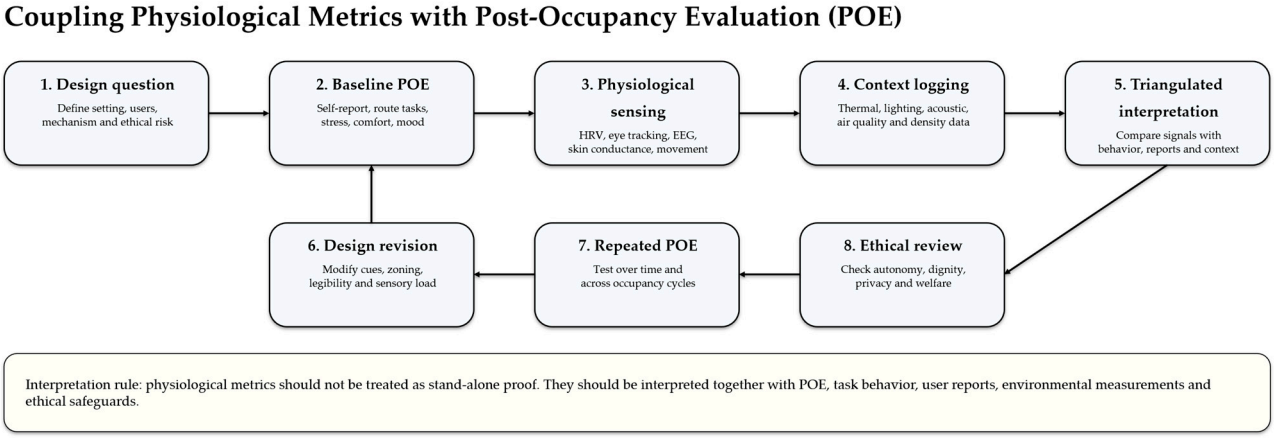

Figure 2. Suggested workflow for coupling physiological measures with post-occupancy evaluation in interior built-environment research.

9. Critical Boundaries and Ethical Considerations

A balanced account of bounded, affective, and heuristic decision-making must avoid environmental determinism. Interior cues do not mechanically produce uniform responses. Effects vary with individual differences, cultural norms, health status, task demands, spatial literacy, disability, neurodiversity, prior experience, socioeconomic context, and institutional power relations. Design research should therefore avoid universal claims such as "blue is calming" or "curves are always welcoming" without specifying context, population, mechanism, and method [34–36,39,50].

Ethical behavioral design in interior built environments can be defined as the use of spatial, sensory, material, and informational cues to support user comprehension, safety, comfort, dignity, autonomy, accessibility, and welfare without covertly exploiting cognitive

limitations or restricting meaningful choice. This definition distinguishes supportive design from manipulation. Supportive design reduces avoidable cognitive burden, clarifies options, protects vulnerable users, and improves environmental fit. Manipulative design steers behavior primarily for institutional or commercial benefit while obscuring intent, limiting agency, or increasing user vulnerability [8,9,53–55].

Several ethical principles are therefore central: transparency where feasible, respect for autonomy, accessibility for diverse bodies and cognitive profiles, dignity in care and institutional settings, consent when behavioral data are collected, proportionality between design influence and user benefit, and explicit consideration of user welfare. These principles are especially important in healthcare, psychiatric, educational, retail, and workplace environments, where users may have limited ability to leave, reduced bargaining power, or heightened stress [47,48,53–55].

Transparent Boundaries in Sensitive and High-Stress Interiors

Sensitive environments such as healthcare waiting rooms, psychiatric units, emergency departments, airports, schools, and workplaces require more explicit boundaries than retail or hospitality settings. Ethical behavioral design in these contexts should satisfy four conditions. First, the intended user benefit should be clear and proportionate, such as reducing confusion, supporting recovery, improving safety, or improving accessibility. Second, the intervention should not conceal material information or restrict meaningful choice. Third, users should not be targeted because stress, illness, dependency, age, disability, or institutional authority makes them easy to steer. Fourth, when behavioral or physiological data are collected, privacy, consent, data minimization, and non-punitive use should be specified. These boundaries help distinguish supportive interior design from opaque manipulation.

The evidence base also has methodological limitations. Many studies use images or simulated interiors rather than lived environments. Virtual reality improves ecological validity compared with static images, but it still cannot fully reproduce long-term occupancy, social meaning, smell, maintenance, real risk, or embodied routines. Physiological measures such as EEG, heart rate variability, skin conductance, and eye tracking provide useful signals, but they require careful interpretation and triangulation with self-report, behavior, and contextual observation [10–14,32,46].

Finally, the broader nudge literature remains contested. Some meta-analyses report meaningful effects of choice architecture, while critical re-analyses question the robustness of effects after accounting for publication bias and heterogeneity. Interior built-environment research should learn from this debate by testing context-specific mechanisms, reporting null results, preregistering where appropriate, and avoiding exaggerated claims about behavioral influence [56,57].

10. Future Research Agenda

Future research should move from broad conceptual claims to specific, testable hypotheses. The framework suggests several priorities. First, interior design studies should compare mechanism-specific predictions: for example, whether a wayfinding intervention reduces cognitive load because of improved legibility, whether a material intervention changes perceived quality through representativeness, or whether a lighting intervention affects stress through arousal regulation [19,21,35].

Second, future studies should use stronger methods. Promising approaches include immersive virtual reality with controlled environmental manipulations, mobile EEG, heart rate variability, skin conductance, eye tracking, post-occupancy evaluation, naturalistic field experiments, and longitudinal residential or workplace studies. Mixed-

methods designs are particularly valuable because spatial experience is both measurable and interpretive [11,14,32]. Table 5 provides an example of how future researchers could operationalize the framework in a longitudinal field study under real occupancy conditions.

Table 5. Sample longitudinal field-study template for validating mechanism-based interior design hypotheses.

Study Phase	Purpose	Example Measures	Design Decision Supported
Baseline POE	Document current user experience and environmental conditions	Wayfinding time, route errors, perceived safety, mood/stress baseline, thermal comfort, lighting/acoustic readings	Identify whether the problem is spatial, sensory, informational, or organizational
Design intervention	Modify one or two mechanism-linked cues	Dynamic lighting gradient, focal landmark, signage hierarchy, acoustic zoning, thermal-comfort adjustment	Avoid multiple uncontrolled changes and connect each cue to a proposed mechanism
Short-term follow-up	Test immediate appraisal and navigation effects	Route-choice task, cognitive-load rating, HRV/EDA or eye-tracking where appropriate, user interviews	Assess whether the intervention changes perception, behavior, and comfort in the expected direction
Longitudinal follow-up	Test familiarity, reliability and temporal feedback	Repeated POE at 1–3 and 6–12 months, maintenance logs, complaint data, occupancy patterns	Determine whether effects persist, decay, reverse, or depend on accumulated experience
Ethical acceptability review	Assess whether influence remains supportive	Perceived autonomy, transparency, dignity, accessibility, privacy, and user welfare ratings	Distinguish beneficial behavioral support from opaque or coercive manipulation

Third, the field needs cross-cultural and inclusive research. Interior responses are not culturally neutral. Color meaning, privacy norms, expectations of comfort, sensory tolerance, institutional trust, gendered safety perceptions, age-related needs, disability, and neurodiversity all shape environmental appraisal. Research should therefore move beyond convenience samples and include diverse user groups [39,50].

Fourth, future research should explicitly measure ethical acceptability. If an intervention guides movement, purchasing, waiting, treatment compliance, or emotional regulation, researchers should ask whether users perceive it as supportive, transparent, coercive, or manipulative. This is essential for distinguishing human-centered behavioral design from covert control [53–55].

Fifth, theoretical development should integrate interior design with current neuroscience and cognitive science without reducing design to brain-response measurement. The most useful direction is not neuro-reductionism but a multi-level model linking environmental cues, bodily state, affective appraisal, cognitive processing, social meaning, and behavior over time [10,14,46].

11. Limitations

This review is narrative, conceptual, and integrative rather than systematic or meta-analytical. It does not provide exhaustive database-specific search strings, formal record counts, duplicate screening, risk-of-bias appraisal, or quantitative effect estimates. This limitation is intentional and is consistent with the article's revised positioning as a narrative review and conceptual framework. The framework should therefore be understood as a structured interpretive model and research agenda, not as a validated predictive tool. The broad application scope should therefore be interpreted as hypothesis-generating rather than as a claim that every context is supported by equal empirical strength.

A second limitation is that much of the available evidence comes from adjacent fields such as environmental psychology, behavioral economics, architecture, retail atmospherics,

and neuroscience rather than from controlled studies conducted specifically within interior design. The translation of these findings into interior practice requires empirical validation in real settings and with diverse populations [10,24,31].

A third limitation concerns the pace of methodological development. VR, EEG, physiological sensing, and AI-supported environmental analysis are evolving rapidly. The evidence base should be updated regularly, especially as more naturalistic and longitudinal studies become available [11,14,32].

12. Conclusions

Interior built environments influence behavior and experience through more than conscious rational evaluation. Users respond through bounded attention, affective appraisal, heuristics, familiarity, embodied perception, and approach–avoidance processes. However, these mechanisms must be distinguished rather than collapsed into a vague category of non-rational behavior [4,7,19].

This narrative review provides a more precise framework for understanding how interior cues are appraised and translated into behavioral and emotional outcomes. It formalizes the pathway from environmental affordances to appraisal, decision mechanisms, behavioral responses, and experiential outcomes while identifying moderators, evidence-status distinctions, and ethical boundaries. It incorporates recent evidence from neuroarchitecture, virtual reality, indoor environmental quality, wayfinding, healthcare design, and room-effect research [10–14,21,44,46,47]. Its theoretical implication is to shift interior built-environment research from object-level preferences toward mechanism-level explanation. Its practical implication is to help design teams specify why a cue is expected to work, for whom, under which conditions, and with what ethical limits. For policy and facility-management stakeholders, the framework offers a language for connecting design quality, accessibility, safety, IEQ, and user welfare in POE and renovation decisions.

For interior built-environment research, the central implication is methodological as much as practical. Designers and researchers should move from broad claims about emotional or intuitive design toward testable, context-specific mechanisms. For practice, the implication is ethical: interior environments should support comprehension, well-being, dignity, and agency, not exploit cognitive limitations. The proposed framework provides a basis for future empirical research capable of testing how interior design can responsibly support human behavior as it actually occurs [8,9,56,57]. Future work should prioritize longitudinal field studies, transparent effect-size reporting, inclusive samples, and integration of user-reported, behavioral, physiological, and environmental data.

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