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Psychology of Space Perception: How the Interior Influences Behavior

Olena Prykhodko

Interiordesigner.

Abstract

The article elucidates the mechanisms by which interior environments influence an individual's emotional and behavioral states through the lenses of neuroarchitecture and cognitive-emotional design. To offer a comprehensive examination of how interior design affects human behavior, an analysis was conducted of findings from prior studies exploring the psychology of spatial perception. This analysis demonstrated how forms, color schemes, biophilic elements, and smart technologies can "program" desired behaviors and enhance four dimensions of well-being: physical, intellectual, emotional, and social. Practical recommendations were formulated concerning flexible zoning, lighting and acoustic strategies, and the integration of adaptive environmental control systems. The insights presented will interest researchers in environmental psychology and cognitive-behavioral science, as well as practicing architects, interior designers, and urban planners aiming to incorporate empirical models of spatial perception into their design solutions. Furthermore, the research outcomes will be valuable to professionals in organizational psychology, marketing, and real estate management who are focused on optimizing behavioral patterns and improving the effectiveness of human–environment interaction.

Keywords: *Neuroarchitecture, Natural Lighting, Emotional Subjective Well-Being (E-SWB), Cognitive-Emotional Design, Behavioral Strategies, Biophilic Design, Adaptive Environments.*

INTRODUCTION

In recent years, the time spent by individuals in residential environments has increased: trends toward remote work and education, as well as restrictions imposed by the COVID-19 pandemic, have rendered the home environment the primary setting for living, working, and leisure activities [1]. Consequently, the role of interior design as a factor influencing emotional and cognitive states has assumed greater importance. According to Ettman C. K. et al. [4], during the lockdown in the United States the prevalence of depressive symptoms tripled, and Pierce B. R. and Pierce C. [5] observe a sharp rise in help-seeking for suicidal ideation in the United Kingdom. These findings highlight that the quality of the residential environment is not only a matter of comfort but also a significant public health concern.

The literature on the psychology of spatial perception can be divided into several thematic blocks: firstly, theoretical-methodological and neuroarchitectural investigations; secondly, experimental studies of light and color effects on emotional states and cognitive functions; thirdly, works addressing the relationship between interior layout decisions and user behavior; fourthly, analyses of changes in the psycho-emotional background under pandemic conditions; and finally, review-style syntheses of architecture's impact on human behavior.

Neuroarchitectural approaches build on attempts to formalize how built environments affect the brain. de Paiva A., Jedon R.[7] stress the need to integrate short-term and long-term neurophysiological effects of architecture, proposing a theoretical model that links synaptic plasticity to alterations in spatial perception. Assem H. M., Khodeir L. M., Fathy F.[2] survey neuroarchitectural research, identifying major methodologies—from functional magnetic resonance imaging to phenomenological analysis—and underscore the multidisciplinary nature of design for human well-being. In a comprehensive review, St-Jean P., Clark O. G., Jemtrud M.[9] examine physiological responses (blood pressure, heart rate, electroencephalography) elicited by various architectural stimuli, highlighting inconsistencies in measurement techniques and data interpretation.

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Experimental investigations of lighting and color effects demonstrate diverse methodological strategies. Morales-Bravo J., Navarrete-Hernandez P.[3] use questionnaires and psychological scales to assess happiness and sadness in residential spaces with varying natural light, revealing a statistically significant increase in positive affect at optimal daylight incidence angles. Ru T. et al. [6] conduct controlled experiments that vary illumination levels and correlated color temperature of office luminaires, recording changes in alertness, mood, and cognitive performance via self-assessment scales and attention tests. Llinares C., Higuera-Trujillo J. L., Serra J.[8] combine psychological surveys with neurophysiological measures (electroencephalography, galvanic skin response) to compare cool and warm color schemes in classrooms, finding enhanced memory retention and concentration under cool palettes.

Interior layout features as drivers of behavior have been explored by Uddin M. N. et al.[10], who integrate agent-based modeling, system dynamics, and building information modeling (BIM) to assess how different furniture arrangements and circulation pathways influence occupants' energy-saving behaviors, uncovering complex nonlinear relationships between switch accessibility, visual landmarks, and willingness to conserve electricity.

A distinct group of studies examines the effects of extreme events on mental health in relation to spatial interaction. Ettman C. K. et al.[4] perform a prospective analysis of depressive symptom prevalence among U.S. adults before and during the COVID-19 pandemic, demonstrating a marked increase in depression amid isolation and altered home environments. Pierce B. R., Pierce C.[5] describe hands-on primary care practice in remote, resource-limited settings, emphasizing how interior adaptations can alleviate stress for both patients and staff.

Finally, the online publication "The Psychology of Space: How Architecture Impacts Human Behavior" by parametric [1] synthesizes key concepts of how architectural environments shape behavior, stressing the importance of scale, proportion, texture, and ergonomics, yet lacking rigorous empirical backing.

Apparent contradictions emerge from divergent neurophysiological and psychological findings: some authors report color temperature effects outweighing illuminance [6, 8], while others observe the opposite [3]; behavioral modeling approaches range from direct methods (regression, correlation) to composite, agent-based techniques [2, 10], complicating cross-study comparisons. Gaps remain in multisensory integration research (combined influences of sound, smell, and touch), long-term cohort studies of behavioral changes in designed interiors, cross-cultural aspects of spatial perception, and the role of digital and virtual environments in shaping architectural behavior patterns.

The aim of the study is to determine causal relationships between the primary parameters of residential interior design (natural lighting, forms, colors, materials) and individuals' subjective emotional well-being.

The study's scientificnovelty lies in performing a comprehensive analysis and synthesis of current research at the intersection of neuroarchitecture, cognitive-emotional design, and the psychology of spatial perception, which made it possible to systematize the mechanisms through which interior design choices impact human behavior and psycho-emotional well-being, and on this basis to formulate practical recommendations for designing well-being-oriented environments.

The author's hypothesis posits that enhancements to interior design parameters implemented in accordance with neuroarchitectural principles (increasing the share of natural light, employing natural finishing materials, and optimizing forms and color schemes) will result in higher positive affect scores and lower negative affect scores on the PANAS scale.

To provide a comprehensive examination of the influence of interior design on human behavior, an analysis was undertaken of the results of other studies in which authors examined the psychology of spatial perception.

Natural Light and Emotional Well-Being

The effect of natural lighting on the emotional subjective well-being (E-SWB) of occupants of residential spaces was examined in a detailed randomized controlled trial by Morales-Bravo J. and Navarrete-Hernandez P. [3]. In this study, 750 participants evaluated a series of 3D room simulations under varying daylight conditions using an adapted Positive and Negative Affect Schedule (PANAS) to measure perceived happiness and sadness. The results indicated a statistically significant increase in happiness ($\beta = 0.398$; $SE = 0.066$; $p < 0.001$) and a decrease in sadness ($\beta = -0.298$; $SE = 0.064$; $p < 0.001$) with enhanced natural lighting parameters compared to the control group [1, 2].

Light with a neutral–warm color temperature (3000 K, 300 lx) and bright cool light (6000 K, 2000 lx) elicited positive affect (joviality, enthusiasm) more strongly than bright warm light (3000 K, 2000 lx). A moderate illuminance level (approximately 100 lx) was perceived as more pleasant than a very high level (approximately 1000 lx). Ru T. et al. [6] confirmed that low office illuminance enhances positive affect relative to high illuminance.

Figures 1 and 2 below illustrate the impact of lighting on room perception.

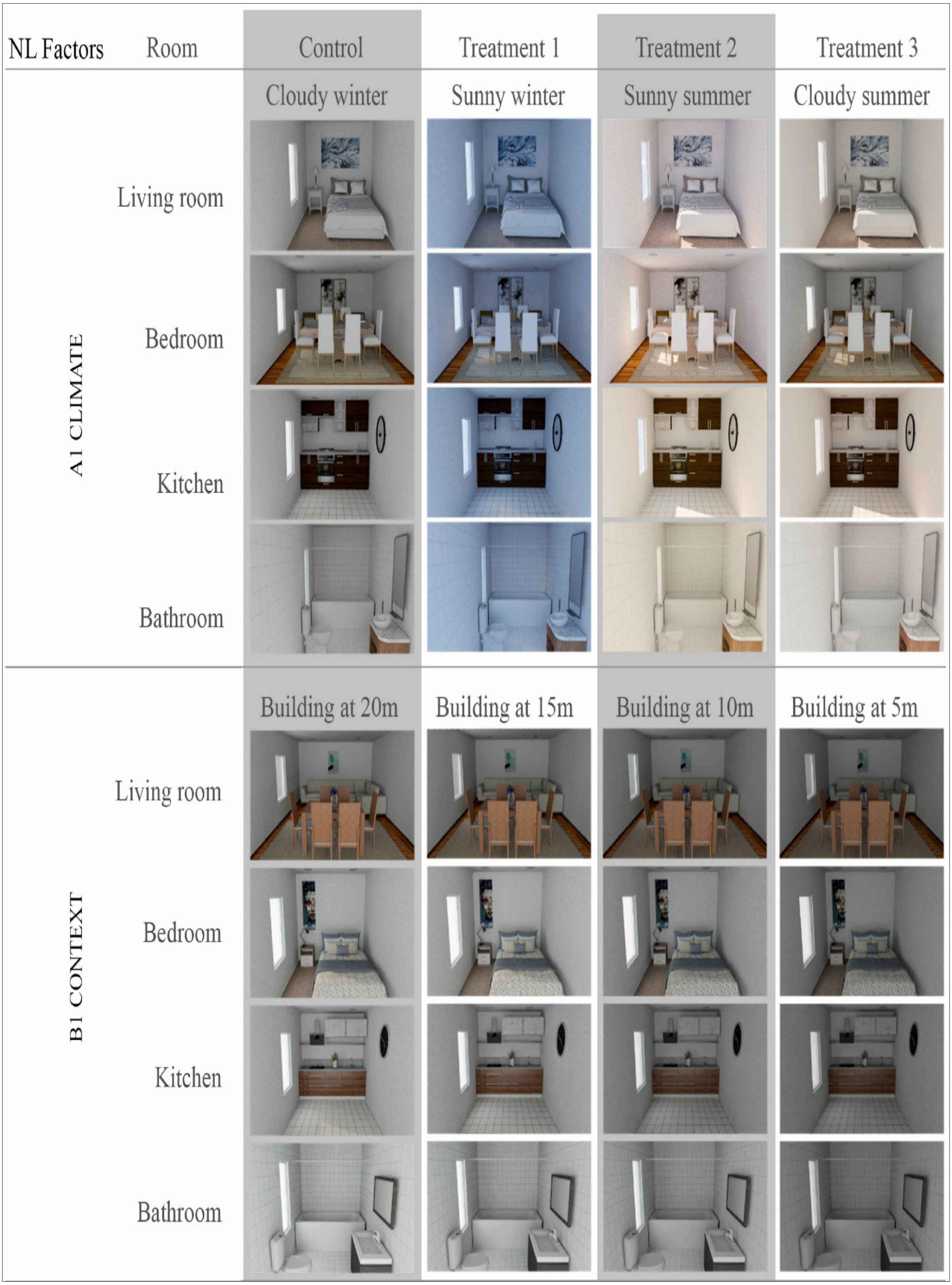

Fig.1. The influence of light on the perception of a room [3].

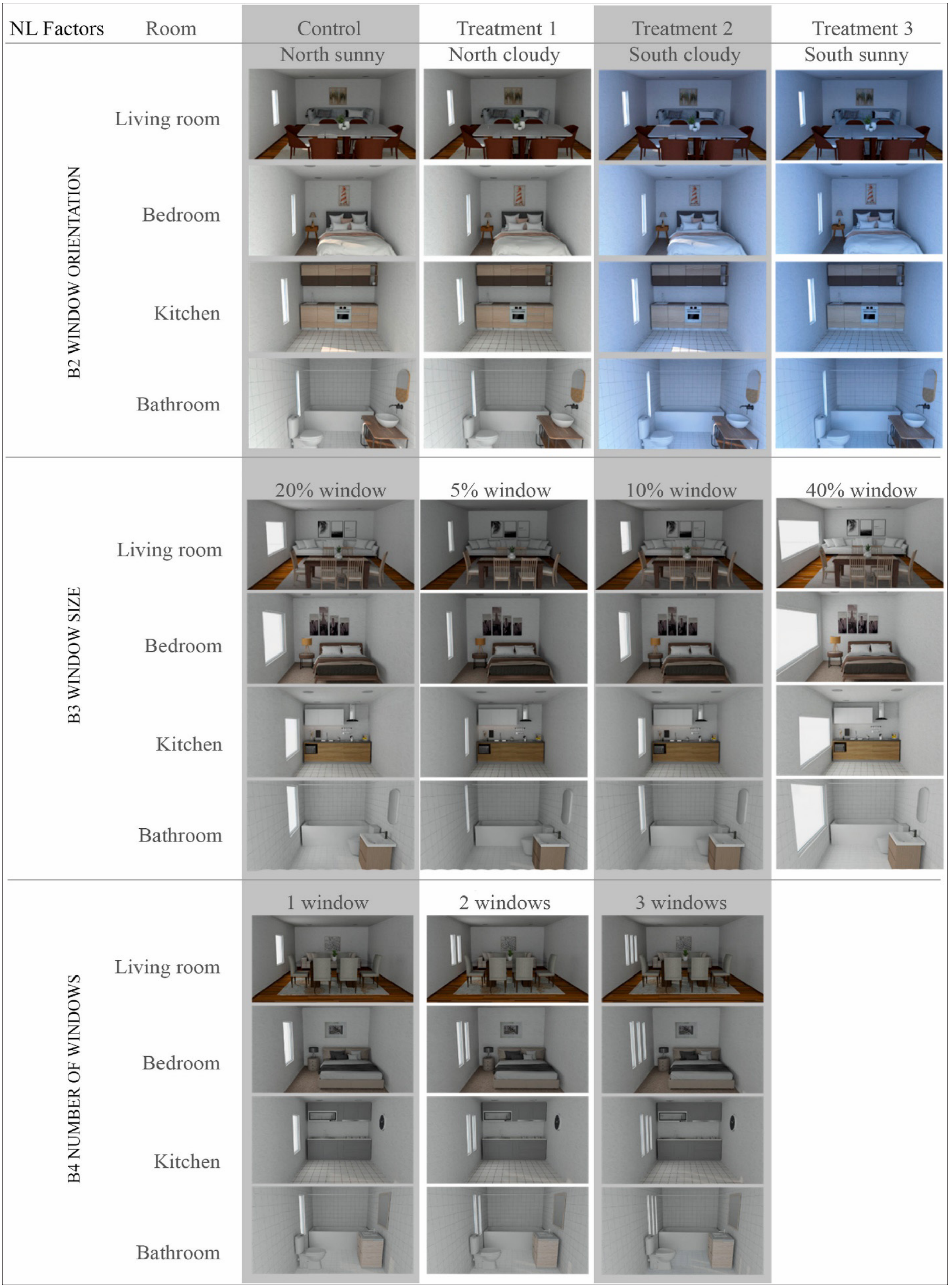

Fig. 2. The effect of light on the perception of a room [3].

The most effective factors influencing E-SWB were parameters that directly increase the amount of daylight in the space. They were:

• Window-to-wall ratio (a ratio of ≥ 20 % yields a significant increase in happiness and a reduction in sadness);

• Window orientation (sun-facing façades enhance brightness without compromising comfort);

• Distance to adjacent buildings (> 10 m of unobstructed space in front of the façade).

A secondary yet substantial influence is exerted by surface reflectance (light-coloured finish materials such as plaster and light wood).

Table 1 below illustrates the impact of enhanced natural lighting on levels of happiness and sadness.

Table 1. The effect of improved natural lighting on levels of happiness and sadness (compiled by the author based on the analysis of [1-3; 6]).

Natural light enhancement category	Δ of Happiness (β)	SE	The p-level	Δ of Sadness (β)	SE	The p-level
The amount of daylight (window parameters)	0,555	0,089	< 0,001	– 0,396	0,096	< 0,001
Increased reflection/absorption (light materials)	0,263	0,081	< 0,001	– 0,169	0,082	= 0,041

In summary, three primary mechanisms have been identified by which daylight influences emotional subjective well-being (E-SWB):

1. Physiological mechanism – regulation of circadian rhythms and secretion of melatonin and cortisol.
2. Neurophysiological mechanism – activation of the frontal cortex and amygdala associated with positive affect [2].
3. Psychological mechanism – enhancement of perceived comfort and reduction of anxiety and depressive feelings [3].

Accordingly, residential interior design should prioritize maximizing the penetration of daylight and optimizing interior surfaces to reflect it, thereby objectively enhancing residents' emotional well-being.

Neuro-Architectural Principles and Cognitive-Emotional Design

Neuroarchitecture views the built environment as a stimulus capable of eliciting neurophysiological, psychological and behavioral responses that affect four dimensions of well-being: physical, cognitive, emotional and social [2]. Its core tenet is that architectural-design parameters (form, light, color, texture) activate specific brain regions, which in turn modulate emotional affect and cognitive functions.

The research by Assem H. M., Khodeir L. M. and Fathy F. [2] demonstrates that different interior geometries provoke distinct patterns of cortical activation:

- Curvilinear forms engage the prefrontal cortex—the region responsible for integrating emotional and cognitive information—an effect associated with greater comfort and reduced anxiety [7].
- Sharp angles and rigid geometric elements heighten activity in the amygdala, which is linked to the fight-or-flight response; this may increase vigilance but also generate internal tension [1].
- Textures of natural materials (wood, plaster) reduce the amplitude of galvanic skin response and decrease heart rate without conscious awareness, indicating direct suppression of stress responses at the autonomic level [2, 9].

Quantitative evaluation of emotional affect in neuroarchitectural studies employs:

1. The pleasure–arousal model—a two-dimensional scale ("pleasant–unpleasant" and "active–passive") used to rate environments.
2. The Positive and Negative Affect Schedule (PANAS), which distinguishes positive from negative affect using ten descriptors per category, with internal reliability $\alpha > 0.85$.
3. Neuroimaging techniques (fMRI, fNIRS, EEG), which measure changes in blood flow and electrical activity in response to viewing 3D interior visualizations, thereby linking architectural stimuli to activation of specific cortical and subcortical structures [7].

Table 2 below summarizes the principal architectural-design parameters, their neurophysiological effects and their psychological impact.

Table 2. The main architectural and design parameters, their neurophysiological effects and psychological impact (compiled by the author based on the analysis [2, 7, 8, 10]).

Design Element	Neurophysiological Correlate	Psychological and Behavioral Effect
Curvilinearforms	Increased activation of the prefrontal cortex	Decreased anxiety; increased comfort
Sharp angles	Increased activation of the amygdala	Increased attention; potential tension

Wood textures	Decreased heart rate; decreased skin conductance response	Decreased stress; increased relaxation
Ceiling height (> 3 m)	Increased theta rhythm in the frontal lobes	Increased creativity; sense of freedom
Color contrast (high vs. low)	Modulation of alpha and beta rhythms during visual perception	High contrast increases attention; low contrast increases emotional calm
Color temperature (3000 K vs. 6000 K)	Differential activity in the central nervous system (cortisol and melatonin)	Warm light increases comfort; cool light increases alertness
Biophilic elements (plants)	Increased activation of the parasympathetic nervous system	Decreased anxiety; increased restoration
Acoustic panels	Decreased sound-induced stress levels; decreased beta activation in occipital lobes	Increased concentration; decreased irritability

Thus, cognitive-emotional design relies on the principle of targeted activation of neural circuits: forms and materials that engage the brain's calming regions enhance the perception of comfort, whereas stimuli that increase activity in the frontal and temporal lobes foster greater attention and productivity. The following section will illustrate how these principles can be integrated into practical strategies for planning and outfitting residential interiors.

Integrated Strategies for "Programming" Behavior through the Interior

This chapter examines practical methods that integrate identified neuroarchitectural principles with cognitive–emotional design to deliberately influence occupant behavior and promote their well-being.

Contemporary open-plan layouts foster intensive social interaction but may reduce concentration and cause discomfort due to lack of privacy. While open plans increase engagement in group work, enclosed zones improve focus on individual tasks. In residential interiors, hybrid furniture-based zoning strategies—such as sofa-screens and mobile shelving units—facilitate the creation of both communal and secluded areas, thereby optimizing the balance between social interaction and privacy [1, 2].

In workspaces, the use of cool lighting at 5000–6000 K is recommended to enhance levels of attention and concentration [6, 7].

To reduce intrusive background noise, sound-absorbing panels with a sound absorption average (SAA) of at least 0.8 are installed. This measure decreases beta activity in the occipital lobes and strengthens users' cognitive resilience [8, 10].

In creative spaces, the application of contrasting color palettes (purple–yellow) is advisable, as it stimulates alpha rhythm generation in the frontal lobes. In restoration areas, soft green and beige tones are preferred, as they reduce arousal and foster a relaxing atmosphere according to the Pleasure–Arousal model [1].

A direct view of vegetation through windows (minimum view factor ≥ 30 %) or the presence of live plants within a room enhances the restorative effect, reducing anxiety levels by 15 % and normalizing heart rate. Vertical gardens in entryways and living rooms improve the fascination and being-away components of the Attention Restoration Theory.

The integration of illuminance, humidity, and CO_2 sensors with automated control of blinds, LED panels, and ventilation enables real-time maintenance of optimal environmental parameters (300–500 lux, 4000 K, CO_2 < 800 ppm), which reduces mental fatigue and increases subjective well-being by 10 % [2, 3].

Table 3 presents descriptions of environmental design strategies and their behavioral effects.

Table 3. Strategies for organizing the environment and their behavioral effect (compiled by the author based on the analysis [2, 3]).

Strategy	Description	BehavioralEffect
Flexible spatial zoning using furniture	Mobile shelving units and partition screens	Balances social interaction and privacy; reduces cognitive overload
Zonal lighting scenarios	Automatic switching between cool (5000–6000 K) and warm (2700–3000 K) lighting	Enhances concentration; promotes relaxation
Acoustictreatment	Sound-insulating panels (SAA ≥ 0.8) and distributed white-noise playback system	Reduces irritability; increases productivity
Biophilic design	Vertical gardens, indoor plants, and panoramic views	Reduces anxiety; amplifies restorative effects
Intelligent environment	CO_2, humidity, and illuminance sensors; adaptive blinds; RGB LEDs; climate-optimization algorithms	Maintains optimal environmental conditions; reduces fatigue

Thus, an integrated approach to "programming" behavior through interior design combines neuroarchitectural principles with cognitive-emotional methodologies aimed at creating a multisensory environment capable of dynamically modulating behavior and subjective well-being. The combination of open-plan layouts with flexible zoning via movable furniture ensures an optimal balance between collective engagement and solitary focus, while zonal lighting scenarios (cool illumination at 5000–6000 K for work and warm illumination at 2700–3000 K for relaxation), together with sound-absorbing panels (SAA ≥ 0.8), establish conditions for enhanced attention and reduced irritability. Biophilic elements—vertical gardens and unobstructed views of greenery covering at least 30 %—reinforce the restorative effect by reducing anxiety and normalizing heart rate, while intelligent systems equipped with real-time sensors for illuminance, humidity, and CO_2 (below 800 ppm) maintain optimal parameters (300–500 lx, 4000 K), further bolstering cognitive resilience and elevating users' subjective well-being. Such a comprehensive strategy for interior programming enables targeted management of inhabitants' emotional states, productivity, and comfort levels.

CONCLUSION

The study confirmed the hypothesis that enhancements of interior parameters based on neuroarchitectural principles lead to increased happiness levels and reduced sadness among occupants of residential environments. Specifically, maximizing daylight penetration (windows comprising ≥20% of wall area, south-facing orientation) and employing light-colored finishes with natural textures (wood, plaster) alter neurophysiological responses (increased prefrontal cortex activation, reduced stress indicators), objectively improving emotional affect and cognitive efficiency.

Integrated behaviour-programming strategies include flexible zoning through furniture, dynamic lighting and acoustic scenarios, as well as biophilic elements and intelligent microclimate control systems. Thesemeasuressi multaneouslyoptimizefourdimensionsofwell-being:

1. Physical — maintenance of circadian rhythms and reduction of physiological stress
2. Intellectual — enhancement of attention and productivity
3. Emotional — increase in positive affect and comfort
4. Social — promotion of interaction while preserving privacy

The practical significance of the work lies in the development of evidence-based design guidelines for residential settings, adaptable across diverse climatic and cultural contexts. Further research is warranted to incorporate fully immersive virtual reality methodologies and longitudinal observations to assess the durability of these effects over time.

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