How Space Impacts Cognitive Performance

Neuroscience and Biophilia Applied to Space Design

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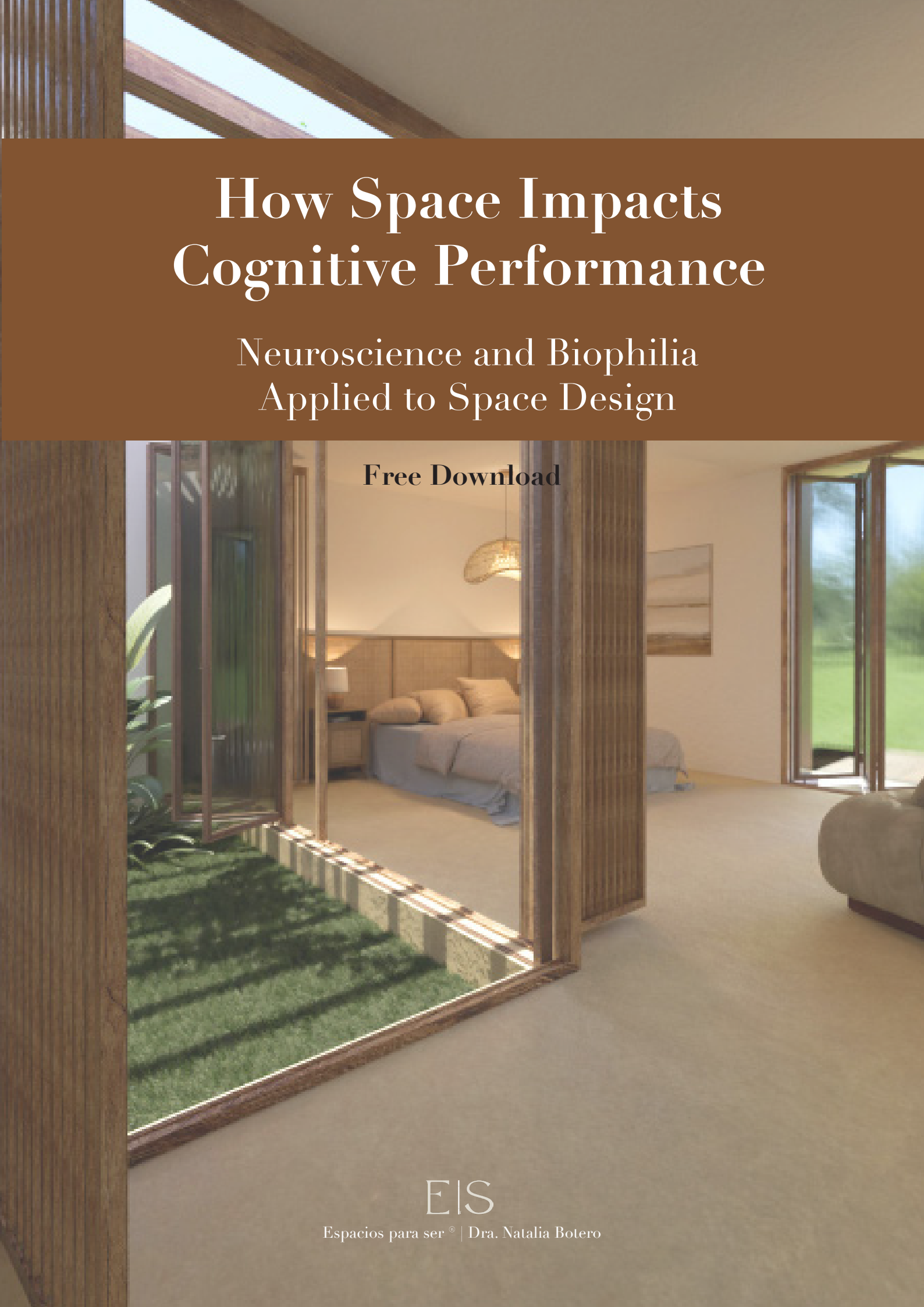

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Espacios para ser ® | Dra. Natalia Botero

How Space Impacts Cognitive Performance.

Neuroscience and Biophilia Applied to Space Design.

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Date: January 2026
Espacios para Ser | Conscious Design for Home & Being

SUMMARY

The average CEO sleeps approximately 5.8 hours per night. 68% of remote workers report concentration difficulties in their home office. Sick building syndrome affects 20-30% of occupants in modern buildings.

These are not statistics about productivity or time management. They are symptoms of a deeper problem: the built environment is not neutral. Every space where we spend time is actively influencing our biology, our cognition and our wellbeing — whether we are aware of it or not.

This whitepaper presents the foundations of Wellness Design: an evidence-based spatial design approach that integrates neuroscience, biophilia and ancestral principles of spatial organisation in order to create environments that optimise human performance.

What you will learn:

- Why your current space may be undermining your performance without you noticing
- The 5 scientifically validated pillars of Wellness Design
- Real cases of transformation (CEO with chronic insomnia, entrepreneur with fatigue)
- A practical framework for assessing and improving your own space

Key fact: It is scientifically proven that spaces designed according to neuroarchitectural principles improve cognitive performance by 15-25%, sleep quality by 20-35%, and reduce cortisol levels (the stress hormone) by 10-20%.

The question is not whether your space affects you. The question is: is it working for you or against you?

Contents

Section 1: The invisible space that governs your life

1.1 Your brain is under constant siege

Every morning, millions of high-performance professionals wake up with the same feeling: exhaustion. Despite 7-8 hours in bed. Despite the premium mattress. Despite leaving their phone outside the bedroom.

The problem is not how much they sleep. It is where they sleep.

30% of the urban population suffers from chronic insomnia related to their environment (WHO, 2024). Workers in poorly lit spaces make 40% more cognitive errors (Harvard, Allen et al., 2016). Poor ventilation reduces performance in complex tasks by up to 50%.

But these statistics, as alarming as they are, do not capture the real problem.

The real problem is that we do not know our space is affecting us.

Your brain processes 11 million bits of sensory information per second. Of those, only 40 bits reach your conscious awareness. This means that the remaining 99.9996% is processed unconsciously, influencing your physiological state, your mood, your ability to concentrate and your sleep quality.

This means that as you read this document, your brain is evaluating the temperature of the space you are in, the quality of the light, the ambient sounds, the materials around you, the geometry of the walls. And it is translating all of that information into chemical processes: hormones, neurotransmitters, signals of alert or calm.

Your space is constantly changing you. The question is: in which direction?

1.2 The modern CEO paradox

I have worked with executives who invest €5,000 a year in executive coaching, productivity courses and biohacking. They track their steps, their heart rate variability, their hours of deep sleep.

Yet they overlook the fact that they spend 16 hours a day in spaces that actively work against their biology.

Consider a typical case:

Chief Technology Officer, 42 years old. Sleeps 5 hours, wakes up 3 to 4 times per night. His home office has a large south-facing window that floods the room with natural light. Minimalist white desk. 6500K LED lighting on constantly until 11pm.

His medical diagnosis: primary insomnia, generalised anxiety. His medication: Zolpidem, which does not work consistently.

The real problem: he does not have insomnia. He has a space designed to keep him awake.

6500K light (a cool colour temperature, similar to midday sunlight) suppresses melatonin production. Being exposed to it until 11pm is the biological equivalent of telling the brain "it is still midday, it is not time to sleep" — in other words, keep working.

This case is not exceptional. It is the norm today.

1.3 What is Wellness Design?

Wellness Design is the design of spaces based on scientific evidence about how the built environment affects its inhabitants in terms of:

- The nervous system (sympathetic vs. parasympathetic activation)
- Circadian rhythms (sleep-wake cycles)
- Cognitive processing (attention, memory, creativity)
- Emotional regulation (cortisol, serotonin, dopamine)
- What Wellness Design is NOT:

❌ Wellness decoration (scented candles, meditation cushions, motivational posters)
❌ Extreme minimalism (removing everything until you create a sterile space)
❌ Biohacking disconnected from architecture (blue-light-blocking glasses that do not compensate for a poorly oriented bedroom)

What Wellness Design IS:

✓ Architecture informed by neuroscience and human biology
✓ Design that respects chronobiology (the body's natural rhythms)
✓ The design of spaces that amplify your best self rather than block it

The difference between decoration and Wellness Design is the difference between placing a plant on your desk because it looks nice, and placing a Sansevieria in your bedroom because it produces oxygen at night and reduces volatile organic compounds by 35%. Both options involve a plant. Only one is based on scientific evidence..

1.4 The hidden cost of poor design

TABLE 1: Impact of Poor Design on Performance

Factor	Impact
Incorrect lighting in home office	-23% processing speed
Ambient noise >55dB	-15% working memory
Absence of natural elements	+12% baseline cortisol
Poor ventilation	-50% performance in complex tasks

How this impacts your health:

- Exposure to blue light at night is equivalent to reducing your body's melatonin by 50-80% (Gooley et al., 2011)
- Poor ventilation reduces cognitive performance by 50% in complex tasks (Harvard, Allen et al., 2016)
- Spaces without visual connection to nature increase the probability of clinical anxiety by 18% (Ulrich et al., 1991)
- Economic impact (conservative calculation for a CEO):

- 20% productivity improvement = 1.6 additional effective hours per day
- CEO hourly value (salary €120,000/year) = €60/hour
- Annual ROI: €60 × 1.6h × 250 working days = €24,000/year
- Typical Wellness Design investment for bedroom + home office: €8,000-15,000
- Return on investment: 4-8 months
- And this is without factoring in reduced medical costs, improved personal relationships (less irritability, more presence), or the impact on longevity and quality of life.

How much is it costing you to ignore this?

Section 2: The 5 Pillars of Wellness Design

TABLE 2: The 4 Pillars of Wellness Design

Pillar	What it regulates	Main benefit
Circadian Lighting	Sleep-wake rhythms	+18% cognitive performance
Biophilia	Nervous system	-12% cortisol in 3 minutes
Natural Materials	Physiological response	-6 bpm heart rate
Geometry and Proportion	Cognitive processing	Activates creativity or concentration

Neuroarchitecture is not a trend. It is an established field of research since 2003, when the Academy of Neuroscience for Architecture (ANFA) was founded, bringing together neuroscientists and architects to study how the brain processes space.

The scientific methods used in these studies include functional magnetic resonance imaging (fMRI), electroencephalography (EEG), salivary cortisol measurement, and galvanic skin response. The results are consistent: space shapes your mind — either negatively or positively.

From this research, 4 fundamental pillars emerge.

2.1. Pillar 1: Circadian Lighting

Your body has an internal clock of approximately 24 hours called the circadian rhythm. This clock regulates when you produce alertness hormones (cortisol) and when you produce sleep hormones (melatonin). And the primary signal it uses to calibrate itself is light. Sunlight is the natural standard, but there is also artificial circadian lighting, which §mimics natural light.

How it works:

Morning natural light (with a colour temperature between 5000–6500K, where the blue spectrum is dominant) suppresses melatonin and triggers cortisol production. This wakes you up and activates you. Essential for starting the day.
Warm afternoon/evening light (with an amber spectrum of 2700–3000K) allows the body to produce melatonin. This prepares you for rest. Essential for falling asleep.
What the science says:

Exposure to blue light during evening hours shifts your circadian rhythm by 1.5 to 3 hours (Gooley et al., 2011). This means that if your body should begin preparing for sleep at 21:00, blue light delays it until 22:30 or even 00:00.

- Offices with dynamic lighting (that shift colour temperature throughout the day) show an 18% improvement in cognitive performance (Mills et al., 2007).
- Proper morning light improves memory consolidation during nighttime sleep (Cajochen et al., 2005).

What happens in poorly lit spaces:

Home offices without direct natural light → Residual melatonin production during the day → Drowsiness, brain fog, fatigue by 15:00.
Bedrooms with blue light at night (screens, cool LEDs, digital clocks) → Melatonin suppression → Insomnia, fragmented sleep, waking up exhausted.
Constant lighting with no colour temperature variation → Circadian rhythm desynchronisation → Hormonal confusion, irregular performance.

Principles of application:
1. Maximise exposure to natural light in workspaces, especially in the morning.
2. Implement strict nighttime light control in bedrooms, with a gradual transition toward warm light.
3. Consider artificial lighting systems with variable colour temperature according to the time of day.

2.2. Pillar 2: Biophilia (Connection with Nature)

Biologist E.O. Wilson proposed the Biophilia Hypothesis in 1984: human beings have an innate need to connect with nature. It is not an aesthetic preference. It is an evolutionary imperative.

For 99.9% of human history, humans lived in natural environments. Our brains evolved to process natural landscapes — not concrete walls and fluorescent light. When we deprive the brain of these stimuli, something breaks down.

What the science shows us:

- Hospitalised patients with a view of trees recovered 8.5% faster after surgery than patients with views of a brick wall (Ulrich, 1984). This study is one of the most cited in the biophilia literature, as it demonstrated for the first time that nature has measurable effects on physical health.

- The use of plants in offices shows a 15% improvement in productivity and a 6% reduction in perceived stress (Nieuwenhuis et al., 2014).
- Viewing nature for 3 minutes reduces cortisol by 12% (Park et al., 2010).
- People without visual access to nature are 18% more likely to develop clinical anxiety (Ulrich et al., 1991).

Brain mechanisms:
Studies show that contemplating nature activates the ventromedial prefrontal cortex (emotional regulation) and reduces amygdala activity (fear and anxiety processing). Natural fractal patterns (tree branching, cloud formations, river meanders) are processed by the brain more efficiently than artificial geometric patterns, resulting in what psychologists call "attentional restoration" (Kaplan, 1995; Joye, 2007).

Principles of application:

1. Ensure visual connection with nature from main living spaces (at minimum, one window with visible vegetation).
2. Introduce indoor plants strategically (not decoratively), selecting species according to their function (air purification, humidification, nighttime oxygen production).
3. Prioritise natural materials over synthetic ones.

2.3. Pillar 3: Natural Materials

The evolution of the human brain throughout history reflects constant contact with wood, stone, earth, and water. Synthetic materials — plastic, laminates, polished metal, particleboard — are an evolutionary novelty. The brain processes them differently.

What the science tells us about wood:

- Visual and tactile contact with natural wood significantly reduces cortisol levels and activates the parasympathetic nervous system (Sakuragawa et al., 2005).
- In school classrooms with wood cladding, students show a heart rate 6 beats per minute lower than in classrooms with synthetic materials (Kelz et al., 2011).
- Workspaces with visible wood increase productivity and reduce mental fatigue (Burnard & Kutnar, 2015).
- Natural wood absorbs volatile organic compounds (VOCs), improving indoor air quality (NASA, 2019).

What the science tells us about stone:

- High thermal mass materials (such as natural stone) regulate indoor temperature passively, reducing heating and cooling loads by up to 30% (Kumar et al., 2016).
- Direct contact with grounded materials (natural stone, clay) has documented effects on pain reduction, sleep improvement, and stress reduction (Chevalier et al., 2012).

What the science tells us about textiles:

- Natural textiles such as linen and organic cotton do not release volatile organic compounds, while synthetics (polyester, acrylic) can release formaldehyde and phthalates for years (Oeko-Tex, 2020).
- Linen has superior thermoregulatory properties: cool in summer, warm in winter.

Principles of application:

1. Aim for at least 40% of visible contact surfaces to be made of natural materials (wood, stone, organic textiles).
2. Avoid excess reflective surfaces such as metal and glass in rest spaces.
3. Prioritise natural tactile textures — untreated wood, linen, or cotton — at frequent contact points.

2.4. Pillar 4: Geometry and Spatial Proportion

Space is not just what it contains. It is the shape it takes. And that shape directly affects how you think, how you feel, and how you act.

What the science tells us:

- High ceilings activate the dorsolateral prefrontal cortex, associated with abstract thinking and creativity. Low ceilings activate areas for concrete, detail-oriented processing (Vartanian et al., 2013). Implication: ceiling height influences the type of thinking you generate.
- The golden ratio ($\varphi = 1.618$), present in nature (shell spirals, petal distribution, human body proportions), is processed by the brain as "harmonious" without conscious effort.
- Sharp angles (90° corners) activate the amygdala, triggering an alert and vigilance response. Soft curves reduce this activation (Dazkir & Read, 2012).

Principles of application:

1. Design ceiling height according to function: high ceilings for creativity and socialisation, medium ceilings for concentration and rest.
2. Minimise sharp angles in bedrooms, favouring smooth transitions and curves.
3. Consider window-to-wall proportions according to the space's intended activity.

2.5. Pillar 5: Ancestral Spatial Organisation

For 5,000 years, Vedic architectural traditions (Vastu Shastra) developed sophisticated spatial organisation systems based on observing how the environment affects human beings. These principles — orientation according to magnetic fields, placement of functions according to solar activity, proportional geometry — are now being validated by modern neuroscience.

Section 3: Case Studies

TABLE 3: ROI of Wellness Design

Concept	Value
Typical investment (bedroom + home office)	8,000 - 15,000€
Productivity improvement	+20% (1.6h/day effective)
CEO hourly value (salary 120,000€/year)	60€/hour
Annual ROI	24,000 €
Return on investment	4-8 months

3.1. Case 1: From Chronic Insomnia to Regenerative Rest

Profile: Chief Technology Officer, 38 years old. Startup in growth phase. Chronic insomnia: 4–5 hours of fragmented sleep. Severe daytime fatigue. Irritability affecting his team and his family.

Medical diagnosis: Primary insomnia, generalised anxiety. Medication: Zolpidem (not working consistently).

Spatial analysis of his bedroom:

- East-facing window with direct morning light between 06:30 and 09:00. Involuntary premature awakenings.
- Artificial lighting: 6500K LEDs (cool colour temperature) on until 23:00. Complete melatonin suppression during the 2 hours before sleep.
- Materials: white laminated particleboard furniture, white walls, synthetic flooring. Zero connection with natural materials.
- Geometry: rectangular room, bed against a wall shared with the living room. Nighttime noise transmission.

The analysis revealed that the bed was oriented in the opposite direction to the optimal geomagnetic flow — a factor that ancestral architectural systems identified millennia ago as decisive for rest.

Wellness Design intervention:

1. Circadian lighting: Installation of a dynamic light system (6500K in the morning, gradual transition to 2700K in the afternoon). Smart blackout on the east window to control waking time.
2. Natural materials: Oak wood headboard. Linen and organic cotton bedding. Wool rug beside the bed.
3. Biophilia: Introduction of a Sansevieria (produces oxygen at night, reduces VOCs by 35%, low maintenance).
4. Acoustics: Textile absorbent panel on the wall shared with the living room.

Measured results (3 months later):

- Hours of sleep: 7.2h average (before: 4.8h) — a 50% increase in sleep hours.
- Nighttime awakenings: 0–1 (before: 4–6) — a 75% reduction in sleep fragmentation.
- Sleep latency: 15 minutes (before: 45–60 minutes).
- Medication: Completely eliminated by week 8.
- Reported side effect: work performance increased by 30%, stable mood for the first time in years.

Client testimonial:
"I thought I had a sleep problem. It turns out I had a bedroom designed to keep me awake."

3.2. Case 2: A Home Office that Blocks vs. a Home Office that Amplifies

Profile: Freelance strategic consultant, 44 years old. Severe difficulty concentrating. Fatigue between 15:00 and 17:00. Frequent headaches. Declining productivity.

Spatial analysis of her home office:

Location: north-facing room. Minimal natural light throughout the day.
Lighting: a single 4000K LED desk lamp. Insufficient, with harsh shadows.
Materials: black melamine desk, synthetic office chair.
View: empty white wall. Zero visual connection with the outside.
Acoustics: pronounced echo (empty room, porcelain tile flooring).

Wellness Design intervention:

1. Spatial reorientation: Relocation of the home office to a southeast-facing room, with direct morning light during peak concentration hours.
2. Lighting: Overhead 6500K LED panel + dimmable desk lamp + sheer curtain for natural light diffusion.
3. Biophilia: Repositioning of the desk to obtain an exterior view. Introduction of two plants for air purification: pothos and sansevieria.
4. Materials: Replacement of the desk with a light wood one. Introduction of absorbent textiles (linen curtains, jute rug).
5. Acoustics: The curtains and rug reduced echo by approximately 15dB.
6. The desk reorientation followed spatial alignment principles documented in the Vastu Shastra architectural tradition, orienting work toward the east to maximise mental clarity during productive hours.

Results (6 weeks):

- Sustained concentration: 3.5 continuous hours (before: 1.5 hours)
- Headaches: eliminated (cause identified: visual fatigue + insufficient lighting)
- Productivity: 2 additional projects per month — a 40% increase in revenue
- Afternoon energy: "I no longer need a nap at 16:00"

Client testimonial:
"My workspace was sabotaging my business. Now it's my most valuable asset."

3.3. Case 3: Residential Villa in Colombia (Ongoing Project)

Context:

A 450m² residence in Colombia (latitude 6.17°N, equatorial climate). Family of 4. Objective: to create a retreat that optimises rest, family connection, and wellbeing. The design integrates a complete ancestral spatial organisation system: orientation of each function according to its nature, a clear central core, and circulation flow that respects the millennia-old principles of energetic movement.

Wellness Design strategy applied:

Extreme biophilia: A vegetated central courtyard occupying 40% of the total surface area. From 80% of interior spaces, there is direct visual connection with nature.
Natural lighting optimised for equatorial latitude: A lattice system controlling zenithal light entry. Orientations calibrated according to the specific solar path at this latitude.
Natural materials: 60% of surfaces in locally sourced, heat-treated tropical wood (resistant to the climate's humidity). Natural stone in wet areas. Natural fibre textiles.
Geometry: Proportions based on spatial harmony principles and Vastu Shastra. Variable ceiling heights according to the function of each space.

Expected results (project completed January 2026):

- Perceived temperature: -2–3°C compared to traditional homes in the area (thanks to cross-ventilation and vegetation)

- Air quality: 35% higher than standard (air-purifying plants strategically placed)
- Subjective wellbeing: to be measured post-occupancy using validated scales

Section 4: Implementation Framework

The 5 Steps of Wellness Design

4.1. Step 1: Analysis

Before changing anything, you need to understand what is currently happening.

- Assessment of the space's orientation relative to the sun and cardinal axes (principles derived from the Vedic tradition).
- Measurement of natural light quality and quantity.
- Materials inventory (natural vs. synthetic).
- Identification of primary issues (insomnia, lack of concentration, stress, fatigue).
- Prioritisation of interventions according to potential impact and required investment.

4.2. Step 2: Strategic Design

With the analysis complete, the intervention is designed by integrating the 4 pillars.

Integration of circadian lighting + biophilia + materials + ancestral geometry.
Application of spatial organisation principles of Vedic origin (Vastu Shastra) to optimise functional distribution according to orientations.
Adaptation to existing architecture (some improvements require renovation, others only optimisation).
Specification of materials, lighting systems, and biophilic elements.

4.3. Step 3: Gradual Implementation

Not everything needs to be done at once. Implementation is organised in phases according to urgency and impact:

Phase 1 (Quick wins): Immediate changes with high impact and low investment. Nighttime lighting, contact textiles, first plant.
Phase 2 (Mid-level interventions): Paint, main furniture, curtains, more plants.
Phase 3 (Structural renovations): Only if necessary and the return justifies it. Windows, spatial redistribution.

4.4. Step 4: Measurement

What is not measured cannot be improved.
- Baseline (before): Sleep quality, concentration capacity, perceived stress level.
- Follow-up (during): Adjustments based on user feedback.
- Evaluation (after): Comparison of objective and subjective results.

4.5. Step 5: Continuous Optimisation

Wellness Design is not a project that ends. It is a living system.

- Seasonal adjustments (sunlight varies according to the time of year).
- Evolution according to life changes (new job, family changes, ageing).
- Maintenance of plants, lighting systems, and materials.

Section 5: Conclusion
5.1. Beyond Financial ROI

The typical question when we design or renovate a space is: "How much is this house worth?" The Wellness Design question is different: "How much is it worth to sleep 2 extra hours every night? To concentrate for 3 hours straight without fatigue? To reduce your chronic anxiety without medication?"

TABLE 4: CEO Case — Before vs. After

Metric	Before	After (3 months)	Improvement
Hours of sleep	4.8h	7.2h	50%
Nighttime awakenings	4-6	0-1	-75%
Sleep latency	45-60 min	15 min	-70%
Medication	Zolpidem	Eliminated	100%
Work performance	Baseline	30%	30%

These are questions that cannot be answered in euros. But they can be answered in quality of life, in years lived with vitality instead of survival, in relationships not contaminated by the irritability of chronic exhaustion.

Wellness Design is not a luxury. It is an investment in your most valuable asset: your capacity to function, to create, to be present.

5.2. The Future of Design is Conscious

After the pandemic, the home went from being just a refuge to becoming an office, a gym, a school, a space for everything. And with that, the quality of domestic space shifted from being a "nice to have" to a determining factor in performance and wellbeing.

The premium real estate market is already responding to this transition. CBRE studies (2024) show that properties with wellness design features have a perceived value 15% to 25% higher. Certifications such as WELL Building Standard and Fitwel are growing exponentially.

But most of these approaches are partial. They integrate Western science yet ignore millennia of ancestral wisdom on spatial organisation that, curiously, neuroscience is now beginning to validate.

The future belongs to those who know how to integrate both worlds.

5.3. Where to Begin?

If you are a homeowner or CEO:

Audit your current space. Especially where you sleep and where you work.
Identify one primary issue. Insomnia? Lack of concentration? Chronic stress?
Implement one quick change this week. It can be as simple as switching nighttime lighting to warm light, or introducing a specific plant.
Measure the result in 2 weeks.
If you are an architect or designer:

Study applied neuroscience. The Academy of Neuroscience for Architecture (ANFA) is a good starting point.
Integrate one Wellness Design principle into your next project.
Measure the impact on your client.
Document the case.
If you want to go deeper:
This whitepaper is an introduction. Implementation requires specific knowledge of orientations, materials, plant species, lighting systems, and above all, the ability to integrate everything into a coherent design.

That is what I am here for.

Next Step

What now? If what you have read resonates with you, there are two ways to continue:

1. Exploratory Conversation (30 min, no commitment)

Sometimes all that is missing is an external perspective. In half an hour, we can identify what is working in your space, what is not, and what the first steps would be — with no commitment whatsoever.

Book a conversation Here

2. Wellness Design Blueprint

For those seeking a complete transformation: a personalised project integrating neuroscience, biophilia, and Vastu into your space. Includes diagnosis, 3D visualisations, technical drawings, and implementation support.

Request information Here

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About the Author

Dr. Natalia Botero

PhD in Architecture with a thesis integrating Vastu Shastra (traditional Indian architecture), Neuroarchitecture, and Biophilia. 18 years of contemplative practice in the Advaita Vedanta tradition. Former lecturer at UIC Barcelona and Elisava (Architecture programmes).

Her unique approach combines scientific rigour with ancestral wisdom, creating spaces that not only function well, but resonate with something deeper in those who inhabit them.

"Space is not a neutral container. It is an extension of your body, a mirror of your mind, and an ally — or an enemy — of your wellbeing. My work is to make sure it is the former."

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