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NEUROERGONOMICS, INCLUSIVE ARCHITECTURE, AND MENTAL HEALTH: DESIGNING NEURODIVERSITY-RESPONSIVE WORK ENVIRONMENTS

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ABSTRACT

According to the World Health Organization, approximately 17% of the world's population is considered neurodivergent, meaning they have neurological variations that differ from what is considered typical or normative. This includes individuals with Autism Spectrum Disorder (ASD), Attention Deficit Hyperactivity Disorder (ADHD), Dyslexia, Dyscalculia, among others. These people have patterns of cognitive, emotional and social development that diverge significantly from what is expected. Therefore, the ergonomic configuration of workspaces must consider new demands that meet not only the needs of this group, but of all employees. Considering that more than 20 million Brazilians have been diagnosed with burnout, anxiety and depressive disorders, this study aims to investigate, through an interdisciplinary literature review, the contributions of neuroergonomics to mental health and the inclusion of neurodiversity in the workplace. It is expected to ensure not only the quality of the built environment for the performance of tasks, but also to meet the biopsychosocial needs of users. As a result, evidence-based design propositions allied to inclusive architecture were considered, such as: spatial references (wayfinding), spatial organization (layout), biophilic design, thermal comfort, acoustics, integrative lighting and degree of sensory stimulation. It is expected to contribute to the planning of healthy, comfortable, safe and inclusive environments.

Keywords: Neuroergonomics. Inclusive Architecture. Neuroscience. Work Environment. Neurodiversity.

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Revista ARACÊ
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INTRODUCTION

Society has been witnessing a remarkable increase in awareness and acceptance of neurodiversity, which encompasses conditions such as Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorder (ASD), Dyslexia, and other neurological variations. The study "*Neurodiversity at Work*" (2021), by Stanford University, points out that only about half of people identified as neurodivergent are aware of their condition, despite research indicating that approximately one in eight people fall into this category. This group is often characterized by possessing high energy, disruptive thinking, and exceptional problem-solving skills, traits that can be highly valued in dynamic work environments. However, the effective integration of these professionals in contemporary corporate spaces represents a considerable challenge (Kirby; Smith, 2021).

The initiative to make work environments more inclusive not only reflects an ethical stance, but also offers substantial business advantages, since talent diversity drives organizational success. To mitigate this problem, it is essential to understand in detail the term "neurodivergent" and the conditions it covers, such as ADHD, autism, and dyslexia. Although estimated at 17% of the population, the worldwide share of neurodivergent people may be even higher due to underdiagnosis (Nerenberg, 2021). The World Health Organization (WHO, 2020) highlights that neurological conditions represent one of the main public health concerns, highlighting the urgency of effective policy responses to address this issue. In this context, neuroscience applied to ergonomics, known as neuroergonomics, can assist in the planning of more inclusive and salutogenic corporate environments — designed and organized in a way that promotes health and well-being (Parasuraman, 2003; Parasuraman; Rizzo, 2006).

NEURODIVERSITY: INTEGRATING NEURODIVERGENT AND NEUROTYPICALS

Judy Singer coined the term "Neurodiversity" in 1999 to describe the wide variety of human brain connections, resulting in unique abilities, needs, and capabilities. This conception is intended to reflect the infinite diversity of the human brain, as opposed to categorization into specific groups, resembling the concept of biodiversity (Feinstein, 2018). However, the term is also used to empower specific groups, distinguishing between neurodivergent and neurotypical, the latter referring to those whose behavioral patterns align with prevailing social expectations (Feinstein, 2018). It is noteworthy that neurodiversity encompasses not only innate differences, but also neurological challenges

Revista ARACÊ
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arising from brain injuries or other environmental causes. Underdiagnosis is common, with many cases remaining unidentified, even among those considered neurotypical, and it is estimated that one in four individuals will face mental health problems at some point in their life (Feinstein, 2018; Nerenberg, 2021). In addition to being a moral issue, the integration of neurodiverse people is being recognized as advantageous for progressive employers, driving inclusive policies and procedures (Armstrong, 2011). However, there is still room for improvement in workplace *design* to adequately accommodate this diversity (Armstrong, 2011; Nerenberg, 2021).

In this context, knowledge from cognitive and behavioral neuroscience indicates that sensory processing refers to the way the nervous system receives, organizes, and responds to stimuli from the environment. Neurodivergent individuals, such as those with Autism Spectrum Disorder (ASD), Attention Deficit Hyperactivity Disorder (ADHD), dyslexia, dyspraxia, and Tourette's Syndrome, show variations in this processing, which can significantly affect their behavior in the workplace (Armstrong, 2011; Nerenberg, 2021; Lent, 2022). Neurodiversity proposes an inclusive perspective, recognizing that these neurological differences are not deficits but natural variations of human cognition, often associated with unique abilities such as creative thinking, pattern recognition, and innovative problem-solving. However, conventional work environments often disregard these particularities, making it difficult to adapt and take advantage of the potential of these professionals (Armstrong, 2011; Nerenberg, 2021).

In the context of work behavior, sensory processing directly influences the productivity, social interaction, and well-being of neurodivergent workers. In this sense, according to Galiana-Simal *et al.* (2020) and Fotoglou *et al.* (2023), sensory modulation can occur at two extremes: (i) Hypersensitivity (Sensory super-reactivity): Through sensory receptors, the central and peripheral nervous system processes stimuli in an amplified manner, resulting in discomfort or sensory overload. Sounds, lights, smells, and touches can be perceived as excessively intense or even painful; (ii) Hyposensitivity (Sensory hyporeactivity): Through sensory receptors, the central and peripheral nervous system processes stimuli in a reduced way, requiring higher intensities to provoke an adequate response. It can lead to sensory seeking behaviors such as excessive touching, the need for constant movement, or resistance to normally noticeable stimuli (Pantazakos, 2023). Chart 1 exemplifies the applicability of these concepts when associated with neurodivergent employees.

Revista ARACÊ
ISSN: 2358-2472

Table 1. Sensory Behaviors and Environmental Needs of Neurodivergent People in the Corporate Environment.

Neurological Condition	Possible sensory characteristics	Impacts on the Work Environment	Suggested Adaptations
ADHD (Attention Deficit Hyperactivity Disorder)	Hypersensitivity to sounds, lights and odors; difficulty concentrating in noisy environments; need for constant stimulation.	Difficulty staying focused for long periods; impulsiveness and restlessness; bigger sensitivity to environmental distractions.	Quiet spaces for tasks that require concentration; permission for intermittent breaks; organized visual stimuli and adjustable lighting.
ASD (Autism Spectrum Disorder)	Hypersensitivity to noises, textures, lights, and intense social interactions; Difficulties in communication nonverbal and routine changes.	Greater need for predictability and structure in the environment; challenges in social interaction and intense sensory stimuli.	Workplaces with noise control and comfortable lighting; predictability in the routine; objective and direct communication; spaces of sensory withdrawal.
Dyspraxia (Developmental Coordination Disorder – DCD)	Difficulty in fine and gross motor coordination; challenges in spatial perception; less manual dexterity.	Difficulty in handling tools and physical equipment; Lower agility in tasks that require precise movements.	Assistive technology for typing and material handling; ergonomic and adapted furniture; training with visual and practical instructions.
Dyslexia	Challenges in speed reading, information organization and decoding of written texts.	Increased time required to process written information; difficulties in conventional written communication.	Use of accessible fonts and read-aloud software; clear structuring of texts and visual information; multimodal instructions.
Dyscalculia	Difficulty understanding numbers, calculations, and abstract mathematical concepts.	Problems in the interpretation of numerical data and in financial or statistical management.	Use of software to support calculations and graphs; Numerical presentations Simplified; training with practical and visual examples.
Tourette's syndrome	Presence of involuntary motor and vocal tics; possible associated emotional difficulties.	Challenges in social interaction due to involuntary manifestations; need for flexibility in the environment.	Organizational culture inclusive and team awareness; permission for free movement without restriction; Individual spaces for moments of self-regulation.

Source: Authors, adapted from Kirby and Smith (2021); and Nerenberg (2021); Hutson and Hutson (2023); Pantazakos (2023).

NEUROERGONOMICS: WORK BEHAVIOR AND *EVIDENCE-BASED* DESIGN

Neuroergonomics is based on the knowledge of neuroscience applied to the ergonomics of the work environment. According to Parasuraman and Rizzo (2006), it

Revista ARACÊ
ISSN: 2358-2472

consists of the study of the brain and work behavior, in order to investigate the neural bases and the functions of perception and cognition mediated by the interaction of the senses of the human body linked to the composition of the built environment, such as remembering, deciding, visualizing, planning in relation to technologies and scenarios in the real world (Parasuraman, 2003). The objective is to highlight the impact of built environments on the biological, psychological and social factors of users, especially in corporate environments, aiming to create spaces that promote connection, emotional value, healthiness and that are responsive to neurodiversity. It seeks to optimize mental health, especially in the face of chronic stress in the workplace, commonly related to *burnout syndrome* and depression (Dehais; Karwowski; Ayaz, 2020).

Since the beginning of 2022, Burnout Syndrome (BS) has been included in the International Classification of Diseases (ICD-11), officially classifying it as an occupational disease by the World Health Organization (WHO, 2022). According to The *American Psychological Association*, BS is characterized by physical, emotional, and mental exhaustion resulting from chronic stress in the workplace. Symptoms of BS can manifest in different ways and include a persistent feeling of extreme tiredness, difficulty concentrating, irritability, anxiety, and sleep changes, such as insomnia or excessive sleepiness. Frequent headaches, muscle tension, gastrointestinal problems, disinterest in work and loss of motivation are also common. In more severe cases, the syndrome can lead to depression, social isolation, and even suicidal thoughts (APA, 2024).

According to a survey by *The Chartered Institute of Personnel and Development* (2024), 79% of respondents identified stress-related absences in their organizations in the last year, with this rate reaching 90% in large companies (CIPD, 2024). Data from the *Health and Safety Executive* (2024) indicate that between 2019 and 2020, 17.9 million working days were lost due to stress, anxiety, or depression (HSE, 2024). In addition, a joint report by the WHO (2021) and the *International Labour Organization* (ILO) revealed that long working hours contributed to the deaths of 745,000 people from stroke and ischemic heart disease in 2016, representing a 29% increase from 2000 (WHO, 2021).

In the United States, burned-out workers are 63% more likely to miss work due to illness than happy, engaged employees, according to Gallup, and burnout accounts for 8% of all occupational disease cases, according to a 2017 report (Wigert; Agrawal, 2018). Studies by APA (2023) also show that employees with burnout have a 57% higher risk of missing work, 180% higher risk of developing depressive disorders, 84% higher risk of type

2 diabetes, 40% higher risk of hypertension, and 23% higher likelihood of going to the emergency room (APA, 2023).

A study conducted by the *International Stress Management Association* (ISMA) revealed that Brazil is the second country with the highest number of diagnosed cases, behind only Japan, where approximately 70% of the population is affected by the problem (WHO, 2022). According to data from the National Association of Occupational Medicine (ANAMT), about 30% of Brazilian workers suffer from the syndrome. Despite the significant impact on the well-being of professionals, companies still face challenges in implementing adequate solutions to deal with the legal issues related to burnout.

In neuroergonomics, *Evidence-Based Design* (EBD) can be used to design spaces that favor the mental health and cognitive performance of employees (Halawa *et al.*, 2020). It follows a structured process that begins with cognitive and sensory analysis, identifying how users perceive and process stimuli, considering factors such as attention and cognitive load. Next, neurophysiological measurement occurs, using technologies such as electroencephalography (EEG), functional spectroscopy (fNIRS), electrocardiogram (ECG), and functional magnetic resonance imaging (fMRI) to evaluate neural and physiological responses, as shown in Figure 1.

Modeling and simulation allows you to predict behaviors through experimental scenarios, virtual reality, and artificial intelligence. Based on this data, prototypes and usability tests are developed to validate comfort, safety, and cognitive-motor performance. The data collection and analysis stage evaluates ergonomic impact through quantitative and qualitative metrics, such as performance, response time, and error rate. Finally, optimization and implementation occurs, refining solutions to maximize efficiency, accessibility, and well-being in the designed environments.

The EBD approach is widely applied in several areas, such as architecture, urbanism, interior design, ergonomics, product engineering, and user experience (UX/UI). The objective is to minimize risks, optimize usability, and ensure the effectiveness of solutions through an evidence-based decision-making process (Ritchie, 2020; Villarouco *et al.*, 2021).

Revista ARACÊ
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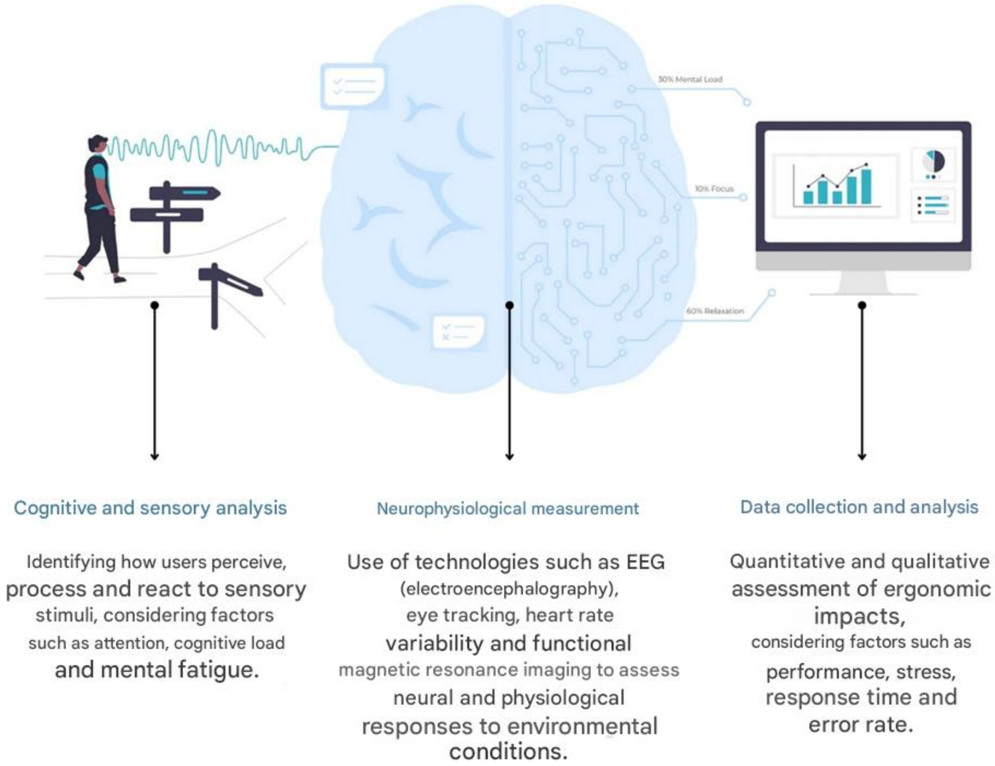
Figure 1. Procedure of analysis, measurement and data collection mediated by evidence-based design applied to neuroergonomics.



Source: Authors (2025), adapted from Sara di Meglio (2022).

OBJECTIVE

Recognizing the importance of this field for the well-being and inclusion of neurodivergent employees, the present study aims to analyze environmental variables through *Evidence-Based Design* in the context of cognitive and behavioral neuroscience applied to architecture, in order to propose efficient directions for the architectural design of salutogenic and neurodiversity-inclusive corporate spaces. Considering that, according to WHO (2022), more than 87% of people's time is spent indoors that are potentially harmful to physical and mental health, this research aimed to evaluate the physiological, psychological, cognitive, and behavioral effects identified in the architectural designs of workspaces, based on a *design* based on scientific evidence.

METHODOLOGY

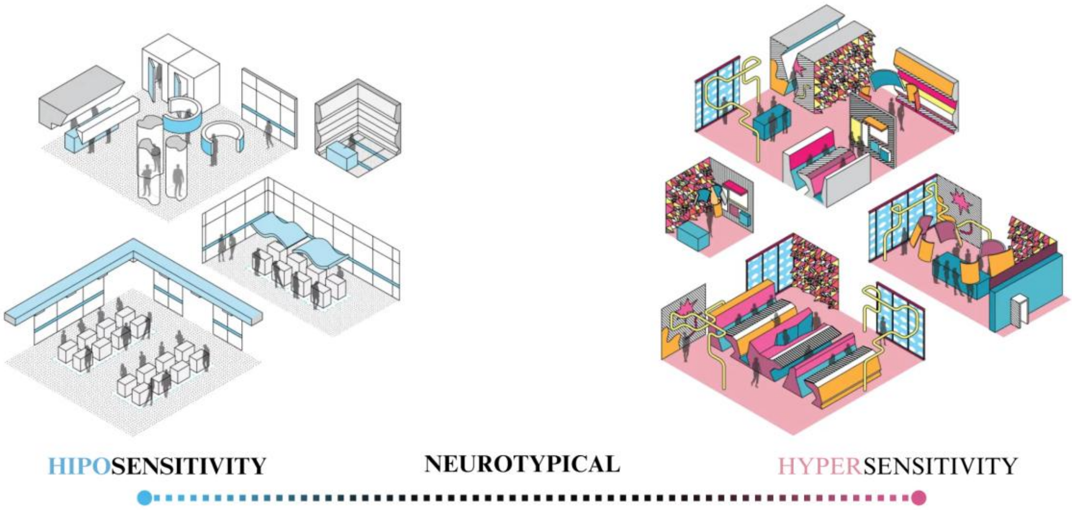
Through the investigation mediated by the interdisciplinary literature review, 16 articles, among 2567 initial studies, were evaluated, with the aim of proposing architectural guidelines based on the knowledge of neuroscience in favor of health-responsive projects and the inclusion of neurodivergent workers. Spatial organization (i), spatial references (ii), biophilic design (iii), thermal comfort (iv), acoustic quality (v), integrative lighting (vi) and degree of stimulation (vii) were evaluated. Therefore, as this is an exploratory study, a literature review was carried out involving the concepts of cognitive and behavioral neuroscience applied to ergonomics. For the review, the following criteria were adopted: articles published between 2018 and 2024, peer-reviewed and in Portuguese or English. It is intended, therefore, to formulate architectural design propositions, taking into account the responsibility of architecture and ergonomics professionals in designing environments beyond the norms, capable of not only allowing, but providing meaningful experiences, inclusive of neurodiversity and aligned with the biopsychosocial diversities of employees.

DISCUSSIONS AND RESULTS

In the design of inclusive work environments, it is considered essential to contemplate a diversity of options that allow users to find spaces appropriate to their specific needs for the tasks required (Hutson; Hutson, 2023). Aspects such as color, lighting, materiality, and sensory stimuli must be meticulously planned with purpose and intention. A qualitative assessment of the work environment, considering environmental variables, can provide significant strategies for human resources and corporate logistics teams, contributing to the creation of environments that are more adaptable to neurodivergent patients (Hutson; Hutson, 2023). Thus, when planning new spaces or renovating existing environments, the inclusion of zones with different levels of sensory stimulation, mediated by architecture, is essential to promote an inclusive culture and a physical environment that meets the needs of the majority. Figure 2 illustrates hypersensory and hyposensory zones for better accommodation of neurodivergent patients in the corporate environment, highlighting the importance of considering their diverse sensory needs. These zones can be designed to offer varied sensory stimuli, making the environment more welcoming and adaptable to the ergonomic needs of each employee. It is worth considering that sensitivity can contain variations in the same individual. Therefore, they may be hyposensitive to some sensory stimuli and hypersensitive to others. Next, it will be described how evidence-based design associated with neuroergonomics can foster inclusive and salutogenic environments, responsive to neurodiversity in corporate environments.

Revista ARACÊ
ISSN: 2358-2472

Figure 2. Neuroergonomics applied to corporate environments responsive to neurodiversity: hypersensory zones and hyposensory zones.



Source: Authors, adapted from HOK Group (2024).

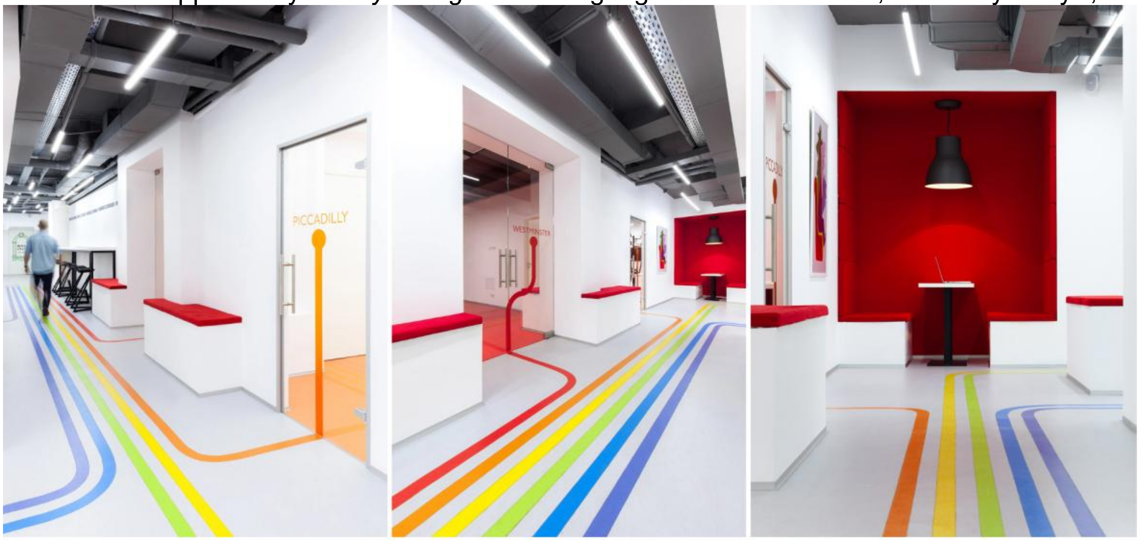
SPATIAL REFERENCES (*WAYFINDING)*

Wayfinding, understood as the process of orienting and navigating built environments, requires spatial design that not only encourages curiosity, reward, and exploration, but also offers an intuitive experience, allowing both visitors and regular occupants to pinpoint their location and easily find their way (Feinstein, 2018; Rosqvist *et al.*, 2020). However, for people with neurodivergent conditions, especially those who thrive on repetition, predictability, and clear boundaries to feel safe, the presence of a readable spatial order becomes even more crucial. Thus, effective design strategies should create memorable spaces using a rhythm of common elements that generate a comforting sense of order, while avoiding the confusing repetition of identical spaces or features (O'Malley *et al.*, 2022).

The implementation of landmarks and focal points, such as stairs or artwork, viewpoints such as mezzanines, and clear sight lines, including views to the exterior, contributes significantly to the orientation of users. In addition, variations in lighting, the strategic use of materials, colors, and signage are key, since people naturally tend to move towards brighter paths (Edelstein, 2005). In complex environments, clear and consistent signage, with concise messaging, simple (sans-serif) typography and informational hierarchy, is indispensable to alleviate sensory overload, while redundant indications through colors, numbers and words offer multimodal assistance to the full range of building users, as illustrated in Figure 3.

Revista ARACÊ
ISSN: 2358-2472

Figure 3. Effective applicability of *wayfinding* at the Language School Underhub, in the city of Kyiv, Ukraine.



Source: Aleks Yanchenko (2016).

SPATIAL ORGANIZATION (*LAYOUT)*

The psychodynamics of work, as elaborated by Christophe Dejours (2017), establishes an intrinsic relationship between organizational conditions and the subjective experiences of workers, and this perspective can be associated with the existing layout in collaborative environments (Dejours, 2017). Continuously performing mental efforts on repetitive tasks can lead to attention fatigue, as described by Yildirim *et al.* (2024), and, when this attention decreases, workers have greater difficulty in dealing with stressful situations, requiring restorative interventions (Goldberg, 2023). Work environments that promote flexible and adaptable layouts not only meet productive demands, but also favor greater interaction, comfort, and inclusion of employees, contributing to the mitigation of suffering and tension generated by a rigid organization (Goldberg, 2023). Collaborative spaces that enable the configuration of open areas for socialization and closed spaces for concentration allow workers to choose the environment that best suits their momentary needs, strengthening autonomy and individual recognition. This flexibility in the design of built environments, by reducing the imposition of rigid rules and valuing the diversity of profiles and work styles, creates favorable conditions for the construction of positive meanings, promoting a healthier and more inclusive organizational climate, according to the principles defended by Dejours in the psychodynamics of work

In addition, the availability of technology-equipped environments, alternating with device-free zones, not only maximizes productivity, but also accommodates neurodiverse employees who need to minimize distractions and sensory stimuli, or who depend on

Revista ARACÊ
ISSN: 2358-2472

specific technologies to manage their daily activities. According to Nerenberg (2020), such choices allow each individual to find a comfortable level of exposure and social interaction, considering that many feel uncomfortable at workstations that leave their backs exposed – a situation that, for some neurodivergent people, becomes unbearable and demands *layouts* more flexible (Goldberg, 2023). As illustrated in Figure 4, offering a variety of activity-based workspaces – including nooks, alcoves, refuge areas, clusters, meeting places, and areas for movement – allows most employees, regardless of their sensory processing capacity, to find the most conducive environment to perform their duties (Goldberg, 2023; Yildirim *et al.*, 2024).

Figure 4. Effective applicability of flexible spatial organization at Humana Louisville Campus Tower, New York City, United States.

Source: Interiorarchitects.com (2023).

BIOPHILIC DESIGN

Biophilic design, with its emphasis on the integration of natural elements and patterns into built environments, serves as the foundation for the creation of spaces that seek to mimic the restorative qualities of nature (Aristizabal *et al.*, 2021)element. Creating spaces with biophilic design involves building environments that provide refuge and relaxation, allowing individuals to establish their sensory and social control over their surroundings. Concepts such as prospect and refuge, attractiveness and danger, as well as sensory gardens, are employed to develop spaces that promote stress reduction and a sense of calm (Aristizabal *et al.*, 2021; Tekin *et al.*, 2023; Albuquerque, 2024). As shown in Figure 5, the use of green areas as the main recalibration zone is a common approach, as access to these spaces from common areas—such as patios or rooftop gardens—offers occupants a sense of relaxation and rejuvenation (Aristizabal *et al.*, 2021). Sensory

Revista ARACÊ
ISSN: 2358-2472

gardens, which may include edible plants and herbs, also provide a calming effect, providing opportunities for experiences such as tea making or other sensory activities (Aristizabal *et al.*, 2021; Albuquerque, 2024). It should be noted that, in terms of oxygen production, trees are more effective than smaller plants, having a more significant impact on air quality. In addition to the use of natural elements, the creation of boundaries and nooks can establish a sense of security and privacy in the space, exemplified by the use of trees as partitions in an atrium, rather than walls (Sieghardt *et al.*, 2005).

Figure 5. Application of biophilic design in environments that require greater focus skills, such as business conversations on the left; and in environments for breaks, rest, and reading, situation on the right.

Source: Aolbuildingservices.com.au (2023).

Incorporating natural elements into the design of a space can significantly enrich the biophilic experience. Materials and elements sourced from nature, when used in their raw or minimally processed state, reflect the local ecology or geology and create a distinct sense of place (Beatley, 2010). For example, the use of local wood and the practice of xeriscaping—which uses native and drought-tolerant plants to create landscape designs that are compatible with the regional climate—are effective strategies for developing a resilient biophilic experience (Zhong; Schröder; Bekkering, 2021). Natural materials such as wood, stone, and exposed brick provide a tactile connection to nature; wood, specifically, has been shown to improve air quality by moderating humidity and evoking feelings of warmth, comfort, and relaxation (Alapieti *et al.*, 2020; Albuquerque, 2024). However, the use of smooth and easy-to-clean surfaces, replacing porous surfaces that retain microorganisms, has been shown to be necessary, especially during the COVID-19 pandemic (Zhong; Schröder; Bekkering, 2021).

Aesthetic details—such as texture, color, sequencing, compartmentalization, temperature, and scents—also influence the level of sensory stimulation and can be used to prevent overload or understimulation. Textures that mimic bark, scales, or other natural patterns can add tactile value to furniture, such as in the use of sequin-glittered cushions or soft fur-like materials, enhancing the experience of the space (Badgett, 2020). Natural patterns, such as the iridescence of a hummingbird or the hexagonal structure of a honeycomb, can equally evoke a connection with nature, intensifying the sense of place (Goldberg, 2023; Albuquerque, 2024; Yildirim *et al.*, 2024).

THERMAL COMFORT

Thermal comfort is often pointed out in research as one of the main factors that generate irritability and compromise mental health in the workplace, reflecting in low employee productivity. This comfort can vary depending on personal characteristics, such as clothing, activity level, metabolism, and neurological factors, and, to meet this diversity, solutions that enable individual temperature control – such as operable windows or air diffusers – have proven effective, allowing workers to adjust the environment according to their specific needs (Goldberg, 2023; Albuquerque, 2024; Yildirim *et al.*, 2024). Estimates associate such individual controls with productivity increases of up to 7%, depending on the nature of the task. Meanwhile, other effective thermal design strategies include controlling solar gains in perimeter areas to prevent overheating near windows, improving the performance of the building's exterior cladding to ensure uniform conditioning, and planning thermally varied spaces – such as naturally ventilated atriums or outdoor courtyards – so that users can choose the environment that best satisfies their thermal preferences (Nerenberg, 2020; Albuquerque, 2024).

ACUSCULEHOODS

Everyday noise in traditional work environments can compromise employees' focus. Although it takes a period of approximately 20 minutes to reach a flow state, interruptions occur on average every seven minutes. On the other hand, an excessively quiet office can also be harmful, since, in the absence of adequate acoustic treatment, small noises become deafening for those especially sensitive or prone to distraction, such as individuals with ASD and ADHD (Assem; Khodeir; Fathy, 2023; Yildirim *et al.*, 2024). Such collaborators can adapt by using headphones to create an environment conducive to

Revista ARACÊ
ISSN: 2358-2472

hyperfocus or by adopting background noise to overlay unwanted sound distractions. An effective acoustic project must offer a variety of auditory configurations that meet the various activities, being adequately distributed throughout each work zone (Assem; Khodeir; Fathy, 2023; Goldberg, 2023; Yildirim *et al.*, 2024).

The use of natural and calming sounds can counteract the release of hormones associated with stress and pain, such as endorphins. Nature-based ambient sound installations have the potential to enhance three core goals of neuroinclusive design: focus, stimulation, and relaxation (Hutson; Hutson, 2023). This approach is particularly important for neurodiverse individuals, who may be hypersensitive to sounds or seek opportunities for multiple sound activations (Harder, 2022). Natural sounds, such as rivers and rain, are common choices to establish a serene and relaxing environment (Hutson; Hutson, 2023).

INTEGRATIVE LIGHTING

Integrative lighting consists of an approach that goes beyond the mere function of lighting, promoting collaborative environments that adapt to the needs and preferences of workers, including those with neurodiversity (Rea; Figueiró; Bullough, 2002). This inclusive design strategy transforms lighting into an essential tool for employee well-being, productivity, and autonomy, offering simple and effective solutions, such as replacing fluorescent luminaires — which emit noticeable flicker and buzz and are especially distracting to neurodivergent individuals — with high-quality modular LED systems (Kapp, 2020).

According to Rea, Figueiró and Bullough (2002), synchronicity between exposure to natural light and the circadian rhythm is fundamental for the well-being of workers in work environments, as it regulates essential physiological processes, such as the production of melatonin and cortisol, directly impacting the sleep-wake cycle, cognition and level of alertness. Adequate exposure to natural light, especially during the morning, promotes a more stable waking state, improves mood, and reduces fatigue, preventing sleep disorders and health problems associated with circadian misalignment, such as stress, depression, and reduced cognitive performance. In corporate settings, the strategic use of natural light can increase productivity, decrease absenteeism rates, and improve employee satisfaction, becoming an essential factor in the design of ergonomic and healthy workspaces.

In this sense, the "*tunable-white" control technologies* allow the modulation of the color temperature, ranging between 3000K and 6000K, and are recommended for the

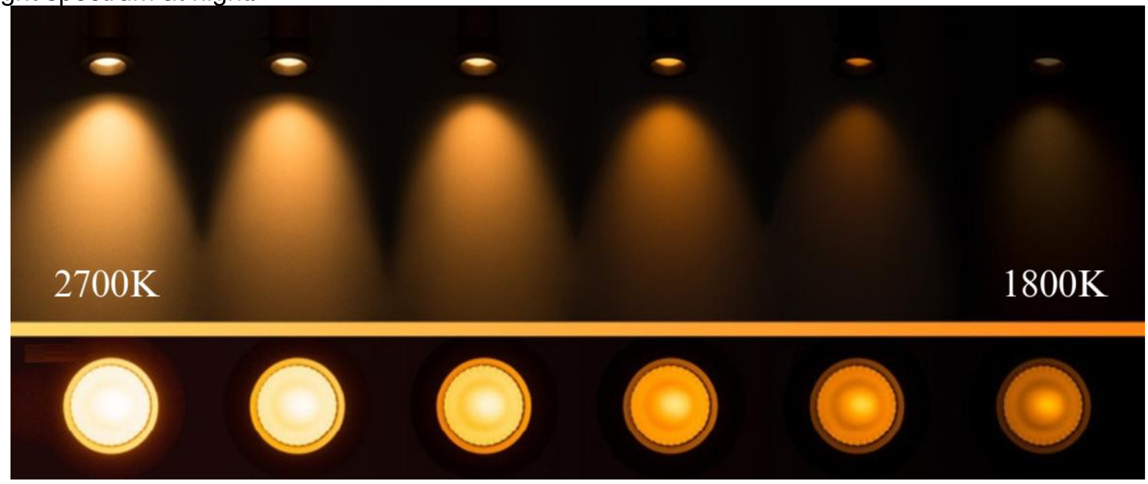
Revista ARACÊ
ISSN: 2358-2472

morning period (Figure 6). On the other hand, during the afternoon and evening, the "*dim-to-warm*" technology makes it possible to adjust the color temperature to values between 2700K and 1800K, as shown in Figure 7, meeting the needs of the night when used appropriately (Bhardwaj, 2021). Studies, such as those conducted by the University of Toronto, show that intense levels of light can amplify both positive and negative emotions, while reducing brightness favors more rational decisions. In addition, the variation in the color and intensity of light throughout the day, mimicking natural changes, contributes to the reduction of stress, benefiting both neurodivergent and neurotypical employees (Rea; Figueiró; Bullough, 2002; Largo-Wight *et al*., 2011; Sundell *et al*., 2011; Bhardwaj, 2021).

Figure 6. "tunable-white" *control technology*. It enables the modulation of the color temperature correlated to the light spectrum between 6000K and 3000K, enabling a better efficiency of the physiological circadian rhythm during the day for individuals whose work is performed exclusively in underground environments or without natural lighting, such as some hospital environments.

Source: Eskwblog (2023).

Figure 7. "Dim-to-warm" *control technology*. It allows the modulation of the color temperature correlated to the light spectrum between 2700K and 1800K, allowing, when positioned correctly, the lowest exposure to the blue light spectrum at night.



Source: Eskwblog (2023).

Revista ARACÊ
ISSN: 2358-2472

Expanded access to natural light in the workplace promotes significant improvements in physical, mental, and emotional health, resulting in greater productivity and overall employee satisfaction. Together with other fundamental aspects, such as acoustics and thermal comfort — the latter identified as one of the main factors that generate irritability (O'Malley *et al.*, 2022) — , the ability to adjust lighting in a personalized way represents one of the most effective strategies to improve performance and well-being in the workplace, reinforcing the importance of a design that adapts to the diverse demands of users (Maslin, 2022; Assem; Khodeir; Fathy, 2023).

DEGREE OF SENSORY STIMULATION

When considering the adaptation of corporate environments to meet the needs of neurodivergent people, it is essential to recognize that these people can present both hypersensitivity and hyposensitivity to specific sensory stimuli, as shown in Chart 2 (Nerenberg, 2020). For those who have hypersensitivity, the presence of visual, auditory, and olfactory stimuli can compromise focus and generate irritability, while for individuals with hyposensitivity, the absence of adequate environmental stimuli can hinder concentration and harmonious integration with space (Doyle, 2020; Fotoglou *et al.*, 2023). Thus, offering options that allow employees to control or select the degree of sensory stimulation in their surroundings is an essential aspect of inclusive design. In addition, people with ASD may exhibit a specific visual sensitivity to certain levels of lighting or colors, so inappropriate visual experiences, such as reflections in frames, can compromise the readability of texts and generate distractions (Maslin, 2022).

Table 2. Behavior of neurodivergent collaborators regarding sensory differences, as well as neuroscientific bases.

Sensory Modality	Hypersensitivity	Hyposensitivity	Neuroscientific Basis
Vision	Extreme sensitivity to lig ht, bright screens, or inte nse visual patterns. Very brightenvironments can generate discomfort.	Difficulty perceiving details, req uiring stronger visual stimuli. It can result in difficulties reading and recognizing facial express ions.	Changes in the visual cortex and in the processing of visual contrasts, affecting the filtering of irrelevant stimuli.
Hearing	Common sounds sound too loud or painful. Sudd en noises can cause anx iety or sensory crisis.	Difficulty perceiving subtle sou nds, such as voices in noisy en vironments. Need for high volu mes to capture information.	Auditory pathway dysfunctions of the brainstem and thalamus, resp onsible for regulating the intensity of sounds.

Revista ARACÊ
ISSN: 2358-2472

Smell	Keen perception of smells, which can cause nausea or aversion to odors Common.	Lack of perception of smells, leading to the search for odors for sensory stimulation.	Dysfunctions in the olfactory bulb and in the orbitofrontal cortex, which modulate the intensity of olfactory perception.
Taste	Heightened sensitivity to certain tastes or textures, resulting in food selectivity extreme.	Search for intense flavors, such as very salty, sweet or spicy foods.	Altered connections between the taste cortex and the limbic system, influencing the emotional response to taste.
Tact	Discomfort with certain fabrics, light touches or minimal pressure. May react negatively to unexpected physical contact.	Need for strong touches to feel stimuli. Search for textures and constant pressure (e.g., tight hugs, heavy blankets).	Dysfunction in tactile processing in the somatosensory cortex and modulation of the thalamus.
Proprioception (perception of the position of the body in space)	Difficulty coordinating movements due to hypersensitivity to postural changes.	Low body perception, leading to motor difficulties and the need for repetitive movements to self-regulate.	Changes in the cerebellum and circuits that integrate movement and balance information.
Interoception (perception of internal signals from the body)	Amplified feel of pain, hunger or thirst. Can be highly sensitive to small changes Physiological.	Difficulty noticing signs resulting in self-regulation problems (e.g., not noticing the need to go to the bathroom or signs of fatigue).	Dysfunctions in the insular cortex, which integrates internal signals from the body.
Vestibular System (balance and movement)	Feeling dizzy or discomfort with light movements, such as climbing stairs or walkingon unstable surfaces. Difficulty with position changes or activities that involve balancing.	Excessive seeking for vestibular stimuli, such as repeatedly spinning, rocking,-or jumping. You may have difficulty perceiving the own spatial orientation.	Changes in the functioning of the vestibular system in the inner ear and its connection to the cerebellum, affecting postural control and perception of movement.

Source: Authors (2025), adapted from Bury et al. (2020); Doyle (2020); Lent (2022); and Fotoglou *et al.* (2023).

The creation of different microenvironments – which includes minimizing visual clutter, implementing quiet and technology-free zones, as well as incorporating rest areas at strategic points – proves to be an effective approach (Goldberg, 2023). The use of color plays an important role, as shades of blue and green tend to promote calmness, while colors such as yellow, orange, and red stimulate and uplift, and conflicting colors, neglected by neurotypical individuals, can profoundly disturb those with increased sensitivity (Bury et al., 2020). Similarly, patterns and textures influence sensory stimulation: the use of predictable patterns, symmetry, or fractals can aid in understanding and navigating the environment (Doyle, 2020; Fotoglou *et al.*, 2023), while the choice of organic

Revista ARACÊ
ISSN: 2358-2472

patterns or the incorporation of irregularities can encourage engagement with the space. Finally, the use of natural materials tends to facilitate sensory integration and promote a more balanced response to the built environment (Doyle, 2020; Fotoglou *et al.*, 2023).

Finally, practical strategies aligned with the principles of *Evidence-Based Design* linked to neuroergonomics were organized, described below, in Chart 4.

Table 3. Strategies for the planning of work spaces responsive to Neurodiversity.

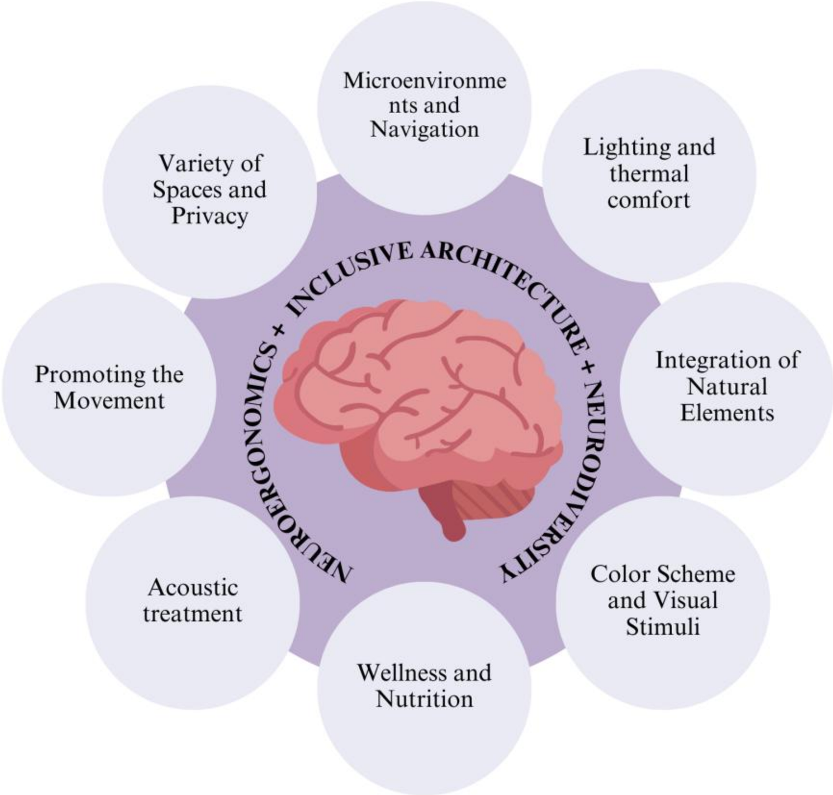
Evidence-Based Design *Strategies*	**Description**
Variety of Spaces and Privacy	Provide a wide variety of spaces for socialization and semi-private or private gathering; offer dedicated quiet rooms to accommodate attentional focuses; Consider using partitions in appropriate areas to block and reduce noise.
Promotion of the Movement	Create active zones and spaces that encourage movement; manage work zones for areas with little movement.
Acoustic Treatment	Design acoustically treated environments that generate white noise; Use acoustic dampening materials to reduce converging sounds.
Lighting and Ventilation	Provide workspaces with dimmable or diversified lighting levels; promote access to daylight and places with natural ventilation within the offices; avoid fluorescent lighting and low-quality LED to reduce flicker.
Integration of Natural Elements	Incorporate natural elements into spaces to create a relaxing effect.
Color Scheme and Visual Stimulus	Adopt non-stimulating color schemes mixed with areas of high stimulation; reduce stress by avoiding chaotic patterns in work areas; strategically use colors for orientation and direction; create spaces that allow for visual connections and memories of positive emotional valence.
Microenvironments and Navigation	Create an ecosystem with different settings and microenvironments that allow people to find the right level of stimulation, whether visual, auditory, or physical; provide intuitive spaces for navigation, contributing to a sense of order.
Wellness and Nutrition	Consider providing *pet-friendly* spaces, areas for physical activities, sensory gardens, and nutrition stations to help all employees maintain healthy blood sugar and hydration levels.

Source: Authors (2025), adapted from Assem, Khodeir and Fathy (2023), Hutson and Hutson (2023) and Yildirim *et al.* (2024).

These strategies aim to create a work environment that is comfortable, welcoming, and conducive to the performance of all employees, regardless of their neurodivergent characteristics, as shown in Figure 8.

Revista ARACÊ
ISSN: 2358-2472

Figure 8. Evidence-based components essential for the architectural design of neurodiversity-responsive workspaces.



Source: Authors (2025).

FINAL CONSIDERATIONS

Neuroergonomics plays a crucial role in creating inclusive workspaces, addressing both physical and emotional, cognitive, and social aspects. This involves meeting the psychological needs of diverse cognitive abilities, considering fundamental elements such as temperature, lighting, air quality, noise, and ergonomics. By planning and designing spaces to accommodate neurodiversity, drawing on knowledge from neuroscience, it is possible to create environments that offer privacy, concentration, connection, and engagement that are suitable for everyone. An inclusive approach, within an organizational culture, can mitigate the adverse effects of neurological differences and promote systemic benefits, proposing lower risks of chronic stress, anxiety, depression, and *burnout* in employees in the long term. Prioritizing the biological, psychological, and social needs of employees, professionals involved in the ergonomic design of workspaces contribute to more connected, healthy, engaged, and empowered environments, which has contributed to inclusive architecture. This provides everyone with the opportunity to thrive in an environment that values diversity of skills and perspectives.

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Revista ARACÊ
ISSN: 2358-2472

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