Neurourbanism. Enriching urban design process through new tools

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Abstract
Objectives: The "Affective City" campaign, led by Federico De Matteis, underscores the idea that cities are not merely constructed from brick and stone but from affects, moods, atmospheres - those ineffable dimensions that are often overlooked in urban planning. Smart city research remains predominantly focused on technology, with an over-reliance on information and communication tools (ICT), Internet of Things (IoT) and AI-based solutions, often neglecting critical discussions around societal objectives and human-centric priorities. The emerging field of *Neurourbanism* acknowledged that urban environments significantly influence human existence, mental health and psycho-emotional well-being, providing the field of urbanism with useful design tools from the neuroscience field. This article underlines a human-centred interdisciplinary approach through

which human values with their discrete dimensions can be infused into urban design processes, by leveraging a wide range of innovative tools specific to neurosciences. By this, enriched urban environments can improve the well-being of all users, in the spirit of an inclusive diversity. **Prior work:** The research is substantiated on established fields such as neurosciences, neuroaesthetics and already formulated concepts as environmental psychology and affective computing. Interdisciplinary applied research of the authors using affective computing tools is introduced. **Approach:** A narrative review based on using case studies and good practice examples has been employed, as well as a review of academic research in the field. In addition to this literature review, the first phase of an ongoing neurourbanism study is presented, which aims to use tools from human-computer interaction (HCI) and affective computing area. **Results:** This paper outlines how neurourbanism can be employed for emotional mapping and urban stress analysis, participatory urban design, monitoring health in cities, inclusivity and accessibility for mental health and for neuroaestethics studies and biophilic urban environments design that confirmed that green spaces in cities have sanative and restorative values. The experiment based on Self Assessment Manikin and EEG measurements confirmed that the perception of an architectural object in a urban context vs. without context is different. **Implications:** Understanding that architecture and urbanism are not only about form, rules and geometries, but also about human experience in space requires a holistic approach to design in urban planning that need to take advantage of these new available tools. The intersection between AI (big-data access) and Neurosciences offers transformative potential for urban planning with the potential to reinvent the urban planning design process through valuable new tools. **Value:** The research contributes in an interdisciplinary architecture-psychology-medicine-mathematics manner to the understanding and the opportunities of Neurourbanism in the context of today's design process.

Keywords: neurosciences, AI, smart city, affective computing, interdisciplinarity

1.Introduction

Urban planning has traditionally focused on functional, aesthetic and geometric aspects of city design, with little focus on embedding tools that assess the emotional and psychological dimensions of human experience in space. Neurourbanism, an emerging interdisciplinary field sought to address this gap by exploring how urban environments impact mental health and well-being. This field emerges as an extension of the modern neuroscience school which gained strength in the second half of the 20th century based on the advances in imaging technologies, such as functional MRI, that allowed a deeper understanding of the embodiment of architectural experience and interconnections between the physical spaces and cognitive and emotional processes [1] [2]. Rooted in environmental psychology, affective computing, neuroaesthetics, and neuroscience, the field of *neurourbanism* advocates for the integration of human values and emotional dimensions into urbandesign processes in order to transfer this knowledge into projects, through various tools that facilitate reading of human emotions. Moreover, the field of neurourbanism can be a major component of smart cities concept by leveraging data-driven technologies and neuroscience insights to design urban spaces that enhance cognitive well-being, social interaction, and environmental sustainability [3] [4]. A recent paper titled "*Neurochallenges in Smart Cities: State-of-the-Art, Perspectives, and Interdisciplinary Challenges*" [5]explores the intersection of neurourbanism and smart cities, outlying that smart city research remains fragmented and technology-driven, relying heavily on IoT or AI-based technologies, while lacking the discussion about societal goals and human-centric concerns. Similarly, Stefano Carboni in a smart cities comparison research, defines the smart city concept only as one that focus on integrating information and communication technologies (ICT) [6]. From this point of ~~a~~ view, the endeavour of this article is to build synergies between the above areas in order to enrich the smart city concept.

Starting from a critique of certain aspects of contemporary urbanism, such as the over-reliance on technology and standardized approaches that ignore local affective contexts, De Matteis argues for a more nuanced and adaptable framework that reflects the diversity of human experiences [7]. De Matteis emphasizes that cities are more than physical structures; they are repositories of emotional and affective experiences, therefore he calls for a shift toward human-cantered design principles, where the emotional needs and responses of inhabitants are placed at the forefront of planning and development. This involves creating spaces that encourage positive emotions, mitigate stress, and promote social cohesion by engaging all the senses, provoking the role of multisensory design in crafting urban environments. By synthesizing perspectives from multiple disciplines, *Affective City* provides a visionary roadmap for designing urban environments that truly cater to the emotional and psychological needs of their inhabitants, fostering cities that are not only functional but profoundly human [7].

This article investigates the potential of tools in the field of neuroscience such as affective computing tools to enrich urban planning design that create environments that foster inclusivity and well-being.

2. Prior work

Neurourbanism builds on established concepts in environmental psychology, which examines the interplay between individuals and their surroundings, including natural, built, and social settings [8] [9]. Gifford's contributions particularly highlight how psychological processes, such as perception, cognition, and emotions, are shaped by physical surroundings and how these insights, brought to light, can inform policies and design interventions to promote environmental sustainability and human flourishing. His work serves as a foundation for applying psychological principles to real-world environmental challenges. In support of this research approach emerged the affective computing, a field pioneered by Picard in 1997 [10], that explores the development of systems that can recognize and respond to human emotions. Emotions are fundamental to human cognition and behaviour, acting as pivotal mediators in decision-making, perception, and social interactions, as argued by Damasio (1994) who highlights their role in the machinery of reasoning [11]. Robu-Movilă's work encouraged a transition from "effective"-hard core computing to affective computing, validating the role of emotions in design [12].

A series of tools and technologies commonly used in affective computing are (fig.1): (1) ***E*motion Recognition Tools (Facial Recognition Software, Speech Analysis, Gesture Recognition Systems),** (2) **Physiological Monitoring Devices (Electroencephalography (EEG), Electrodermal Activity (EDA), Heart Rate Monitors, Pupil Dilation Sensors**), (3) **Wearable Sensors (Smartwatches and Fitness Bands, Smart Clothing),** (4) **Environmental Sensors (Smart Cameras, Acoustic Sensors),** (5) **Immersive Technologies** (**Virtual Reality/VR, Augmented Reality/AR).**

Fig.1 Input modalities for affective computing
Source: Environmental Psychology: Principles and Practice [8]

There are many applications that fosters research in neurourbanism, such as:

2.1. Emotional mapping and urban stress analysis

Affective computing technologies, such as wearable devices and emotion detection algorithms, provide tools for real-time data collection on physiological responses (e.g., heart rate, skin conductance) and different emotional states (high/low arousal, high/low valence etc.). For instance, wearable sensors and emotion-detection algorithms, can track physiological and behavioural responses (e.g., heart rate variability, facial expressions) in real-time as people navigate urban environments. This enables the creation of emotional maps that show how different urban areas (e.g., parks, busy intersections or residential streets) affect residents' emotions and mental well-being. Similarly, AI-powered emotion recognition systems, integrated with video analytics, can assess collective mood states in public spaces, informing urban design strategies to enhance mental health and social cohesion [13]. In other studies of the same author, affective computing adds precision by identifying micro-scale stress triggers in city environments. Researches like "Urban Mind" (2018) emphasize the importance of data-driven approaches in understanding the impact of urban design on mental health. The researchers developed the “Urban Mind” app to examine how exposure to natural features within urban environments affects mental health [14]. Another study that engages affective computing to analyse emotional quality of multi-type urban public spaces using multi-sensor data, ensemble learning and classification models, investigates how affective computing can assess the emotional quality of various urban public spaces by analysing physiological signals from users [15]. The researchers collected data from participants in ten public spaces across Japan and China, utilizing sensors to monitor physiological responses such as electrodermal activity (EDA), electromyograms (EMG), and electrocardiograms (ECG). By applying ensemble learning techniques to classify these multi-sensor data, they developed models capable of evaluating the emotional impact of different urban environments. The study concludes that affective computing, combined with advanced machine learning methods, offers a feasible approach to evaluating and enhancing the emotional quality of urban public spaces, thereby supporting urban design renewal decisions.

2.2. Participatory urban design

Immersive technologies (VR and AR) integrated with affective computing allow urban dwellers to interact with virtual urban models while their emotional responses are tracked. This can be invaluable in participatory planning. The use of virtual reality in participatory urban design processes [16] foster human-centered approaches as the participants' preferences and affective states influenced final urban designs. Claudiu Bârsan-Pipu's research [17] focuses on integrating affective computing with virtual reality in the early stages of conceptual stages of the design, creating virtual procedural environments (VPEs) that adapt to users' emotional responses in real time. By combining brain-computer interfaces (BCIs) and eye-tracking technologies within game engine frameworks, his work aims to make possible the modelling of shapes by reading the emotions and empathic reactions.

2.3. Monitoring health in cities

Many studies prove the impact of the built environment on people's well-being and mental health - from the city as an ensemble, to the architectural objects itself (that constitute the city). From a physical health perspective, relevant studies prove the impact of factors such as indoor or outdoor air quality that led to asthma or allergies impacting people's performance. Also, the increases in mental health disorders in Western societies represent a significant public health concern, hence causative research that ties elements of the built environment to mental health outcomes is needed. Without evidence-based research, policymakers cannot develop clear guidelines and incentives to foster built environments that support the health of occupants. [18] [19]The WHO's Urban Health Framework (2021) serves as a guide for cities worldwide to adopt sustainable, health-promoting policies and practices that align with the Sustainable Development Goals (SDGs), particularly SDG 3 (Good Health and Well-being) and SDG 11 (Sustainable Cities and Communities) [19]. The complex interplay between urban environments and public health can be addressed by data and evidence-based policies and targeted interventions, like calming public spaces or optimizing traffic noise by certain strategic urbanistic interventions

2.4. Fostering the development of responsive urban spaces

Smart infrastructure integrated with affective computing, such as adaptive lighting and dynamic crowd control systems, enables cities to respond to real-time emotional states. Responsive systems reduced stress in transit hubs by modulating lighting and sound levels dynamically or 'Phygital Installations' AR/XR technologies can blend physical and digital elements, captures people's perceptions for enhanced urban design proposals. [20]. Urbanization in dense cities, especially in warm-humid climates is contributing to urban stress syndrome. This research [21] demonstrates that a virtual urban oasis, developed using Unreal Engine 4 and tested with virtual reality, effectively reduces stress by decreasing heart rate by 11% and increasing heart rate variability by 8%. Heart Rate and Heart Rate Variability can be used to measure urban stress levels. Designing and constructing an urban oasis does not automatically ensure its therapeutic effectiveness, this is why advanced virtual reality technology enables the evaluation of design's therapeutic and healing impact before it is physically built.

2.5. *Inclusivity and accessibility for persons with mental health disorders*

Data from affective computing biosensors can inform urban designs, mindful to specific needs of persons with mental health disorders. For example, environments that reduce sensory overload can be developed by analysing emotional and physiological responses for a population group. Affective computing can identify stress responses in individuals during their interactions with urban environments, such as during commutes or in overcrowded spaces, informing strategies for optimizing public transit spaces to reduce anxiety.

Poorly designed environments, such as overcrowded spaces or those with excessive noise, can exacerbate psychological distress [22]. Incorporating sensory-friendly designs and access to nature improves mood and cognitive functioning in persons with mental health disorders. The use of sensory stimulation can promote relaxation and reduce symptoms of anxiety, depression, and post-traumatic stress disorder [23]. Key design elements, including spatial layout, acoustics, and materials, significantly impact emotional states and cognitive processes, offering support for individuals with mental disorders [22].

Growing evidence suggests that individuals with autism spectrum disorder (ASD) often face challenges in their relationship with their surrounding environment, highlighting that a primary issue is the users's altered perception of sensory stimuli and processing of environmental information. As a result, there is increasing recognition of the need for "sensory-sensitive" urban spaces, with recommendations aimed at making environments less overwhelming for persons with ASD [24]. Research highlights the importance of tailored design in mental health facilities for specific disorders, such as Alzheimer's disease, where smaller, homely environments with controlled stimuli reduce distress and improve adjustment [25]. Moreover, in the context of an accelerated population ageing trend and the increase in the number of older persons with neurocognitive disorders, it is also in the interest of researchers to reconcile and adapt the urban built environment to the needs of this category of users. [26] This approach aims to support more inclusive and empathetic urban planning, aligning design practices with the varied experiences and requirements of city dwellers.

2.6. Neuroaestethsics studies

Neuroaesthetics, a field of study focusing on the neural mechanisms underlying aesthetic experiences and the perception of beauty, was introduced by Zeki Semir in 1999 and investigates the neural basis of aesthetic experiences, while neuroscience provides insights into the brain's response to environmental stimuli. For instance, recent VR-EEG studies have revealed a preference for curved forms in design, suggesting that such shapes elicit positive emotional responses [27]. În "*The Neuroaesthetics of Architectural Spaces*" by Anjan Chatterjee, Jennifer Coburn, and Nicole Weinberger [28]. it is discussed how elements such as symmetry, proportion, materials, spatial configurations, lighting, and materials can affect psychological well-being, providing insights relevant to neurourbanism—the study of how urban settings characteristics impact brain function and mental health. The central thesis posits that the way people perceive and respond to architecture is mediated by both innate and learned mechanisms that govern emotional and cognitive processing.

2.7. Biophilic urban environments

Researchers widely agree that exposure to nature enhances mental health, well-being, and overall quality of life in urban environments. Layers of the landscape, landform, vegetation, color and light, compatibility, archetypal elements and character of peace and silence are the specific features of urban green spaces that promote positive emotions, mindfulness, and relaxation by an increased alpha brainwave activity, indicative of relaxation, highlighting their critical role in enhancing mental well-being. These findings emphasize the importance of thoughtfully designed greenery to maximize psychological benefits, encouraging urban planners to incorporate such elements into cityscapes [29]. Another study from 2015 [30]. highlights the neurological impacts of biophilic design by demonstrating how exposure to natural environments reduces activity in the subgenual prefrontal cortex, a region associated with stress and rumination. The findings support the incorporation of biophilic elements in urban settings to promote mental well-being and mitigate stress-related disorders, aligning with the principles of neuro-urbanism. This restorative effect of biophilic design elements on human health and cognitive performance is all the more present in interior environments. This fact has been confirmed by many studies as a reality + VR study supported by wearable sensors to measure blood pressure, galvanic skin response and heart rate investigating how biophilic design elements increase in positive emotions after experiencing the biophilic setting [31]. Reduced heart rate and lower cortisol levels, indicate decreased stress and increased relaxation while heart rate variability (HRV), (an indicator of relaxation and autonomic balance), improved significantly in biophilic settings therefore biophilic environments (indoor and outdoor) offer significant benefits for both physiological health and cognitive function.

3. Approach

In addition to this repository of literature review, this article wants to present the conclusion of the first stage of the author’s research study in neurourbanism. This endeavour aims for a brief exploration of how neurourbanism can inform urbanism in the design concept stage. The field of architecture has undergone profound changes in recent years as artificial intelligence (AI) and advanced algorithms have transitioned from being auxiliary tools in the design process to becoming integral to the design methodology itself. This shift is revolutionizing how architects conceptualize, develop, and execute their projects, transforming both the creative and technical aspects of architectural practice. AI and algorithms have introduced generative design, where architects collaborate with computational systems to explore vast design possibilities, this generative ecosystem of AI tools expanding each day. These systems leverage algorithms to generate multiple iterations of a design based on predefined parameters, such as spatial requirements, material constraints, or environmental considerations. Urban planning benefits from predictive models that analyse traffic patterns, population density, and environmental impact, helping architects design buildings and spaces that respond to community needs. This iterative process expands the architect's creative capacity, enabling the exploration of innovative solutions that might not have been achievable through traditional methods.

Fig.2 The generative ecosystem of AI tools to assist the design process
Source: Collage by first author

While these generative systems offer an abundance of solutions to design problems, they also introduce the "paradox of choice", a concept theorised by Schwartz in 2002 [32] making it overwhelming to curate, evaluate, and refine the vast latent space of possibilities. Building on extensive clinical insights into the role of emotions in decision-making and reasoning by Damasio and its school [33], our study aims to explore the potential of leveraging affective computing and EEG-based affective computing to navigate and mitigate the paradox of choice. For the purpose of our study an evolutionary genetic-generative algorithm that run in Grasshopper - Rhino representing a tower generation task in a dense urban context. The metaheuristic optimization ran with Lady-Bug and Wallacei and from the 10^{13} latent space solutions from 97 generating stages (fig.3), the Pareto Front of 40 solutions has been extracted, together with the phenotype and genes related to each solution.

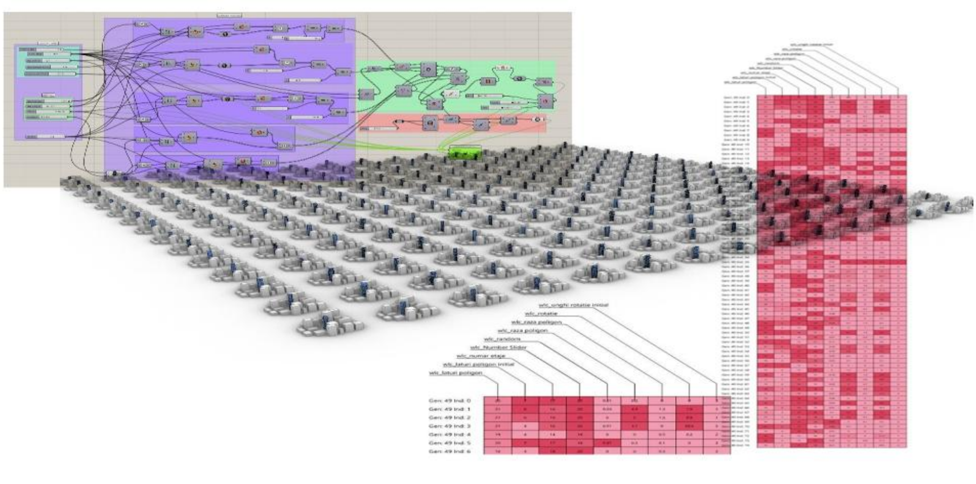

Fig.3 Excerpt of the solutions field and the phenotype and genotype related to each solution
Source: Collage by the authors

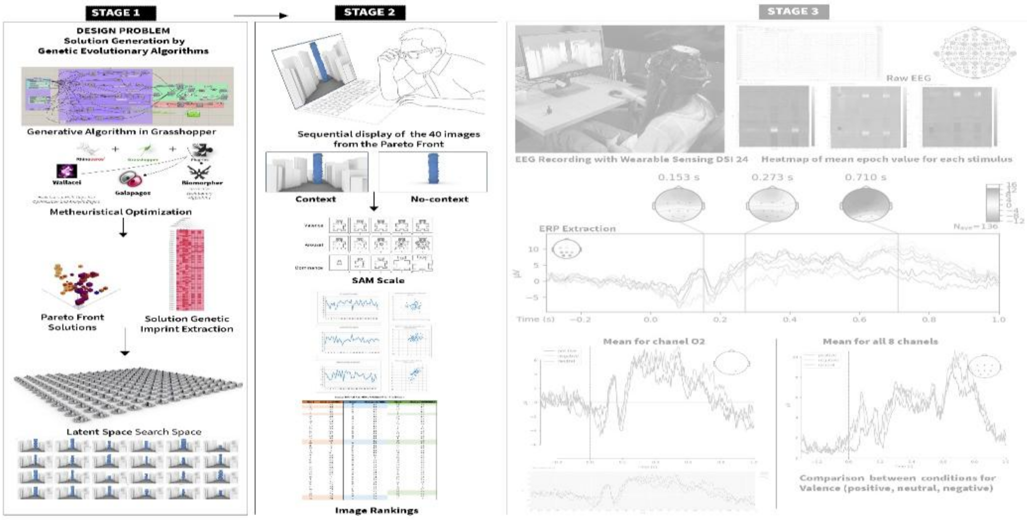

Fig.4 The three stages of the study
Source: Collage by the authors

The study was meant to be conducted in three stages(fig.4). In the first stage (currently completed) we have validated the affective value of the Pareto Front generated solutions from the rating of 40 generated architectural solutions. A computerized version of the SAM Self-Assessment Manikin (fig.5), a pictorial scale for the measurement of pleasure, arousal and dominance - has been employed. In this study we were interested to assess the most appreciated solutions and to see if there are major differences of appreciation of the same solution in urban context or without context. 16 practicing architects took part in the first part of the study, assessing to the SAM scale the same 40 tower solutions in an urban context and no-context to understand to what extent the environment influences the qualitative perception of the same architectural solution.

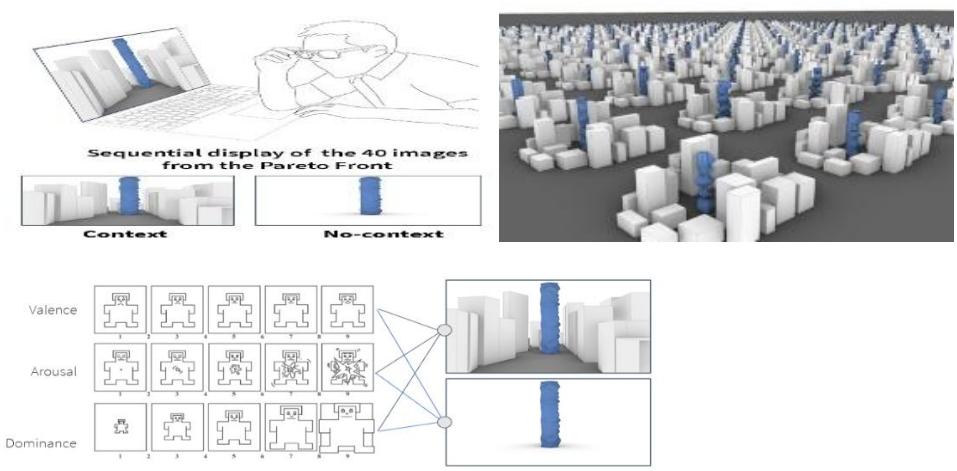

Fig.5. Solution rating using SAM (Self-Assessment Manikin)
Source: Collage by first author

In the second stage (which will not be explicitly detailed in this paper as the results are being under analysis at the moment), we have used ERP components of P300 to observe shifts and patterns in image processing of solutions, using a Wearable Sensing DSI-24 dry electrode EEG Headset and a pipeline with MNE-python library.

4. Results

We found a significant difference in the rating of the same towers in context/no-context, with a p value of 0.03, the arousal component accounting for the main difference (p=0.02). Based on this analysis we have extracted the 2 towers with highest, lowest and neutral ratings for each assessment category, resulting in 18 images that were used in the next stage, twenty-three practicing architects taking part in the ERP second stage.

Considering what we set out to study in this first stage of the study, it can be concluded that showing architectural solutions in an urban context versus no context reveals differences in perception because the environment significantly shapes how people interpret and respond to architectural designs. In conclusion, During the perception of a stimulus, context provides meaning and anchors a solution. When architectural solutions are presented within an urban setting, viewers evaluate them based on their relationship to surrounding buildings, streets, and public spaces and urban environments evoke specific emotional responses. Without context, architectural solutions are perceived in isolation, often leading to a focus on abstract qualities like form, material, or aesthetics, rather than their holistic implications. Without environmental cues, emotional responses are more neutral or abstract, as viewers lack the sensory and experiential inputs and there is no phenomenological appropriation and projection in space. Humans, as embodied cognition beings, experience and understand the world through the interaction of their minds, bodies, and environments. Unlike a purely computational view of cognition, this perspective highlights how physical presence, sensory experiences, and bodily movements influence thought, perception, and decision-making. Our embodied nature integrates abstract reasoning with physical realities, demonstrating that cognition is deeply grounded in our lived, physical and contextual experiences. Moreover, in terms of perception of scale and proportion in an urban setting, the scale of a building is judged relative to its surroundings. A tall building in a dense city might feel appropriate, while the same building in a rural area might seem overwhelming. Without reference points, viewers may struggle to assess scale and proportion accurately, leading to different interpretations of the design. Other research supports these observations. For example: Nasar [34] found that urban context influences perceptions of safety, aesthetics, and livability while Kaplan & Kaplan [35] demonstrated that natural and urban environments evoke different emotional and cognitive responses, which in turn affect how architectural designs are perceived.

In conclusion the environment acts as a lens through which architectural solutions are interpreted. By comparing urban and no-context presentations, researchers can isolate the influence of context on perception, revealing how deeply intertwined architecture is with its surroundings. This understanding is crucial for designing solutions that resonate with their intended settings and users, demonstrating that urban design should not be done in the abstract and in the absence of a very good understanding of the urban, social, affective context etc. In this sense human evaluation unlike effective computation is able to evaluate an architecture solution holistically, affective computation tools providing opportunities to mediate this gulf.

5. Implications

The integration of neurourbanism into urban planning - both in terms of the principles it promotes and the study tools it provides- may constitute a paradigm shift, emphasizing that architecture and urbanism are not solely about form and geometry but also about human experience in space. Especially as today neuroscience tools become commercially available, platforms like iMotions facilitate the integration of measurements from different consumer neuroscience tools simultaneously, enhancing the depth and accuracy of consumer insights. The global neuroscience market has a forecast compound annual growth rate of 4.2% in the coming years, reflecting the increasing availability and adoption of neuroscience tools across various sectors [36]. Beyond the use of these tools in design stages, they can also be used in post-occupational analysis, the observed information feeding back the design process. In an article by Ergan et al. it is explored how human experiences in architectural spaces can be quantified by integrating virtual reality (VR) with body sensor networks to capture physiological responses. This approach provides an objective method for evaluating the impact of spatial design on human comfort, perception, and overall experience, enabling data-driven improvements in architecture. [37] Therefore the intersection of VR/AR, AI and neuroscience tools offers transformative potential, enabling the analysis of big data in different mediums to inform design decisions. However, these should not replace human factor interrogation. By leveraging tools such as EEG headsets and biosensors, urban planners can create healthy and inclusive environments and cities can become more human-centred, fostering environments that support mental health, social cohesion, and overall quality of life. The use of affective computing in neuro-urbanism holds the potential for positive outcomes, such as fostering emotionally adaptive urban environments and enhancing well-being, but it also raises concerns around privacy, ethical data usage, and the risk of emotional manipulation, necessitating careful governance and responsible implementation to balance innovation with ethical integrity. In terms of the ethical concerns of artificial intelligence in urban planning, AI technologies in urban planning can presents potential ethical challenges as privacy issues, surveillance, and data breaches, biases, highlighting the need for ethical considerations in their application. In this regard human oversight and continuous monitoring are essential to ensure ethical practices.

6. Value

This research contributes to the interdisciplinary understanding of urban planning in the realm of neurourbanism, that is bridging together architecture, psychology, medicine and mathematics. By highlighting the potential of innovative tools to enrich urban design processes, the study advocates for a holistic approach that prioritizes human well-being in the creation of urban environments by leveraging available principles and tools from the neurourbanism field. This integration of affective computing creates a direct link between the creator and its creation, representing a groundbreaking step in aligning technology with human-centric urbanism. Affective computing can complement existing smart city IoT frameworks by feeding emotional data into AI algorithms for predictive modelling and optimizing resource allocation and service delivery based on real-time emotional feedback. Therefore, a huge value resides in seamless integration of emotional intelligence into AI-powered urban systems. Neurourbanism represents a transformative paradigm in urban design as it merges neuroscientific insights with traditional architectural practices. Through tools like neuroimaging, psychophysiological measurements, and VR simulations, designers can create environments that resonate more deeply with human cognitive and emotional needs [38]. Although challenges remain, ongoing advancements in technology and interdisciplinary collaboration promise to make neurourbanism a cornerstone of future urban design processes. Furherly, neurourbanism offers an unprecedented opportunity to transform the urban design process, crafting environments that not only meet functional needs but also resonate deeply with the human mind and spirit. It represents a promising frontier in urban planning, offering new tools and methodologies on two layers: (1) to integrate human values and emotional dimensions into design processes or (2) to assess the post-impact of design on human psyche. By leveraging insights from neuroscience, affective computing and environmental psychology, urban planners can create enriched environments that promote well-being and inclusivity.

The presented case study highlights the difference in perception of an object outside and within an urban context that underscores the profound role that environmental context plays in shaping human experience and interpretation of the built environment. This phenomenon can be elaborated upon in several key dimensions:

- Urban contexts imbue objects with an emotional tenor derived from the surrounding atmosphere—light, sound, movement, and overall activity. An architectural object might seem serene in a calm park yet evoke stress or excitement in a bustling commercial district. In terms of cognitive processing, the Gestalt Principles says that Humans naturally perceive environments as unified wholes rather than isolated elements. Within an urban context, an object's perception is influenced by how it integrates with or disrupts the gestalt of the area;
- In terms of semantic anchoring, an object in an urban setting is interpreted through its functional and narrative role within that context—whether as art, utility, or infrastructure;
- There is also a temporal influence in changing perceptions that can evolve over time within its context as people associate it with historical events, shifts in urban usage, or changing cultural attitudes. This research underscores the interdependence between objects and their settings, suggesting that understanding urban environments requires a holistic view that considers not only the intrinsic properties of objects but also their dynamic interactions with context, culture, and human activity.

Neurourbanism enrich the urban design process with principles and new tools that that can be employed for a transformative approach to building human-centric cities that prioritize psychological well-being and cognitive health.

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