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# Editorial: Extended mind for the design of human environment

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## Editorial on the Research Topic Extended mind for the design of human environment

When, in 1998, [Clark and Chalmers, 1998](#) proposed the extended mind hypothesis, they challenged one of the most deeply entrenched assumptions in the philosophy of mind: that cognitive processes are confined within the boundaries of the skull. Their parity principle suggested that if an external process functions in a way that, were it carried out internally, we would have no hesitation in counting it as part of the cognitive process, then that external process is part of the cognitive process. This seemingly simple thought experiment opened a vast conceptual territory that has since been explored across cognitive science, philosophy, psychology, and, increasingly, the disciplines concerned with the design and planning of the built environment.

The idea that architecture, urban spaces, and the material infrastructure of everyday life might play a constitutive rather than merely causal role in human cognition is not, however, entirely novel. As early as the 1930s, the Austrian-American modernist architect [Neutra, 1954](#) developed an interest in physiological psychology and argued that the design of residential spaces could potentially alleviate neurotic conditions in their inhabitants. His visionary work, *Survival Through Design* (1954), anticipated what would later become environmental psychology: the systematic study of how physical surroundings shape perception, behavior, and wellbeing. In more recent decades, scholars such as [Pallasmaa, 2005](#) have further advanced research at the intersection of neuroscience, embodiment, and architectural design, emphasizing that our experience of the built world is fundamentally multisensory and that materials, textures, and spatial configurations resonate with the body in ways that precede and exceed conscious deliberation.

This Research Topic was conceived to bring together contributions from architecture, neuroscience, psychology, urban planning, cognitive science, and design studies, all converging on a shared question: how does the built environment participate in, and shape, human cognitive, affective, and social processes? The Research Topic that has emerged is remarkably diverse and yet surprisingly coherent, spanning theoretical frameworks, empirical investigations, computational models, and design proposals across four continents. In what follows, we offer a reading of the twenty-one contributions that compose this Research Topic, organizing them into an overarching

conceptual architecture that reflects the multiple dimensions along which the extended mind paradigm intersects with the design of human environments.

A first cluster of contributions addresses the theoretical and conceptual foundations linking extended and embodied cognition to the built environment. [Candeloro et al.](#) provide a systematic historical and philosophical mapping of the relationship between extended mind theories and urban planning, tracing three successive waves (functionalism, social externalism, and radical enactivism) and their corresponding implications for reorienting urban planning approaches. By conceptualizing the city as a distributed socio-cognitive architecture, they argue that participatory design, environmental affordances, and enactive engagement with the urban space are not optional add-ons but intrinsic requirements of cognitively informed planning. This contribution provides a theoretical scaffolding for the entire Research Topic.

[Viale](#) extends this conceptual terrain by introducing the notion of the Behavioral City, a framework that integrates behavioral urbanism and behavioral public policy into a unified approach to city design. Drawing on the tradition of bounded rationality and enactive problem-solving, he argues that built environments function as systems of social affordances through which embodied agents engage in reciprocal feedback loops. His concept of enactive nudging, that focuses on how urban spaces actively shape behavior through their material and spatial properties rather than through abstract informational cues, offers a powerful bridge between cognitive science and urban policy.

[Grusso et al.](#) directly engage with the concept of the extended mind of public space, proposing a theoretical framework in which squares, parks, and gathering places function as laboratories for human experience and wellbeing. Their identification of six design paradigms—ritual-based, body-based, sensory-based, atmospheric-based, performance-based, and intelligent/augmented-based—provides a systematic taxonomy that connects spatial design features to different modalities of cognitive and experiential extension. This contribution lays foundational groundwork for a design-oriented reading of the extended mind hypothesis.

[Charalambous et al.](#) extend this theoretical framing in a complementary direction by focusing on situated affectivity and the orchestration of brain-body-environment rhythms. Their perspective article challenges the computational metaphor of the brain by proposing that cognition emerges through the resonance of brain-body systems that become attuned to environmental rhythms. Drawing on evidence from neural entrainment research, they argue that the built environment's temporal and rhythmic properties such as its patterns of light, sound, movement, and spatial recurrence, are not merely background conditions for cognition but active participants in the orchestration of perceptual, affective, and cognitive states.

[Rambhoros et al.](#) contribute an innovative empirical operationalization of an emerging concept in urban design: loveability. Moving beyond the more established notion of liveability, which focuses on infrastructure, functionality, and services, they investigate the emotional bonds that city dwellers form with psycho-spatial aspects of urban environments. Through on-site surveys administered in two creative cultural third places (Museums Quartier Haupthof in Vienna and Praça de Joan

Coromines in Barcelona), they argue that loveability is quantifiable and that its dimensions involve a complex interplay of psychological and spatial factors, providing empirical evidence that affective resonance between persons and places is amenable to systematic investigation and design intervention.

A second cluster of contributions explores how specific design features and environmental conditions shape human perception, neurophysiology, and behavior. [Manohar and Kurukkanari](#) present a neurourbanism pilot study conducted in Calicut, Kerala, using mobile EEG technology to measure how diverse urban settings varying in street enclosure, natural features, and activity levels, influence neurophysiological states including excitement, engagement, interest, relaxation, and stress. As the first application of mobile EEG in a South Indian urban context, their work provides direct neurophysiological evidence that urban design shapes cognitive and affective experience in real time.

[He et al.](#) address a complementary dimension of the environment-mind interface through their multi-objective optimization study of residential building glass in Chinese summer-hot and winter-cold regions. By employing genetic algorithms to simultaneously optimize energy consumption, carbon emissions, and indoor health performance parameters, they show how the material properties of the building envelope such as light transmittance, thermal transfer, and solar heat gain, have measurable consequences for occupant health and wellbeing, showing how the physical mediation of environmental stimuli through architectural elements affects the biological and cognitive substrate of human experience.

[Rana et al.](#) offer a culturally rich counterpoint through their study of vernacular facades in the Bhal region of India. Using visual ethnography and grounded theory techniques, they identify eight thematic levels of human-nature connections fostered by the spatio-artistic features of traditional half-timber dwelling entrances. Their findings reframe vernacular architecture as an exemplar of relational design, i.e., a form of built environment that has long facilitated the kind of cognitive and affective extension that the extended mind hypothesis theorizes, through the intimate interweaving of spatial, artistic, and ecological elements.

[Alfaris et al.](#) examine the adaptive reuse of industrial heritage buildings through a case study of the Erbil Silo in Kurdistan-Iraq, proposing its transformation into a hotel. Their qualitative analysis of design strategies for spatial transformation demonstrates how the cognitive and cultural memory embedded in industrial structures can be preserved and reactivated through adaptive reuse, illustrating that built heritage functions as a form of collective extended memory: a material repository of cultural identity that mediates between past experience and contemporary use.

A third cluster brings computational, technological, and methodological innovation to the interface between cognition and the built environment. [Gangemi and Lucifora](#) present BEACON (Built Environment Architecture Cognitive Ontology Network), a comprehensive multi-layer ontological framework that integrates physical, experiential, social, normative, behavioral, cognitive, and neural analytical dimensions. Applied to a comparative analysis of Pachino's central square in Sicily across historical and contemporary configurations, BEACON demonstrates how AI-assisted methods can extract tacit knowledge from built environments, offering a structured

methodology for making the extended mind legible to both researchers and practitioners.

Ullrich et al., 2024 present a hybrid workflow for predictive pedestrian movement modelling that integrates an agent-based model with a network model. Their approach provides urban planners with a comprehensive tool for simulating how spatial configurations shape pedestrian behavior at both micro and macro scales. By predicting how people will navigate urban environments before they are built, this contribution operationalizes a key implication of the extended mind thesis: that spatial design does not merely accommodate movement but actively constitutes the cognitive-motor patterns through which inhabitants engage with their surroundings.

Bayramov et al., 2024 contribute a quantitative assessment of urban surface deformation risks in Almaty, Kazakhstan, using multitemporal satellite remote sensing. Primarily a geophysical study, their work reveals how subsurface geological dynamics like tectonic movements and ground deformations invisible to everyday perception create material risks for the built environment that ultimately constrain and shape the conditions of urban habitation. This contribution extends the scope of the extended mind framework to include the geological substrate upon which cognitive environments are constructed.

A fourth cluster addresses the socioeconomic, behavioral, and public health dimensions of the human-environment relationship, bringing the extended mind paradigm into the domain of urban systems and population-level outcomes. Ouyang and Bai, 2024 investigate how social media facilitates public participation in Chinese urban planning through the lens of place attachment, using the Guangzhou banyan tree incident as a case study. Their analysis demonstrates that the emotional connections residents form with elements of their built environment, i.e., what the extended mind framework would characterize as affective scaffolding, can mobilize collective action and reshape urban governance, showing how cognitive-environmental coupling operates at the political and institutional scale.

Tristram et al., 2025 examine environmental predictors of active commuting to school among German adolescents through a mixed-methods approach combining parental and adolescent perspectives. Their findings reveal how the built environment's physical infrastructure of sidewalks, cycling paths, street lighting, and traffic density shapes the decision-making processes through which families negotiate transport mode choices beyond mere mobility patterns. This contribution shows that the extended mind operates developmentally, as the spatial affordances of the built environment structure the cognitive habits and embodied routines that form during adolescence.

Chen and Liu investigate how urban amenity, understood as the subjective attractiveness of urban environments, affects the willingness of college-educated youth to remain in Chinese first-tier cities. Their development of an urban amenity scale based on subjective evaluation captures how the cognitive and affective qualities of urban environments influence major life decisions, highlighting that the extended mind operates not only at the level of individual perception but also through the aggregate socioeconomic dynamics that shape urban populations.

Fang et al. focus on the gendered dimensions of urban experience through their study of female-friendly residential

facilities in Yangpu District, Shanghai. Drawing on 923 survey responses and structural equation modeling, they show that the built environment of community facilities significantly influences perceptions of female-friendliness and residential satisfaction. This contribution stresses the point that the extended mind is not a gender-neutral abstraction: the ways in which environments scaffold cognition, affect, and social interaction are shaped by embodied social identities and differential patterns of spatial use.

Liu et al. contribute a methodologically sophisticated coupled model linking infectious disease hazard and urban vulnerability across eighteen cities in Sichuan Province, China. Their hazard-vulnerability risk coupling model reveals that economic, spatial, social, and environmental factors display pronounced interaction effects and spatial heterogeneity in shaping public health risk, underscoring that urban environments are active systems whose structural properties cascade through population-level health outcomes.

Zhao et al. examine the spatio-temporal coupling between carbon emissions from urban land use and ecosystem service values at the municipal scale across China. Their analysis contributes to the extended mind framework by demonstrating that the ecological infrastructure of urban environments (green spaces, waterways, and land use patterns) constitutes a fundamental dimension of the experiential environment within which human cognitive and affective lives unfold.

Jęśkowiak-Kossakowska et al. provide an instructive contribution through their study of skin cancer prevention behaviors in the Polish population during the COVID-19 pandemic. Their findings illuminate a critical dimension of the human-environment interface: the ways in which public health crises restructure the relationship between individuals and their physical surroundings, altering patterns of outdoor exposure, preventive behavior, and health risk perception. The pandemic fundamentally reconfigured the cognitive ecology of built and open environments, revealing the normally invisible scaffolding that environments provide for health-related cognition and behavior.

Several cross-cutting themes emerge from this Research Topic that deserve emphasis. First of all, the remarkable methodological pluralism on display, spanning mobile EEG, structural equation modeling, visual ethnography, ontological frameworks, genetic algorithms, agent-based simulations, satellite remote sensing, and discourse analysis, demonstrates that the extended mind paradigm is not tied to any single disciplinary toolkit but can be productively investigated through radically diverse approaches. Moreover, the geographic breadth of the Research Topic encompassing India, China, Austria, Spain, Italy, Cyprus, Germany, Poland, Kazakhstan, and Iraq, reveals that the cognitive entanglement of mind and built environment is a universal phenomenon that nonetheless takes culturally specific forms, from the biophilic thresholds of Gujarati vernacular architecture to the place attachment politics of Guangzhou's banyan trees. Finally, the Research Topic operates across multiple scales of analysis, from the neural oscillations measured in individual brains to the population-level dynamics of urban migration and public health risk, suggesting that the extended mind paradigm offers a genuinely multi-scalar framework for understanding how built environments participate in human cognitive life.

Taken together, these twenty-one contributions demonstrate that the extended mind hypothesis, when applied to the built environment, is not merely a philosophical provocation but a productive research program with empirical traction across multiple disciplines and scales of analysis. What emerges from this Research Topic is a vision of design as cognitive stewardship: the deliberate shaping of environments that support, extend, and enrich the mental lives of their inhabitants. This vision demands a genuinely transdisciplinary approach that integrates the insights of neuroscience, psychology, architecture, urban planning, economics, public health, and computational science. As urbanization accelerates and the challenges of sustainable, equitable, and health-promoting design become ever more urgent, the framework developed across these contributions offers both a conceptual compass and a methodological toolkit for navigating the complex entanglement of mind, body, and built world.

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## Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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