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*Research Article*

# Integrating Neuroscience into Age-Friendly Urban Governance

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**Abstract:** Global policy frameworks such as the WHO Age-Friendly Cities initiative and the Sustainable Development Goals have played a significant role in shaping contemporary urban responses to population aging. These frameworks promote inclusive, healthy, and accessible cities, yet they are often translated into practice through standardized design checklists and physical accessibility measures. This study argues that such approaches are insufficient to address the cognitive and neuro-sensory dimensions of aging, resulting in a governance gap between global standards and local lived experience. It examines how age-friendly policies are mediated by urban environments based on concepts from neuroarchitecture, an interdisciplinary approach that focuses on psychological and physiological dimensions of human experience in the built environment, health geography, and urban governance. It introduces the notion of neuro-responsiveness as an evaluative lens for assessing whether urban governance structures meaningfully engage with aging-related cognitive diversity. As a result, neuroarchitectural considerations are frequently marginalized, despite their relevance to well-being, and everyday mobility for older adults. In the context of a shifting world order, marked by demographic aging, decentralization, and increasing demands on local governments, the study calls for a reorientation of age-friendly governance toward neuro-informed planning methods. This involves integrating cognitive criteria into urban policy, fostering cross-sector collaboration, and recognizing neuroarchitecture as a form of necessity embedded in local decision-making. The study concludes by identifying pathways to more cognitively equitable and contextually sensitive urban governance, to empower the next generation of designers, planners, and future decision-makers, to navigate complex social change.

**Keywords:** Neuroscience; age-friendly; urban governance

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## 1. Introduction

### 1.1. Demographic Flux and the Current Urban Conditions

The aging population experiences one of the most significant socio-demographic shifts that the twenty-first century is about to see (Bloom et al., 2010). It is expected that people over the age of 60 will represent more than 20% of the world's population in the year 2050, which, will be particularly visible in urban areas, where local governments and urban planning systems (especially at the level of neighborhoods and everyday living environments) will play a crucial role in addressing the challenges associated with an aging population (UN DESA, 2019). It is possible to mention that

the two megatrends, urbanization and aging population, are intersecting (OECD, 2025). Various global policies have made age-friendly cities and communities the norm to be achieved, like the World Health Organization (WHO) Age Friendly Cities and Communities framework (WHO, 2007), the inclusion of the Sustainable Development Goals (SDGs) (United Nations, 2015), specifically SDGs 3 and 11, and the "New Urban Agenda" (UN, 2020). These frameworks may be considered critical in enhancing aging and promoting a response by local authorities in addressing the barriers to participation, mobility, and service delivery (Buffel et al., 2012). Nevertheless, in translating the various frameworks into implementation, the physical, functional, and service aspects were distinguished and highlighted. There was minimal emphasis and attention devoted to the cognitive or neuro-sensory aspects of aging, the environment and the built environment and particularly the findings and views from the fields of neuroscience, environmental psychology, and the study of aging (van Hoof et al., 2018). For example, approximately 15–20% of adults aged 60 and over experience mild cognitive impairment, a condition associated with an increased risk of dementia (Petersen et al., 2018). Globally, the number of people living with dementia is projected to reach around 152 million by 2050 (Alzheimer's Disease International, 2019).

Population aging has emerged as one of the most consequential demographic transformations shaping contemporary cities. Across diverse geographical contexts around the world, declining fertility rates, increased life expectancy, and migration dynamics are reconfiguring urban population structures, resulting in a growing proportion of older adults residing in cities (UN DESA, 2018). This demographic flux intersects with other structural changes, such as economic restructuring, climate stress, rapid digitalization, and shifting geopolitical orders characterized by deglobalization and multipolarity. This demographic flux intersects with broader structural transformations shaping contemporary urban development. Economic restructuring has accelerated the transition of many urban economies toward knowledge-intensive and service-oriented sectors, reshaping labor markets and patterns of spatial inequality (OECD, 2020; Florida et al., 2021). At the same time, cities face increasing climate stress associated with rising temperatures, extreme weather events, and environmental risks that challenge urban infrastructure, resilience, and public health (IPCC, 2022; UN-Habitat, 2022). Rapid digitalization is transforming governance systems and everyday urban life through the expansion of data-driven technologies, digital platforms, and smart urban infrastructures (Kitchin, 2023; Cugurullo et al., 2020). These developments unfold within a changing geopolitical landscape characterized by the partial reconfiguration of globalization processes and the emergence of a more multipolar world order, which increasingly shapes global investment flows, migration dynamics, and urban development strategies (Rodrik et al., 2023). Together, these dynamics challenge established urban governance models and demand new forms of spatial knowledge capable of addressing complexity (multiple interacting transformations e.g. demographic, climate, digital), uncertainty (unpredictable future risks such as climate, economic change), and diversity (heterogeneous urban populations i.e. aging, cultural, social) (Imrie & Hall, 2001). Urban contexts are instrumental in defining the experience of aging (Buffel and Phillipson, 2024). They can either become supportive of autonomy, participation, and health in older age or contribute to vulnerability as a consequence of spatial exclusion, environmental strain, and mental overload (Finlay & Kobayashi, 2018; Madanipour, 2010). Urban areas constitute key settings in which everyday experiences of mobility, social interaction, and place identification are shaped (Marston et al., 2021). However, public spaces are often designed and regulated in ways that are informed by assumptions about the more useful, normatively cognitive, and able-bodied inhabitants.

In geographical research, aging is understood not only as a biological process but also as an experience that involves the politics of scale, culture, and power relationships inscribed in space (Andrews & Phillips, 2005; Lawton & Nahemow, 1973; Peck & Theodore, 2015; Skinner et al., 2018). Issues related to aging and the responses of developers, urban planners, governance, decision-makers, etc., therefore, need analytical methods that span the policy frameworks of the global and the local, and the lived experience of the individual. As a result, many cities formally recognized as age-friendly add just another layer of discomfort, instead of addressing the fundamental problem of inclusion with their rapid temporal rhythms, complex spatial layouts, and cognitively demanding infrastructures (Evans, 2003; Kaplan & Kaplan, 1989; Milgram, 1970; Peace et al., 2006). This paper contends that this gap is not only an issue of design oversight but is instead indicative of broader issues concerning the governance of policy transfer, institutional silos, and scale mismatches, opposing global best practice and lived reality.

While architecture and urban planning operate at different spatial and institutional scales, both disciplines shape the sensory and cognitive conditions of everyday environments. Insights from neuroscience-informed architectural research, often referred to as neuroarchitecture, have primarily focused on building-scale design, examining how spatial configurations influence stress, attention, and well-being. In this paper, these insights are not treated as a separate

disciplinary framework but as an interdisciplinary knowledge base that can inform broader discussions in urban planning and governance regarding cognitively supportive and age-responsive urban environments. By integrating perspectives from neuroscience into debates on urban governance and geography, the paper reframes age-friendly urbanism as a question of cognitive justice and argues for the use of quantitative neuroscientific methods capable of measuring how environmental conditions influence cognitive load, stress, and patterns of exclusion (Eberhard, 2009; Mallgrave, 2015, 2018; Vecchiato et al., 2015; Williams, 2011; Zeisel, 2006). The present paper proposes the major argument that it is impossible to create age-friendly cities solely based on universally set standards, which are not fully inclusive, and there is a need for neuroscience-informed architectural perspectives in urban governance, which can translate into the ambitions of global policy in context-sensitive and cognitively informed urban spaces. In sum, the paper's aim is to identify the pathways to more contextually sensitive urban governance, empowering today's designers, planners, and students to become future decision-makers (Healey, 2007; Stirling, 2010).

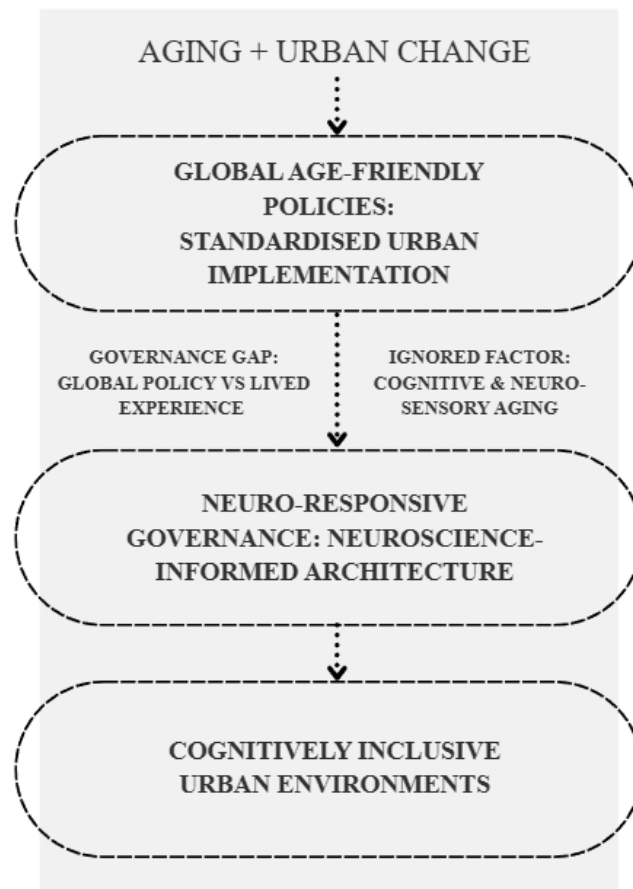
### *1.2. Age-Friendly Cities and the Limits of Standardization*

Over the past two decades, global policy frameworks have placed growing emphasis on addressing population aging through the development and promotion of age-friendly cities. The WHO Age-Friendly Cities & Communities framework (WHO, 2007), which shares the same relevance as the SDGs, remains the leading guideline in the field of urban population ageing. They emphasize healthy, accessible, and inclusive communities through areas such as outdoor spaces, transportation, housing, and participation. The age-friendly movement is successful in mainstreaming aging as an important topic under the discourse of the urban, and it is translated into action by the use of formal indicators, checklists, and benchmarking techniques (WHO, 2015; Rugel et al., 2022; Huovila et al., 2019). These techniques made the action feasible and transferable to different cities, and were generally made controllable and measurable. However, these age-friendly actions often overlook cognitive and neurosensory challenges associated with aging. Thus, this paper opposes such an approach, which is a reflection of a narrow understanding of both aging and the urban environment. By reducing age-friendly issues solely to a number of technical requirements of compliance, a risk arises of having a gap between global issues and local experiences through a re-evaluation of forms of geographic knowledge that are founded upon age-friendly issues of the urban environment.

### *1.3. Geography Education on Age-Friendly Governance*

In geography education, the idea of strong geographic knowledge has been used to illuminate different forms of knowledge that allow people to interpret, explain, and critically engage with the natural and the built environment within their own contexts (Bendl et al., 2025). Strong knowledge is abstract, systematic, and transferable because it helps people cope with the complexities associated with societies (Young, 2008; Young & Muller, 2010). However, strong knowledge has been associated with the critique of promoting dominant epistemology (understood as the framework through which knowledge is defined and legitimized) at the expense of trivializing established knowledge (Maton, 2014; Muller, 2009). An age-friendly urban governance approach becomes a fertile ground to explore these contradictions (Buffel et al., 2012). In one respect, global discourses offer a body of powerful knowledge, which, in turn, influences the policy agenda and the curriculum in universities (Young 2013; Peck & Theodore, 2015). Conversely, however, the reality of aging in a particular urban environment illustrates the didactic nature of these abstractions (Andrews & Phillips, 2005; Skinner et al., 2018). This paper argues, therefore, that the inclusion of neuroscientific aspects of embodied cognition in geographical education can offer an enriched outlook because it views geographical knowledge through the cognitive and sensory lens.

The objective of this paper is to discuss how neuroscience could inform age-friendly governance and geography education during this period of population change. Through an application of health geography and governance, as well as neurosciences and urban design, neuro-responsiveness will be explored as an approach to understanding how well cognitive diversity in an aging population is engaged. Accordingly, the paper hypothesizes that integrating neuroscientific insights and measurement tools into urban governance can strengthen age-friendly planning by enabling the systematic evaluation of how urban environments influence cognitive load, spatial orientation, and well-being among older adults (Figure 1).



**Figure 1.** Conceptual flow of neuro-responsive age-friendly urban governance

The structure and flow of the paper are as follows. Section 2 introduces the theoretical framework, which positions neuroarchitecture in the context of health geography and urban governance. It continues with the critiques of the state-of-the-art global frameworks for age-friendly policies and the mechanisms for policy transfer. It examines the consequences and repercussions for public space in cities that are undergoing demographic shifts from the perspective of neuroarchitecture. Section 3 presents the methodology. The relevant discussions are in Section 4, which puts the findings and learnings from the paper in perspective for education and training in geography and the growth of future citizenship. The conclusion summarizes the paper and identifies the future course towards more appropriate city governance and future-proof education in Section 5.

## 2. Literature Review

### 2.1. Age-Friendly Governance

The WHO Age-Friendly Cities and Communities Framework (2007) has been initiated due to the emerging recognition of the significance of urban aging in the current scenario (UN, 2015). It has a wide range of coverage and helps the cities to promote active aging. Therefore, the framework has been implemented on a large scale, and many cities have joined the Global Network for Age-Friendly Cities and Communities (WHO, UN-Habitat, 2018).

In terms of governance and politics, the role performed by this framework is that of a policy script because it gives legitimacy and accessibility to transnational networks (Peck & Theodore, 2015). For local authorities, this act is an indication of commitment to inclusivity and social responsibility (Buffel et al., 2012). Geographers have characterized such frameworks as a form of policy mobility, through which knowledge and models move from one location to another through various routes of expertise validation (McCann & Ward, 2011). Policy mobility can be an aid to learning and innovation, yet it entails processes of simplification and abstraction (Peck & Theodore, 2015). Local complexities are

reduced to indicators that can be measured and ranked according to a scale of knowledge, in which qualitative knowledge is secondary to quantitative knowledge (Power, 2007).

Addressing age-friendly cities, it has been noted that benchmarking as a method has more emphasis on infrastructure delivery than on experiences (van Hoof et al., 2018). The cognitive and sensory characteristics of space cannot be rendered as standardized experiences and remain less visible within governance (Peace et al., 2006). This tendency reflects general attitudes within urban governance towards technocratic rationality (Flyvbjerg, 1998). The de-emphasis on cognitive criteria in age-friendly governance has several implications (Buffel et al., 2012). Even in cities that have adopted age-friendly initiatives, older people may be enabled to take part in public spaces, but such spaces would still present them with stressful, confusing, or alienating environments (Evans, 2003). This could result in decreased mobility, isolation, and quality-of-life deficits (Lawton & Nahemow, 1973; Finlay & Kobayashi, 2018). For example, mobility limitations affect approximately 35% of people aged 70 and over, significantly restricting their ability to participate in everyday activities and maintain independence (Webber et al., 2010). At the same time, 10–20% of older adults in many European countries report experiencing loneliness, and around 20% of people aged 65+ live alone, increasing the risk of social isolation and reduced well-being (Puyan  et al., 2025). These governance deficits are not distributed evenly (Skinner et al., 2018). Socio-economic disparity, cultural variation, and climate variability influence how cognitive demands are distributed (Phillipson, 2010). These global frameworks are not aware of these variations, leading to spatial injustice in postcolonial and urbanizing settings (Soja, 2010).

## 2.2. Health Geography and the Spatial Experience of an Aging Population

Health geography has long emphasized the role of place in determining health outcomes, access to care, and well-being (Andrews & Phillips, 2005). This approach has been particularly important for framing issues about aging insofar as neighborhood characteristics, environmental quality, and spatial accessibility impact older adults' competencies to age in place (Peace et al., 2006). For instance, research has indicated that a greater facility for walking, green space, and proximity to services result in better physical and mental health conditions among the aging population (Kaplan & Kaplan, 1989; Sugiyama et al., 2009; Maas et al., 2006). However, much of this literature remains focused on structural and material determinants, with limited attention to cognitive processes that mediate how environments are perceived and navigated. Aging is often accompanied by changes in sensory perception, memory, attention, and stress regulation (Salthouse, 2010). These changes do not necessarily imply decline but rather increased variability and diversity in cognitive functioning (Park & Reuter-Lorenz, 2009). The visually cluttered, acoustically discomfoting, or spatially ambiguous urban environments make high demands on cognitive resources, reducing confidence and a lowered willingness to venture into public space (Evans, 2003; Milgram, 1970).

In geographical terms, these cognitive factors are spatial by nature (Andrews et al., 2018). Cognitive factors are determined by street arrangements, urban rhythms, and symbolic concepts of place (Lynch, 1960). By incorporating cognitive concepts into geographical research on health, a more holistic perception of aging is made possible because of its embodiment and situational nature (Cutchin, 2003). The WHO Age Friendly Cities and Communities Framework (2007) is currently the most widely accepted global framework for urban aging policy. It lists eight areas in which the city should make self-assessments and improve. This standardization has made it easier to diffuse globally but has, in turn, constricted the space to interpret and respond to more intangible aspects of aging, such as comfort, cognitive engagement, and emotional security (Buffel et al., 2012). Assessments of age-friendly initiatives in cities show excellent performance in transport delivery and social programming, but with challenges in navigation complexity, overstimulation in the public domain, and exclusion in information technology (van Hoof et al., 2018; Lui et al., 2009). For instance, although effective communication and information are formally considered in the guide, it remains difficult to assess how well older adults can cognitively navigate urban environments or feel emotionally secure within dynamic and changing spaces, dimensions that are central to environment, behavior research and neuroscience (Zeisel, 2006). The Vancouver protocol, which informs all such assessments, emphasizes physical and social factors through focus group interview methodology but does not try to evaluate feelings of stress, overstimulation, or cognitive workload (WHO, 2007a). This observation motivates a closer examination of selected urban contexts in which age-friendly policies have been implemented, to explore how different governance frameworks approach the planning and management of aging-related urban environments. The examples presented in this study were selected using a case study approach aimed at illustrating different governance contexts where age-friendly urban policies are implemented. Rather than presenting statistically representative cases, the selected cities serve as illustrative examples highlighting how age-related issues

are integrated into urban planning and governance systems. Three cities, Vancouver, Manchester, and Tokyo, were chosen because they represent different geographic regions, demographic conditions, and planning traditions, while also possessing well-documented age-friendly initiatives. Vancouver represents the North American context, where age-friendly policies are integrated into municipal planning frameworks and community-based programs. Manchester provides an example of a European governance model where age-friendly initiatives are closely linked to social policy, urban renewal, and collaborative governance networks. Tokyo was selected to represent the East Asian context, particularly due to Japan's advanced stage of demographic aging and its long-standing efforts to adapt urban environments and infrastructure to an aging population. The inclusion of these cases makes it possible to comparatively examine how different institutional and cultural contexts shape the implementation of age-friendly policies and to what extent the cognitive and neurosensory dimensions of aging are taken into account in urban governance frameworks.

In Vancouver, age-friendly plans for action involve wide-ranging inventories of changes that can be made for improved safety and accessibility for seniors, which cover more than sixty discrete actions that vary from transportation to social support and engagement (City of Vancouver, 2013). On the other hand, more quantitative assessments, particularly with a formal indicators approach, generally favor outcomes related to transportability and physical accessibility over the emotional security, comfort in public places, or digital exclusion of older people (Power, 2007). In certain areas within Canada, studies that apply life satisfaction surveys have observed that “neither cognitive stimulation nor social interaction, which draw on concepts that refer to emotional and experience components, were well represented by current assessment domains.” (Flores et al., 2019; Menec et al., 2011).

The conflict between technological success and experiential reality is made manifest in empirical evaluations of those cities celebrated for their positive age-friendly shifts. Manchester, being one of the earliest adopters in the UK for the age-friendly model, offers insight. Studies emerging from research conducted through the Manchester Institute for Collaborative Research on Aging (MICRA) demonstrate that, while Manchester scores highly on infrastructural aspects such as accessibility and social engagement, aspects which are more salient to people are those of human connection and routeway reliability. This qualitative data confirms that, due to budgetary constraints faced by local administrations, there has been less emphasis on experiential aspects (Rémillard-Boilard, 2020).

Interestingly, age-friendly assessments in East Asian megacities like Tokyo point out issues of cognitive navigation and environmental overstimulation. Tokyo walkability and age-friendly planning studies indicate that, despite good public transportation and accessible infrastructure, cognitive overload issues arise in older people due to complex transit systems and land use patterns in Tokyo, even among older people experiencing mildly reduced spatial cognition (Annear et al., 2024). Although age-friendly strategies in Tokyo focus on walkability and engagement comparable within WHO domains, there is evidence that the measures employed do not fully encompass difficulties associated with orientation or sensory processing in highly diverse urban environments (Annear et al., 2024). Moreover, experimental strategies based on using mobile and Augmented Reality (AR) orientation tools, at present under investigation in research environments, seem to highlight demands for environments that promote cognitive engagement and orientation beyond physical accessibility. At the same time, urban environments play a crucial role in facilitating social interaction, which is a key determinant of well-being in later life.

### 2.3. Neuroarchitecture

Neuroscience is the scientific field concerned with understanding the structure and function of the brain and nervous system, including how humans perceive, process, and respond to environmental stimuli. When applied to the built environment, neuroscience contributes insights into cognitive functioning, emotional responses, and physiological reactions to spatial conditions (Makanadar, 2024; Metzger, 2018). In this interdisciplinary context, neuroscientists provide knowledge about brain processes and behavioral responses, while architects, designers, and urban planners contribute expertise in spatial organization, environmental planning, and design principles (Aslanoğlu et al., 2025). Together, these perspectives support the development of evidence-based design approaches that aim to improve mental health and well-being in urban environments (Aslanoğlu, 2025). Such approaches incorporate empirically supported environmental features, such as access to green spaces, water elements, and calming pathways, that can help reduce stress and enhance cognitive and emotional comfort. An architectural framework offers a unique perspective on the debate within cognitive neuroscience and philosophy regarding whether cognition is fundamentally embodied or decoupled from physical structure (Djebbara et al., 2019). Evidence shows that various architectural and environmental factors like light-

ing, acoustics, space layout, material, and visual complexity affect the neural engagement associated with stress response, attention, memory, and emotional regulation (Evans, 2003; Ulrich et al., 2008). For instance, empirical research indicates that the influence of natural light promotes the functioning of the circadian cycle (Boubekri et al., 2014), predictable spatial arrangements diminish spatial anxiety, and perceptual overload negatively impacts direction and memory (Kaplan & Kaplan, 1989). These results and recommendations were developed mainly for application within healthcare facilities and office and academic settings as modes for evaluating performance and its related effects (Ulrich et al., 2008). Consequently, neuroarchitectural research adopts a holistic perspective by addressing both the psychological and physiological dimensions of human experience in the design of the built environment.

Urban environments are often understood primarily in terms of physical or social infrastructure; however, they also function as cognitive and emotional infrastructures that shape how people perceive, navigate, and experience urban space. From a neuroscientific perspective, urban environments provide sensory and spatial cues that facilitate orientation, reinforce memory through repeated routines, and regulate affective and stress responses, thereby influencing how individuals cognitively adapt to and situate themselves within complex urban environments. For older adults, well-remembered routes and locations could help with identity formation and independence (Hill, 2023; Sun et al., 2020). Demographic change, however, may involve very fast-paced urban change. Urban renewal, densification, and technological transformations may disturb established cognitive maps, which in turn may lead to confusion and anxiety (Aslanoğlu, 2025).

Within an aged demography, such interactions turn out to be especially relevant owing to factors such as older adults' slower information processing speed, reduced working capacity, decreased contrast sensitivity, and susceptibility to sensory stress (Salhouse, 2010; Park & Reuter-Lorenz, 2009; Owsley, 2011). Findings from environmental gerontological research, for instance, demonstrate that environments characterized by intensive visual clutter, noise, glare, or wayfinding ambiguity are primary stressors for older people, especially those with mild cognitive impairment and dementia (Lawton, 1986; Marquardt et al., 2014; Zeisel, 2006). By contrast, environments that promote legibility, predictability, transition, and moderation improve autonomy and confidence (Lynch, 1960; Kaplan & Kaplan, 1989; Wahl & Lang, 2003). Neuroscience-informed architecture, therefore, represents an overhaul from accessibility for people with disabilities to cognitive accessibility, which remains an un-institutionalized but critical aspect of age-friendly urbanism (Zeisel, 2006; de Paiva, 2025).

Aging Neuroscience-informed architecture is substantially absent from planning and governance on an urban scale. It is mostly discussed from a design point of view, rather than from a governance point of view, when mentioned at all in this context. This paper aims to challenge this by proposing that there are governance implications of neuroarchitecture, specifically related to age-friendly cities.

### 2.3.1. *Technological Change and Its Implications for Urban Governance*

Many new applications of technology exist within government, but some have become much more widely used than others. Examples include digital public service platforms (e-government portals), open data systems, Geographic Information Systems (GIS) for spatial planning, sensor-based urban monitoring within smart city initiatives, and Artificial Intelligence (AI) tools used for administrative decision support and service optimization. One specific example is the potential of using AI-based digital platforms and sensors in the management of resources for local government, as well as improving service delivery for local government (Yigitcanlar et al., 2024; Wolniak & Stecuła, 2024; Engin et al., 2025). Many municipalities are already using the AI model as a tool for optimizing traffic congestion and public transit routes, and monitoring citizen energy usage. Also, some of them are keeping the community and its members safe through the use of video surveillance technology, and creating a personalized service for citizens thanks to the development in technology (Townsend, 2013).

However, it has been observed by critical geography studies that smart city development is not just an improvement in technology but a transformative change in the dynamics of power and knowledge (Kitchin, 2014). AI is designed with certain presumptions about efficiency and rationality, which might not be inclusive (Crawford, 2021). Although smart urbanism is expected to be inclusive because of technological advancements, it is associated with potential challenges related to surveillance and algorithmic bias affecting the elderly population (Zuboff, 2019). AI-based urban infrastructures tend to cultivate velocity, optimization, and throughput, which translate into energetic, data-rich, and rapidly shifting spatial cues such as dynamic signage and real-time data updates. Studies have shown that such designs can lead

to increased mental burden, raised levels of stress, and impaired spatial orientation, particularly for older adults, as well as those with mild cognitive impairments, as illustrated by intelligent transport interchanges that prioritize digital screens, message signs, and smartphone-assisted wayfinding, which can result in improved efficiency and compromised emotional security and spatial confidence for older people (Salthouse, 2010; Marquardt et al., 2014). Further, the infrastructures of smart cities also impact the perception and regulation of public space. Algorithmic crowd control systems, smart policing, and sensor-enabled public space surveillance influence the affective context of public space; in many cases, the resulting space appears knowingly monitored, fast-paced, and exclusionary in nature (Zuboff, 2019).

Neuro-governance is an important concept in this regard to define the manner in which governance is effectively occurring through not only institutional and spatial arrangements but also through cognitive and affective processes that are embodied in the experience of urban environments (Rose & Abi-Rached, 2013). Neuro-governance might be described as the manner in which policies, technology, and space condition, in an implicit manner, aspects of attention, behavior, and decision-making (Rose & Abi-Rached, 2013). The role of AI systems, in effectively attempting to define in which manner and when particular information is to be delivered to target groups, might add strong agency to neuro-governance in cognitive experiences in space and, in particular, in age-friendly space. Smart mobility projects provide evidence of such processes in practice. There may be a need for the rapid processing of multimodal information in the optimized transport systems based on artificial intelligence, a dependence on digital tickets, as well as interaction with dynamic changes in the route plans (Kitchin, 2014). Although younger generations of citizens with digital literacy skills might feel empowered by such processes, older individuals feel uncertain and dependent on the system in general. An approach in neuroarchitectural studies has pointed to the importance of predictability, redundancy of cues, and sensory moderation in supporting cognitive engagement in older people (Wiener & Pazzaglia, 2021; Marquardt, 2011; Davis & Weisbeck, 2016). Hence, from a neuroarchitectural perspective, effective neuro-governance in an aging society must pivot from optimization to cognitive support. By prioritizing the inclusive design principles, governance can move beyond mere behavioral control and toward fostering genuine cognitive autonomy for older adults within the urban environments.

Through education, students are capacitated to critically interrogate the spatial governance of AI and the impact on the distribution of power through space. Through the lens of neuroarchitecture, the question of “smart cities” is interrogated beyond the confines of the politics of knowledge and cognition. Pedagogically, the themes of artificial intelligence and smart urbanism embody both a future focus and considerable controversy, and are, therefore, highly amenable to geographical critique (Cugurullo et al., 2024). Students might be invited to critically assess particular cases of ‘smart’ public realms, discuss whose needs are privileged in decisions made by algorithms, and explore new frameworks to support digital governance with neuroscientific data. This approach directly serves the powerful geographical knowledge goals of informed students who can not only explain ‘how’ particular technologies work but also ‘how’ they transform notions of citizenship and resilience in aging societies.

#### 2.4. From Design Intervention to Governance Lens

Urban governance refers to the processes, structures, and power relations surrounding the making of decisions on the built environment (Healey, 2007). It involves a wide range of scales, including the international policymaking level down to the local planning regulatory level (Brenner, 2014). The incorporation of neuroscientific methods within this context involves seeing this discipline not just as a set of design instruments but as a form of soft infrastructure. Soft infrastructure describes a non-tangible system of norms, knowledge structures, and institutionalized practices that condition the development and utilization of physical infrastructure (Latham & Layton, 2019). In this definition, the scope of neuroarchitecture impacts where attention is placed in terms of defining a problem, what merits consideration as a criterion of legitimacy, and from whose perspectives (Rose & Abi-Rached, 2013).

Urban governance is informed by multi-level dynamics whereby global standards set the tone for national frameworks (Brenner, 2004). The scholarship of policy mobility has drawn attention to ideas like age-friendly cities disseminated through conferences, toolkits, investment packages, and international bureaucracies (McCann & Ward, 2011). Through this dissemination, policies tend to simplify ideas in line with bureaucratic capabilities. As age-friendly agendas travel, these cognitive dimensions of aging are particularly vulnerable to getting lost in translation. Cognitive comfort, unlike ramps or benches, is hard to standardize, measure, or retrofit within existing regulatory frameworks. This produces a governance bias toward visible, countable interventions and further entrenches the disconnect between formal policy compliance and everyday cognitive experience (Peck & Theodore, 2015).

Cognitive experience is affected by norms and the environment. What constitutes a calm and legible environment differs in various settings. For instance, in high-density environments, it may be experienced as vibrant or overwhelming depending on the norms of cognitive experiences. Hence, an age-friendly governance approach based solely on universal design principles could have the negative consequence of projecting a set of normalizing spatial ideologies that lack resonance within certain contexts. A neuro-responsive approach, therefore, requires place-based knowledge and active engagement with older adults as experts in their own spatial experiences, reflecting principles of inclusive design that view exclusion as a mismatch between environmental conditions and the diverse cognitive and sensory capabilities of users (Holmes, 2018).

### 3. Materials and Methods

This study adopts a qualitative, integrative research design. It does not aim to provide a systematic literature review; rather, it develops a critical and interpretive synthesis of selected global policy discourse, examples from age-friendly cities, and interdisciplinary research. The analysis combines insights from urban policy and planning with complementary perspectives from neuroarchitecture, environmental gerontology, education, and urban health to build a multi-layered understanding of the topic. To support analytical depth and organization, NotebookLM (developed by Google) was used as an assistive tool to organize notes, summarize author-selected sources, and help identify recurring themes across the material. The selection of sources, interpretation of findings, and development of conclusions were conducted and critically verified by the author.

### 4. Results

#### 4.1. Cognitive Blind Spots in Frameworks

The global frameworks for an age-friendly environment cover the principles of inclusion, participation, and safety, but the approach to aging is mostly from a mechanical point of view (van Hoof et al., 2018). Here, the criteria for transport involve affordability and accessibility, and the priorities in public spaces involve cleanliness and safety. The cognitive aspects involved in dealing with situations like the functioning of navigational complexity of hubs, nodes, signage, etc., then sensory overload as a consequence of mishandling the spatial complexity are, in fact, untouched. This is particularly important to note, considering evidence showing associations between prolonged environmental stress and accelerated mental and physical diminishment among the older population. Governance informed by neuroscience would extend existing age-friendly frameworks by complementing functional indicators with evidence on cognitive and sensory experiences in urban environments. While current policy instruments, such as those promoted by the WHO, have successfully mainstreamed aging through indicators related to accessibility, transport, and services, their implementation often remains focused on physical functionality rather than cognitive engagement or environmental perception (Lui et al., 2009; Buffel et al., 2012; van Hoof et al., 2018). Incorporating neuroscientific insights, as suggested by John P. Eberhard (2009) and Harry Francis Mallgrave (2015, 2018), could shift governance toward evidence-informed environmental assessment that considers stress, attention, and spatial orientation. For planning and construction, this would encourage interdisciplinary collaboration and the adoption of evidence-based design strategies, such as clearer spatial cues and moderated sensory environments, supporting more inclusive and cognitively accessible urban spaces.

Urban authorities implement the agenda of age-friendliness through planning guidelines, pilots, and sectoral committees (WHO, 2007). For instance, in the UK, age-friendly approaches have mainstreamed aging into various departments such as planning, transport, housing, and public health, encouraging cross-sector coordination (Means, 2007). Nevertheless, there is a lack of expertise in the area of neuroscience-informed age-friendly governance among planning professionals, and public health knowledge is hardly integrated into planning (Rydin et al., 2012). For example, in Poland, despite significant investment in fully accessible infrastructure, older adults are still experiencing challenges due to urban complexity, density, and temporal rhythms (Aslanoğlu, 2025). These experiences underscore challenges that are difficult to address through a focus on infrastructure.

The emphasis on indicators and benchmarking also underlines cognitive invisibility (Power, 1997). The characteristics, such as sensory calm, spatial familiarity, and temporal appropriateness, cannot be measured, and hence they lie on the margins of governance frameworks that prioritize performance measurements. As previously mentioned in the hypothesis, the results are environments that satisfy formal conditions, which contribute to cognitive exclusion.

Municipalities are increasingly identified as being of prime importance to the management of population ageing and are widely acknowledged as the relevant level of governance by global organizations. The OECD's activity on population aging and territorial development underlines that urban and regional areas are more than just executors of a national strategy of population aging; they are governance arenas where population change meets housing, transport, land use, and provision of services (OECD, 2015). Nevertheless, at the same time, the OECD refers to the lack of capacities of governance at a municipal level, to fragmented competencies, to fiscal dependency, and to a lack of integration of health, social, and land use sectors.

OECD policy analyses put emphasis on place-based, people-centered approaches to aging, arguing that aging outcomes result from local environmental conditions just as much as individual ones. The OECD frames age-friendly governance as a cross-cutting challenge requiring coordination across housing, transportation, public space, health, and social care, with data-driven decision-making and community engagement as underpinning supports.

These issues are closely connected to the potential contributions of integrating neuroarchitectural principles, as such an approach highlights how the design and governance of urban environments can influence cognitive processes, sensory experiences, and overall well-being. Although local governments can support age-friendly visions, the planning agencies might not have the mandate and capacity to handle cognitive and sensory aspects of aging. This often leads age-friendly governance to be process and infrastructure-driven, and not experience and neuro-related. Yet, while the OECD recognizes the built environment's role in healthy aging, cognitive and neuro-sensory dimensions are only implicitly covered under concepts such as well-being, accessibility, and quality of life. This provides a directly relevant opportunity for neuroarchitecture to serve as a bridging framework, translating broad wellbeing objectives into concrete spatial and design criteria that municipalities can operationalize.

#### 4.2. Neuroarchitecture as Soft Infrastructure in Local Governance

Building on the understanding developed by the OECD, neuroarchitecture should not be considered merely a “soft” addition to urban infrastructure but an approach that needs to be embedded in the planning and design of infrastructure itself. From the perspective of embodied cognition, how people perceive, navigate, and emotionally respond to environments are inseparable from the material configuration of transport systems, public spaces, and urban facilities. Consequently, elements such as the management of sensory load in public spaces, the clarity of spatial hierarchies, legible wayfinding systems, and gradual transitions between high-stimulus and calmer environments should be incorporated directly into the design of infrastructure. When these aspects are neglected in early planning stages, later improvements become difficult and costly. In this sense, neuroscience-informed assessment tools—such as behavioral observation, cognitive mapping studies, or physiological indicators of stress and attention—can provide governance actors with mechanisms to identify environments that generate cognitive overload and to guide more inclusive infrastructure planning. Case studies carried out by the OECD reveal that experimentation and pilots, and, in particular, “policy learning” are essential in dealing with complex demographic change. This includes local authority projects, particularly “dementia-friendly neighborhoods” in the Netherlands (van Hoof et al., 2020), “age-friendly streets” in Japan (OECD, 2025), and “traffic-calmed neighborhoods” in Europe, that showcase their approaches to implementation to go beyond compliance with best-practice international norms and “learn and adapt.” (Choudhury, 2024; Macniven, 2024; Pérez et al., 2025). Neuroscience-informed urban planning reinforces such approaches by offering an evidence-based explanation as to why certain spatial layouts promote autonomy and wellness in older age. It achieves this by enhancing the ability to apply global age-friendly guides through the cognitive needs lens in urban areas.

### 5. Discussion

In an international environment that seems to represent globalization, aging, and decentralism, with rising demands being placed upon local governments, age-friendly urbanism represents an essential tool in which to view educationally the challenges of planning and governing in the present time. Through the promotion of cognitive experience, this paper can be said to both engage with debates around the study of spatial inequality and the politics of time through consideration of the ways in which age-friendly policies move around the world, with little consideration given to cognitive experience. Neuroarchitecture acts as the focus through which students can learn to critique the knowledge priorities contained in curricula around urban governance and why cognitive knowledge is given such low status.

Aging has continued to be a socially and politically delicate subject, commonly addressed from deficit-based or technocratic perspectives (Phillipson, 2013). In the field of geography education, the emergence of neuroarchitecture potentially provides a new attitude towards the subject of aging from a point of view, rather than a specialist concern, and can be used to reposition enquiries about space, governance, and citizenship from the vantage point of aging. The use of neuro-response urbanism to teach about aging attempts to deal with complexity and ethical responsibilities, as opposed to dependency. The integration of neuroarchitectural knowledge into urban governance also brings up several ethical concerns that need to be addressed. The use of biometric data, for instance, which could include neurophysiological data such as stress levels, attention, and cognitive load, raises ethical concerns about data ownership and potential neuro-surveillance in urban spaces. While neuroarchitectural design can offer many benefits for understanding the impact of urban spaces on human well-being, it is important to be mindful of ethical concerns related to data collection and use (such as exploiting the data for commercial gain). Therefore, there is a need for a set of regulatory guidelines to govern the use of neuroarchitectural knowledge in urban governance. Moreover, the teaching philosophy resonates strongly with those of critical and forward-looking pedagogies, which stress the importance of reflexivity, empathy, and the ability to deal with problematic knowledge (Freire, 1970; Biesta, 2013). In analyzing the ways in which space affects cognitive experience throughout life, students will be encouraged to reflect upon their assumptions about space and to appreciate differences in the ways in which perceptions of space are constructed (Relph, 1976). Such an educational strategy is especially relevant to the needs of an aging society. It thus proposes a wider definition of powerful geographical knowledge in educational practice, one that overtly embeds embodied and cognitive dimensions of spatial experience. Neuroarchitectural knowledge supplements traditional geographical analysis by accounting for how environments are negotiated at the level of perception, memory, and emotion. This integration strengthens geography education by connecting abstract spatial concepts to lived experience and everyday urban practice.

In sum, the paradigm shift should support interdisciplinary learning and critical inquiry in the practice of geography educators. This would allow students to question whose knowledge is legitimized in urban governance, how policy frameworks are constructed, and whose cognitive needs are rendered invisible. By doing so, neuro-responsive urbanism provides a catalyst not only for studies but also as a pedagogical tool to promote critical awareness and ethical reasoning. Hence, geographic education that encourages students to engage with neuro-responsive urban and regional spatial environments will permit them to become more informed and critical members of their communities. Students will develop an understanding of how cognitive processes, spatial relationships and governance mechanisms interact, thereby giving them the ability to work toward more cognitively just urban and regional environments and to participate meaningfully in discussions regarding developing inclusive urban futures. In aging societies, these educational approaches are vital for building resilience, creating opportunities for democratic engagement, developing socially responsible urban decision-making practices and establishing future-proof education (UNESCO, 2025).

## 6. Conclusions

As cities face demographic aging in conjunction with other societal changes, the shortcomings of standardized physically focused age-friendly governance have become increasingly evident. This paper has argued that the integration of neuroarchitectural perspectives opens a pathway to more inclusive and context-sensitive urban policy. By conceptualizing neuroarchitecture as a governance criterion, the paper contributes to debates on powerful geographical knowledge, critical citizenship, and future-oriented pedagogy. In this light, the perspective unfolds as a means for geography education to address complexity, controversy, and care in urban governance. Finally, such cities are not only more age-friendly but also more humane. They recognize diversity not as a deviation from the norm but as a foundational condition of urban life. Such recognition is imperative in times of demographic flux for building resilient, inclusive, and critically informed urban futures.

This paper argues that the limited incorporation of neuroscience-informed knowledge into age-friendly urbanism stems primarily from governance limitations rather than from a lack of technical capacity. The only way to bridge the gap between global standards and local cognitive needs is by reorienting neuro-responsive urban governance.

Age-friendly urban governance should go beyond mere physical and social infrastructure checklists (e.g., WHO frameworks) and include cognitive and neurosensory dimensions. Structural elements involving sensory overload, complex information, or spatial ambiguities must be transformed into environments that foster essential experiential outcomes for an aging population, such as emotional security, self-esteem, and sustainable social interaction. Policy considerations should include cognitive principles in an age-friendly framework, enhancing the capacity of municipalities in

neuroscience-informed planning, and promoting intersectoral collaboration between planning and health sectors. Ultimately, cognitive inclusive cities are not only age-friendly but livable and resilient for all citizens.

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