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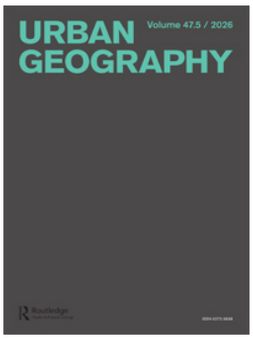
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Borg urbanism: emerging neural infrastructures of urban governance

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ABSTRACT

This commentary introduces the concept of Borg Urbanism to examine the urban implications of neurotechnologies that enable direct, bidirectional interfaces between human cognition and urban systems. While urban studies have engaged extensively with smart cities, platform urbanism, and neurourbanism, these literatures largely conceptualise the brain as a passive recipient of environmental influence. Borg Urbanism identifies an emergent logic that moves beyond this framing, focusing on cities that can read, anticipate, and respond to neural states in real time, and in doing so, enrol cognition itself into infrastructures of governance. Reviewing developments in consumer services and military experimentation, the commentary argues that neurotechnology-enabled urbanism represents a qualitative shift in how power, control, and coordination operate in cities. Rather than governing behaviour through platforms, sensors, or atmospheres alone, these systems open the possibility of governing through cognition. The Borg metaphor is deliberately deployed as a critical provocation, highlighting the risks of assimilation, loss of mental autonomy, and the normalisation of cognitive surveillance. The article positions Borg Urbanism as an emergent field requiring serious engagement within urban studies, calling for anticipatory theorisation, ethical scrutiny, and new governance frameworks before neurotechnological logics become embedded in everyday urban life.

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Borg urbanism; cognitive governance; neurourbanism; emerging urban infrastructures; brain-computer interfaces

Introduction

Communication technologies, from telegraphs and telephones to smartphones, have structured urban life. This essay asks what happens if the city itself begins to interface directly with human brains and nervous systems. Advances in neural devices suggest that such scenarios, once science fiction, are approaching reality. Neurotechnologies already read from or stimulate the brain and nervous system through external sensors or implanted devices, enabling the modulation of people's mental states, and allowing

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them to control software. Policy briefings are already mapping their societal implications (Broderick & Bunn, 2025)

While only a small number of people currently have invasive implants, wearable consumer neurotech is expanding rapidly, driven by investors such as Meta (Awuah et al., 2024). As with social media, users may trade neural privacy for convenience, but with neurotechnology, they may also do so for employment or legal compliance. We anticipate the extension of these technologies into urban settings, where networks of neural devices may link people, machines, and infrastructures (Lomas, 2024). An intelligent traffic system, for example, might detect driver inattention and alert others or intervene. A small number of people with disabilities already control homes through mental acts interpreted by neural devices (Cepro, 2024). Such developments mark a radical departure from conventional urban experience, as humans begin to interact with the city through neural activity.

We call the emerging paradigm *Borg Urbanism*. The name invokes the *Star Trek* Borg collective, whose doctrine, "resistance is futile", warns of involuntary assimilation (Lipschutz & Hester, 2013). The metaphor is deliberately cautionary. Whereas Haraway's (1985) cyborg celebrated hybridity and partial connection, the Borg represents total integration into a networked whole. Borg Urbanism, therefore, signals the risk that urban inhabitants become manipulated neural nodes in a pervasive socio-technical system.

Urban studies have only begun to explore related possibilities. Neurourbanism examines how city environments, including noise, density, green space, and architectural design, affect mental health and stress (Adli et al., 2017; Pykett et al., 2020). Yet it treats the brain primarily as a passive recipient of environmental stimuli. Borg Urbanism instead imagines a feedback relation in which neural activity also reconfigures the environment. The urban milieu becomes neuro-responsive as a space that both reads and writes to the brain.

Conceptually, this recalls cybernetics, in which Norbert Wiener (1948) defined feedback systems as systems that control themselves using information about their outputs. Post-war planners saw such ideas as a new basis for urban control. Borg Urbanism realises this dream, or nightmare, coupling brains and machines in continuous, high-speed feedback loops. It resonates with Kitchin and Dodge's (2011) notion of *code/space*, in which software and physical space are co-constitutive, except that here part of the "code" interfaces directly with the human nervous system and aligns with the co-evolution of cognition and digital media (Hayles, 2012). To situate these possibilities, we draw on literatures in platform urbanism (Caprotti et al., 2022), military urbanism (Graham, 2012), and the sociology of data and surveillance, recognising that the promise of neurotech may entail the surrender of privacy and autonomy. In this way, the essay contributes to ongoing debates in urban geography about the governance of emerging infrastructures, showing how neurotechnologies extend existing concerns with code, platforms, and atmospheres into the mind itself.

We build the argument through three propositions. First, that neurotechnologies extend neurourbanism into *neurotechnically enabled urbanism,* where neural states and infrastructure co-produce one another. Second, that military experiments in networked cognition prefigure civilian applications. And third, the Borg metaphor helps analyse these assemblages.

Proposition 1: from neurourbanism to neurotechnically-enabled urbanism

Neurourbanism is an emerging interdisciplinary field that applies neuroscience methods to understand how cities influence mental health and behaviour (Adli et al., 2017). Studies use wearable neurotech to show that green space reduces stress, motivating "brain-friendly" design through trees, pedestrian zones, and quiet housing (Fitzgerald et al., 2016). The emphasis is on the city shaping the brain, with urban form as the stimulus and the brain as the recipient.

Borg Urbanism reframes this relation by speculating on a possible wider uptake of neural devices in the future. Neurotechnologies create a real-time bi-directional interface in which neural and urban systems could co-produce one another. Cities may not only soothe or relieve stress but also begin to *respond* to neural data. If enough people have accessible neural devices, a lighting network might shift colour according to nearby residents' brainwaves, or a traffic system might adapt to collective concentration levels. Urban infrastructure becomes continuously tuned to mental states, while brains adjust to these responsive environments.

A range of devices could enable this coupling, and consumer EEG headbands already allow mental control of games and drones, as well as tracking attention. Implants such as Neuralink's promise more precise, continuous access to neural signals. If these data streams feed into urban networks such as transport, buildings, or public services, mental states could configure infrastructure, for example, through a "neural dashboard" aggregating the collective affect of a district to manage energy use, safety, or ambience.

This shift extends neurourbanism through bidirectionality. Where neurourbanism studies how cities affect brains, in contrast, Borg Urbanism also asks how brains might govern cities. In cybernetic terms, this transforms a one-way flow – **city → brain** – into a closed-loop relation – **city ↔ brain** – that operates in real time. We define an "urban system" broadly to include infrastructure networks, digital platforms, and governing institutions. When each can read or respond to neural signals, a *neurotechnically-enabled urban assemblage* arises. In such systems, neural feedback becomes a new input alongside traffic data, energy demand, or weather.

The implications are profound. Neuro-responsive infrastructure could enhance safety and accessibility by monitoring driver attention, detecting fatigue in machine operators, and assisting residents with limited cognitive capacity or mobility. However, it intensifies ethical questions. Neural data is among the most intimate forms of personal information. Continuous collection introduces risks of surveillance, coercion, and inequality, especially if only some citizens possess or can refuse devices. Workplace monitoring could blur the boundary between occupational safety and behavioural control. Municipal regulations might even require neural sensors in high-risk zones, extending the reach of surveillance into the mind.

These issues echo neurourbanism's concern with privacy and equity but in amplified form. They demand new analytic tools and governance frameworks. Urban planning and design must account for feedback architectures in which neural data circulates through public and private infrastructures. Political-economic analysis is crucial for revealing how corporations might monetise data or how governments might rationalise neural

monitoring as "well-being management" extending biopolitical governance into the neural domain (Lemke, 2011).

In summary, Proposition 1 argues that the neurourbanist lens must broaden to encompass technologies that enable the *co-production* of mind and environment. Urban geography should examine whether spatial form affects neural states, and how neural states, mediated by devices and platforms, might reconfigure spatial organisation, policy, and everyday interaction. Whether realised through citizen experiments or institutional deployments, these neurotechnically enabled systems mark a new stage in the governance of the atmosphere, mental states, and behaviour.

Proposition 2: neurotechnology in urban warfare

Military research often foreshadows civilian technological adoption (Amoore, 2009; Graham, 2012). Our second proposition examines how armed forces are working on neurotechnological integration of soldiers into networked systems, creating "neural collectives." U.S. agencies such as DARPA have funded experiments to link human brains directly to combat technologies (Miranda et al., 2015). Projects like *Silent Talk* aim to enable communication through neural signals alone (Drummond & Schachtman, 2009). RAND analysts envisage a "totality of information" where commands, observations, and emotional states circulate among soldiers, producing a distributed cognition capable of faster, covert decision-making (Binnendijk et al., 2020).

These initiatives mark a significant shift in the imagined human – machine relationship, in which soldiers become both data nodes and sensing instruments within a tactical network. Yet the initiatives also reveal vulnerabilities. Technical risks include hacking by adversaries, and the RAND report warns that such systems could blur distinctions between individual thought and command authority, undermining accountability.

Stephen Graham's (2012) work on *new military urbanism* shows how techniques of war routinely migrate into civilian governance. Police, rescue services, or security agencies could adopt the same neural-assimilation logic. Urban combat is a testing ground for high-connectivity systems such as drones and AI analytics, each capable of real-time coordination between humans and machines. Neural devices intensify this trend, extending surveillance and control directly into the mind.

For urbanists, these developments matter as prefigurative infrastructures. The ability to decode thought and emotion in real time introduces a new domain of governance. Clearly, the management of neural data raises concerns about privacy and potential coercion in contexts such as policing or immigration control. The social sciences of surveillance and algorithmic governance (Amoore, 2009; Graham, 2012) provide early warning that neurotechnologies could open another frontier of state and corporate power, reconfiguring what it means to participate in public space.

Proposition 2 thus serves both as evidence and as caution. Military experiments expose the institutional and technical momentum behind Borg Urbanism and highlight the stakes of its civilian translation. Understanding these neuro-military assemblages enables urban scholarship to anticipate and contest their diffusion, before the logics of neural monitoring and even modulation is normalised within city infrastructures.

Proposition 3: Borg-like collectives – assimilating humans into technological systems

Borg Urbanism points toward a possible social order in which cognition, perception, and volition circulate across humans and machines. The Borg metaphor helps us think through this condition as a provocation for analysing neuro-assemblages that integrate minds into technological infrastructures. We outline three interpretive lenses that make this intelligible.

Enhanced or therapeutic cyborgs

The dominant discourse frames neurotechnology around individual enhancement or therapy through implants that restore sight, regulate mood, or improve cognition. Yet once such devices connect to external networks, their implications extend far beyond the individual body. If neural implants become part of health or welfare systems, questions arise about access, consent, and data privacy. Who decides eligibility for "cognitive health" upgrades, and who profits from the resulting data?

Borg Urbanism insists that the collective and infrastructural not be neglected. If an implant transmits neural signals to coordinate care, or to improve workplace productivity, each connection exposes thought and emotion to organisational oversight. Those without access may be disadvantaged in environments calibrated for neural interactivity. What begins as an enhancement can produce stratified citizenship between cognitively connected and unconnected populations.

The neurotechnological milieu

Critical neuroscience already recognises the wider cognitive milieu as the sociomaterial conditions that shape brain function (Fitzgerald et al., 2016). Borg Urbanism extends this to consider environments that themselves sense and respond to neural states. If there were sufficient neurotechnological roll-out and people were incentivised or compelled to make their data public, offices, hospitals, and transport systems could aggregate neural data to manage comfort, risk, or efficiency. An open-plan workspace might detect collective stress through employees' headsets and adjust lighting or sound. Hospitals might triage patients using neural metrics of fear or pain.

These possibilities raise deep political questions about the design decisions involved in the devices and mental states that might be aims of the system, for instance, should the sociotechnical system be aimed at calm, focus, or happiness? Neural infrastructures could translate emotional states into data that might be monetised or used to discipline, or both. Opting out could become difficult if such environments are embedded in everyday services.

The neuro-milieu, then, is not simply responsive. It is normative as systems establish thresholds for acceptable thought and behaviour, deciding when citizens are "too anxious," "too distracted," or "insufficiently productive." As such, it extends algorithmic governance into the brain and mind.

Human – machine teaming and hyperurbanism

At a systemic scale, neurotechnology enables what we call "hyperurbanism" with cities functioning as collective cognitive fields where brains, algorithms, and infrastructures operate in concert. Here, traditional interfaces, such as screens, keyboards, and touch, give way to more direct brain-to-code links. A person might summon mobility services or trigger safety systems through thought alone. Neural analytics could detect collective emotion across a neighbourhood, prompting automated crowd control or therapeutic ambience.

Building on Williamson's (2017) notion of "computing brains" in smart cities, hyperurbanism imagines a shared operational awareness spanning people and platforms. However, the potential benefits of responsiveness, coordination, and accessibility are matched by new issues relating to mental privacy, brain-hacking and autonomy. Indeed, participation in urban decision-making might even one day shift from conscious deliberation to automated response, as systems anticipate desires before they are articulated.

This fusion redefines agency. Rather than autonomous subjects using technology, inhabitants become components in recursive feedback loops. Spatial justice thus depends on who designs and controls these loops, corporations, states, or publics. In a neuro-urban network, control over the interpretation of neural signals could equal control over the city's collective mind.

Borg-like collectives challenge the idea of the modern liberal subject as humanity becomes distributed across a socio-neurotechnological network. As Wimark and Hedlund (2024) note, social media already shapes emotional behaviour, but neurotechnologies extend this conditioning directly into the brain. Without anticipatory governance, neural infrastructures could normalise surveillance at the level of thought, reducing dissent to a data anomaly. "Neural gating" or affective filtering might one day restrict which emotions are permissible in particular zones as an atmospheric politics of mind.

Just as earlier proponents of social media did not envisage its emergent properties, such as echo chambers and polarisation, it will be necessary to find ways to monitor the urban collective's emergent properties. These hard-to-anticipate macro-level properties might need other forms of legal (or other) response that go well beyond a focus on individual rights.

Borg Urbanism therefore demands vigilance and critical engagement (Garden et al., 2016). The task is to identify which forms of assimilation should be resisted and to explore alternatives grounded in human rights and collective care rather than control. A "cognitive commons" might involve public or open-source neural platforms that prioritise accessibility, privacy, and well-being, creating spaces for shared attention and reflection rather than extraction. Designing such alternatives requires crossing disciplinary lines between neuroscience, urban design, law and political theory, re-embedding technological futures within democratic and ethical debate.

Borg Urbanism does not presume total neural command. Much existing technological practice involves data extraction and the modulation of behaviour through surveillance, nudging, and other means. The concern is that neurotechnological coupling may normalise and intensify cognitive governance and infrastructural intervention at the urban scale.

Conclusion

Borg Urbanism is a project for today as neurotechnologies already permeate medicine, gaming, workplaces, and defence, and will not remain niche. We have argued through three propositions that cities will both host and be reshaped by these technologies. Urban environments may one day respond to our thoughts, and our perceptions may be mediated by networked code. This implies a form of hyperurbanism marked by unprecedented speed, connectivity, and cognitive coupling.

The Borg metaphor alerts us to the dangers of assimilation, specifically surveillance of thought, loss of autonomy, and pre-emptive governance through predictive analytics. Living in such a city could mean constant participation in a system where mental privacy is obsolete. The challenge for urban research and policy is to imagine safeguards before these infrastructures solidify.

We propose three priorities for critical engagement:

First, to rethink oversight and agency. Conventional governance models, such as "human-in-the-loop", assume discrete decision-makers controlling machines. Neuro-urban systems operate through entangled circuits of humans and algorithms. Urbanists must theorise new forms of *cognitive governance*, examining whether consent is meaningful when neural data flows continuously. Legal frameworks on privacy, mental integrity, and freedom of thought will need to be extended.

Second, to explore inclusive use-cases. Not all neurotech futures are corporate or militaristic. Devices that assist communication, mobility, or therapy could advance accessibility and care. Urban studies can clarify how design choices differentiate empowerment from exploitation and ensure that inclusion does not entail intensified surveillance.

Third, to foster public and institutional debate. Discussion of neural interfaces is currently confined to laboratories, tech firms, defence agencies, international bodies and some sections of academia. Broader participation is essential. Municipal ethics councils, diverse academic forums, and citizen assemblies should debate neurotechnological governance as they have with genomics and AI. Urban scholars can catalyse such dialogue, translating speculative futures into democratic deliberation.

Taken together, these priorities constitute an agenda for anticipatory governance by designing the normative and institutional conditions through which neurotechnically-enabled urbanism might evolve responsibly. Recognising these emerging cognitive infrastructures as part of the evolving urban condition is vital, as they reconfigure questions of power, autonomy, and spatial justice at the level of thought itself.

Borg Urbanism ultimately reframes the city as a cybernetic whole with a collective nervous system mediated by code. Militaries and corporations may already be assembling parts of this future, but it is the task of critical urban geography to expose and contest it. Doing so requires the conceptual tools of spatial analysis of power, infrastructure, and atmospheres to interrogate how the mind itself becomes urbanised. Only by confronting this transformation early can we ensure that a neurally networked reorganisation of urban life unfolds under public scrutiny and in a way that respects human rights.

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