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Smart Spaces, Information Processing, and the Question of Intelligence

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Abstract: As spaces increasingly come to be described as "smart," "sentient," or "thinking," scholars remain in disagreement as to the nature of intelligence, knowledge, or the "human mind." This paper opens the notion of "intelligence" to contestation, examining differing conceptions of intelligence and what they may mean for how geographers approach the theorization of "smart" spaces. Engaging debates on the distinction between cognition and consciousness, we argue for a view of intelligence as multiple, partial, and situated in and in-between spaces, bodies, objects, and technologies. This paper calls on geographers to be attentive to the *multiple* forms of intelligence made possible by innovations in information processing and to the ways particular intelligences are prioritized – while others may be neglected or suppressed – through the production of smart spaces in the context of our rapidly changing understandings of the "humanness" of intelligence.

Keywords: *cognition, consciousness, digital technology, intelligence, space*

Introduction

Recently, geographical inquiry into "smart" spaces, particularly but not exclusively cities, has expanded. Geographers have examined the political economy of the smart city as a development model and new urban planning paradigm (Batty 2013; Marvin and Luque-Ayala 2017), while asking questions about the logics of securitization and control on which smart models are based (Klauser, Paasche, and Söderström 2014; Pötzsch 2015; Leszczynski 2016; Amoore and Raley 2017). Authors have highlighted the fuzzy definition of smart, from approaches driven by technology to those stressing the "smartness" of coupled human-technical systems or the importance of human capital (e.g., smart people) to the information economy (Kitchin, 2014). In all, the notion of smart spaces is generally described in its entanglements with shifting ideologies of planning and governance and the expanding domains of contemporary techno-capitalism. This approach is appropriate for understanding the spread and power of smart discourses and practices. Yet, geographers have engaged less with the concept of *intelligence*—a key topic of debate in psychology, neurobiology, philosophy, computer science, and digital humanities. We address this lacunae by re-situating geographical discussions around smart spaces within these broader debates around intelligence.

We argue that expanded understandings of intelligence as multidimensional, variegated, and exceeding the human open up new ways to imagine so-called "smart" futures. We lay out a vocabulary for examining the various forms of intelligence that are increasingly proliferating into the spaces of everyday life and how these might be understood in relation to classically-understood human forms of intelligence. We draw on the distinction between cognition and consciousness and their relationship—supported by Hayles (2017) and Shanahan (2010)—to interrogate both the evolving agency of technical systems and the complex socio-technical milieu

within which (post)human consciousness is entangled. We re-frame "smart" spaces as cognitive—or as ongoing processes in the evolving spatialization of cognition—albeit in a way that is quite different from cognitive and behavioral geographers (c.f., Aitken and Bjorklund 1988). At the same time, we re-assert a role for differentiated forms of (post)human consciousness, often ignored in literature that tends to focus on forms of *technical* agency with little attention given to the human (Rose 2017).

In what follows, we review the existing literature on smart spaces in geography. We argue that within this literature, terms like "smart," "intelligent," "sentient," and "thinking" have been undertheorized—often inadvertently reinforcing reductive cognitivist notions of intelligence. This cognitivist approach limits geographers' capacity to think creatively about intelligence because it operates in a binary logic of conscious and unconscious, human and nonhuman. To challenge this logic, we turn our attention to the question of intelligence as a non-binary process of knowledge production and consumption. We outline the debates around intelligence across psychology, philosophy, and computer science, among others, and offer Hayles' distinction between cognition and consciousness as a working vocabulary for thinking about the complex and evolving entanglement of human and technological modes of producing meaning.

Smart Spaces

The notion of smart in geography has been employed to describe a range of interventions and development strategies globally. As many have discussed, the smart moniker has been used to describe both initiatives focused on adopting new digital technologies—embedding sensors in space and collecting and analyzing data in near real-time (Kitchin 2014)—as well as those

development strategies focused on attracting skilled workers in the "knowledge economy." In this sense, smart operates as a branding technique for emerging forms of digitalized public-private management—reflecting what Söderström, Paasche, and Klauser (2014) refer to as a form of "corporate storytelling" and Hollands (2008) calls "urban labeling." Recognizing this, many scholars have ignored the term while focusing attention on the socio-technical assemblages or political economic logics that is represents.

Geographers have explored how evolving digital systems—constituted by "coded objects, infrastructures, processes, and assemblages" (Kitchin and Dodge 2005: p. 170)—have come to play increasingly vital roles in the production of urban space and everyday life. Ash (2017), for instance, describes the way "smart objects"—from light bulbs to watches and toothbrushes—generate "phases" or "space-times, around which human and non-human life is organized" (16). To describe the agentive capacities of these objects and assemblages, however, scholars have typically employed a constellation of terms interchangeably—including intelligence, sentience, and thinking—with very little operational discussion of their meaning (Beer 2007; Shepard 2011; Albino, Berardi, and Dangelico 2015; Picon 2015). For example, in writing about the rise of "sentient" spaces, Crang and Graham (2007) argue that the spatial diffusion of information processing means "we not only *think* of cities but cities *think* of us" (789, *our emphasis*). Amin and Thrift (2016) similarly describe urban socio-technical systems as "thinking" entities. Both go on to offer detailed analyses of spatialized information processing, but their use of terms like "thinking" and "sentient" lack specificity and deeper theorization. This ambiguous terminology blurs the distinctions between human and technical agency and modes of being.

When not clearly theorized, this ambiguous terminology reinforces problematic and hotly contested conceptions of intelligence. Perhaps worse, it reduces "thinking" to information

processing. For geographers, this reduction poses a significant challenge to a robust theorization of intelligence and its application to emerging smart discourses and spaces. Put another way, this theory of intelligence—referred to as the "cognitivist paradigm" (Hayles 2017) or as the "executive theories" (Hardcastle 1995)—constitutes a direct relationship between information, on the one hand, and knowledge, intelligence, and consciousness, on the other. In this model, the latter are theorized as the direct product of the former. The human brain is compared to a computer and thought is understood as the manipulation of abstract symbols inputted from an exterior world (Thompson 2007). Dupuy (2009) calls this model the "mechanization of the mind," an approach that reproduces a mind-body dualism long deconstructed by feminist and queer theorists (Grosz 1994; Murray and Sullivan 2012).

This cognitivist approach to intelligence has been robustly critiqued by psychologists and cognitive biologists, among others (Hardcastle 1995). Even so, it continues to exert significant academic and applied influence, driving research programs in artificial intelligence and hopes or fears of a coming "technological singularity"—a moment of unprecedented technological growth marked by the rise of "thinking" machines operating well beyond human capacity—among some in the technologist community (Shanahan 2015). When scholars passively accept—or fully embrace—terms like smart, intelligent, or sentient and then focus on information processing systems, they help reinforce a problematic conception of intelligence, which is at the heart of debates in computer science, psychology and philosophy.

Similarly, Rose (2017) has critiqued smart city research in geography for under-theorizing the differentiated forms of posthuman agency, as the agential capacities of technical objects become the primary object of analysis. Relying on Stiegler, Rose suggests that we must "theorize (digital) posthuman agency by thinking it as always already (digitally) sociotechnical"

(789). Rose asserts that geographic scholarship must move away from the human as a "supplement" to digital life. Put another way, "geographers must… reconfigure their understanding of digitally mediated cities and acknowledge both the reinventiveness and the diversity of urban posthuman agency" (ibid.). We cannot, as she intimates, fall into the trap of thinking machinic intelligence is the only intelligence of the future or that human intelligence will simply be augmented by new machinic intelligent systems. Our spaces are overly complicated by the constitutive posthuman relations of socio-technological life to assert such reductions.

Intelligence, Spatialized Cognition, and Consciousness

Given this lingering critique of intelligence in the conversation around smart spaces, we turn to debates surrounding the nature of human and nonhuman intelligence. In this, we employ Hayles' (2017) distinction between cognition and consciousness to build a vocabulary for thinking about the abilities of emerging spatialized information processing systems and their relationships to differentiated human forms of intelligence.

A. The Question of Intelligence

Within the fields of psychology and cognitive science, there is little agreement as to the nature of human intelligence. In relation to the debates over the cognitivist model discussed above, psychologists have long questioned the role of consciousness, bodily processes, environment and culture in relation to something called intelligence. Theories of general intelligence posit a correlation of relative individual strengths and weaknesses across an array of cognitive functions, with humans and other creatures falling somewhere along a continuum of intelligence. This theory holds that one's place on the continuum can be quantitatively measured through IQ tests and similar mechanisms.

Of course, such notions of intelligence have long been contested. Within psychology, Howard Gardner (2011) rejects theories of general intelligence, arguing for a theory of multiple intelligences, distinguishing among 8-10 different intelligences, from logical-mathematical and verbal-linguistic to bodily-kinesthetic and visual-spatial intelligences. Others have critiqued theories of general intelligence for their racial biases and role in historical and contemporary projects of colonialism, eugenics and various forms of scientific racism (Smedley and Smedey 2005). Recently, autism rights activists and psychologists have called for the recognition of "neurodiversity," deconstructing conceptions of "normal" neurological behavior and challenging the pathologization of autism, ADHD, dyslexia and other common "mental disorders" (Armstrong 2015).

Such debates around intelligence become more complicated when claims of intelligence are extended to non-humans. Hayles (2017), for example, discusses the debates around plant intelligence in which Brenner et al. (2006) draw homologies between animal neurology and plants' mechanisms for responding to environments. While controversial among plant scientists and neurobiologists alike, Hayles points out that the controversy is more about the use of the word "intelligent" than it is about the science of plant behavior. Hayles (2017) sees in such work a "double intent to draw upon the cachet of 'intelligence' as an anthropocentric value while simultaneously revising the criteria for what constitutes intelligence" (p. 19). In other words: what traits and attributes constitute intelligence, and whether or not the term can and should be extended to non-humans, and to what extent? Brenner et al's critics draw a clear line between animal forms of intelligence—based on their neurological similarities to humans that sees the brain as the site of intelligence—and responsive plant behavioral mechanisms not connected to a neurological structure.

Similar debates across computer science have found renewed attention in relation to artificial intelligence (AI). The field of AI is remarkably diverse and composed of multiple working theories as to the nature of intelligence and the route to engineering an AI. The ability to build an AI depends essentially on one's definition of intelligence. Many in the field have set "human-level intelligence" as a benchmark—essentially that an AI would be able to perform most or all human functions equal to or better than an "average" human. One of the primary approaches to human level AI has been to engineer faster and more complex information processing systems. Recently, this approach has led to major advancements in machine learning. This approach to AI is most directly influenced by cognitivist notions of intelligence. A competing approach to AI has focused on brain emulation and neural networks. This approach locates intelligence in physical processes and structures in the brain—specifically in the electric signaling of neurons—and aims to emulate those processes in artificial systems. In all these systems, computer scientists have begun to shy away from the term "AI," preferring instead "intelligence augmented" to describe the ways machine learning algorithms or even neural networks extend human intelligence but do not replace it. While this reframing problematically re-asserts the binary of human and nonhuman it also suggests the possibility of a theorization based in co-constitution and not a binary logic.

Reflecting on these debates, several scholars have highlighted the possibility for multiple forms of intelligence, not directly comparable to a metric of "humanness" (Shanahan 2010; 2015). These scholars argue for an expanded notion of intelligence as multidimensional and diverse while decentering the human as the ultimate metric. As new technological apparatuses are created and used in new ways, we do not know what kinds of intelligences may emerge/are emerging. It is, therefore, important that we leave the question of intelligence open, and shift

attention to the diversity of interpretive and agential capabilities emergent within complex systems. This shift has clear ethical and analytical implications for how we understand the agential capacities of nonhumans, including technical apparatuses. In order to explore the diversity of intelligences across human and nonhuman actors, we reflect on the distinction that Hayles (2017), Shanahan (2010), and others have drawn between cognition and consciousness. This distinction allows us to think more specifically about the multiplicity of intelligences and their entanglements and inter-dependencies.

B. More-than-Human Cognition

Drawing on sources across cognitive biology and philosophy, Hayles (2017) defines cognition as "a process that interprets information within contexts that connect it with meaning" (22). This means reframing cognition as a process rather than an attribute or ability residing in a particular individual or entity. Hayles further describes this as "dynamic unfolding within an environment in which its activity makes a difference" (25). Cognitive roboticist, Murray Shanahan (2010), similarly argues that "[c]ognition has arisen because it beneficially modulates a creature's behaviour... it intervenes in the sensorimotor loop by means of which the creature interacts with its physical and social environments" (3). In both these definitions, cognition is a process of interaction with an environment in which an entity processes sensory information and responds according to set goals—be it biological drive for survival or a programmed objective.

Understood in this way, cognition "becomes a pervasive activity among humans, animals, and technical devices, with many different kinds of agents contributing to a rich ecology of collaborating, reinforcing, contesting, and conflicting interpretations" (Hayles 2017, 213). Understanding technical apparatuses of data input and algorithmic knowledge production as processes of cognition calls into question how they relate to other forms of spatialized cognition.

Smart city data flows represent only one aspect of information processing in cities; they need to be understood in their larger entanglements. This requires an attentiveness to the various forms of information that may not be captured by technical devices and translated into digital data streams as well as the affective relationships among devices, bodies, and spaces that escape digital capture.

Yet, most geographies of information processing in smart spaces has shown little engagement with the questions of embodied sensory input and knowledge production long explored by feminist theorists (Davidson and Milligan 2004; Kwan 2007). How does, for example, the spatial knowledge produced through an Internet of Things (IoT) sensor network relate to the knowledge produced through embodied sensory experience? And, more importantly, how are these becoming entangled and enmeshed in new ways? To address these questions, Mitchell (2004) conceives of networked infrastructure and smart devices as extensions of the body, writing: "Not only are these networks essential to my physical survival, they also constitute and structure my channels of perception and agency—my means of knowing and acting upon the world… They are as crucial to my cognition as my neurons" (61). Similarly, artistic and transfeminist political interventions highlight the way information and sensory data flow through entangled relationships among bodies, spaces, and technologies (Jones 2006; Egaña and Solà 2016). Such interventions call for an attentiveness to the differential experiences of embodiment in smart spaces, as well as to the role of bodies (of workers, residents, etc.) in the production, maintenance, and everyday functions of smart infrastructures.

Within geography, Louise Amoore's work on algorithms—in collaboration with others—offers an excellent example of the relationship between technical and 'human' forms of cognition, exploring the ways algorithms reorient forms of perception—bringing to the fore

previously imperceptible patterns (Amoore and Piotukh 2015; Amoore and Raley 2017; Amoore 2018). Reflecting on the entanglement of embodied action and the proliferation of algorithmic procedures, Amoore and Raley (2017) argue that: "To draw attention to the embodied actions of algorithms, then, is precisely to reflect on how the already broad cognitive function of thought is distributed and extended through algorithms" (5). Amoore (2018) thus calls to "extend attention beyond the data centre and into the spatialities of perception itself" (16)—or as Hayles might argue, into the broader "cognitive ecology." By carefully tracing the operations and entanglements of complex infrastructures, data assemblages, and algorithms, this sort of scholarship de-centers the human in cognition. Yet, by maintaining a focus on embodiment and forms of perception, the human is not simply dissolved into an amorphous milieu of agential entities, but rather understood as differentially co-constituted in complex spatial and temporal relations with myriad nonhuman others.

Hayles (2017) thus recognizes a range of differentiated cognitive capacities across different entities and assemblages, writing: "On the technical side are speed, computational intensity, and rapid data processing; on the human side are emotion, an encompassing world horizon, and empathic abilities to understand other minds" (140). While Hayles highlights the entanglement of human and nonhuman cognition, she also reinforces a narrow, normative conception of "human" cognition that calls for further critique. In exploring the distinct capacities of a diversity of cognitive agents, Hayles raises the question of consciousness and its role in human forms of cognition. We turn to this question of consciousness to build from but also push beyond Hayles' account to draw attention to the diversity of human modes of being and knowing.

C. Consciousness

Hayles does not dissolve human intelligence into an undifferentiated category of information processing. Instead, she highlights the role of human consciousness, while asserting the cognitive capacities of a range of actors. Hayles argues, for example, that "there is no technical agency without humans, who design and build the systems, supply them with power and maintain them, and dispose of them when they become obsolete" (32). Her argument builds on the work of Simondon (2017), who sees humans as the assemblers of technical systems, even as these systems operate according to distinct logics not directly controlled by a human inventor. Similarly, Stiegler (1998) highlights the importance of the social and material processes of production and reinvention in which humans play a key role, simultaneously remaking their environments and themselves as subjects.

Hayles' notion of consciousness does not reinstate a sovereign human subject as the rational director of technical assemblages understood as tools of human will. Rather, she recognizes the entanglement of consciousness in spatialized cognitive assemblages and reflects on the ability to interact with those assemblages in different ways. Significantly, this recognizes human consciousness as fundamentally embodied and embedded, and thus in constant interaction with complex material realities—reflecting what Varela, Thompson, and Rosch (1991) have termed an "enactive approach" to questions of mind and being. These cognitive assemblages—both technical information processing and embodied human forms of sensing—fundamentally shape modes of awareness. This is why Hayles distinguishes between nonconscious cognition and consciousness, arguing that consciousness requires various forms of nonconscious cognition to process and filter sensory input. She writes: "Mediating between material processes and modes of awareness, nonconscious cognition provides a crucial site where intra-actions connect sensory input from the internal and external environments ("events") with the emergence of the

subject ("entities")" (75). While recent advances in neurobiology highlight the importance of nonconscious cognition in human life, Hayles reflects on the entanglement of "internal" nonconscious cognition with the rapidly expanding realm of "external" or "technical" nonconscious cognitions, recognizing that both shape modes of awareness.

Recognizing the multiple forms of agency exercised by non-humans in the continual constitution of consciousness, this approach also stresses the role of conscious forms of human agency in shaping complex technological systems. As Hayles (2017) explains, "effective modes of intervention seek for inflection points at which systemic dynamics can be decisively transformed to send the cognitive assemblage in a different direction" (203). While cognitive assemblages shape consciousness, they are also the object of conscious intervention, or, as Rose (2017) and Stiegler (1998) suggest, "reinvention." If we understand the cognitive functions being carried out by technical apparatuses and the ways they reorient human forms of perception and cognition within broader cognitive assemblages, then we open up space for conscious reflection on its workings and our differential relationships to it.

Reflecting on the ways posthuman forms of consciousness may be aware of and intervene in complex cognitive assemblages raises the questions of ethics and politics and opens up possibilities for imagining alternative technological futures. As Hayles asks: "How should we reimagine contemporary cognitive ecologies so that they become life-enhancing rather than aimed toward dysfunctionality and death for humans and nonhumans alike?" (141). Yet, reflecting on the possibilities for conscious forms of reinvention within such cognitive ecologies requires a move beyond Hayles, to an attentiveness to how the human is differentiated in its complex entanglements with nonhumans—and the ways evolving cognitive assemblages rework those differentiations (Rose 2017). This includes a recognition of neurodiversity and the ways

different human cognitions and consciousnesses may intra-act differently in complex social and material environments (Armstrong 2015). This also requires a critique of how access to "technological" knowledge and claims to "expertise" are policed and entangled in the re-production of race, gender, class, age, ability, as well as other markers of difference in the everyday power relations of militarized techno-capitalism. We might thus understand critical posthuman consciousnesses as ongoing embodied experiments with alternative modes of differential becoming with an array of cognitive agents.

A growing literature across digital geographies points toward expanded conceptions of intelligence, highlighting the entanglement of technological cognitions with differentiating forms of human experience, embodied sensing, and conscious reflection. Wilmott (2015), for instance, offers an ethnographic account of embodied experiences of spatial big data in Hong Kong and Sydney, highlighting how they challenge logics of calculability and profitability. Likewise, Pink and Fors (2017) argue that "while self-tracking technologies might appear on the surface to belong to a quantified world of measurement… they participate considerably in how people 'feel' or sense in their everyday environments" (376). Such accounts do not privilege one form of intelligence over another, but rather point to the entanglement of multiple ways of knowing and producing meaning that operate according to a diversity of logics. Recognizing this diversity of possible relationships to technological systems presents opportunities for imaging and building alternative futures beyond the logics of the smart discourse. Lynch (forthcoming), for example, examines how activists in a grassroots movement around "technological sovereignty" in Barcelona consciously reflect on the evolving role of digital technology in everyday life and experiment with alternative social practices for managing and negotiating these relationships.

Conclusion

This paper expands and clarifies the vocabulary for geographers writing about the capacities and agencies of spatialized information processing systems. It offers a specificity to the kinds of operations performed by such systems and their relationships to a broader milieu, or what Hayles (2017) calls a "cognitive ecology." Within this framing, we highlight the role of "posthuman agency" (Rose 2017) and the possibilities for forms of conscious posthuman reflection and interaction in complex techno-social entanglements. This is not meant to reinstate a rational human subject at the center; it is to recognize the complex interplay among a diversity of cognitive actors while also calling for critical reflection on the part of posthuman subjects.

Reframing debates over smart spaces to more actively engage theories of intelligence offers a number of benefits to geography. First, it connects smart city debates to discussions of the differentiated and entangled capabilities and agencies of a range of human and non-human actors. Second, it offers greater analytical specificity as to what kinds of processes are occurring and which actors are involved. Third, it helps geographers move beyond the "smart city" as a set of policy prescriptions and urban management techniques to think more about the spatialization of a range of technical devices and apparatuses. Fourth, it highlights the entanglements of emerging digital devices not only with differentiated human processes and forms of agency but also with biological forms of cognition. Finally, it raises the question of consciousness and the possibilities for collective reflection and intervention into processes of technological development and implementation.

This intervention points toward several areas for future inquiry. On the one hand, there is a need for more empirical explorations of the multiplicity of social, political, and economic possibilities emergent in the evolving "cognitive ecology"—and of the work of social

movements, hackers, cyberfeminists, and everyday individuals and collectives that creatively explore those possibilities. On the other hand, by re-situating the "smart city" in relation to broader debates over intelligence and cognition, there emerges an opportunity for geographers to become more relevant to the discussions around artificial intelligence, machine learning, and robotics. As these technologies develop and become increasingly ubiquitous, there is a need for a robust geographic theory that helps think about the spatial dimensions and entanglements of smart spaces and the various intelligences at play in everyday post-human life.

References

Aitken, S. C., and Bjorklund, E. M. 1988. Transactional and Transformational Theories in Behavioral Geography. *The Professional Geographer* 40 (1): 54-64.

Albino, V., Berardi, U., and Dangelico, R. M. 2015. Smart Cities: Definitions, dimensions, performance, and initiatives. *Journal of Urban Technology* 22 (1): 3-21. DOI: 10.1080/10630732.2014.942092.

Amin, A. and Thrift, N. 2016. *Seeing Like a City*. Malden, MA: Wiley.

Amoore, L. 2018. Cloud geographies: Computing, data, sovereignty. *Progress in Human Geography* 42(1). DOI: 10.1177/0309132516662147.

Amoore, L. and Piotukh, V. 2015. Life beyond big data: governing with little analytics. *Economy and Society* 44 (3): 341-366.

Amoore, L. and Raley, R. 2017. Securing with algorithms: Knowledge, decision, sovereignty. *Security Dialog* 48(1): 3-10.

Armstrong, T. 2015. The Myth of the Normal Brain: Embracing Neurodiversity. *AMA Journal of Ethics* 17 (4): 348-352.

Ash, J. 2017. *Phase Media: Space, Time and the Politics of Smart Objects*. London, UK: Bloomsbury.

Beer, D. 2007. Thoughtful territories: Imagining the thinking power of things and spaces. *City* 11 (2): 229-238.

Brenner, E.D., Stahlberg, R., Mancuso, S., Vivanco, J., Baluska, F., and Van Volkenburgh, E. 2006. Plant Neurobiology: An integrated view of plant signaling. *Trends in Plant Science* 11 (8): 413-419.

Crang, M. and Graham, S. 2007. Sentient Cities: Ambient intelligence and the politics of urban space. *Information, Communication & Society* 6 (10): 789-817.

Davidson, J. and Milligan, C. 2004. Embodying emotion sensing space: introducing emotional geographies. *Social & Cultural Geography* 5 (4): 523-532.

Dupuy, J. P. 2009. *On the Origins of Cognitive Science: The mechanization of the mind*. Cambridge, MA: The MIT Press.

Egaña, L. and Solà, M. 2016. Hacking the Body: A transfeminist war machine. *TSQ: Transgender Studies Quarterly* 3 (1-2): 76-82.

Gardner, H. 2011. *Frames of Mind: The theory of multiple intelligences*. 3rd ed. New York: Basic Books.

Grosz, E. 1994. *Volatile Bodies: Toward a corporeal feminism*. Bloomington, IN: Indiana University Press.

Hardcastle, V. G. 1995. A critique of information processing theories of consciousness. *Minds and Machines* 5: 89-107.

Hayles, N. K. 2017. *Unthought: The Power of the Cognitive Nonconscious*. Chicago, IL: University of Chicago Press.

Hollands, R. G. 2008. Will the real smart city please stand up? *City* 12 (3): 303-320.

Kitchin, R. 2014. The real-time city? Big data and smart urbanism. *GeoJournal* 79 (1): 1-14.

———. 2015. Making sense of smart cities: addressing present shortcomings. *Cambridge Journal of Regions, Economy and Society* 8(1): 131-136. DOI: 10.1093/cjres/rsu027

Kitchin, R. and Dodge, M. 2005. Code and the Transduction of Space. *Annals of the Association of American Geographers* 95 (1): 162-180.

Kwan, M-P. 2007. Affecting Geospatial Technologies: Toward a Feminist Politics of Emotion. *The Professional Geographer* 59 (1): 22-34.

Jones, C. A. ed. 2006. *Sensorium: Embodied experience, technology, and contemporary art*. Cambridge: The MIT Press.

Leszczynski, A. 2016. Speculative futures: Cities, data, and governance beyond smart urbanism. *Environment and Planning A 48*(9): 1691-1708. DOI: 10.1177/0308518X16651445

Lynch, C. forthcoming. Contesting Digital Futures: Urban politics, alternative economies, and the movement for technological sovereignty in Barcelona. *Antipode*.

Mitchell, W. 2004. *Me++: The Cyborg Self and the Networked City*. Cambridge, MA: The MIT Press.

Picon, A. 2015. *Smart Cities: A spatialized intelligence*. New York: Wiley.

Pink, S. and Fors, V. 2017. Being in a mediated world: self-tracking and the mind–body–environment. *cultural geographies* 24 (3): 375-388.

Pötzsch, H. 2015. The Emergence of iBorder: Bordering Bodies, Networks, and Machines. *Environment and Planning D* 33 (1): 101-118.

Rose, G. 2017. Posthuman agency in the digitally mediated city. *Annals of the Association of American Geographers* 107(4): 779-793. DOI: 10.1080/24694452.2016.1270195.

Shanahan, M. 2010. *Embodiment and the Inner Life: Cognition and Consciousness in the Space of Possible Minds*. Oxford, UK: Oxford University Press.

Shanahan, M. 2015. *The Technological Singularity*. Cambridge, MA: The MIT Press.

Shepard, M. 2011. *Sentient City: Ubiquitous computing, architecture, and the future of urban space*. Cambridge, MA: The MIT Press.

Simondon, G. 2017. *On the Mode of Existence of Technical Objects*. Minneapolis, MN: University of Minnesota Press.

Smedley, A. and Smedley, B. D. 2005. Race as biology is fiction, racism as a social problem is real: Anthropological and historical perspectives on the social construction of race. *American Psychologist* 60 (1): 16-26.

Söderström, O., Paasche, T., and Klauser, F. 2014. Smart cities as corporate storytelling. *City* 18 (3): 307-320.

Stiegler, B. 1998. *Technics and Time, 1: The Fault of Epimetheus*. Palo Alto, CA: Stanford University Press.

Thompson, E. 2007. *Mind in Life: Biology, Phenomenology, and the Sciences of Mind*. Cambridge, MA: Harvard University Press.

Varela, F. J., Thompson, E., and Rosch, E. 1991. *The Embodied Mind: Cognitive Science and Human Experience*. Cambridge, MA: MIT Press.

Wilmott, C. 2016. Small moments in Spatial Big Data: Calculability, authority and interoperability in everyday mobile mapping. *Big Data & Society*. doi: 10.1177/2053951716661364

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