Chapter 8

Infrastructuring Bodies: Choreographies of Power in the Computational City

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Abstract

The aim of this chapter is to shed light on the power-related infrastructural dynamic that actualises in the interrelations of big data collection and the bodily movement of urbanites in contemporary cities. By drawing from Husserl's and Merleau-Ponty's phenomenologies of the body and combining them with recent theorisations on choreography, material media theory and critical technology studies, the authors address city dwellers' embodied relations with mobile devices and ambient technologies as integral to the micro-, meso- and macro-level (re)production of urban infrastructures. By way of discussing the technologically mediated kinaesthesia and movement trajectories of lived bodies, the chapter develops a novel conceptualisation of urban choreography for exploring the mechanisms through which dwelling-in-the-city today functions in a globally extensive cybernetic feedback loop with profit-motivated and surveillant big data operations.

Keywords

Urban infrastructure

Lived bodies

Mediated bodily movement

Choreography

Big Data

Computational city

Phenomenology

1. Introduction

We can't see how the street is immersed in a twitching, pulsing cloud of data. (…) /Such data emerges from the feet of three friends, grimly jogging past, whose Nike+ shoes track the frequency and duration of every step, comparing against pre-set targets for each individual runner. This is cross-referenced with playlist data emerging from their three iPods. Similar performance data is being captured in the engine control systems of a stationary BMW waiting at a traffic light, beaming information back to the BMW service centre associated with the car's owner. /The traffic light system itself is capturing and collating data about traffic and pedestrian flow, based on real-time patterns surrounding the light, and conveying the state of congestion in the neighbourhood to the traffic planning authority for that region, which alters the lights' behaviour accordingly. (Hill, 2008, para 1–3)

In this extract from an essay written in 2008, designer and urbanist Dan Hill illustrated how the urban environment, in the near future, would produce data on a vast scale, while the technical operations that afforded this data collection would remain beyond the perception of ordinary city dwellers. Ten years later, the situation Hill imagined has increasingly become commonplace, as computation in diverse forms today literally envelops people in cities. In addition to incessant signal traffic pulsating wirelessly through the air, algorithmic technologies are embedded in urban

physical structures, run the billboards, move along on the streets in vehicles or are carried around by people in their smartphones and other portable and wearable accessories. Meters and sensors are deployed on the streets, usually with little or no information about their actual purpose. The personal devices and their designs, which appear haptically attractive to urban consumers, often disguise the inconspicuous collection of data, busily performed by the gadgets and their numerous applications.

By envisioning how the future street would feel, Hill prompted a discussion about how ever more effective data generation and collection affect urban life. In more infrastructural terms, we can say that the technical systems enabling the production, collection and transmission of these data, as well as the quality of connections and their various levels of openness or privacy, all impact, in ways equally imperceptible and profound, how people dwell in the city, and how the urban environment, in turn, is furnished with new digitally embedded objects, products and services. Indeed, considering that cities have increasingly turned into all-encompassing computed environments, it makes sense to claim, as architecture and media studies scholar Mark Shepard (2009, 2012) does, that code-based technologies have become as important if not more important than buildings 'for organizing space, time, and the boundaries around the body in public space'.

What is striking in Hill's narrative is the crucial role people's bodies play in the processes of mass-scale data generation and collection in cities. Data are not collected merely, or even primarily, through autonomously observing external systems, but through the involvement of city dwellers' corporeality in diverse intentional and unintentional ways. In this chapter, we address the connections between moving bodies, portable and wearable technologies, and the pervasively computed urban ambience with the aim of grasping the power-related sociotechnical complexity that characterises the (re)production of infrastructures in twentyfirst century cities—infrastructure referring here to the fundamental sociotechnical structures that enable and guarantee the stability

and continuity of urban life in the first place (see, e.g., Graham & Marvin, 2001). To do this, we develop around the notion of choreography a novel conceptualisation that directs attention to urbanites' mediated kinaesthesia and movement trajectories and, most particularly, sensitises us to their interconnections with large-scale computational systems.

2. Moving Bodies, Urban Mediation and Power

Movement and mobility are by now acknowledged to be crucial, in both research and politics, for understanding and facilitating the transformation of cities, including new lifestyles, sustainable transportation systems, creative architecture and innovative town planning.[1] To date, however, few theoretical attempts have been made to address how city dwellers' technologically mediated bodily movement and, more particularly, their embodied relations with algorithmic 'smart' technologies relate with increasingly digitalized and networked urban infrastructures. Our argument in this chapter is that the rhythms and paths of this movement, including diverse stopping points, are inherently infrastructural, and that this infrastructural dynamic can be captured fruitfully through a phenomenologically informed concept of choreography.

In approaching contemporary urban infrastructures from a choreographic perspective, we do not use the notion of choreography with reference to dancing and performing arts (e.g. Lepecki, 2006; Manning, 2009; Schiller & Rubidge, 2014), nor do we consider choreography in terms of inscription, as in studies inspired by actor–network theory (Loke & Kocaballi, 2016). Instead, we

[1] See, e.g., European Commission's strategy on smart cities: *Cities of tomorrow. Challenges, visions, ways forward*, published in 2011. http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/citiesoftomorrow/citiesoftomorrow_final.pdf.

attach our understanding of choreography to how urbanites' media- and technology-related movements tend to form, through repetition, bodily habits, routines and practices, thereby contributing essentially to the constitution of urban sociotechnical structures (Ridell, forthcoming).

To begin to address the infrastructural dynamic that actualises in urbanites' mediated corporeality, a key reference point can be found in Merleau-Ponty's view of the lived body ('corps vivant'). In his *Phenomenology of Perception*, Merleau-Ponty (1962/1989) points out that bodily movements and gestures are the means through which any animate body explores its world and enacts intentions. These movements are an intermediary, since every action is performed within an intersubjective space (ibid., p. 98). Equally important, Merleau-Ponty conceives the lived body as both the lived centre of consciousness and one's own body as experienced.[2] In the distinction between the lived body and the physical body, the notion of the lived body captures the body in the embodied first-person perspective, whereas the physical body is an objectified, corporeal and material entity. Furthermore, following Husserl's phenomenology, Merleau-Ponty addresses the notion of motor intentionality, which concerns the lived body's intention towards objects, its directing itself towards goals, and its acting in a way that enables it to make sense of a collection of disparate bodily movements, unifying them into meaningful action (ibid., p. 137).

As for the notion of movement, we include in our discussion kinaesthesia, in the sense of both an individual's bodily movements and collectively formed movement patterns across the city. We conceive urban space, in turn, as increasingly software-dependent and data-intensive: as a

[2] More exactly, Merleau-Ponty states that '[c]onsciousness is being-towards-the-thing through the intermediary of the body' (Merleau-Ponty 1962/1989, pp. 138–139).

computational environment that can be fruitfully described as a cybernetic system (see, e.g., Kitchin & Dodge, 2011; Hayles, 2009; Gabrys, 2016; Krivý, 2016).

To formulate the orientation of the chapter with respect to the contemporary urban condition, then, our focus is on how code-based algorithmic technologies engage city dwellers as corporeal beings in the (re)configuration of spatial power relations. From this starting point, it is not only that technologies as material components provide infrastructural support and control, but that mediated bodily practices with their entwinement in political and economic interests couple with and contribute to sociotechnical ensembles in multiple complex ways. In these constellations, urbanites' corporeality and, most particularly, the movements of the lived body become a constitutive aspect of infrastructural power.

More generally speaking, due to the overall digital mediation of both space and people's daily activities, the quantity of personal data generated daily in different spatial settings has reached an unprecedented scale in the past few years. Elmqvist (2011) and Haddadi, Mortier, McAuley, and Crowcroft (2013), in pointing to limitations in traditional human–computer interaction (HCI) research, suggest that it is time to pay attention to human–data interaction (HDI). The latter type of research is not only interested in relations between humans and large personal datasets but also takes into account that people often interact with technological structures that condition their activities in ways they do not necessarily recognise or understand, or which they would rather ignore. Unpacking how such infrastructures function poses specific challenges in the urban context. This is because the scale of these systems is much more extensive than that usually considered in studies focused narrowly on the level of human–computer interaction. In the present context, a pertinent question is how so-called 'big data' are generated and collected in urban environments,

and how such data subsequently circulate back into these environments in diversely processed forms.

To grasp the infrastructural dynamic of data generation, collection and circulation in contemporary cities, it is important to consider the different levels of sociotechnical activity and, above all, to pay direct attention to how these levels interrelate. Klauser and Albrechtstlund (2014) suggest that the micro and macro levels constitute the opposite ends of the big data spectrum, emphasising that these opposites are not separate from one another but connect through complex feedback systems. The choreographic approach we develop here also includes as an essential dimension the middle-range or meso level in considering city dwellers' everyday uses of smart devices, phones, wearables, cameras and sensors as bodily gestures that connect integrally to the macro-choreography of collecting big data for the purposes of governance and economic profit.

In what follows, we develop *urban choreography* as a concept that reaches across different technologically mediated sociospatial scales by reworking Husserl's notion of *kinaesthesia* relative to more recent theoretical discussions. As for the latter, we bring together the phenomenology of movement (Sheets-Johnstone, 1999), theorisations on choreography in the urban context (Parviainen, 2010; Robertson, Lycouris, & Johnson, 2007) and discussions on the mediated city (Frers & Meier, 2007; Mattern, 2015; McQuire, 2008; Parviainen, 2010; Parviainen, Tuuri, & Pirhonen, 2013; Ridell, 2010, 2013). In addition to kinaesthesia, valuable related concepts for defining urban choreography are *movement trajectory*, *kinaesthetic field* and *kinesphere*.

The chapter is structured as follows. In the next section, we proceed from the theoretical discussions on choreography to introduce our own conceptualisation of urban choreography; we also demonstrate how this notion can assist in analysing everyday movement trajectories and

kinaesthesia as integral to the infrastructural dynamic of the computational city. In the following section, we direct particular attention to big data generation and collection in contemporary urban settings. We outline how urbanites' mediated bodily movements and their encounters with ambient technologies as part of their movement trajectories interconnect as micro- and meso-level choreographies with global big data developments, thereby contributing to urban macro-choreographies. We conclude with critical reflections on the recursive cybernetic logic by which the infrastructural macro level feeds back to lived urbanity, disciplining the embodied aspects of city life in novel ways and giving rise to new types of adaptive practices.

3. Conceiving Urban Choreography Phenomenologically

While in dance aesthetics choreography refers to dance composition, in recent discussions of interaction design and related disciplines, the notion of choreography seeks to capture the meaningful continuums of movement that humans, as individuals or as groups, experience during interaction with technology (Loke & Kocaballi, 2016). Typically, in computer science, human behaviour in urban settings has been approached at the level of physical bodies and their relations to other bodies and things, creating agent-based movement models to depict patterns of behaviour (Torrens, 2016). The discussion on urban choreography more specifically has raised interest in the movements of lived bodies (Lycouris, 2009; Schiller & Rubidge, 2014), and this discussion resonates with explorations in the fields of time geography (Crang, 2001; Hägerstrand, 1982; Pred, 1977; see also Sullivan, 2017), urban anthropology and sociology, particularly as concerns the study of everyday pedestrian and crowd movement (see, e.g., Carter, 2009; Ingold, 2011; Sheller & Urry, 2006). The idea of choreography is also indirectly present in studies of urban

polyrhythmicities at different sociospatial scales (Amin & Thrift, 2002; Edensor, 2010; Lefebvre, 2004; Smith & Hetherington, 2013).

In our consideration of urban choreography, we approach bodily movement in the computational city as a key element in a cybernetic system of thoroughly mediated interrelations. Choreography in this sense actualises as joint material performances by bodies, actions and environments rather than as simply bodies alone making movements to create choreography. *There* is a *reasonable amount* of theoretical discussion on choreography (e.g. Bench, 2014; Hirsch, 2014; Parviainen, 2010; Prytherch, 2015; Robertson, Lycouris, & Johnson, 2007) that can assist in developing a consistent choreographic take on the movement of data and bodies in the contemporary urban context. Broadly, the notion of choreography in our usage also contains an aspect of simultaneous multisitedness, as it refers to movements and activities in which the movements express relations and articulate meaningful interactions in and across lived and virtual spaces between various animate or inanimate agents. This means that no one choreographer can determine the overall constellation; rather, the connections between human and nonhuman agents create and sustain choreography in an ongoing manner. Treating human and nonhuman agents symmetrically, choreography arises from their reciprocal relations, actualising in movements, motions, patterns and rhythms.

This kind of conception of choreography has resonance with actor network theories (ANTs) (e.g. Latour, 1997; Law, 1992). In the ANT version developed by Latour (1997) and his colleagues, humans and objects become agents or *actants* influencing courses of action as well as being the results of them. An assemblage of people, objects and technologies are composed of heterogeneous elements that enter into mutual relations with one another. With regard to digital technologies, when action and materiality intertwine, human bodies do not remain independent from technologies. In such assemblages, embodied connections with technologies modify physical and lived bodies, forming new kinds of hybrid practices. One way to capture how the movement of

human bodies and the motion of machines become synchronised in these practices would be to use geographer Nigel Thrift's (2004c) notion of *hybrid kinaesthesia*. Deborah Lupton (2013, p. 400) borrows Peter Freund's (2004) term *technological habitus* to describe how bodies develop new habits and routines to blend in with the functions of technologies. Lupton suggests, however, that bodies do not intermesh smoothly or seamlessly with technology, but that there are disjunctions between bodies and objects (ibid.).

In Latour's (1997) articulation of ANT, the agency of actors and their assemblage is addressed without giving too much attention to the quality of action by the different actants in question; not showing interest in, for example, how affects and sensations of lived bodies may influence relations among actants. In contrast, the phenomenologically informed choreographic approach we are developing here is interested in the specific weights of actants' movement, i.e., how they make things happen and keep the action alive. To address the relational and affective dynamics of lived bodies and how their actions pull and push things towards a constellation, we draw inspiration from and develop further Husserl's idea of *kinaesthesia* (e.g. Husserl, 1997). This means that we sharpen the focus on embodied activities and transitions in an enmeshed network of heterogeneous elements, emphasising the reciprocal relations between hardware and software, bodies and environments in specific spatial configurations that can be partly planned and partly improvised. In contemporary cities, these dynamic interconnections form a socio- and body-technical membrane in which infrastructural power vibrates.

Husserl's (1997) particular relevance for our discussion, combined with Merleau-Ponty's view of the lived body, is that, for him, kinaesthesia is not interchangeable with the term *proprioception,* which denotes interoceptive information about limb position and how it contributes to motor programming. Instead, he refers to the notion of exteroceptive information of moving in space. In

other words, kinaesthesia provides information about changes of location and motility as affective and social interaction with other living and non-living beings. Hence, what is at stake is an ability to sense or feel movement or the sensation of movement. Such sensation is not necessarily associated with the body's own intentional movements; for example, motor vehicles or other living beings can cause movements in the body. This warrants an analytic distinction between two possible kinaesthetic situations: *self-motion* and *being-moved*. Self-motion refers to self-generated movements by which one intentionally moves one's body, and these generated movements physically, affectively or socially influence or resonate with other beings in proximity. At the same time, one can feel kinaesthetic sensations of being moved by the movements of other beings.[3] For instance, being-moved occurs when sitting on the bus and feeling how the bus transports one's body, sensing the vehicle's speedups, turns and brakes through the body but with very limited ability to influence the movements of the bus.

Kinaesthesia, then, is a central factor in addressing the interactions in and between lived bodies and their relations with objects and environments in the contemporary urban context. More generally, it is through kinaesthesia that individuals recognise differences and similarities in their own movement qualities and haptic sensations, as well as in the motions of the objects around them (Sheets-Johnstone, 1999). The movement of lifting a mobile phone reveals something about its weight. Rubbing one's fingers across the phone's surface reveals details about its texture, material and shape. Dropping the phone reveals something about its structure and resilience via the sound it makes when it hits the floor.

[3] In the contemporary urban context, this constellation has been rendered even more complex through the development of wireless technologies and, more precisely, through digital signal processing. While the materiality of the 'Herzian space' (Shepard 2009) is not directly perceived by our senses, it affects the body's sensory orientation and relation to other bodies and things in urban space (Mackenzie 2010; Ridell forthcoming).

Furthermore, instead of focusing only on the body's internal kinaesthetic feelings, Husserl suggests that the kinaesthetic system should be analysed as a whole, i.e., as a *kinaesthetic field*. Motion appears to us as an integral part of relational systems, including visual and aural impressions of moving objects. Simplifying Husserl's own highly abstract formulation of the kinaesthetic field, we refer with this notion to the characteristic motions embedded in geographic locations and places and which vary according to the time of day and season (Parviainen, 2010). For instance, people gathering for a picnic in a city park on a sunny Sunday afternoon generate a kinaesthetic field that differs drastically from the kinaesthetic field co-created by the same people when driving in their cars to work on a highway on a rainy Monday morning. Such a formulation of the kinaesthetic field, in fact, comes close to Husserl's (1989) concept of *Umwelt* and resonates with what Thrift later called the 'qualculative background' (see Thrift, 2004a). For Husserl, entities are 'meaningful' to us as a 'motivating' force similar to how we 'shake hands with one another in greeting' (Husserl, 1989, p. 192).

Proceeding from and developing further Husserl's notions enable us to formulate a conceptualisation of choreography that provides methodological tools to analyse more systemically how human and non-human movements in contemporary cities are tightly involved in kinaesthetic fields. In our previous studies (Parviainen, 2016; Parviainen, Tuuri, & Pirhonen, 2013), we developed a notion of choreography that specifies the movements of actants by dividing choreography analytically into micro, local and macro levels. To emphasise the power-related infrastructural aspect, we replace the notion of local level in this connection with *meso-level* choreography (for the analytic distinction between micro, meso and macro levels of infrastructure, see, e.g., Edwards, 2003). In a *micro-level* analysis, the focus can be, for instance, on the swiping movements of the index finger across a *screen.* More generally, these movements occur within one's kinesphere or internally. By *kinesphere* we refer to Rudolf Laban's definition of 'the sphere around the body whose periphery can be reached by easily extended limbs' (Laban, 1966, p. 10).

Coming close to Edward T. Hall's (1966) notion of *personal space*, the notion of the kinesphere emphasises bodily movements, as well as their qualities, dynamism, tensions and efforts, as forming a lived space. The intersubjective spatiality that individuals live in and through their kinespheres plays a central role in *meso-level* choreographies through collectively shared kinaesthetic fields. At this level, choreography refers to bodies' socio-spatially attuned movements; for instance, when pedestrians navigate through the throng at a busy crossroad, or when passengers, sitting on a bus, use their phones to avoid eye contact with fellow passengers. While there is plenty of research on social intercourse from the perspective of situational conventions and 'grammars', particularly inspired by Erving Goffman's studies on behaviour in public places (Goffman, 1963, 1971; see e.g., Jensen, 2010), the corporeal dimension is not too often addressed (see Ridell, forthcoming). The *macro-level* choreography, in turn, refers to movements that connect individual bodies in their micro- and meso-level kinaesthesia with large-scale, even globally extensive, movement trajectories enabled by the physical infrastructures of transportation or the internet. Hence, passengers on a bus, hiding from those physically co-present behind their portable devices, may be reading text messages from friends on other continents or watching a video on YouTube that is being viewed simultaneously by hundreds of thousands of other people all over the globe.

To summarise, the phenomenologically informed approach to urban choreography we propose views singular bodily gestures and movements interrelated to digitally afforded objects and computationally mediated environments as integral parts of spatially extensive and sociotechnically complex trajectories and transitions. Understood this way, the choreographic analysis is not restricted to bodily movement in limited spaces and short time spans but instead takes into account the spatiotemporal multidimensionality involved when people respond to ambient technologies and use their portables and wearables in urban settings.

4. Choreographies of Data Generation in Urban Settings

Sociotechnical ensembles are now more complex and actualise on a greater scale than ever before. In western countries, a majority of people carry smartphones and other networked devices with them all the time; these devices have an inbuilt capacity to generate and collect data on how they are used. The phenomenon of 'personal data' has emerged only in recent years, representing an entirely new class of data. These data about one's locations, bodily movement trajectories and actions are produced by users themselves and are obtained automatically from their smartphones, activity trackers and other wearable devices, or are captured by sensors embedded in physical urban structures.

With regard to self-generated data, self-tracking applications, for instance, collect information about a variety of everyday activities, from status updates to discrete activity data that technology firms and platform owners can store, analyse and sell for profit to other companies. Smartphones, in turn, include multiple sophisticated technical functions and applications, such as cameras, navigation systems, proximity meters, heart rate sensors, accelerometers, gyroscopes, barometers and thermometers, that monitor individual bodies' movements and the state of one's physical body. Applications also assist users in generating data from their lived bodies that sensors currently cannot capture, such as data on food and drink consumption, aches, pains and even moods. Taken together, these data provide quantifiable, and thus profitable, information about urbanites' everyday movement trajectories as well as about their mediated bodily habits and routines in the city.

Technologies embedded in the urban environment and the collection of data about people's movements and daily activities in different locations often go unnoticed by city dwellers themselves. Moreover, urbanites mostly remain unaware of how the data gathered from them—for

instance, by cameras with facial recognition systems—are stored, circulated and sold. In addition to commercial data collection, political and administrative interests shape the use of these algorithmic technologies in cities. We can take as an example current developments in China, the groundbreaker globally in the deployment of facial recognition systems and the integration of huge image databases of human faces for algorithmic processing. In several Chinese cities, facial data collected on streets and in banks, hotels, airports and even public toilets are used to verify people's identities.[4] The motivation for these operations is to strengthen the political surveillance of citizens by both local administration and the central government. The far-reaching existential implication of the widespread deployment of facial recognition systems is that, as Gray (2003) points out, they will necessarily alter societal conceptions of privacy in public (urban) space as well as the dynamics of individual and group interactions.

The example of China demonstrates that the limits to how thoroughly politically motivated facial recognition may permeate urban space are flexible indeed. For example, in Ürümqi City, located in the Xinjiang region, street cameras can automatically classify pedestrians according to their gender, clothes and even hair length, and software allows people to be tracked from one surveillance camera to the next based on facial data alone. In 2018, China deployed a flock of 'bird drones', high-tech spy drones disguised to look like birds, to step up surveillance levels in the Muslim-

[4] Journalists from *South China Morning Post*, located in Hong Kong, and journalistic and other media in western countries have reported that a massive system is being established by the Chinese government to identify its citizens based on facial recognition technologies: see, e.g., 'China said to be testing facial recognition system to monitor Muslim-dominated Xinjiang region', http://www.scmp.com/news/china/society/article/2129473/china-testing-facial-recognition-system-monitor-muslim-dominated; 'China to build giant facial recognition database to identify any citizen within seconds' http://www.scmp.com/news/china/society/article/2115094/china-build-giant-facial-recognition-database-identify-any; 'China testing facial-recognition surveillance system in Xinjiang – report' https://www.theguardian.com/world/2018/jan/18/china-testing-facial-recognition-surveillance-system-in-xinjiang-report.

majority Xinjiang region.[5] Chinese authorities also have plans to track, in the near future, urbanites' habitual movement routines and trajectories in order to spot 'problematic pedestrian behavior'. One of the directors at *Cloudwalk,* a Chongqing-based firm, provides a different example: 'If you know gambling takes place in a location, and someone goes there frequently, they become suspicious'.[6] When a suspicious person is identified, the system can examine her or his connections with other people by tracking the movement trajectories relative to their meeting points.

The notion of *movement trajectory* in urban settings refers to people's daily travels and patterns of movement in the city between home, work and social events. These trajectories often attach to and are supported (and sometimes disrupted) by ambient technologies and portable devices. In contemporary cities, movement trajectories form personal and collective choreographies, as people move regularly from home or place of work or study to having lunch or going shopping. Individual trajectories include different stopping points, with multiple networks of movement trajectories converging to form complex nodes of human–human, human–nonhuman and nonhuman–nonhuman interconnections (Gabrielli, Rinzivillo, Ronzano, & Villatoro, 2013). Another extract from Hill (2008) illustrates one such instance:

As the bus departs, the new passengers on-board swipe their RFID-based integrated transport system ID cards, updating mass transit databases with every possible aspect that can be gleaned

[5] See, for instance, 'China takes surveillance to new heights with flock of robotic doves, but do they come in peace?', https://www.scmp.com/news/china/society/article/2152027/china-takes-surveillance-new-heights-flock-robotic-doves-do-they; 'China is using robotic bird drones with cameras to monitor its citizens', https://bgr.com/2018/06/26/china-bird-drones-surveillance-robots/; 'China is testing creepy drones that look and fly like real birds to monitor citizens', https://www.businessinsider.com/china-is-testing-creepy-dove-drones-to-monitor-citizens-2018-6?r=US&IR=T&IR=T.

[6] See Simon Denyer's article 'Beijing bets on facial recognition in a big drive for total surveillance' https://www.washingtonpost.com/news/world/wp/2018/01/07/feature/in-china-facial-recognition-is-sharp-end-of-a-drive-for-total-surveillance/?utm_term=.aff3000ae762.

from this simple activity (time of day, location, frequency of use, favourite entry points etc.) The now-empty seat in the bus-stop registers that it is indeed now empty using simple sensors, and wirelessly logs this fact with a database monitoring the usage and state of street furniture in the neighbourhood. (Hill, 2008, para 12)

Embedded algorithmic technologies, such as facial recognition systems, while often unnoticed by city dwellers, structure urban ambience unobtrusively, thereby contributing to the formation of what Thrift (2004a) called the urban qualculative background. With this notion, he refers to the abstractly material background of city life that is rarely questioned but merely assumed, i.e., 'the landscape which the body "naturally" adjusts to and which it regards as a normal part of its movement' (Thrift, 2004a, 584). Thrift's notion of hybrid kinaesthesia, in turn, captures how urbanites' bodily movements and gestures often take place in multiple spatial contexts simultaneously. Furthermore, Thrift (2004b) argued (over a decade ago) that we have entered a new phase of 'technological unconscious', one which is fundamentally shaping how corporeal activities are organised and coordinated in the city (see also Thrift & French, 2002). Unlike the Freudian or Lacanian notions of unconscious, this body-technical unconscious refers to the taken-for-granted processes that keep the corporeal body in the recursive loop of code-based technological infrastructure. What is especially noteworthy in this connection is that the repetitive uses of smart devices and complacency regarding what they afford automate urbanites' mediated bodily actions to a point of complete self-evidence.

The proliferation of networked portables is generally perceived as a positive development, because these gadgets provide people with easy access to information and social connections while on the move. At the same time, the amount of data collected, transmitted and stored about users through both these personal devices and via sensors and surveilling systems have grown exponentially. Increasingly in urban spaces, users can be tracked by nearby urbanites' devices, which can collect information about them. In all cases, personal data can be used to profile individuals as consumers and citizens based on their gender, age, social class, income, political opinions, habits, preferences, etc. with the aim of influencing, managing or controlling them. Considering this situation,

surprisingly little is known about the repercussions of data collection in urban centres. In our view, the need to critically analyse the infrastructural dynamics of urban data generation and collection resonates with the broader need to grasp and make publicly visible the full implications of networked tracking for power relationships and social justice on the societal level (Gray, 2003; Lyon, 2001).

5. Bodies in the Feedback Loops of Computational Cities

To facilitate the generation and collection of personal data on a daily basis, digital gadgets are designed in ways that attach users in an affective loop of bodily habit formation via technologies. Nagamura (2015) suggests that the action of looking at a mobile phone display, for example, has become increasingly universal. There is an aspect of technologically induced compulsion at play, as users may look at their displays with rapid frequency and strong intent even when this action is nonessential. Research has also pointed to social functions of mobile phone display looking, as some users apparently rehearse this activity to avoid social encounters in public places (see, e.g., Baron & Campbell, 2012; Hampton & Gupta, 2008). In any case, be it intentional or unintentional, this simple kinaesthetic repetition can be fruitfully approached in terms of choreographic gestures on different infrastructural levels and at their intersections.

With regard to the micro-level choreography, the act of looking at a mobile phone display restricts the user's movement to turning the head and eyes towards the screen, while the fingers are needed to hold the phone, keep the display alive and access content. The choreography here consists of sequences of movement performed by individual bodies to check received messages or other content on the device. The length of checking sequences may vary depending on how often the user

handles his or her gadget. The action becomes compulsive if the repetitive movements start to disturb essential daily activities (Roberts, Yaya, Honore, & Manolis, 2014). As Nagamura (2015) points out, the mobile phone is considered an insensitive and forcible medium because it keeps the user in an affective checking loop even without any external impulse. Importantly in the present context, there is a clear connection between compulsive behaviour and the macro-level choreographing of movement, as mobile devices and ambient urban technologies are designed to be immersive and to generate data imperceptibly.

To understand how city dwellers' bodily movements and gestures generate mass data comprising digital traces that technology companies collect, classify, refine and sell on a global scale, it is useful to take a look at the big data end of the urban feedback system. Big data is often defined as datasets whose size is beyond the capacity of ordinary database software tools to capture, store, manage and analyse (Manyika et al., 2011). In 2011, such a large amount of data was produced every two days; by 2013, the same amount was generated every 10 min (Ajana, 2015). Although scholars often place emphasis on sheer volume, it is worth recognising that big data is not merely about huge sets of bits. In fact, big data is, above all, about networked relational information (Ajana, 2015; Manovich, 2012). Size is certainly an important factor in that the more massive the volume of data, the better sorting algorithms become at spotting connections, creating and/or unlocking patterns, and rendering recognised relations in visible form—and, most importantly, *learning* from these operations. It is these latter aspects that make big data such a seductive field of investment for both commercial actors and political and administrative agencies.

Regarding the political economy of the feedback loop, the measurement of bodies by wearable devices, for example, is based on proprietary algorithms that track various aspects of their users' movements and actions. What is noteworthy is that these devices not only track and collect data on

users but also function to steer their actions by, for example, suggesting that they exercise or pop into cafés or bars. When biosensors monitor how long someone has been sitting and working at a café, the apps installed on the device may prod him or her to walk around at specified intervals. Another example is that of a person taking a stroll along the street who receives automated 'fitness nudges' from his or her device stating, 'You're near a park. Why not go for a run?' In these cases, urbanites' bodies, while apparently in self-motion, are being-moved by their gadgets and the predatory applications installed on them. Put differently, embodied agency and individual decision-making are mediated by algorithms in a manner that renders bodily actions less intentional. Furthermore, as wearable devices continue to shape perceptions of the body and of bodily movement, people's individual and social activities may increasingly adapt to the algorithmic logic that runs their smart devices (Budish, 2015; Schüll, 2016), becoming integrated within urban algorhythmicities (cf. Miyazaki, 2013; also Coletta & Kitchin, 2017; but see Tironi & Valderrama, 2018). And the more seamless our experiences with wearables become, the more we may tend to rely on them to interpret the needs of our bodies. An extreme example of such a loop of embodied technology-dependency is the use of applications such as Apple's Screen Time app to reduce the time one spends using the applications installed on the device.

Companies and governments alike promote the idea that algorithmic processes and data-driven systems have been purged of human bias, error and interference, thereby ostensibly facilitating more neutral and objective decision-making (Ajana, 2015; Muller, 2004). Yet, computational classifications and the recommendations based on them are neither neutral nor objective; on the contrary, they are biased towards their own purposes (Burrell, 2016; Mackenzie, 2017). According to Dwork and Mulligan (2013), greater attention should be directed to the values embedded in big data classifications and to how their automation is transforming public and private life in diverse spatial settings (see also Gitelman, 2013).

From the perspective of technology manufacturers, it makes profitable sense to design wearable devices that are simultaneously immersive and pervasive in terms of data collection. Such devices are an integral part of a feedback loop that not only consists of the effective generation, collection, refinement and selling of data but also includes the transmission of the refined data back into urban settings as new products, services and smarter surveillance and control systems. In this inherently cybernetic circuit, an ever-increasing amount of data produced by human bodies is needed to hone algorithms to offer ever-better targeted suggestions for customers and citizens (Harwood, 2014).

What is particularly noteworthy in contemporary cities is that as the algorithms running wearables and surveillance cameras, for example, continue to advance, they become increasingly precise at recognising an individual's connections with other people, especially in physical spaces. Consequently, when technological systems can track relations with other potential actants around individual users and profile them as well, the feedback mechanism itself becomes significantly more complex than when it is based solely on a simple input–output logic. A logical next phase in this simultaneous broadening and deepening of the cybernetic cycle would be to socially rank individuals' movement trajectories relative to their associates' or nearby users' movement trajectories in urban environments. In the course of time, increasing accuracy in the relational recognition of individual movement and gesture patterns may enable the formation of practices in which algorithmically assessed relations with others are used to define the societal status and value of individuals. One may even propose, only mildly provocatively, that the current developments in China we mentioned above already demonstrate actual steps taken in this direction. In any case, following the cybernetic logic at play to the full promises (or threatens) to realise a sociotechnical tendency whereby the relationships, movement trajectories, daily routines and activities of individuals count as key signifiers of their infrastructurally co-conditioned social existence.

As we have stressed above, big data operations intertwine closely with urban physical infrastructures and city dwellers' embodied practices. Urbanites' bodies, in a few words, are not external to the hybrid constellations and cybernetic circuits to which their mediated movements and actions contribute (cf. Gabrys, 2016). Bodies themselves, intentionally and unwittingly, individually and jointly, are both shaped by and contribute to new adaptive habituations and practices. Apparently, it is possible to express embodied resistance to and even protect oneself from algorithmic tracking and surveillance through diverse bodily actions by, for example, avoiding particular urban hotspots, abandoning the use of smartphones or covering one's face with a mask or other form of camouflage when moving about in the city. Yet most urban technological systems are such that, in actual practice, urbanites cannot help but submit to their logic, which reaches beyond the local and the situational. To give a mundane example, customers paying for their groceries by flashing a smart card at the supermarket checkout or passengers swiping their travel cards on an integrated transport system on a bus are involved in a feedback loop that extends far beyond the micro gesture of paying for food or transportation or the meso gesture of attuning to co-present customers' bodily movements. With the constantly growing role of algorithmically processed big data in urban infrastructural systems, it remains to be seen what kinds of embodied practices and accompanying norms will evolve from the multiscale interplay of mediated choreographies.

6. Concluding Remarks

In this chapter, we have provided a phenomenologically informed take on the ways in which city dwellers' mediated bodily movements, their multispatial hybrid kinaesthesia, and their movement

trajectories are integrally linked to contemporary urban infrastructural processes. Our proposal is that the conception of urban choreography as outlined above opens up a fruitful perspective for understanding how pervasively computed cities function increasingly as complex cybernetic systems. Furthermore, we suggest that the choreographic approach can pave the way for studying empirically how embodied adaptation to algorithmic technologies interrelates with digitalized urban structures, as well as how, among other things, the policies of city planning are affected and challenged in the process.

It seems, paradoxically, that the more individuals pursue making personal choices in urban settings, the more frantically they facilitate a world in which means and ends are dislocated. In other words, through their mediated bodily actions, urbanites contribute actively yet unintentionally to the acceleration of the circular feedback mechanisms that deepen technological saturation (Davison, 2004). In order to tackle the multiple ways in which city dwellers as corporeal beings are presently involved in power-related spatial production, we emphasise the importance of not restricting the choreographic analysis to the micro level. Nor is it enough to focus merely on the situational meso-level dimension of bodily movement. Unless we address these two levels as mutually connected and simultaneously interrelated with macro-choreographic forces, we will fail to uncover the broader political and economic implications of contemporary sociotechnical ensembles and their complex infrastructural dynamics.

To avoid reducing the discussion on human–technology relations in the urban context into approaches that overemphasise subjective experiences and unproblematic user intentionality (as is often the case in studies of human–computer interaction), the choreographic approach we have outlined addresses even the most personal movements and acts in the *context* of large-scale data-processing systems. These are driven by strong economic and political interests, and often jointly

so, as in the case of the Smart City developments, for example. As we have illustrated, the couplings of lived bodies with physical urban spaces today are increasingly mediated by computation. This means that while smartphones and wearable trackers may be experienced as intimate technologies, they at the same time render corporeality into an external object to be (self-)surveilled, and the data generated in this way can be delivered to global technology companies for profit. Moreover, as we have suggested, various tools based on big data generation may easily be transduced into new mechanisms for steering and controlling both individual and social behaviour in urban space. Finally, due to affective attachment to personal devices, urbanites actively and willingly, yet in a deeply compulsive and unthinking vein, participate in the generation of big data, thereby assisting in the acceleration of cybernetic feedback mechanisms.

With regard to thinking about interaction design in the contemporary urban context, the choreographic approach underscores the importance of not concentrating exclusively on user–device relations or addressing some specific situational circumstances of use. The starting point here as well should be on how city dwellers' mediated bodily activities intertwine with macro-infrastructural processes across different spatial scales of bodily movement and movement trajectories, and how, ontologically speaking, corporeality in this process functions as a key element in the complex constitution of sociotechnical and institutional structures. The more practical implications of such an approach for interaction design would deserve a separate discussion.

To formulate the fundamental aspiration behind our sketching of the premises of the study of urban choreography in pervasively computed cities, a key aim concerns the politicisation of infrastructure (cf. Rossiter, 2016). One way to do such a choreographic analysis in practice would be to expose and scrutinise critically the concrete ways in which personal data promotes an end to embodied agency as a personal and private issue in the sense of individuals' ownership of their lived bodies.

References

Ajana, B. (2015). Augmented borders: Big Data and the ethics of immigration control. Journal of Information, Communication and Ethics in Society, 13(1), 58–78. doi:10.1108/JICES-01-2014-0005

Amin, A. & Thrift, N. (2002). Cities. Reimagining the urban. Oxford: Blackwell Publishing.

Baron, N. S., & Campbell, E. M. (2012). Gender and mobile phones in cross-national context. *Language Sciences, 34*, 13–27. doi:10.1016/j.langsci.2011.06.018

Bench, H. (2014). Gestural choreographies: Embodied disciplines and digital media. In S. Gopinath & J. Stanyek (Eds.), Oxford handbook of mobile music studies, Vol. 2. (pp. 238–256). Oxford: Oxford University Press.

Budish, R. (2015, October 20). What my hearing aid taught me about the future of wearables. *The Atlantic*. Retrieved from http://www.theatlantic.com/technology/archive/2015/02/what-my-hearing-aid-taught-me-about-the-future-of-wearables/385145/

Burrell, J. (2016). How the machine 'thinks': Understanding opacity in machine learning algorithms. Big Data & Society, 1–12. doi:10.1177/2053951715622512

Butterworth, J., & Wildschut, L. (Eds.). (2009). Contemporary choreography: A critical reader. London: Routledge.

Carter. P. (2009). Dark writing: Geography, performance, design. Honolulu, HI: University of Hawaii Press.

Charara, S. (2015). *How machine learning will take wearable data to the next level*. Retrieved from http://www.wareable.com/wearable-tech/machine-learning-wearable-data-sensors-2015

Coletta, C., & Kitchin, R. (2017). Algorhythmic governance. Regulating the heartbeat of a city using the Internet of Things. Big Data & Society, 1–16. doi:10.1177/2053951717742418

Crang, M. (2001) Rhythms of the city. Temporalised space and motion. In J. May & N. Thrift (Eds.), Timespace: Geographies of temporality (pp. 187–207). London & New York: Routledge.

Davison, A. (2004). Reinhabiting technology: Ends in means and the practice of place. Technology in Society, 26, 85–97. doi:10.1016/j.techsoc.2003.10.007

Dwork, C., & Mulligan, D. K. (2013, September 3). It's not privacy, and it's not fair. *Stanford Law Review* [online], 66, 35. Retrieved August 21, 2015, from: www.stanfordlawreview.org/online/privacy-and-big-data/its-not-privacy-and-its-not-fair

Edensor, T. (2010). Introduction: Thinking about rhythm and space. In T. Edensor (Ed.), Geographies of rhythm (pp. 1–18). Surey: Ashgate.

Edwards, P. N. (2003). Infrastructure and modernity. Force, time, and social organization in the history of sociotechnical systems. In T. Misa, P. Brey, & A. Feenberg (Eds.), Modernity and technology (pp. 185–225). Cambridge, MA: The MIT Press.

Elmqvist, N. (2011). Embodied human-data interaction. In A. N. Antle, P. Marshall, & E. Van Den Hoven (Eds.), *Proceedings of workshop embodied interaction: Theory and practice in HCI CHI 2011*; (pp. 104–107). New York: ACM

Frers, L., & Meier, L. (Eds.). (2007). Encountering urban places: Visual and material performances in the city. Hampshire: Ashgate.

Gabrielli, L., Rinzivillo, S., Ronzano, F., & Villatoro, D. (2013). From tweets to semantic trajectories: Mining anomalous urban mobility patterns. In J. Nin & D. Villatoro (Eds.), Citizen in sensor networks (pp. 26–35). Heidelberg: Springer.

Gabrys, J. (2016) Program Earth. Environmental sensing technology and the making of a computational planet. Minneapolis, MN: University of Minnesota Press.

Gitelman, L. (Ed.). (2013). "Raw data" is an oxymoron. Cambridge, MA: The MIT Press.

Goffman, E. (1963). *Behavior in public places*. New York: The Free Press.

Goffman, E. (1971). *Relations in public*. New York: Basic Books.

Graham, S., & Marvin, S. (2001). Splintering urbanism: Networked infrastructures, technological mobilities and the urban condition. London: Routledge.

Gray, M. (2003). *Urban surveillance and panopticism: Will we recognize the facial recognition society?* Retrieved March 1, 2018, from: https://queens.scholarsportal.info/ojs-archive/index.php/surveillance-and-society/article/viewFile/3343/3305

Haddadi, H., Mortier, R., McAuley, D., & Crowcroft, J. (2013). *Human-data interaction* (Technical Report No. 837). Retrieved October 19, 2015, from The University of Cambridge Computer Laboratory website: http://www.cl.cam.ac.uk/techreports/

Hägerstrand, T. (1982). Diorama, path, and project. Tijdschrift voor ekonomische em sociale geografie, 73(6), 323–339. doi:10.1111/j.1467-9663.1982.tb01647

Hall, E. T. (1966). The hidden dimension. New York: Anchor Books.

Hampton, K., & Gupta, N. (2008). Community and social interaction in the wireless city: Wi-fi use in public and semi-public spaces. New Media & Society, 10(6), 831–850.

Harwood, K. (2014). *Algorithms: The next wearable tech frontier*. Retrieved October 19, 2015, from: http://www.wired.com/insights/2014/10/algorithms-wearable-tech-frontier/

Hayles, N. K. (2009). RFID: Human agency and meaning in information-intensive environments. Theory, Culture & Society, 26(2–3), 47–72.

Hill, D. (2008). *The street as a platform*. Retrieved March 1, 2018, from: http://www.cityofsound.com/blog/2008/02/the-street-as-p.html

Hirsch, A. B. (2014). *City choreographer: Lawrence Halprin in urban renewal America*. Minneapolis, MN: University of Minnesota Press.

Husserl, E. (1989). *Ideas pertaining to a pure phenomenology and to a phenomenological philosophy, second book: Studies in the phenomenology of constitution* (R. Rojcewicz & A. Schuwer, Trans.). Dordrecht: Kluwer Academic Publishers. (Original work Ideen zu einer reinen Phänomenologie und phänomenologischen Philosophie. Zweites Buch: Phänomenologische Untersuchungen zur Konstitution published in 1952).

Husserl, E. (1997). *Thing and space. Lectures 1907*. (R. Rojcewicz, Trans.). Dordrecht: Kluwer Academic Publishers. (Original work *Ding und Raum* published in 1973).

Ingold, T. (2011). Being alive: Essays on movement, knowledge and description. London: Routledge.

Jensen, O. B. (2010). Negotiation in motion: Unpacking a geography of mobility. Space and Culture, 13(4), 389–402.

Kitchin, R., & Dodge, M. (2011). Code/Space: Software and everyday life. Cambridge, MA: The MIT Press.

Klauser, F. R., & Albrechtslund, A. (2014). From self-tracking to smart urban infrastructures: Towards an interdisciplinary research agenda on Big Data. Surveillance & Society, 12(2), 273–286.

Krivý, M. (2016). Towards a critique of cybernetic urbanism: The smart city and the society of control. Planning Theory *17*(1), 8–30. doi:10.1177/1473095216645631

Laban, R. (1966). Choreutics. London: MacDonald and Evans.

Latour, B. (1997). *On actor–network theory: A few clarifications*. Retrieved August 21, 2015, from The Centre for Social Theory and Technology, Keele University, UK website: http://keele.ac.uk/depts/stt/stt/ant/latour.htm

Law, J. (1992). Notes on the theory of the actor network: Ordering, strategy and heterogeneity. Systems Practice, 5(4), 379–393.

Lefebvre, H. (2004). *Rhythmanalysis*. (S. Elden & G. Moore, Trans.). London: Bloomsbury. (Original work Éléments de rythmanalyse published in 1992).

Lepecki, A. (2006). Exhausting dance: Performance and the politics of movement. London: Routledge.

Loke, L., & Kocaballi, B. (2016). Choreographic inscriptions: A framework for exploring sociomaterial influences on qualities of movement for HCI. Human Technology: An Interdisciplinary Journal on Humans in ICT Environments, 12(1), 31—55.

Lupton, D. (2013). Quantifying the body: Monitoring and measuring health in the age of mHealth technologies. Critical Public Health, 23(4), 393–403. doi:10.1080/09581596.2013.794931

Lycouris, S. (2009). Choreographic environments: New technologies and movement-related artistic work. In J. Butterworth & L. Wildschut (Eds.), Contemporary choreography: A critical reader (pp. 346–361). London: Routledge.

Lyon, D. (2001) Surveillance society: Monitoring everyday life. Philadelphia, PA: Open University.

Mackenzie, A. (2010). Wirelessness: Radical empiricism in network cultures. Cambridge, MA: The MIT Press.

Mackenzie, A. (2017). Machine Learners: Archaeology of a data practice. Cambridge, MA: The MIT Press.

Manning, E. (2009). Relationscapes: Movement, art, philosophy. Cambridge, MA: The MIT Press.

Manovich, L. (2012). Trending: The promises and the challenges of big social data. In M. K. Gold *(Ed.),* Debates in the digital humanities (pp. 460–475). Minneapolis, MN*:* The University of Minnesota Press.

Manyika, J., Chui, M., Brown, B., Bughin, J., Dobbs, R., Roxburgh, C., et al. (2011). *Big Data: The next frontier for innovation, competition, and productivity*. Retrieved June 4, 2015, from the McKinsey Global Institute website: www.mckinsey.com/insights/business_technology/big_data_the_next_frontier_for_innovation

Mattern, S. (2015). Deep mapping the media city. Minneapolis, MN: The University of Minnesota Press.

McQuire, S. (2008). The media city: Media, architecture and urban space. London: Sage.

Merleau-Ponty, M. (1962/1989). *The phenomenology of perception*. (C. Smith, Trans.). London: Routledge. (Original work Phénoménologie de la perception published in 1945).

Miyazaki, S. (2013). Urban sounds unheard-of. A media archaeology of ubiquitous infospheres. Continuum: Journal of Media & Cultural Studies, 27(4), 514–522.

Muller, B. (2004). (Dis)qualified bodies: Securitization, citizenship and "identity management". Citizenship Studies, 8(3), 279–294. doi:10.1080/1362102042000257005

Nagamura, T. (2015). The action of looking at a mobile phone display as nonverbal behavior/communication: A theoretical perspective. Computers in Human Behavior, 43, 68–75. doi:10.1016/j.chb.2014.10.042

Nissenbaum, H. (2009). Privacy in context: Technology, policy, and the integrity of social life. Stanford, CA: Stanford Law Books.

Parviainen, J. (2010). Choreographing resistances: Kinaesthetic intelligence and bodily knowledge as political tools in activist work. Mobilities, 5(3), 311–330.

Parviainen, J. (2016). Quantified bodies in the checking loop: Analyzing the choreographies of biomonitoring and generating Big Data. Human Technology: An Interdisciplinary Journal on Humans in ICT Environments, *12*(1), 56–73.

Parviainen, J., Tuuri, K., & Pirhonen, A. (2013). Drifting down the technologization of life: Could choreography-based interaction design support us in engaging with the world and our embodied living? Challenges, 4(1), 103–115. doi:10.3390/challe4010103

Pentland, A. S. (2013). The data-driven society. Scientific American, 309(4), 78–83. doi:10.1038/scientificamerican1013-78

Prytherch, D. (2015). Rules of the road: Choreographing mobility in the everyday intersection. In J. Cidell & D. Prytherch (Eds.), Transport, mobility, and the production of urban space, human geography (pp. 45–63). London: Routledge.

Ridell, S. (2010). The cybercity as a medium: Public living and agency in the digitally shaped urban space. IRIE: International Review of Information Ethics, 12(3), 11–19.

Ridell, S. (2013). The city as a medium of media: Public life and agency at the intersections of the digitally shaped urban space. In S. Tosoni, M. Tarantino, & C. Giaccardi (Eds.), Media and the city: Urbanism, technology and communication (pp. 32–50). Newcastle: Cambridge Scholars Publishing.

Ridell, S. (forthcoming).Mediated urban routines as infrastructure: Human embodiment and power in the pervasively computed city. International Journal of Communication.

Roberts, J. A., Yaya, P., Honore, L., & Manolis, C. (2014). The invisible addiction: Cell-phone activities and addiction among male and female college students. Journal of Behavioral Addiction, 3(4), 254–265.

Robertson, A., Lycouris, S., & Johnson, J. (2007). An approach to the design of interactive environments, with reference to choreography, architecture, the science and the complex systems and 4D design. International Journal of Performance Arts and Digital Media, 3(2-3), 281–294.

Rossiter, N. (2016). Software, infrastructure, labor: A media theory of logistical nightmares. New York: Routledge.

Schiller, G., & Rubidge, S. (2014). Introduction. In G. Schiller & S. Rubidge (Eds.), Choreographic dwellings: Practising place (pp. 1–10). New York*:* Palgrave Macmillan.

Schüll, N. (2016). Data for life: Wearable technology and the design of self-care. BioSocieties, 11(3), 317–333.

Sheets-Johnstone, M. (1999). The primacy of movement. Amsterdam: John Benjamins.

Sheller, M., & Urry, J. (2006). Mobile technologies of the city. London*:* Routledge.

Shepard, M. (2009). Toward an architecture of Hertzian space. *ACADIA 09: reForm*, pp. 209–215.

Smith, R. J. & Hetherington, K. (2013). Urban rhythms: Mobilities, space and interactions in the contemporary city. In R. J. Smith & K. Hetherington (Eds.), Urban rhythms: Mobilities, space and interaction in the contemporary city (pp. 4–16). West Sussex: Wiley Blackwell.

Sullivan, R. (2017). The Geography of the everyday: Toward an understanding of the given. Athens, GA: University of Georgia Press.

Thrift, N. (2004a). Movement-space: The changing domain of thinking resulting from the development of new kinds of spatial awareness. Economy and Society, 33(4), 582–604.

Thrift, N. (2004b). Remembering the technological unconscious by foregrounding knowledges of position. Environment and Planning D, 22(1), 175–190.

Thrift, N. (2004c). Driving in the city. Theory, Culture Society, *21*(4/5), 41–59.

Thrift, N., & French, S. (2002). The automatic production of space. Transactions of the Institute of British Geographers, 27(3), 309–325.

Tironi, M., & Valderrama, M. (2018) Unpacking a citizen self-tracking device: Smartness and idiocy in the accumulation of cycling mobility data. Environment and Planning D, 36(2), 294–312. doi:10.1177/0263775817744781

Torrens, P. M. (2016). Computational streetscapes. Computation 4(3), 37. doi:10.3390/computation4030037

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