Smart Somatic Citizens
Responsibilisation and Relations in the Empowered City(sense) Project

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Introduction

In the second half of the 20th century, the idea of selfhood as something which is narrativised through the choice of consuming a particular set of goods has affected how healthcare is governed. Individuals are assumed to want to be healthy and to make sure to choose the best option there is. In the new regulatory regimes of health "experts instruct us as to how to be healthy, advertisers picture the appropriate actions and fulfillments and entrepreneurs develop this market for health".¹ The New Labour movement in the UK was concerned with remaking the relationship between the state and citizens, and reformed public service by trying to empower people to make choices in their welfare, which can be viewed as a form of responsibilisation.² These are only more recent examples of mechanisms employed to discipline individuals and manage populations, or exercises of biopower. Health campaigns designed to reduce risk behaviour of the subject at risk is another such expression of this disciplinary power.³

In this mode of governing individuals through choice, the emergence of the healthcare technology which is loosely referred to as mobile health (mHealth), seems to be particularly relevant since they promise to support the individual in all matters of decision making relating to health. Investigating these technologies from the perspective of biopower seems particularly relevant as they are said to have brought us to the cusp of a revolution in healthcare.⁴ With the use of geospatial data, mHealth technologies begin to encroach on the discourses of smart cities⁵, while at the same time the smart city discourse tends to stake a claim in the improvement of urban dwellers’ health through for example decreased pollution. The implications of the interaction of discourses on smart cities and mHealth technology remain largely unexplored and is the focus of this investigation.

⁵ The concept based on a combination of traditional regional and neoclassical theories of urban growth and development, and is characterised along six dimensions: people, governance, living, economy, mobility and environment (FPX2). Although no agreed definition exists on smart cities (Vanolo 2014, p. 887)
**Theoretical framework and Purpose of Study**

The purpose of this study is to investigate how processes of subjectification constitute the empowered citizen/patient in the discourses on smart cities. The concept of smart city is highly contentious and usually involves normative statements regarding cities. While not an exhaustive definition, for the purpose of this study, the smart city will be understood as an umbrella term encompassing at least the practices and technologies utilising sensors to gather data in an urban environment. Empowerment is understood as giving individuals power, authority and agency to do something. I aim to critically examine the notions of empowerment enabled by environmental sensing toward the goal of health in the discourses on smart cities. More specifically, this study will aim to answer the following:

- To what extent can empowerment through environmental sensing be understood as responsibilisation?
- What are some of the effects on the citizen-subject’s relations to knowledge and power brought on by the practices advanced in the material?

A discourse analytic approach to governmentality will be employed. Biopower was introduced by Foucault as one of the "great technologies of power". It highlights the rationalized ways in which it has been attempted to intervene upon human existence. The way it is being exercised, he claimed, was divided in two categories: On one hand it is exercised by trying to maximize human body performance and successfully integrating its capacity in an efficient system; on the other hand, it views the body as something to be regulated, often in populations, in regard to birth rate, disease, mortality and life expectancy.6

Rabinow and Rose have developed the concept of biopower into a set of operational tools for critical inquiry. They suggest that it contains the following characteristics: "a form of truth discourse about living beings and an array of authorities considered competent to speak that truth; strategies for intervention upon collective existence in the name of life and health; and modes of subjectification, in which individuals can be brought to work on themselves under certain forms of authority, in relation to truth discourses, by means of practices of the self, in the name of the individual or collective life or health.7"

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7 Ibid p. 203-204.
**Delimitations**
As citizen engagement through environmental sensing creates a demand for consumer products with environmental sensors, the marketing material in the form of websites and videos on the products will also be examined. The study will focus on smartphone apps using environmental sensing, especially sensor technology measuring air quality, since there is a connection between cities’ air quality and a health impact, such as asthma. From the perspective of biopower and responsibilisation, environmental sensing and asthma is interesting because prevention strategies can occur both at the level of individuals avoiding exposure to poor air quality and prevention strategies at government level, including regulation of vehicle pollution and urban planning. Crucially, this market has developed enough to have several different solutions to analyse. The products that were chosen were done so on the grounds of being high-profile enough to have been featured in wired.com:s online publication or mhealthnews.com. A google search was performed with keywords ““asthma” + app + sensor + site:wired.com’ as well as ““asthma”+ app + sensor + site:mhealthnews.com’ and the top 10 of each were reviewed. The products mentioned in these articles were chosen based on them using environmental or geospatial sensing that was given as feedback to the user. Based on this search, the following consumer-oriented asthma products were chosen: Propeller health and Apple ResearchKit’s Asthma Health app. Furthermore, the search results also included multi-purpose environmental sensors with apps, which do not specifically market to asthmatics but make explicit references to environmental sensing and health. The products have environmental sensors measuring various factors including air quality, accompanied by an app. They are called: Clarity, TZOA and AirBeam/AirCasting.

For the analysis of the Asthma apps the following material was used: the iTunes app description and, if available, the developer website devoted specifically to the app. Video material produced by Apple or featuring Apple employees was also included. The multi-purpose sensors did not have any apps available, and hence the analysis is based solely on their respective websites.
Smart Governmental Strategies

Studies of governmentality have highlighted how the mode of governing the citizen-subject has changed in the last century. This section gives a short introduction to governmentality and describes how the citizen is responsibilised through freedom and choice.

The term governmentality was introduced in the 1970s by Michel Foucault. Governmentality offered a way of understanding the emergence and characteristics of ways in which individual and collective conduct was problematized and acted on, motivated by certain objectives external to the state, meaning, in the interest of society. In a publication summarising his work, the term is to be understood broadly in the "sense of techniques and procedures that direct human behavior", which encompasses a wide variety of situations of governance: government of children, souls and consciousness, households, of a state or of oneself. The governmentality analysis is primarily concerned with how thoughts are operationalized in programs that have the aim of shaping and reshaping conduct as well as practices and institutions; the object of analysis is thus how thought is made practical and technical.

Societies which employ governmental strategies of governing autonomous individuals through their freedom, Rose has termed 'advanced liberal'. Freedom here is referred to as "autonomy, the capacity to realize one's desires in one's secular life, to fulful one's potential through one's own endeavors, to determine the course of one's own existence through acts of choice".

According to Rose, in 'advanced liberal' societies individuals are forced to make choices based on what they have learned from their past and what they expect from the future. Being a competent person means exercising your freedom continually. Competence has become synonymous with being able to acquire skills and make choices necessary for self-realization. Independent experts fill the role of disseminating norms of conduct to society. As individuals' personal desires align with the social norms of conduct, their relationships with expertise of various professions have become collaborative. The language, values and techniques of these

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8 Ibid p.199-200
10 Mitchell Dean, Governmentality: Power and rule in modern society, (Sage publications, 2010). p.18
11 Rose, Powers of freedom: Reframing political thought, p. 84.
professions has spread to individuals who act upon themselves in terms of them.\textsuperscript{12} In this society "it has become possible to govern without governing society - to govern through the 'responsibilized' and 'educated' anxieties and aspirations of individuals and their families"\textsuperscript{13}. Cruikshank argues that the welfare state is a mode of governance “that work upon the capacities of citizens to act on their own behalf”\textsuperscript{14}. Through her thesis she questions the unquestionable nobility associated with the political strategy of “empowerment”\textsuperscript{15}

**Healthy City(sense)**

The responsibilised citizen-project extends to the realm of health, emphasising the individual’s responsibility to act on risks, informed by experts. The healthy and responsible citizen has also been situated in the context of urban governmentalities, while smart cities and mHealth have previously been studied from a critical perspective separately.

Since the 1970s, healthcare has been moving more responsibility to individuals to protect themselves from risk.\textsuperscript{16} 'Experts' present risks for which individuals are supposed to estimate likely consequences and these should then help them make informed decisions.\textsuperscript{17} As several authors have shown, there has been a reconfiguration of the individual psychological theories and practices, within health discourse, where the subject has gone from a passive actor in the health care system to "one who possesses the capacity for self-control, responsibility, rationality and enterprise".\textsuperscript{18} Failing to act in accordance with what would be deemed rational in the face of a particular risk can thus be linked to a persons moral qualities.\textsuperscript{19} The more recent technological development of mobile health technologies have been argued to be entangled in the citizen self-optimisation and management project. Lupton argues that mHealth technologies advance techno-utopian, enhancement and healthist

\textsuperscript{12} Ibid p. 86-87.
\textsuperscript{13} Ibid, p. 87.
\textsuperscript{15} Ibid, p.39.
\textsuperscript{18} Ibid, p. 213.
\textsuperscript{19} Monica Greco, "Psychosomatic subjects and the ‘duty to be well’. Personal agency within,” *Economy and Society* 22.3 (1993), p. 357-372.
discourses, further noting that the consequences of mHealth technologies on everyday life merit more exploration.\textsuperscript{20}

The healthy citizen’s self-control has been situated in the governmentality of cities by Rose and Osborne (2001) as they “capture the different ways in which government has been territorialised in an urban form.” Drawing on a historical archive ranging from ancient Greece to neo-liberal modes of governance, they are concerned with “the city as a way of diagramming human existence, human conduct, human subjectivity, human life itself—diagramming it in the name of government.”\textsuperscript{21} The authors purport that, in recent decades, an image of the city “as a network of living practices of well-being”\textsuperscript{22} has emerged. An agenda of well-being has been invoked as “urban communities are to be empowered such that they collectively and individually are made responsible for their own healthiness.” The healthy city “is an active organic striving for its own maximisation against all that which would threaten it including the threats that it secretes as part of its very existence.” Gabrys considers how the smart city reimagines what it means to be a citizen. Gabrys argues that the imaginings of the smart and sustainable city recasts what it means to be a citizen.\textsuperscript{23}

\section*{I. Smart Practices of The Urban Citizen-Subject}

This section describes practices of tracking and monitoring that are encouraged by the designers of the sensing technologies and examines how they affect knowledge. Becoming a user of a wearable sensor and accompanying app tends to involve a reformulation of what it means to know yourself and your environment. Furthermore, this truth of the body and environment tends to be framed in terms of what is healthy and unhealthy. Finally, the relationship between the citizen-subject and knowledge production is also modified.

\textit{Sensing and Knowing Yourself}

In becoming a user of some of the apps and sensors, the citizen-subjects modifies their relationship to the body. Both the Icahn and the Propeller Head solutions have sensors that

\textsuperscript{20} Lupton, p. 396-400


\textsuperscript{22} Ibid, p. 752

measure and keep track of different parameters related to the users respiratory disease while simultaneously providing the users with feedback. Knowing yourself is expanded to entail reading the information provided by the app-connected to a sensor.

The Icahn app allows you to keep track of symptoms, inhaler use, contact with the healthcare system, as well as triggers. By tracking these parameters, the users’ medical condition becomes observable, filtered through the parameters of the app and the information it provides. The user of the app receives reminders and notifications and starts to use the phone as a source of knowledge and helps them to manage their health and know what their environment is like. Knowing your respiratory disease through the physical experience of having had symptoms is augmented with a practice of recording the experience. The codified nature of the information gathered in the app, lets the citizen-subject know their condition in a new way, which is continuous and consistent, in accordance with the constraints of the interface and input fields.

Similarly, Propeller Health also gives the citizen-subject the ability know themselves in a new way. The user has the ability to view their data, captured by the sensors, “including time, date and location” of where an inhaler was used. The device also keeps track of adherence to medication. The user is better able to follow ordination by making the adherence visible. Users can use the data and feedback that are made available with the sensor in order to understand and manage their condition. The objective health data is supposed to lead to an improved ability to manage the respiratory disease. The propeller head description calls upon “experts” to motivate the need to track symptoms, triggers and use of medication, and alleviates the user from having to keep a diary, which “often becomes an inaccurate and incomplete record” of health over time. The messy practice of diary keeping is replaced by automatic tracking which is both accurate and complete. For the citizen-subject, knowing yourself becomes expanded to include what the sensors notice and the subjective experience of quantitative aspects of the respiratory disease is eclipsed by the objectivity of the sensor. The codified consistency of a standardised input interface and sensors gathering data, in combination with visualisation techniques of measurements over time allow the citizen-subject to know their condition as a continuum.

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25 Ibid.
26 Propeller Health, How it works, 2015-05-17
Sensor data also has implications for how the respiratory condition can be discussed with the user’s physician. The Propeller Health user gathers objective data on symptoms and medication in order to help the physician understand the respiratory condition. A new way of for the citizen-subject to convey their condition to others presents itself. Answering the question of how one is doing is modified to not only include the citizen-subjects understanding of their condition but now also encompasses a review of the data that was collected over time.

The novelty suggested with the introduction of this technology is not so much a new way for physicians to understand a patient’s condition, since different types of sensing and survey technologies have long been employed. Rather, the practices of gathering data in order to understand the patients are now extended beyond the traditionally more temporally and spatially concentrated methods. Institutionalised collection of patient data is scaled out from the doctor’s office as the apps and sensors expand the milieu of knowing and temporal scope of collection. Compared to the app-supported collection of data, previous non-standardised self-tracking practices would have been a comparatively solitary activities, a practice on the self on its own, possibly in collaboration with a physician. Furthermore, diary keeping and other non-standardised tracking practices formulated by the citizen-subject can be moulded according to person and circumstance, whereas a standardised interface forces the citizen-subject to recount their experience in accordance with the demands of adhering to a standards. A unified product for sensing and recording a persons health condition also standardises the way of knowing oneself. Where measuring health had previously largely been the responsibility of a health professional, implicit in these descriptions is also the assumption that the citizen-subject should be responsible for doing the measurement correctly.

Apart from giving the user a new way of knowing themselves, the apps also aspire to give the citizen-subject new expertise in how to interpret themselves. The Icahn user is given the opportunity to watch videos and educate themselves about their conditions. The user is also able to watch “physician-approved videos for tips on effective asthma management”, thus improving their ability to take care of themselves. The Propeller Health app also provides “feedback and education on ways to improve” asthma control or COPD status. Not only is

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27 Propeller Health, Our solution, 2015-05-17
29 Propeller Health, Our solution, 2015-05-17
the way of knowing yourself streamlined in this technology but also the knowledge on how to manage yourself is unified. Plugged into a data stream and given the ability to interpret that stream, to interpret themselves, the citizen-subject has become its own health analyst. The truth discourses operationalised in the design of the products, immanent in the design choices of calibrations, parameters, visualisations, and units of measurement, allow the user to see themselves directly through this lens.

**Sensing And Knowing The Environment**

All of the studied products provide feedback about the air quality and the majority of the products also make the individual into a perpetual environmental tracker. In doing so, these sensors modify the citizen-subject’s ability to perceive and know the environment as well as their ability to determine whether or not the environment is good for them. The citizen-subject’s perception of the environment is mediated through sensors and visualisation techniques which also conditions this relationship.

The key-chain sized Clarity sensor, is meant to track the air as you go about your everyday living. As the sensor can be attached to a persons bag or bike, or left charging in the home, the act of collecting data can be integrated into every movement of the individual’s life. The citizen-subject thus becomes a perpetual passive data harvester. The user also receives information and alerts on pollution levels of when the “environment is healthy.”

The accompanying app provides a graph of exposure over time, including an air quality index indicating whether or not the current air is “healthy.” Instead of relying on the sense of smell, how it feels to breath in the air or what the sky may look like, the citizen-subject’s senses are augmented so that a Clarity user is able to know the air based on the measurement provided by the sensor.

TZOA can be used together with a smartphone in order to see the sensor’s readings, and professes to make it possible for people to “#SeeTheAir,” giving them a new way of acquiring knowledge about their environment. An image of the TZOA application shows a visualisation of the current air quality status, letting the user know whether it is clean and making it possible for the them to determine whether the current status in their location is

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30 Clarity, 2015-05-18
31 Ibid.
32 Ibid.
33 TZOA, About TZOA, 2015-05-18
healthy or not. Also in this case, is the citizen-subject is able to sense and know their environment mediated through the the sensors and apps. TZOA also provides the user with information about whether or not their “daily limit”\(^{34}\) has been reached, presumably of exposure to pollutants. This device reformulates the individual’s ability to interact with the environment, mediated through this sensor, as it enables sensing and knowing the environment, having the environment “at your fingertips.”\(^{35}\) The air is made tactile as it is perceived through the smartphone, suggesting a closer interaction as well as a greater degree of agency compared to its inherent fluidity.

AirBeam is another wearable technology which can be used to monitor pollution exposure. It maps, graphs and crowdsources the sensor data in realtime and consists of “wearable sensors that detect changes in your environment and physiology.”\(^{36}\) By visualising the users exposure to pollution over time, the user can read the air quality on a display.\(^{37}\) The citizen-subject can perceive the environment in a new way. With this sensor, the user’s understanding of the environment as situated through being and breathing is warped by allowing them to not only know the environment as it surrounds them, but to know it as an exposure over time. Continuous monitoring and accumulation of health data also allows the citizen-subject to understand their interaction with the environment as a cumulative process.

The Propeller Health sensor which attaches to the inhaler is used to determine when and where the inhaler was used. Revealing this information to the user is then supposed to provide “valuable clues about environmental exposures that cause attacks”.\(^{38}\) The promotional video shows a map with pins indicating where and attack has taken place. In addition, a region surrounding the pins is coloured in red, presumably indicating what area is considered to be risky.\(^{39}\) Air quality in space becomes knowable in a relative sense, disclosing how unhealthy one are is in comparison to others. The citizen-subject is also given the ability to avoid the environmental pollutants thanks to the map indicating possibly risky areas. This kind of

\(^{34}\) Ibid.
\(^{35}\) Ibid.
\(^{36}\) AirBeam, 2015-05-21.
\(^{37}\) Ibid.
\(^{38}\) Propeller Health, *What is Propeller?*, 2015-05-17
\(^{39}\) Ibid.
visualisation encourages risk minimisation practices, by colouring certain areas red, a colour which can be associated with danger or a restricted area.

While certainly all the sensors display relevant environmental data, the analysis of the environment is not exhaustive and the measured parameters vary between the products. Any given sensor combination is a selection of the possible environmental pollutants which could be measured. While the choice of pollutants is more likely to have to do with having a marketable product in terms of price and size than a particular agenda, the privileging of some parameters of air quality still potentially displaces unmeasured unhealthy pollutants from the attention of the user as they are told that the air they are breathing is healthy. The question is whether or not the citizen-subject becomes complacent as they are assured that the air is healthy.

**Sharing and Connecting**
The act of sharing and connecting also alters the users’ ways of knowing. The relation to the environment is changed as the user plugs into a distributed network of sensors, through which the user can sense multiple locations simultaneously. Sharing also relativises the citizen-subject’s sensor data, allowing them to know how they are compared to others.

The data stream from the TZOA sensor is used to create a large-scale map, extending the users reach into the entire network of sensors.\(^40\) The citizen-subject’s way of knowing their environment is expanded to a collective sensing, filtered through the sensors and apps. Knowing your environment thus becomes a fundamentally cooperative activity. It is also explicitly suggested that the map makes it possible to compare neighbourhoods.\(^41\) Information from the sensors makes the citizen-subject using the map into an evaluator of how a neighbourhood is doing relative to others. Similarly, clarity suggests a collective activity but also encourages competition. As the exposure that the Clarity sensor measures over time is presented according to an index, the users are able to track their exposure over time. The product communication encourages users to enter into a competition with other users “for the freshest score.”\(^42\) Minimising the exposure thus becomes a competition for the least exposure to ‘un-fresh’ air.\(^43\) In entering the competition, the citizen-subject is made aware of their

\(^40\) **TZOA, About TZOA**, 2015-05-18
\(^41\) Ibid.
\(^42\) Clarity, 2015-05-18
\(^43\) Ibid.
relative exposure at the individual level. This can be contrasted to TZOA, which operates at a community level. The relation to the self is also changed as it becomes knowable in comparison to others’ standardised representation of themselves. In the act of sharing your data, you also begin to know yourself in relation to others.

The connected citizen-subject is also explicitly privileged in some instances and sharing is made out to be an end in itself. The Propeller Head app encourages sharing your anonymous data, suggesting that it can help you “feel connected to other people in your community with respiratory disease.”

The Research Subject and Assistant
In this section, the modifications of the citizen-subjects relations to knowledge production advanced explicitly and implicitly in the material will be described. These are modifications of the citizen-subject’s relation to the production of truth discourses that underpin the very practices discussed in the previous section. On the one hand, the citizen-subject is made into a perpetual passive data point for experts to analyse. However, as the user is sometimes given a choice of whether or not, and to what extent to share the data with researchers, the subject also becomes an active part of in the processes producing the truth discourses on the health of the citizen-subject. The technologies thus allow the user to assume a different role in knowledge production.

In the video promoting the TZOA wearable, the use of wearable, it is argued, will have the most impact on the research community. They are the ones who will study the data that is collected with wearables. Hence, the citizen-subject in possession of a wearable is made primarily into a passive vessel for data collection for an external community, which enables this community to do research. By using the Icahn app, the user can easily participate in asthma research and become a research subject. The app developed in order to work with Icahn is a project that invites the user to “participate in medical research studies and help contribute to improving health care.” In using this app, the citizen-subject passively becomes part of the improvement through sharing their data. Furthermore, simply by virtue of carrying an iPhone, the citizen-subject becomes eligible to participate in a research study.

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44 http://propellerhealth.com/solutions/patients/
45 http://www.mytzoa.com/about-tzoa/
46 Apple, ResearchKit – how iPhone is transforming medical research, 2015-05-19.
47 http://apps.icahn.mssm.edu/asthma/
person who consents to participate in a study, and interacts with the asthma app on their iPhone, can become a research subject. The interactions with the asthma app, and the sensor data that is recorded, passively becomes integrated in a network of research practices. Through this technology, the research study becomes omnipresent in the citizen-subjects life, where every moment of their life, which the app can ‘perceive’, becomes amenable to research practice. The user is being studied by researchers who, “hope to discover new ways to personalize treatment.”48 Through this way of finding new ways of improving the treatment of asthma, the citizen-subject is participating is at all times participating as a subject in a research study. Furthermore, the interaction between truth discourses and practices on the self become closely intertwined through with the help of technology as the data gathered allows the researchers with access to the data to find new insights which can be directly fed back to the user via the feedback, recommendations and notifications described earlier.

The user is also made into a researcher with their device, when they posses the “iPhone to perform activities and generate data wherever”49 they are. This device is suggested to give the user the ability to participate in the research study in a more active way, when it suggests that now “we can all have a hand in it.”50 The ResearchKit solution is keen on ensuring that the privacy of the user is considered and gives options about what information to opt in for. When the site later proclaims that “the more people who contribute their data, the bigger the numbers, the truer the representation of a population, and the more powerful the results”51 it is explicated that the impact of the choice is consequential. Making a choice is not only a choice about whether or not to share ones data, it is also a choice about whether or not to contribute towards the generation of powerful results. Citizen-subjects make a choice about what to share, and in that choice they are in control of what in their life can be studied. In doing this, part of the interaction with the app also has an element of research design built into it. Furthermore, the accuracy of the research also depends on the citizen-subject skills in deploying the technology, which makes them into a more active .

II. Calling The Citizen-Subject To Take Action

48 http://apps.icahn.mssm.edu/asthma/ D2, B2
49 https://www.apple.com/researchkit/ D7, D9, B10, D11
50 https://www.apple.com/researchkit/ D7, D9, B10, D11
51 https://www.apple.com/researchkit/ D7, D9, B10, D11
This section describes the various ways in which the descriptions of the apps are encouraging the users to take action. Users are attributed more agency and choice as they start using the technology and in that are both explicitly and implicitly given more responsibility for their health and the quality of the air. It allows for the user to employ a variety of risk mitigating strategies. The transferability of the data also allows for a shared responsibility.

**The Risk Mitigator**
Simultaneously as giving users knowledge about themselves, these practices of sensing both implicitly and explicitly assume that the individual will take action and take on a greater responsibility. As a user of an app with sensor data feeding to it, the citizen-subject becomes a manager of their own health.

The product communication of Clarity emphasises the agency of the individual to protect themselves as they encourage the user to “make smarter decisions”. In the context, “smart” has strong connotations with the use and collection of data with sensors. The future users of Clarity are made to be masters of their destiny, since they are in a position to make decisions. Furthermore, “smart” decisions also suggest that they have the ability support their decision-making with sensor data. In addition to having a connotation with the sensor technology, the word “smart” also benefits from having a normative meaning, making the act of using sensors to support decision-making all the more cogent.

The user of the Icahn app will have a personalised tool that gives insights about the user’s asthma, helps with adherence and avoid triggers. Users can track their condition and receive feedback, becoming a perpetual health manager, looking for ways to minimise their asthma-related distress. The Icahn app encourages you to “take charge of your health”. With the help of the insights and reminders that it serves the user with, this app wants the user to become an agent in their health status, in order to “experience less asthma-related distress with better symptoms control, improved quality of life, and fewer unexpected medical visits.”

This Icahn app also allows the user to become a risk mitigator by providing information about air quality. Presumably giving users this information in such an accessible way is a way to enable them to take action based on this information. If local air quality is poor, by being

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52 [http://joinclarity.io/] B5,
53 [http://apps.icahn.mssm.edu/asthma/] D3, B3
aware of this, the user is given the option of acting upon this information and is thus becomes partly responsible by having been given the choice to act on the information or not act on it. The user of the health app is able to mitigate the risk by using the app to avoid “areas where air quality could worsen symptoms”. Information about where the user could potentially experience a deterioration of their health should be used to “self-manage their asthma”. Similarly, The TZOA is to be “worn by people to help them manage their asthma & allergies” thus making the life with the respiratory diseases something that is actionable for the individual.

In addition to encouraging the user to keep track of the respiratory disease, the Propeller Health user is also ascribed agency and responsibility to manage the risks that are made knowable as a consequence of the sensing. In describing asthma and COPD, the communication on the website of Propeller Health points out the importance of monitoring the conditions, as “people with uncontrolled respiratory disease are at greater risk of suffering an attack, or worse, ending up in the hospital”. Presenting the risks of an uncontrolled condition gives the user a clear imperative to keep track of their disease. The act of controlling your respiratory disease is made into a choice with consequences. A personal choice of how to live with ones respiratory disease thus becomes coupled with a certain risk behaviour. Will the user choose to control their condition and minimise risk, or not and by extension, choose to become more exposed to the risk? Either way, since the subject now has a choice in relation to the level of risk they are willing to expose themselves to, they also become partly responsible for the outcome.

**Co-Producing Health**

In one of the products, the data gathering practices also makes the includes more people around the patient in the management of the disease. The joint access to the knowledge about the citizen using these technologies allows the responsibility to become shared.

In addition to making the respiratory disease something the individual can control and understand with the help of information generated with propeller health, it also suggests it to be something that can be managed jointly by both the user, healthcare professionals and

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54 http://apps.icahn.mssm.edu/asthma/ B5, B7
55 http://www.mytzoa.com/about-tzoa/ Video B6
56 http://propellerhealth.com/solutions/ B9
relatives. Their “mobile solution helps patients, physicians and public health agencies systematically manage COPD and Asthma.” The responsibility is shared. The layout of the website describing the Propeller Head solution also suggest a joint stake in the citizen’s health. With one section each for patients, providers and payers, there is a sense of shared responsibility of managing the respiratory disease. The user gathers objective data on symptoms and medication in order to help the physician understand the respiratory condition with the help. Discussing the condition with the physician is made possible by data, which makes it possible to change the therapy. The data can also be reviewed together with the doctors during doctors visit. By making the respiratory disease knowable beyond the subject, transcending space, the effective management of the disease outside of the doctor’s office can also be displaced beyond the subject. Anyone who has access to the data stream is now able to see how the person with a respiratory condition is doing. While the ultimate decision to act in accordance with what the data suggests is left to the patient, simply being privy to the information gives a person a new responsibility as they can choose to either encourage or discourage a behaviour. Also, inaction in response to the data becomes a choice. The management of the disease has thus been distributed through the sensor and data distribution technology that Propeller Health makes available. The realtime monitoring and stream of information expands the risk minimisation responsibility away from the individual to all those who have access to the data. Where risk minimisation was an individuals solemn practice previously, the sensors and visualisation techniques make it into a space for collective action for all those plugged into the data stream.

While the technology does allow users to become more responsible and engaged in their own health, it also makes it possible for healthcare providers to monitor the health of the user. The data can be monitored by the physician in order to assess the therapy and whether there is a need to change the current regiment. Used in this way, the subject using the technology is rather passively intervened on as the . The intervention is meant to be preventative, meaning intervening “before they suffer an exacerbation or return for additional care”. The intervention thus happens at the level of risk. The monitoring by a physician and family can also become a way of disciplining the body of the user. As the unhealthy is made knowable in realtime, the

57 Propeller Head video B8
58 http://propellerhealth.com/solutions/ B25,
ability to nudge a person towards a healthy behaviour becomes more instant, and having “objective” data to back it up becomes. Objective becomes unarguable, the users perspective is eclipsed by the sensor, as a bearer of truth and disciplines the user to make the necessary changes to.\(^5\)

By sharing the data that is produced by the tracker with a family member and the physician the responsibility is shared for children or elders in order to ensure that there is adherence or if there is more use of the medication.\(^6\)

**Navigating Through Polluted Air**
A specific risk mitigating practice encouraged by all of the products enabled by the information on air quality is navigation through the landscape of air pollution. The air pollution maps function as a new way of diagramming the city. Through this map, the choices of the “smart” flaneur are not only constrained by the physical space but also by the informational space that is layered upon it. In being given choice to avoid certain areas, the user has to shoulder part of the responsibility for the consequences of those choices. In all of these instances the way of knowing the environment has been operationalised in a risk mitigating strategy of avoiding exposure to risk.

With the help of the application that comes with the sensor, the user is able to “search for places with good air quality”. The act of orienting oneself in space becomes augmented to include manoeuvring with an air quality map. The app is able to visualise pollution hotspots on a map. The users’ access to a fresh environment is modified to also include a spatial delineation based on air quality. The user of the clarity app an analyst of their environment, in search of a fresh place, that they can then choose to be safe. Being safe becomes a practice whereby a location has to be found and navigated to, and through areas that are not fresh. The accompanying images suggest that once the fresh areas have been identified with the app, the user can freely exercise, enjoy a coffee with their friends and let their kids play outside without having to worry about pollution.\(^6\) By encouraging the user to find locations with fresh air, the app also leaves it up to the user to ensure that exposure to air of poor quality is reduced. Similarly, when the website proclaims that the user will be able to better find an

\(^6\) [http://joinclarity.io/](http://joinclarity.io/) D8, B8, D9, B9
appropriate route, in search for a fresher and safer area, it is also leaving the risk mitigation up to the individual. The informational layer alters the urban dweller’s access to parts of the city. Follow the necessary risk mitigating strategies of avoiding areas with pollution, and the space in which you can move is constrained. Choose to ignore the recommendations and you are willingly subjecting yourself to risk.

Other apps tell a similar story. The user of the icahn app can use the app in order to change their behaviour according to the air quality in a particular area. Location data from the GPS is combined with air quality data to help the user “avoid areas where symptoms could be triggered”. Again, by being given choice with the help of information, the user is made responsible for the exposure to areas with poor air quality, which could trigger an attack. The Propeller Head map of areas with triggers encourages a practice on the self whereby individuals adapt their route, as “using this anonymous data can help plan your day”. The individual should look at the map of areas with common triggers and act upon it in order to plan their day. Implicit in this description is that the provided information is supposed to be used as a way to avoid areas where people have experienced symptoms. Similarly, the TZOA user is participating in creating a “crowdsourced map of environmental data in real-time”.

The data collected by your AirBeam and shared with the community of people using the AirCasting platform in order to get a complete map of the air quality in an area is also used as a way to manoeuvre through the urban city pollution. “Technology now exists that you can use, that is being used” the narrator says as the video shows a smartphone with a map overlayed with red, yellow and green indicators of pollution, suggesting that the user can use the AirBeam in order to manoeuvre not only through the spatial circumstances put also in accordance with the air quality. With this map the user is given a choice to take a particular path or not take it depending on their whims.

In some ways, TZOA goes even further, with its actionable recommendations. Having a visual representation of the areas with poor air quality will then allow the user to “make lifestyle decisions such as where to find the freshest air to go for a run, where to plan a

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62 https://www.apple.com/researchkit/ D8, B8
63 http://propellerhealth.com/solutions/patients/ D18, B18
64 http://www.mytzoa.com/about-tzoa/ D11, D12, D13, B13
picnic”. An image of the TZOA app shows that simultaneously as giving the user feedback on the air quality, it also displays a suggestion in the bottom of the screen that the user “get you for a bike ride in point grey while the air is still warm and clean”. Users can rely on the app to ensure that the air they breath is clean, while also being nudged into physical exercise. As a user of TZOA, you will also receive “actionable recommendations, such as opening your windows for ventilation, choosing less polluted routes, and making sure you are getting enough sunshine through the winter seasons and not too much during the summer seasons”. The recommendations given by the app makes it possible to change things in your environment, and in your behaviour. In describing the product as a way to support the users decision making, it also makes the user into someone who should take part in mitigating the health effects of the environment, in this case through changing what routes one takes or whether or not to open the windows. Travelling abroad is also an activity that is laden with risk mitigation, as the user is encouraged to check the map before venturing into an area with too much pollution. In choosing where to go, the user needs to first determine whether whether or not the cleanliness of the area makes it a good choice.

Co-Producing a Fresh Future
The user also becomes an agent in changing the environment with the help of their sensor. The user is encouraged to become an agent in the change of their environment. It calls to action to help the city in the improvement of air quality. The person gathering the data is part of a network of researchers and government who “pinpoint sources, track polluters, understand how pollution moves, to better improve air quality”. The citizen becomes part of a collective effort between different actors to change the urban environment by addressing the pollution itself. The accompanying image of a cartoon with a cape and the slogan “Be an air hero”, has an obvious connotation of a super hero fighting villainous pollution and polluters, being an active part of saving the individual’s environment. The website suggests that the effort to reach “a fresher future” is a joint effort, towards which we are “working together”.

The visualisation of pollution hot spots is also meant to let the user “help fix them and live a healthier life”. Apart from changing one’s life, this sensor should also be used to change

66 http://www.mytzoa.com/about-tzoa/ D15
67 http://www.mytzoa.com/about-tzoa/ D11, D12, D13, B13
68 http://joinclarity.io/ D10, B10,
69 http://joinclarity.io/ B11, B12
the pollution hotspots themselves in the users surroundings. Accessing the data with the sensors is meant to inspire users to advocate for change. TZOA also makes proclamations that envision the user as an activist, when they hope to “create a social movement for environmental change”. As the user of TZOA becomes aware of the air quality, they should be inspired to advocacy, which in turn should help “perpetuate innovation and green technology”. “together we can democratize data”70

The data that will be aggregated from the TZOA sensor is said to “help us move to greener solutions and better policies that will keep us all healthier”. This solution is at least partly meant to lead to collective action to change the future. 71

**Data-driven Change**

Several of the proclamations on the importance of measurement also construct the smart citizen-project as responsibilisation. In the emphasis on knowing and sensing in order to do something, political agency and citizenship becomes contingent on and, in some cases, reduced to measurement. Contextualising the environmental and health sensing in relation to healthcare cost also situates the practices in a cost-minimisation agenda. In one instance, the technology is made out to be a corrective to the short-comings of existing publicly sanctioned sensing practices.

The slogan “know what you breathe” calls for the citizen to be aware of the air in their surroundings. The imperative form is a call for action, where a person can no longer passively accept their ignorance about the air quality but must know it through the sensor provided by Clarity. In arguing that “the first step to solving a problem is measuring it”, it becomes clear that the user is meant to take part in solving a problem, which is presumed to become apparent as it is measured.72 Similarly, TZOA asks how we would live differently if we knew how our environment was affecting us, assuming that by knowing about how our environment affects us, we would finally be able to and want to change it.73 AirBeams KickStarter video goes even further when it asks the viewer to imagine “how the world can change when we can each accurately measure the amount of air pollutions we are breathing in at any given

71 [Video Tzoa B3](http://joinclarity.io/) B3, B2
moment” and is later encouraged to take part in the open-source project to build new solutions.

The Kickstarter video promoting AirBeam starts by setting the scene by establishing the severity of air pollutions impact on health as “one of the most serious and widespread health hazards in the world.” The trouble is that we cannot see it and “everyday we breathe in dirty air that goes deep into our lungs” and causes respiratory diseases. The words “share and improve your air” appear in the video as the narrator recounts the dangers of poor air quality, calling the viewer to take action against the problem. The act of sharing is turned into a way of solving the problem. The practices of sensing and knowing also become acts of cost-reduction when they are contextualised in the financial costs society has to bear due to respiratory disease. A part of the argument of using AirBeam, is the dramatic cost of poor air quality. They estimate that it “costs the United States alone over $78 billion dollars annually”. Furthermore, air pollution is considered to be “among the most serious and widespread human health hazards in the world”, which causes respiratory diseases, including terminal illnesses such as cancer. While the costs are high, the available data is sparse, rendering the real impact of air pollution invisible, which “is where YOU, AirCasting, and the AirBeam come in.” The AirBeam professes to help individuals and communities to make change at both individual, community and government level. When the developers of AirBeam proclaim that they are taking matters into their own hands, they are also taking responsibility for the change they want to see. The self-management with Propeller Head is also seen as a way of reducing costs. The subject becomes active in minimising the cost of healthcare as “improved self management reduces the cost of treating asthma and COPD by eliminated unnecessary hospitalisation, ED visits and office visits”.

The AirBeam user is called an AirCaster, and collects data for the open-source platform AirCasting. The AirCaster collects and broadcasts air quality data as part of a “DIY air monitoring movement that uses information about local environments to inform, educate, 

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74 https://www.kickstarter.com/projects/741031201/airbeam-share-and-improve-your-air/description B19
75 https://www.kickstarter.com/projects/741031201/airbeam-share-and-improve-your-air/description B19
76 https://www.kickstarter.com/projects/741031201/airbeam-share-and-improve-your-air/description B19
77 https://www.kickstarter.com/projects/741031201/airbeam-share-and-improve-your-air/description B4, B3, B6, B19, D19
78 Propeller Head B4
share, and ultimately improve health in communities around the world.” The AirBeam is a way of addressing the problem of the sparse and expensive government owned monitoring stations. The citizen is here called to action to address the issue of lack of data, which is currently not adequately observed by existing institutionalised monitoring, which is unable to monitor personal exposure. The air quality problem is here taken down to the level of the individual, where importance of air quality is pegged against the individuals exposure. The individuals exposure is put in contrast to the general air quality. “If noone knows what they’re breathing in, how can we expect that things will ever change?” the narrator asks, putting the individual at the centre of change making. Individual insights about exposure are seen as a way to make change.

Discussion

In the spirit of Cruikshank’s analysis of empowerment, the intention has been to critically examine how the citizen-subject is operationalised in discourses related to smart cities, but not to undermine it as a citizen project. The purpose is rather to to highlight how it modifies relations of power and knowledge. Similarly to Gabrys findings on how smart cities reimagines urban citizenship, this review suggest that the relations of urban citizenship to knowledge are reformulated and redistribute responsibility. Based on the definition of empowerment, the reviewed material is advancing a form of empowerment through knowledge of the environment and the subject.

The reviewed material both implicitly and explicitly advances a notion of the health of the human body as a maximisation project. As strategies for intervening on the subject in the name of health, they are more granular in the sense that the they extend their reach into every moment of the citizen-subject life which is measurable by the wearable sensors.

Empowered and Responsibilised

While the responsibilisation advanced in the material is firmly grounded in the ‘advanced’ liberal form of governmentality stemming back to the 20th century practices on the self, these

79 https://www.kickstarter.com/projects/741031201/airbeam-share-and-improve-your-air/description
80 Cruikshank.
81 Gabrys.
new technologies enable a new scope of the responsibilisation. In all cases, data and the derived knowledge is represented as a form of empowerment. A user of these sensors and apps can become a manager of their own health, and a catalyst for changing the environment. However, as the information from the data streams is transferable it also redistributes responsibility in the network of individuals who have access to it. Hence, responsibilisation in the descriptions of these technologies does not work exclusively to redistribute responsibility to the citizen-subject. Overall the responsibilisation of the individual is most pronounced when it comes to self-management of health, while responsibility for environmental change tends to operate at the level of political advocacy.

The empowerment technologies map the responses of the body and air quality in the users environment. The sensors and apps help constitute the empowered citizen-subject that can know and interpret themselves and the environment in order to take appropriate actions. Appropriate actions are determined by what is healthy and as such are an expression of governing life and death at a distance, with the citizen-subject being governed through choice. Equipped with this knowledge, the subject is able to intervene on itself through choices and in that becomes responsibilised. Self-management processes of risk mitigation, in which the subject regulates itself in accordance with the readings on the sensors, can be contrasted to the historical conception of biopower operating at population level. The citizen-subject is also empowered to use the sensor readings to demand changes to be done on the environment, turning to political advocacy in the name of health.

The material discussed here highlights how biopower in the ‘advanced’ liberal society relies on the subjects making responsibilised choices based on their knowledge of the past and belief about the future. Individuals with a respiratory conditions are to make choices that let them avoid exposure to air pollution in order to remain healthy. The risks of an asthma attack can be avoided by navigating around the most polluted areas with the help of the air quality map that the sensors have generated. Furthermore, individuals can reduce healthcare costs by making sure that they do not expose themselves to risks. These practices can be viewed as health maximisation project in the ‘advanced’ liberal society, where citizen-subjects are responsibilised and governed through their choices.

The sensor based technologies that feed back information from the patient to a physician or relative also, however, distribute the responsibility beyond the individual by
making the body knowable to anyone who has access to the data. The responsibility of governing the body is folded back on the healthcare system as physicians come to use the sensor readings to examine their patient’s conditions in realtime. Hence, responsibilisation can be said to operate both at the level of the subject as well as in a distributed form, on everyone who is plugged into the data stream.

The emphasis on the importance of gathering data in order to improve health and the environment also, to some extent, produces the responsibilised citizen-subject. Because measurement is made to be so central to change, and the citizen-subject is at the heart of measurement, the choice of whether or not to engage in the practices of the smart citizen-project also carry a weight of responsibility.

Since there is a correct and incorrect way of using sensors and inputting information, the smart practices also create new responsibilities in terms of accurately using the technology. Such responsibilities would have previously been located among the healthcare profession. Furthermore, subjects disposition to privacy and sharing make research studies dependent on choices made by potential research subjects. In these instances, the individual has been given agency to affect their own as well as other people’s destiny.

**Smart Relations**
The smart citizen project imagined in these products modifies the relationship to knowledge. The way of knowing the self and the environment is augmented to include a codified interface with set parameters that can be studied over time.

The citizen-subjects relationship to knowledge of their own body is modified by sensors and structured information inputting. A mere recording of these information points externalises and moulds the account of the experiences according to the constraints of the recording format. Relativising the experience of health is located in data points rather than subjective experience. The consistency makes it possible to make observations about the body in a continuum in time, as it becomes possible to visualise a progression in time.

One particularly salient feature of the mobile health and sensor technology is its omnipresence. While learning about a patient through a set of tests that are represented in a standardised way is not new in itself, the scope at which it is able to exists is different. In becoming pervasive and ever present, these technologies of self-management allow the
subject to view themselves through a standard medicalised lens at any time and anywhere, instead of only when in contact with the healthcare system. This kind of shift has the potential to have persistent consequences for the citizen-subjects relationship to knowledge of themselves.

The embedded feedback and educational material function as the users own expert deploying truth discourses on healthy living in support of the subject’s practices on the self. Knowledge of one’s own body is mediated through the sensor readings and the feedback and education condition the interpretation. To some extent, the sensor and giving feedback to the individual on how to act healthy displace the role of expertise, which was previously directed primarily at population level, whereas here it is proclaimed to be able to give personalised recommendations. The citizen-subjects improved ability of make choices in accordance with what is healthy can be seen as another step in the institutionalisation of the advanced liberal mode of governance.

Similarly, the citizen-subjects relationship to the environment is modified. The sensor collects information about the air quality and feeds it back to the citizen-subject who is given a technology-mediated and contingent way of knowing their environment. At the same time the citizen-subject becomes a data harvester in a network of sensors, as the data can be fed back into crowd-sourced mapping of the environmental factors.

Interestingly, the chosen parameters vary between the products while the dichotomisation of air as healthy and unhealthy exists in all of them. By privileging some parameters, the unmeasured ones are made invisible. Design choices become a kind of codified and operationalised truth discourse. This is particularly consequential if the citizen-subject comes to evaluate their environment solely through the lens of sensor readings.

The ability to know exposure to environmental factors is also modified as the experience is made into a continuous progression over time. It also enable a cumulative experience as the exposure over a period can be compounded.

The elusiveness and fluidity of the air is also tamed, as it is made tactile by being mediated through a touch screen, giving the citizen-subject more agency in relation to it. Overlaying the environmental sensor data on a map also modifies the citizen-subjects knowledge of the air. The air is segmented into more or less healthy areas and is trapped into
particular regions. Exposure to unhealthy air can be understood as being present in an area with unhealthy air. This kind of visualisation situates the quality of the air in a particular location. The creation of the air quality zones in. Furthermore, the smart citizen-subject’s existence in the city can be seen as diagrammed in a new way, when the informational space is overplayed on the physical, forming a new relation between the subject and space that is accessible without risk.

By sharing and crowd-sourcing data, the citizen-subject’s way of knowing the environment is further modified. As the citizen-subject plugs into a network of distributed environmental sensors, their ability to interpret their current environment with their sensor’s reading is equivalent to interpreting that of the reading of another users. The citizen-subject is able to simultaneously read the environment in multiple locations. This is a cooperative way of knowing also distributes the discursive truth about the environment in the sense that anyone with the necessary technology can produce a truth on an environmental factor made measurable.

Sharing also determines whether or not comparisons are possible. A standardised way of representing the citizen-subjects data makes it possible to know yourself relative to others, which also alters the way of knowing oneself and the environment, as a comparative practice, a constant benchmarking. Belonging to a community is also modified into a data sharing practice, in a sense reducing relations to others into exchanges of data points.

The relations in knowledge production are also modified with the use of wearable sensors and apps. The citizen-subject who uses this technology is potentially always a research subject when they carry around their sensor. The realm of what is researchable expands as the citizen-subject can be researched anywhere they go with this equipment. As the production of truth has a wider reach into different aspects of living, the dynamics of truth discourses and the citizen-subject’s practices on the self could potentially also be modified as a consequence. The clinical gaze can extend its reach outside of the confines of the classical research settings, out into what was a private sphere.

At the same time, the subjects relationship to knowledge production is changed when they come to possess their data and the choice lies with them whether or not to share it.
Research results are made contingent on access to data. Since the user possess the data and is in a position to decide on whether to share it, the citizen-subject also comes to participate in the design of the research study. Furthermore, the quality of research also depends on the citizen-subjects data-gathering habits, giving them further agency in the knowledge production. The citizen-subjects role in knowledge production has thus become more active.
References:

Print
Cruikshank, Barbara, The will to empower: Democratic citizens and other subjects, (Cornell University Press, 1999).
Dean, Mitchell, Governmentality: Power and rule in modern society, (Sage publications, 2010).
Greco, Monica, 'Psychosomatic subjects and the 'duty to be well’. Personal agency within,” Economy and Society 22.3 (1993), p 357-372.

Electronic Material
Apple, ResearchKit – how iPhone is transforming medical research, <https://www.youtube.com/watch?v=VyY2qPb6c0c> (Acc. 2015-05-19)
Icahn, <http://apps.icahn.mssm.edu/asthma/> (Acc. 2015-05-20)