Interfacing bodies:
representing the human body in designing digital health tracking apps

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Abstract

Following the shift from hardware and screens into software and data, the interface between user and technology is transforming. In order to conceptualise this transformation and explore the opportunities and challenges that arise it is needed to study the process in which these interfaces come into being. This thesis will thus approach the coming into being of interfaces as an interfacing process, in order to identify implicit aspects of designing digital health tracking technologies. The lens of interfacing shows that the body is thought of as a problem area that needs solution by design. This is problematic and therefore a transformative way of interfacing bodies needs to be developed.

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"The "eyes" made available in modern technological sciences shatter any idea of passive vision; these prosthetic devices show us that all eyes, including our own organic ones, are active perceptual systems, building on translations and specific ways of seeing, that is, ways of life.

There is no unmediated photograph or passive camera obscura in scientific accounts of bodies and machines; there are only highly specific visual possibilities, each with a wonderfully detailed, active, partial way of organizing worlds."

Citation by Donna Haraway, 1988
Photograph by Mel Bles, part of the "Islands" series, 2017

Introduction

Interfaces, as active gateways between user and technology, are affected by the technological transformation from screens and hardware into sensors and data. This calls for a transformative approach towards designing applications too. Due to the current approach of design and ability of sensors and data, representations of bodies are understood in a specific manner. This thesis will make explicit the underlying assumptions of bodies in designing digital health tracking apps, as well as analyse such dynamics. This is done with the help of a case study of a running app that is currently in development: Runner Assist.[1]

      To conduct this analysis, the following thesis is split up in three parts. The first part will introduce tensions between users and digital health tracking apps that lead to a critical review of period-tracking apps. This review will show the importance of the wider landscape in which these self-tracking apps come into being, as the development of apps does not happen in a vacuum. The interfacing lens is introduced, with which specific implications of representing bodies can be identified. The case of Runner Assist will be then used as a vehicle to show the importance of conceptualising interfacing as a process in which representations of bodies come into being. The second chapter of the thesis will outline three implications that have been identified via the lens of interfacing. It will show how implications that slip in in practice set specific dynamics between different actors such as users, technologies, and developers. As the lens of interfacing is challenged with the case of Runner Assist (and digital health tracking app in general) it is needed to deepen the analysis with theory. The third part will explore a transformative approach to representing bodies when designing digital health tracking apps. It will re-situate existing notions, and show that users and designers are simultaneously in a process of interaction (all part of an interfacing process). By doing so, this part will argue for a representation of bodies that can be opened up by design and allows interrogation by users.

1. This thesis situates itself among different fields and draws inspiration from fields such as feminism, science and technology studies, design theory, art criticism, phenomenology, and aesthetics. Previous research on interfaces as multifaceted and non-linear entities has been done in the movement of Interface Aesthetics - in which the interface is identified as historically and spatially informed (Hadler, 2018; Bertelsen and Pold, 2004). The established body of work on human-computer interaction focusses mostly on technological and cognitive aspects of the interaction between human and computer (Bardzell, 2011), this allows for a privileging of some over others. Several scholars have studied the relation between representation and reality, and how this can be conceptualised suggesting a perceptual and evolving relation (Berger, 2008; Benjamin, 2008), this thesis draws inspiration from those writers. The thesis also draws motivation from feminist technoscience studies, arguing for locating knowledge in a subjective and situated body.

Period-tracking apps are not for women

In November of 2018, a critical article written by Kaitlyn Tiffany was published on vox.com headlining: "Period-tracking apps are not for women" (2018). The article shows how 'the golden age of menstrual surveillance' is a gold mine for men, internet marketers, and medical companies, but definitely not for the women using the apps. An article written in The Guardian in April 2019, starts with "Your vagina has been digitized. So have your ovaries. So has your period." (Mahdawi, 2019). Both articles are a critical response to the rise of "femtech" (Mahdawi, 2019: Tiffany, 2018: Das, 2018) which is a term that refers to women's digital health technologies; most common in the form of digital contraceptives and period trackers (example of user interfaces in image 1). Tiffany mentions how in the past three years an amount of 1 billion dollars have been invested in women's health technology. These technologies could become a $50 billion market by 2025, but globally, only 10 percent of investor money goes to women-led startups (Tiffany, 2018). This shows an important issue within the industry: the gross of development is not done by women. There are hundreds of free, ad-supported apps to track the menstruation cycle as well as fertility (and at the same time ask their users to track their diet, workout, sex lives, moods, state of skin and smell of vaginal discharge). Reproduction is a focal point of for the industry, but developers[2] of women's health technologies are confident that their technologies can help fight the absence of women in scientific research and social taboos surrounding women's health such as menstruation, postnatal depression and breastfeeding (Mahdawi, 2019). Next to the hundreds of free apps, there are some paid options, such as Glow and Eve (image 2) founded by Max Levchin (co-founded PayPal) and four other men, Natural Cycles (who claim to be a contraceptive and not merely a tracking app) and Clue (which is one of the few apps who argue to be based on medical literature) (Tiffany, 2018).

A core issue with these menstruation tracking apps is that the act of measuring is not neutral, and female bodies are used as 'temples of lucrative information' (Mahdawi, 2018). "Every technology of measurement and classification legitimates certain forms of knowledge and experience while rendering others invisible" (Karen Levy in vox.com, 2018).

2. A key term that is used in this thesis is *developers*. This term refers to the creators that set the norm and have a pivotal role in the process of designing digital health tracking apps as developers of an application. This term is chosen because it allows for a critical review of designing a digital health tracking app in a technological and cognitive context, without focussing on only the design aspect of producing an app - as there is more to the process of designing than design. This term should be understood as several actors with an infrastructural nature in a specific context informed by time and space.

Image 1: User interfaces in the App Store when searching for 'period tracker' (retrieved on June 21, 2019).

The app simplifies highly experience-laden and subjective elements into commensurable data-points. This indicates that the design of such apps don't acknowledge the full range of a woman's needs, but rather reduces the needs to a few points that can be translated into data in order for the app to work. Women are being reduced to a body that is menstruating. Thus, strong assumptions on women's menstruation cycle, sexuality and bodies are built into the design, which can marginalise a lot of the experience of sexual health i.e. not being able to log a shorter or longer cycle than 'average', not being able to log a pregnancy or abortion and therefore being provided with feedback affirming your body as 'dis-functional'. Tiffany mentions in the article how period-tracking apps, due not being perceived as mass-market products have been given the mantra "shrink it and pink it" which is a familiar guiding ethos of sportswear and basic household tools design for women. She mentions how these apps are "a product of the culture of Silicon Valley user interface design: mostly male, and predicated on quantitative metrics like interaction counts and time spent" (Tiffany, 2018, n.p).

This shows that the usability of a product is measured via elements such as interaction count and time spent. There are multiple stories of women in which the digital health tracking apps representation of female bodies did not correspond with the women's perception of their bodies. For example, Apple Health did not include a period tracker for a full year (Duhaime-Ross, 2014), although it aims at "making it easy to learn about your health and start reaching your goals" (Apple, n.d, n.p). Or, weight tracking apps that don't allow for gaining weight and only congratulate the user losing weight (Bogle, 2019). Tensions arise, as users' bodies start to resist these designs and do not fit the representation. This leads to a situation in which existing notions are starting to mess up. Being 'healthy' is suddenly identified by the representation created by the app developers. Take for example Natural Cycles, a contraceptive app, one user critiqued: "But I was also angry that I'd been treated like a consumer, not a patient." (Sudjic, 2018) These apps are failing users who are pregnant, ill, disabled or injured or fall out of the envisioned category of users - as they don't fit the envisioned customers of a product. It is also important to note here that users are referred to as customers, rather than patients. This
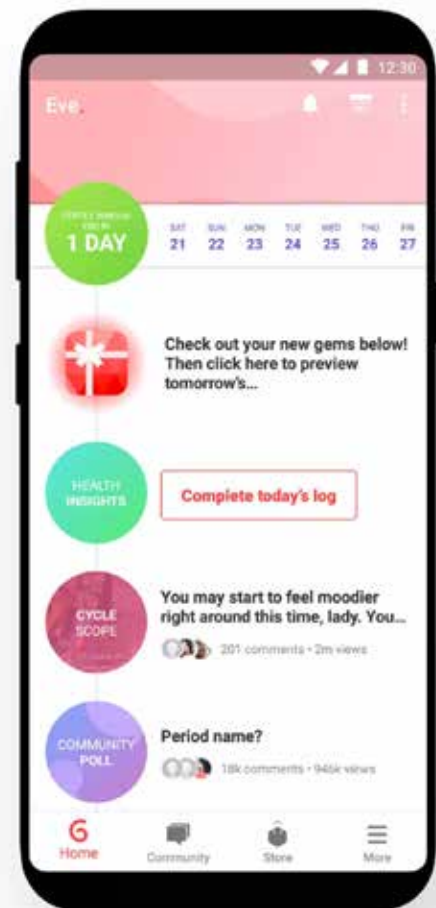

Image 2: Eve notifications user interface

Glow launched with the aim of helping their users get pregnant, this project got a founding round of 17 million dollars - but as half of the users were not trying to get pregnant but tried to avoid pregnanct the concept was further developed. Thus, the new app Eve was launched, an app for documenting "your period and sex life." Eve opens with a splash screen that says "Go get it, girl." The first version was criticized for referring to their users as 'girls' and describing sex with emoji's.

alludes to how app developers are identifying their users and the goals they have in mind.

Interestingly enough, Gary Wolf, identified as the initiator of the quantified self movement wrote: "Electronic trackers have no feelings. They are emotionally neutral, but this very fact makes them powerful mirrors of our own values and judgments" (Wolf, 2010, n.p). This citation indicates that the understanding of users quantifying themselves see the technologies with which they do so, as mirrors showing their bodies to themselves. The understanding between users' bodies and the representation of those bodies is thus conceptualised as a mirroring one, which becomes problematic for users that don't recognise the body in the mirror. The problem with this general perception of the relation between user and technology showed women not recognising their bodily representations in the apps they used. Thus, these mirrors should be transformed into emerging extensions, which indicates that the nature of an app is not that it is a deliverable product, but rather its processual nature that allows users to interact accordingly.

Thus, a transformation should take place: a product should be designed for it allowing to fit its individual users' needs and allowing development over time and across space, rather than a user being designed to fit the products needs. These examples call for an understanding of current dynamics and show how re-conceptualisation of interfacing is necessary, as feedback from these apps becomes all the more personalised with the help of sensors and data. This isn't about whether or not an app takes pregnancy into account, this is about bodies being reduced to a static representation and the app by design allowing no interrogation by the user whatsoever of that representation.

The thesis will not discuss data surveillance or privacy issues, as these have been addressed many times. The concern of this thesis is the relation between a users' perception and the process of representing a particular view by developers creating an app.

From screens and hardware to sensors and data
Human bodies have become inextricably intertwined with digital technologies such as posture improving clothing,

data tracking wearables, medication. People carry around digital technologies (such as mobile phones, smartwatches or sensors), locate and relocate using online navigation (i.e electric vehicles), or are being 'sensed' in public places (think of CCTV, smart city initiatives).[3] There seems to be a shift from targeted, purposeful and discrete forms of information towards always-on, ubiquitous and ever-expanding practices of data collection (Andrejevic and Burdon, 2014). The increased use of sensors and data is leading to important changes in concepts of representation, body, and information allowing for a transformation in understanding between the user and the representation of their bodies. Computation is ubiquitous and is, therefore, playing an important (shaping) role in humans' personal lives. For human-computer interaction to advance it is crucial to understand the challenges and opportunities posed by a constantly transforming (technological) world.

In the case of digital health technologies, this means a transformation from not only using hardware (such as limb prosthetics, heart pace-makers, and insulin pumps) to also using mobile digital technologies often in the form of tiny sensors that are intimately associated with the body (Lupton, 2013). These sensors are enhanced to monitor body behaviour automatically. Following this, many functions of the body can be monitored, recorded and rendered into data, and from that into representations in order to make the data understandable for the user. To encompass and understand what the design process entails in such a technologically transformative world, this thesis is conceptualising interfacing as the process in which digital representations of human bodies are coming into being. Seen from this perspective interfaces are often studied as (invisible) representational and active gateways between body and technology, designer and user.

Currently, (following the situated perspective on designing an app), designers rely on data and usability to design the best-fitted solution for their design problem. But, with the transformative character of interfaces, there is a need for a re-conception of these defined categories. Interfaces are transforming from screens and hardware into sensors and data, and thus the interfacing process is changing as well. In order to provide a better understanding of the process of interfacing, this thesis will attempt to open up current categories to call

3. This transformation entails a dissolving of boundaries and alters the understanding between digital, physical and biological worlds. Luciano Floridi has referred to this as the 'on-life' experience, part of the Fourth Revolution (Floridi, 2007). Others are referring to this transformation as the Fourth Industrial Revolution (Schwab, n.d). Also known as the Internet of Things.

for a transformative and flexible understanding of designing interaction between users, technology, and developers via interfaces. Due to the rise of sensors and data a different way of interfacing the human body is needed, as current representations don't allow for interrogation by the user. A specific view of bodies is privileged and portrayed as an objective view. Sensors and data allow for transformative interaction between human and technology. Boundaries between bodies and technology are dissolving as sensors allow for real-time feedback about that same body and thus the understanding of the interaction between both is altered as well.

Following the shift from hardware and screens into software and data, the interface between user and technology is transforming. In order to conceptualise this transformation and explore the opportunities and challenges that arise it is needed to study the process in which these interfaces come into being. This thesis will thus approach the coming into being of interfaces as an interfacing process, in order to identify implicit aspects of designing digital health tracking technologies. The lens of interfacing shows that the body is thought of as a problem area that needs solution by design. This is problematic and therefore a transformative way of interfacing bodies needs to be developed. The core argument of this thesis is that implicit aspects of digital representations of the human body are not taken into account when representations of bodies are solely based and focussed on cognitive and technological aspects of a body.

Chapter 1
Interfacing bodies

Representing the human body in designing digital health tracking apps is part of a larger network of processes in which there is a diffuse of power. Resulting from this are representations in which some perspectives are privileged over others. Visual design has the power to convey large amounts of unstructured information (such as data gathered via self-tracking) into structured, understandable and clear informational visualisations. But visualised data provides a specific conception of reality. In reducing all bodily phenomena

into numbers, tensions arise. Users of self-tracking apps are confronted with visual information about themselves in which bodily phenomena are translated into understandable data, and thus users are experiencing their bodies via self-tracking applications. This visual information is announced with a specific goal in mind (i.e preventing injuries, losing weight or monitoring menstrual cycles). But this does not happen in a vacuum.

There is a shift from users generating and filling out their data (as is the case with the previously introduced menstruation apps) into data constantly and continually being generated by the availability of sensors. As already shown, designs of apps have a certain perspective of the representation of bodies, allowing for an interface that mediates understanding between users bodies and the representation of those same bodies. The transformation into sensors and data calls for an altered way of conceptualising the interface between technology and user, in which the interaction with one another takes place. Therefore, the following section will firstly discuss the wider landscape in which this transformation is taking place as these interfaces do not arise in a vacuum. Following it will address the conceptualisation of interfaces as an active representational gateway between bodies and technologies, and lastly, it will provide a case study which will show how designing of interfaces is currently approached in practice when designing digital health tracking apps.

Self-tracking

Digital health tracking technologies such as period tracking apps, contraceptive apps, weight-tracking apps or running apps are supporting the practice of quantifying bodily phenomena. This is referred to as self-tracking: users keeping track of their (daily) practices. Self-tracking and quantifying bodies is not a novel practice, it does not require anything more than pen and paper: people have kept diaries, weighted their bodies, kept record of financial savings and made use of other 'analogue tools' in order to keep track of themselves. But, with the rise of wearable technology and big data practices, it is possible to keep track with higher pace and a much larger volume (Neff and Nafus, 2016). Available technology extends the possibility of self-tracking, transforming the way users interact with their

bodies. Digital health tracking apps make it available to store and analyse enormous amounts of data, allowing self-tracking to become widespread and more visible.

These self-tracking apps are often analysed in relation to the 'quantified self movement.' A movement of users that use self-tracking technologies that enable to monitor diverse aspects of their health (and other aspects of one's life), such as menstrual cycle, sleep habits, workouts or food consumption in order to improve certain aspects of the body. Neff and Nafus (2016) identify five common styles of self-tracking: (1) monitoring and evaluating, (2) eliciting sensations, (3) aesthetic curiosity, (4) debugging a problem, and (5) cultivating a habit. Self-tracking allows for many functions of the human body to be monitored, kept track of, recorded and stored with help of digital technologies (i.e apps on mobile phones or smartwatches). This can be done at an enormous volume, resulting in excessive amounts of digital data being produced and consumed about and from bodies. Users use (to an extensive amount) self-tracking technologies to learn about their bodies, and understand their bodies better.

An illustration of a user generating data at an enormous volume is data-researcher Rob ter Horst (image 3), who gave an interview to Wouter van Noort (2019) of the daily newspaper NRC Handelsblad. Ter Horst approximately measures 400 different aspects of his body, per day. He is probably the most quantified person living in the Netherlands. He measures (some automatically, some manually) a.o his blood, keeps track of information from activity trackers, he has electrodes on his head during his sleep once a week to track sleep patterns, fills out 4 question forms on a daily basis on his emotional wellbeing and sends in a sample of his feces to the lab every week. According to ter Horst the results don't show anything out of the ordinary so far (he has been measuring for 1,5 years now). He wants to start experimenting with his body and for example will try to stand up at 5 in the morning, or eat an enormous amount of chocolate to see how the data responds to these changes within his physical body. Ter Horst says: "Hiermee leer ik hopelijk echt iets over mijzelf" [Hopefully I will really learn something about myself] (van Noort, 2019, para 13).

As the example of ter Horst shows the body seems,

Image 3: researcher Rob ter Horst in NRC Handelsblad

in his case, to be disconnected from the mind which alludes at some Cartesian remains. There seems to be an embodied self that is disconnected from its rational self, and if users can reconnect these spheres via the digital health tracking apps they will learn more about themselves, for technology helps them to become an informed self that is connected. Bodies are thought of as being repositories that store endless knowledge about the self, which can only be accumulated via technology. These technologies thus shape the perception of the body, resulting into an intensified informational regime in which the body that knows itself becomes an informed body with a responsibility to act within this intensified self-knowledge, self-improvement and bodily control (Viseu, 2013), mediated by the digital health self-tracking app.

Data practices in a metric culture

Via self-tracking, everyday experiences are turned into data. These data connect users to wider social systems (Neff and Nafus, 2016). This phenomenon of turning experience into data is not only a dynamic that arises because of self-tracking practices but also results from the wider cultural context of the interest in numbers in general. In this wider the context there is an urgency to quantify reality in order to make sense of it. Bthijai Ajana (2018) refers to this culture as 'metric culture.' This term demonstrates the immense cultural interest in numbers as well as those numbers shaping and affecting culture. Results in numbers having been throughout history (on and off) a tool of governing and disciplining individuals and societies (Rose, 1999: Blauw, 2018). Currently, a substantial amount of governing individuals and societies is done by the spreading use of metric techniques, such as technologies for self-tracking. But, numbers need to be made commensurable for them to work and for every user to make sense of them.[4]

      Thus, to measure and understand numbers and use them accordingly, universal categories (in the form of standards) are established. As only with a proper and adequate definition of a term, it is possible for something to become countable.[5] But, standards embody certain ideologies (Blauw, 2018). Ajana writes: "New ontologies, new metaphors and new ways of seeing the body and the self are emerging, and in ways that are undoubtedly reconfiguring the relation between

4. As history shows, in order for the development of the dominance of numbers in society, standardisation had to take place as numbers used to be locally used and weren't globally commensurable. The remains of this can still be seen as some countries use different metrics i.e United States, Liberia and Myanmar still use pounds and miles.

5. As Ian Hacking mentions:

individuals and their bodies, between citizens and institutions, between the biological and the social" (Ajana, 2018, p.3). This results in people that are self-tracking being shaped by those technologies, while in return those users also shape the technologies by own ideas and ways of using the technologies with both having a shaping effect on each other. Self-tracking is part of a wider culture that enjoys a heavy reliance on numbers for identifying certain aspects while rendering others invisible. This provides a tremendous amount of power to the actor(s) that are defining the numbers, which are data that are being used for reflection, as standards embody certain ideologies. Thus, in representing the body when designing a self-tracking app this results in apps operating as shared artefacts that co-construct and negotiate meaning of and from bodies.

Although data is often perceived and regarded as objective and true, data too are partial and embody ideologies. Numbers are a way of making sense of the world. This means that self-tracking tools abstract human bodies and minds into data flows, allowing for decorporealized and decontextualised bodies to come into being (Ruckenstein (2014) refers to this phenomenon as data-doubles). But, these data flows only contain a partial and informational view of bodies, living on servers rather than in the world (Ruckenstein, 2014). In order for these data to make sense, they are recontextualized via an interfacing process. Interestingly enough, data are not re-corporealized as visual design authorises data to be portrayed as objective truths. "The apparently clean orderliness of digital data appears able to contain and control the inherent and mysterious tendency towards disorder (disease, disability, pollution and early death) of the body." (Lupton, 2013, p.9) Thus, the technical ability to generate data provides a certain perspective of what the human body is and should or not should do. Digital data are highly relative, located in time, space and specific social and cultural context. Lupton (2013) argues that they can only ever tell one narrative, privileging one perspective of the body over the other. Thus, representing the body derived from digital data offers a limited perspective on that body, as it only partially shows the body. This is due to the partial nature of data: only some aspects are highlighted and labeled as 'relevant data' whilst others remain unnoticed (Lupton, 2016). Data generated by digital devices might focus

"Counting is hungry for categories. Many of the categories we now use to describe people are byproducts of enumeration" (Hacking, 2016, p.66).) Hacking, I. (2016). Biopower and the avalanche of printed numbers. Biopower: Foucault and beyond, 65-81.

on some specific aspects of the body while ignoring others (for example a period-tracking app with an aim to prevent a pregnancy not allowing to log a pregnancy). Data visualisations make information accessible for the lay-public and also provide the chosen data as being significant and essential. Users and designers, when using or designing digital health technologies for self-tracking interact with these data via interfaces. Interfaces are important media for producing, consuming and interacting with bodily data.

Many of these collected user data are accessed and exploited by actors that interpret and determine how to make sense of the data. In the case of self-tracking, users often choose to voluntarily share data about their bodies. Thus, the data collecting technologies often focus on inherent capacities of the body, highlighting specific details. Bodily processes that are rendered into digital data, allow for those processes to become visible in extraordinary and bizarre ways. Self-tracking technologies capture and materialise aspects of the human body that users otherwise might not even have considered (i.e materialising the preferences in relation to that body, and the habits involved such as the body's food consumption, workout, sexual activity, mood and state of skin and vaginal discharge).

This re-contextualising of data allows for turning formerly undetected bodily phenomena (such as reactions and behavioural clues) into traceable and perceptible information (Ruckenstein, 2014). Thus, the designing of digital health technologies aimed at self-tracking builds upon this notion of making undetected phenomena visible and countable and therefore allowing certain aspects to become valuable (such as glucose levels or heart rate). Consequently, in making unknown parts of the body known, there seems to be a notion of gaining more control over life processes making information available for mapping (Edwards, 2010). Self-tracking practices are rooted in a tradition in which the 'natural body' is something that can be transformed. Sensors allow for immediate and live feedback, but in order to make sense of sensors, an interface is needed. As self-tracking applications in the form of wearable technologies are often aiming for an 'improvement' of the body, this transformation becomes not only possible but also desirable i.e Nike - "get more out of your running" (Nike, n.d, n.p).[6] Wearable technologies have a shaping role in the

6. These companies and popular media also strongly

desirability of improvement as they allow for the interaction of real-time feedback from the body to that same body. As the user of sensors is often designed in the form of wearable technologies, the following section will shortly discuss how these relate to the physical body.

Wearable technologies

Wearables are defined as "fully functional, self-powered, self-contained computer that is worn on the body [… and] provides access to, an interaction with, information anywhere at any time (Viseu, 2013). Representations made from data about and from the body are often provided to users and collected via technologies that can be worn on bodies as they make it possible to provide real-time feedback that allows for 'actionable insight' (Runner Assist, 2019). Forms of designed interaction can be lighting up sensing body heat or motion, responding to moist, or physical movements enabling shocks or vibration (Wissinger, 2016). Via this actionable possibility, bodies are imagined to become augmented, informational and informed through their use of wearables. Wearable technologies are embodied, but at the same time also technologies about bodies. This makes them excellent sites to investigate the understanding and perception of bodily entities of its users. Viseu (2013) shows the split in the discourse of wearable computers: between the artificial and the natural, the senses and the instruments, indicating a body that is augmented by technology, but somehow remains intact and natural (Viseu, 2013). According to Lupton (2013), the notion of bodies as a system of codes and disease as information malfunction is central to the current debate on digital health technologies. These technologies are represented as being able to provide insight into users' body in order for the user to overcome their bodies illnesses. It does so by implying that via gaining self-knowledge in generating and producing data, symptoms of disease can be made visible even before diseases make themselves known.

Viseu identifies the immediate challenge as not one of technology but one of cognition: the world presents itself as filled with difficulties that the 'natural' body should overcome. Think of information processing and storage: memory skills. As the 'natural' body does not have these memory skills,

technology should be added to that body in order for it to be able to cope with those informational challenges. Thus, wearable technologies arise in the discourse and practices of developers and their imagined users, as a means for personal empowerment: "they are seen as the path to the augmentation of human motor, sensory and cognitive abilities" (Viseu, 2013, p. 135). Due to the rise of sensors and data a transformation in interaction between user and technology is taking place, which also calls for a transformation in representing bodies when designing digital health tracking apps. Technologies that allow self-tracking are transforming from one-way interaction to tools that suggest and interact with its user, for example from a hand-written note in a calendar to keep track of a menstruation cycle towards an app that regulates and responds to a digital note/input giving 'more insight' about that same menstruation cycle. As digital health technologies are part of a wider movement of self-tracking and development of wearable technologies (in which there seems to be a focus on corporeal limitations), these movements also shape the process of representing the body as well as the understanding of users and the representation of their bodies. Wearable technologies allow for a transformative interaction with and via bodies, as these technologies can provide realtime feedback. The growth and transformation of self-tracking practices via wearable technologies asks for raising questions about representing bodies when designing a digital health app. Currently, the development of products that aim at human-computer interaction (such as wearables) is often done following a human-centered design or design thinking process. The following section will thus explore how these products with a specific aim are being developed.

Current approach on designing interfaces of digital health tracking apps: human-centered design

This part will discuss a common approach among design agencies for the development of products. The field of designing human-computer interaction is more or less characterised by a standard textbook process of problem definition, user study, iterative prototyping, and evaluation (Bardzell has derived this argument from looking at the field's primary textbooks such as Preece et al, (2007) (Bardzell, 2011)). A commonly used approach in design practice for

designing applications is the an approach that aims to centralise humans. Often designers with these expertises have positions such as user experience designer, interaction designer and user interface designer. This approach is named 'human-centered design' (HCD).

HCD is a practical approach pioneered by global design company IDEO (with offices in Cambridge, Chicago, London, Munich, New York, Palo Alto, San Francisco, Shanghai and Tokyo). IDEO aims for creating 'innovative solutions to real-world problems'. The first sentences of their book "The Field Guide to Human Centred Design" (2015) introduces the approach as: "Embracing human-centered design means believing that all problems, even the seemingly intractable ones like poverty, gender equality, and clean water, are solvable. Moreover, it means believing that the people who face those problems every day are the ones who hold the key to their answer" (IDEO, 2015, p.9). It is an approach to the development of interactive products and systems that aims as useful products by focusing on the people using it. HCD is a framework that develops solutions to identified problems by involving users' perspective in all steps of the process in order to achieve a usable system (Maguire, 2001). Ideally, user involvement is done at every stage of the process and typically takes place in observing the problem within context, brainstorming, conceptualizing, developing, and implementing the solution (IDEO DesignKit, n,d, n.p). When understanding the people one is trying to reach, and take into account their responses and answers to questions concerning the problem, a solution can be designed tailored to meet the users' needs. From this, a designer can design a solution that users will embrace and use. HCD is a process consisting of three phases, (1) inspiration: opening oneself up to creative possibilities and trusting that the final result will be one that fits the users' needs, (2) ideation: coming up with an enormous amount of ideas and building prototypes from the workable ideas to test with users (iterating, testing, integrating feedback) and (3) implementation: get your idea out in the world (IDEO DesignKit, n,d, n.p). But, as will be shown in the case study below, it is also a process in which decisions are made dependent on the end-goal of a design (ie. designing an application with the aim of obtaining as much downloads as possible)

Usability is widely recognised as a critical component for the success of an interactive system or product (Nielsen, 1994). But, the definition of a 'good user experience' is highly dependent on the aim of the product (set by developers rather than users). HCD thus thrives on the assumption that use of products can and should be designed and determined by developers, as use is defined as problem solving. This results in the assumption that every interface should be invisible, as the best user experience would be so intuitive that users are no longer aware of the technology. In tracing these assumptions it is revealed that in the approach of HCD, human is actually defined as user-of-a-product. As the focus is on the usability and experience of the product rather than the interaction between user and interface. Consequently, HCD is centralising design of humans, as the focus is more on the product than the user. This allows for the objective that design is the solution to every problem to be confirmed over and over again (even clean water and gender equality). Designing the interface between user and technology with a focus on usability allows for a certain representation of bodies to slip in. The body is thought of as a problem area that needs solution by design. Following this, the human does not shape the design process, but rather the user does. Currently, the process of designing a solution to a problem is a process that aims at a rather fixed outcome: a product that incorporates users needs. But, in focussing on the product as an end (generating user data), rather than a process (let user/designer take part in the interaction that shapes the product), what is actually designed is the user of the product - as the product is portrayed as an objective tool to help it's user become a better, healthier and more self-knowledgeable person. Thus, HCD is currently an approach that is more concerned with design humans via products, rather than designing for and with humans. The product should be seen as a means to an end, not as an end in itself. The user is becoming part of the process of creating, and thus the design should be done accordingly.

Designing a digital health tracking app: a case study of Runner Assist

This section will provide a case study of a wearable technology that has been developed with a human-centered design

approach. Interfaces of period-tracking apps are often graphic user interfaces, which aim at guiding the user. But, due to sensors becoming ubiquitous the interface is shifting. This transformative element is highly interesting as the tensions previously mentioned discussing period-tracking apps become all the more present. Currently, following a human-centered design approach and the wider context of self-tracking the representation of the body is still perceived and thought of as a mirroring of the actual living and breathing bodies using the applications. In this section a case study will be introduced, that will outline how an application with the use of sensors and data works.

This thesis is part of a graduation project done at TRIMM, a digital agency in Enschede. During that graduation phase, I also worked part-time as a user experience designer on this project. The following is thus partly based on discussions with colleagues, as well as some in-house presentations given about the project. The project is named Runner Assist. It is a project currently still in development aimed at preventing running related injuries. It aims to provide the user real-time feedback (with the help of sensors) so the user can run more effectively. It's developed by TRIMM, Roessigh RRD, Xsens and Sensorun. Xsens provides the sensors for the application, Roessigh RRD provides the interpretation and making sense of the data that is generated, TRIMM will develop the online platform and Sensorun will bring the product to the market (TRIMM, n.d).

According to the developers of Runner Assist, over two million people run for practice in The Netherlands, which causes approximately two hundred thousand injuries a year. Sixty percent of these injuries are resulting from runners that aim for too much, too fast and unknowingly change their techniques because of that (Runner Assist, 2019). Most existing running apps provide merely data generated from the body, without an advisory nature. No advice is given about how to improve the training. As Runner Assist identified injuries as one of the most important and preventable elements of running, they aim for filling this gap. The developers thus try to generate meaning from the data that is collected and to put it to use in its users' advantage. Their aim is to create a product "that provides the runner with realtime and personalized feedback

on his or her running technique, to prevent injuries and help improve results" (Runner Assist, 2019). The application, which is supposed to be set up as an online platform (with an app, smartwatch, and website), providing real-time and personal feedback on its users running techniques. It does so to prevent injuries and to improve performance. Runner Assist makes use of sensors that should be put on a users body (shins and pelvis), from which the application can sense several different aspects of the body. A challenge for developers is how measurements measured with the accelerometer, gyroscope, and magnetometer can be turned into parameters that make sense to measure in relation to running related injuries.

The following sketches (figures 1, 2 and 3) are screens and sketches developed being a part-time designer, setting up some first analyses on the user journey as well as the essential screens in designing a running app that provides real-time feedback. As a common practice, I first identified some persona's which are constructed profiles (some with personal details or as in this case a little text describing the person) that refer to potential users/customers of the product. In this case, I made a distinction in their goal of purchasing and using the application: the targeted runner, the runner with stress, the reluctant runner and the competitive runner (and optional: the social runner). Following, a user journey had to be created showing all the touch-points potential users can have with the brand Runner Assist (this journey is limited to the app and not taking the entire platform into account, as this case is about the app and not the entire platform). From the analysis of this journey in combination with technological limitations and possibilities, sketches of the screens that are thought to be central to the application are drawn.

This case study shows the importance of taking into account the process of designing a product, as assumptions can slip in. The interface can be considered as the site where user and developer meet each other. It is therefore important to understand the interface as actor in this process, in order to trace and understand decisions that were made and actions that were carried out while designing a digital health tracking app.

Figure 1: Personas are fictional representations and generalisations made up by designers. They allow designers to target their users and categorize them in personas with similar attitudes, goals and behaviors in relation to the product. These are based on user research, and are human-like snapshots of customer groups (Flaherty, 2018).

→ geslacht ?

De doelbewuste hardloper

Deze hardloper heeft geen tijd voor langdurige team-sporten of een sociale yoga les, ze is een medium tot ervaren loper en weet wat ze doet. Haar hardloopschema moet passen in haar drukke werk en privé-leven. Dat betekend dat het schema zo gecreëerd moet worden dat het volledig werkt voor haar organisatie. Deze hardloper is gefocust op de tijd dat ze hardloopt en wil zo veel mogelijk resultaat behalen. Ze is zich bewust van het belang van een goede gezondheid en organiseert dus het hardlopen rondom haar dagelijkse drukke schema.

Zij gebruikt de app voornamelijk om doelbewust beter te lopen, meer resultaat te behalen en bij te houden hoe ze zich ontwikkelt. *→ compatible w/ other apps*

De hardloper met stress

Na een lange stressvolle dag op het werk gaat deze hardloper rennen om de stress kwijt te raken. Ze moet rennen, ze heeft het nodig om de stress uit haar lichaam en geest te laten verdwijnen. Daarnaast is ze zich ook bewust van haar gezonde levensstijl, zowel fysiek als mentaal. Ze is op de hoogte van het totale plaatje van haar gezondheid en vind het prettig om gecoacht te worden - om de juiste balans tussen lichaam en geest te vinden. Deze hardloper is medium tot geavanceerd en hecht dus veel waarde aan overzicht.

Zij gebruikt de app om dit overzicht - in ieder geval lichamelijk - te hebben. Daarnaast vindt ze de coach-mogelijkheden erg fijn en gebruikt ze deze dan ook graag tijdens het lopen.

→ synced / integrated music

De hardloper met tegenzin

Op het moment dat ze moet gaan hardlopen heeft ze geen motivatie, en het liefst sport ze dan ook in gezelschap. Dit is helaas voor haar niet altijd mogelijk en daarom sport ze ook individueel, met tegenzin. Ze overwint deze tegenzin omdat ze weet dat ze zich na de tijd fantastisch voelt. Na haar hardloopsessie wil ze deze dan ook graag delen via de socials, met een voorkeur voor Instagram. Doordat ze haar persoonlijke vooruitgang ziet en voelt, blijft ze het volhouden om individueel te hardlopen. Ze is zich niet bewust van doelen zetten, maar vind het wel heel fijn (voor de motivatie!) om een overzicht te hebben van haar eventuele vooruitgang.

Zij gebruikt de app om haar persoonlijke vooruitgang te zien zodat ze aangemoedigd wordt om te gaan hardlopen. *→ socials*

De competitieve hardloper

Deze hardloper heeft de marathons en races die ze wil gaan doen exact in haar agenda staan. Ze loopt elk weekend en verbeterd zich vaak en snel, dat betekend dat haar hardloopschema zo samengesteld moet worden dat ze veilig de grenzen van haar eigen kunnen kan opzoeken. Daarnaast rent ze elke run alsof haar leven ervan afhangt en gaat ze graag tot het aller-uiterste voor de prestatie. Ze is dus gefocust om de taak te voltooien, *she wants to get the job done.* Ze zet veel doelen, om deze vervolgens ook glansrijk te behalen. Deze hardloper is overduidelijk een ervaren hardloper, die zichzelf keer op keer uitdaagt om het uiterste te behalen.

Zij gebruikt de fitness-app om doelen te stellen en inzicht te krijgen in haar prestaties. *→ without phone ?*

Optioneel: de sociale hardloper
→ social enterprise

encourage / guide / record

Figure 2: An example of a finalised persona from a different source

Figure 3: Users ouchpoints with the mobile app of Runner Assist.
User journey is sometimes referred to as customer journey. The
scheme is helpful for gaining insight in the experiences that users
have with a product. It is meant to identify underlying needs and
problems that a user might encounter.

Figure 4: Wireframes of central screens in order for the app to work.
A wireframe is used to sketch the lay out content and functionality
of a product. It should take the user journey and a users needs into
account and translate these into functionalities. Wireframes are
used to establish the basic structure of a product before the visual
design and textual content is added.
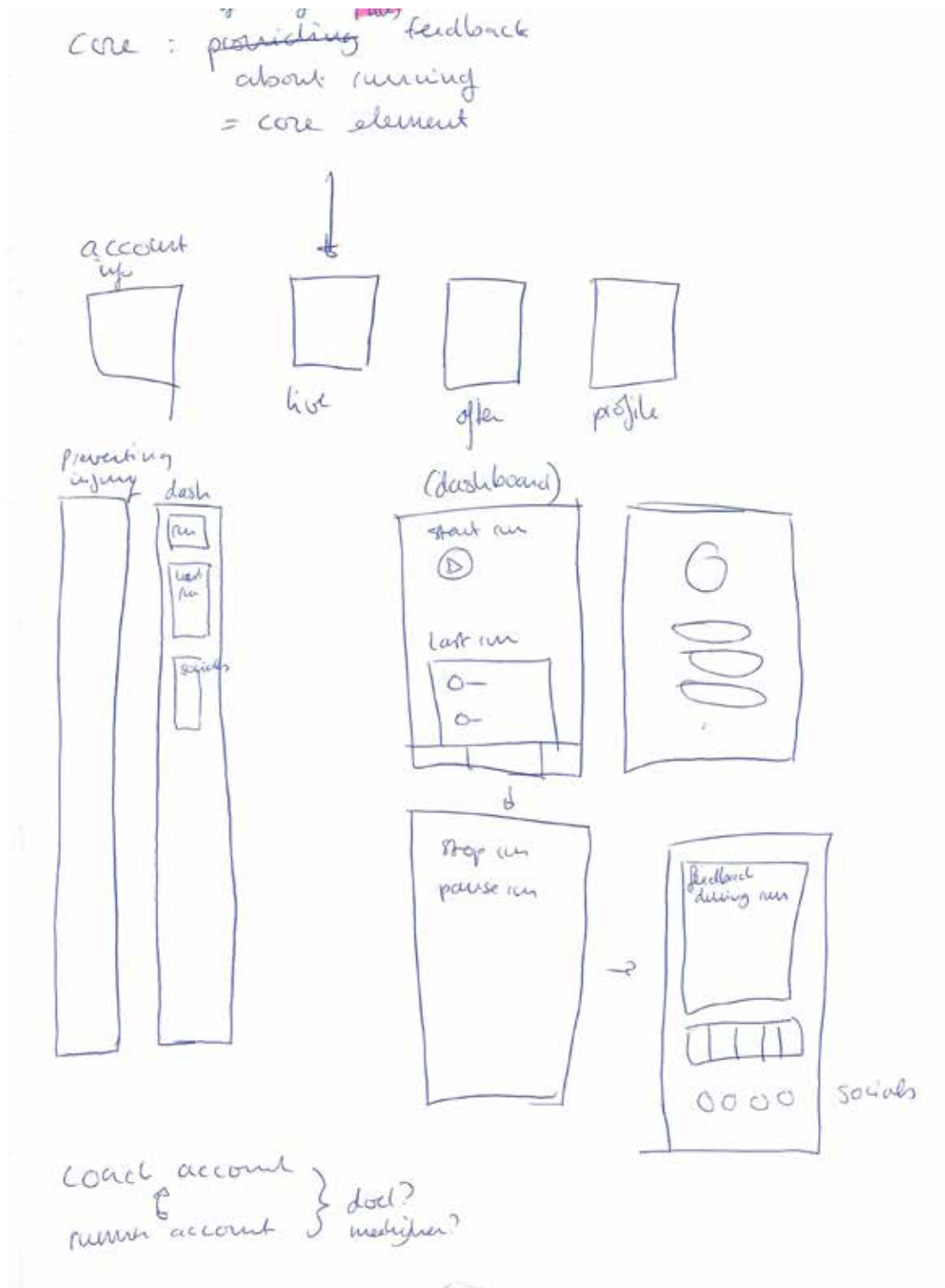
Active gateway between user and technology

The interface can thus be considered as the site where developer and user meet, it is therefore important to explore the concept of the interface and see that an interface is more than a technological feature. "An interface is not just a surface or a passive gateway or threshold, not only a mode or a site of interaction or communication, but a deeply historical artifact: a structured set of codes, complex processes and protocols, engineered, developed and designed, a space of power where social, political, economic, aesthetic, philosophical and technological registrations are inscribed" (Hadler, 2018, para 1). A merely technological perspective would view the interface as a site where incoherent modes of communication are rendered coherent, where signals are translated and combined, a portal between databases, code modules and other forms of machine-based communication. But, an interface is not merely a technological artefact, an interface is also a site where technological and human preconditions meet and allow for sense-making and interaction. It is a form of relation, of inclusion and exclusion, of transition and mediation. It is, as Hadler mentioned, therefore not just a surface or a passive gateway. It is a deeply historical and cultural artefact and an active gateway that allows for interaction between user and technology. The interface is made up of complex processes in which a multitude of relations are inscribed (Hadler, 2018).

Self-tracking practices via wearable technologies allow for a transformation of the interaction between technology and user. From apps where users can register and keep an overview of their daily practices, apps are now being designed with use of sensors in order for the technology to respond to and interact with the user's data (to provide real-time feedback for actionable insight). Floridi characterises this transformation as "interfaces becoming less progressively visible" and therefore "the digital-online world is spilling over into the analogue offline world and merging with it" (Floridi, 2007, p.6). Due to this transformation, the interface is part of a larger network in which there seems to be a diffuse of power spread over many kinds of different networks. The form and structure of interaction are shifting from non- and multi-linear to simultaneous and instantaneous interaction. This means that bodies are not only knowing and perceiving, but they are

sensing, responding to and interacting with the information given by interfaces.

The interface is designed in such a way, that the user has no idea that he/she is dealing with an algorithmically structured system that provides feedback based on data. As a user, you merely see the surface of the interface. These apps are being developed to become black-boxes. This is a user experience that is made possible by the constant and continuous sensing of users and technologies. Digital health tracking apps that make use of sensors, Runner Assist is an adequate example, are expected to work with real-time data and to deliver and optimise context sensitive and user oriented interfaces. Interfaces that guide its user and meets their needs and expectations in order to guide the user towards subtle affordances towards desired interactions. In order to generate value, the interface requires interaction from its user (Hadler, 2018).

Currently, cognition (usability) and technology (sensors and data) are taken as the basis of interface design, but this limits the contexts and makes it way too narrow in order to understand contextual factors of interfaces properly. As interface is not merely a term that indicates human-computer interaction but also indicates many different points of contact and exchanges between different machines and humans. In focussing on the technical and cognitive functions, it is ignored that the user is often engaged in a "hermeneutical process of interpretation" (Bertelsen and Pold, 2004, p.23). Therefore, the scope of defining interface should be broadened in order to go beyond merely technological and cognitive notions of representing bodies. In doing so, current focusses can be challenged and a simultaneous and instantaneous approach to design can be established. Bertelsen and Pold (2004) aim for seeing aesthetics as a new paradigm for HCI, taking aesthetic theories of representation, experience and sense perception as basic categories. Due to sensors, representations of bodies have an actively shaping role in the interaction between user and technology. Thus, the interface should be regarded as a process in which (political) decisions are being made, and the shaping of bodies (and therefore users) takes place.

In going beyond the question of usability or optimisation of user experience, the interface should be regarded as an

obscure, hybrid and fuzzy term that is multifaceted and can thus have different meanings in different contexts. Interfaces are not static entities, they are active gateways that allow access to and from user and machine. Focus should be expanded, so that implicit aspects of interfaces when designing digital health tracking apps can be taken into account. In opening up the designing of digital health tracking app Runner Assist, and analyse the process via a lens of interfacing, implicit representation of bodies can be made explicit.

Chapter 2
Implicit assumptions of current representations of bodies

The following observations are supported by ethnographic research conducted at TRIMM while working on the project of Runner Assist. Runner Assist, as well as the period-tracking apps, imply a certain perspective on what bodies are is and what bodies should do. As Runner Assist is a project in development, not all implications mentioned in this chapter are directly derived from the development of the project. Some arguments and observations are brought about by a broader discussion and considerations in the context of digital health tracking apps (also drawing from chapter 1).

       The lens of interfacing allows seeing what digital representation of human bodies is coming into being in the process of designing digital health tracking apps. An interface is not merely a technological artefact nor merely based on cognition, but a deeply cultural and historical artefact that is co-shaped by a multitude of processes. Visual design has the power to render things invisible and highlight others. It has the ability to convey data into structured, understandable and clear forms of information. In reducing all bodily phenomena into numbers, tensions arise as knowledge is situated and does not stand outside the world it is in. Thus, going beyond the question of usability and user experience optimisation, this chapter will regard the interface as an obscure, hybrid and fuzzy term that has different meanings in a different context. In doing so, this

chapter will use the lens of interfacing to state three implicit aspects of representing bodies when designing digital health tracking apps - as a multitude of infrastructural processes is taking place, this part will zoom in on three specific relations that arise when representing bodies in designing digital health tracking apps. The first aspect that will be addressed is the relation of the user via the technology with him/herself. Secondly, the relation between the developers and the technology will be discussed to investigate what the interfacing lens can reveal. Thirdly, the relation between developers and users that entail power via the technology will be uncovered. As interfacing is the lens via which these processes (in practice) are viewed, it is necessary to use theory to completely open up and fully understand the dynamics and to put the interfacing lens at work.

Users understand their bodies via its representation
Self-tracking apps are used in order to gain more insight into bodily processes (van Noort, 2019). But, these apps don't show how the understanding of users' bodies via these representations are shaped and the consequences these might have. Tension only shows until the felt body is deviating from the apps' representation. Several aspects, previously mentioned, shape the representation of bodies when designing digital health tracking apps. In the case of period-tracking apps, it showed that the act of measuring is not neutral and female bodies were used as "temples of lucrative information" (Mahdawi, 2018, para.1). This has an impact on the way users understand their bodies via its representation.

Runner Assist aims at injury prevention, as this would help runners to better train and perform. But, physically not feeling pain is classified as a disease: congenital insensitivity to pain (CIP), indifference to pain or congenital analgesia (US National Library of Medicine, n.d). It is a rare condition and there are not many known cases of people having the condition. Nevertheless, it is important to consider that this physical shape of bodies is identified as a disease (and thus perceived as unwanted) and seen as dis-functioning of the body. Which in return shows that feeling pain is seen as a regular bodily condition. The aim of preventing injuries is shifting the understanding of (un)healthy bodies. This shows

an implicit aspect of representing the body when designing digital health tracking apps: there seems to be a shift in the perspective of the functioning of human bodies.

In order to deepen the analysis of the shift of understanding and explain the dynamics occurring in the relation between the technology and the user, it is needed call upon Benjamin, and his essay 'the Work of Art in the Mechanical Age of Reproduction' (2008).[7] Benjamin argues that technology is interfering with the very core of humans' understanding of the world around them. Partly due to the availability and possibilities of sensors and data digital health tracking apps have a transforming impact on users' understanding of the world around them. The rise of sensors and data interferes with the core of understanding humans' own bodies. As discussed, not feeling physical pain is classified as a disease. With the ability to generate data, more mediated information from the body is available today than at any other given time in human history. Sensors and data call for a constantly on and continuously 'on-mode' of body and specifically, Runner Assist allows for insight into running patterns and possible injuries while running. The body can thus be viewed, understand, and considered in ways that were not possible before data practices (i.e measuring glucose levels or the number of steps taken on a specific day). Screens and hardware called for a rather static representation of bodies, in which the relation between users and the representation of their bodies is a mirroring one - integrating the users' perspective (following a human-centered design approach) as much as possible. But, screens and hardware don't provide real-time and active feedback, sensors and data do. As Runner Assist analyses users' runs with the help of sensors, it is possible to monitor and constantly provide feedback adjusting the users run and thus to see when and how injuries occur. This shows that the sensors (via data generation) are taking over the ability to detect and feel physical pain, as the user is informed via real-time feedback whether he or she should alter their running techniques. Thus, the technology is taking the place of detecting physical pain, and trying to prevent this.

Technology is thus interfering with the very core of users' understanding of their bodies via the representations provided to them. In the case of Runner Assist, the

7.Benjamin is calling attention to how changes in art are an expression of changes that apply to the fundamental understanding of matter, time and space. Experience of the world around one is not merely biological or natural, but also historical. This means that in the relational structure of subject and object, the historical has an influence. Thus, users understanding of the representation of their bodies is also historically defined.

representation provided is a body that is never in any physical pain, as the app can prevent this. The tension that arises is that this shifts how users understand pain (and being healthy) concerning their own body. As not feeling pain (up until the rise of sensors and data) has been identified as a disease and therefore is an unwanted state of body, suddenly not feeling pain is portrayed as the ideal condition of bodies.

Benjamin shows with an example of how the (video) camera altered humans relation with reality. The camera can freeze and frame certain parts of the world, allowing for only parts of reality to be represented and thus the camera (and the user of the camera) has a shaping effect on what is represented. Thus, technology affects how the world is represented. This can be used as an analogy to explain how the nature of sensors and data affect the representation of users' bodies - by the availability of data and sensors, perception of bodies is altered. By framing and freezing certain aspects of the body, sensors and data allow for an only partial (and thus distorted) representation of bodily phenomena. This affects how the users' view of the body is mediated via its representation through sensors and data. Benjamin argued that the ability of technology to alter understanding between subject (user) and object (representation of the body) has an effect on what is seen and how it is seen. Thus, sensors and self-tracking apps (the technology) have transformative power over how the user understands the representation of its body. Sensors allow for a specific representation of body to arise (one in which it is possible to monitor and prevent/alter physical states like pain), which has a specific perception of the user of the technology - namely the technology stands in for a bodily feeling (pain) and is perceived as the objective entity that allows for more insight into bodily processes.

But, what is happening is that the understanding of (healthy) bodies is transformed: feeling pain (before the availability of sensors and data) was considered as part of the felt body whereas now it something that can (and should) be prevented with help of technology. Due to self-tracking applications, feeling pain is identified as something that should be prevented and one should do so with the help of technology. This means that the self-tracking apps are getting a pivotal role in shaping the perception and identification of bodies.

A body that does not feel pain is considered healthy and the wanted state of physicality. Thus, by representing the body in designing digital health tracking apps, developers interfere with the very core of (in the case of Runner Assist) what is thought of as being healthy. The app is making the body thought of as something that has a default of being sick (feeling pain is an unwanted state if we must adhere Runner Assists' aim) - and in need of help by technology that will prevent the body from getting hurt and stay in that sick state. This means that the understanding of the user and the representation of their body is mediated by the availability of sensors, the always-on capacity of bodies and the assumptions of the representation. This allows for a shift in understanding from a healthy body to a sick body. Feeling no pain seems to be the default setting and technology shapes when bodies are understood as healthy or unhealthy.

Experience of the visible

As shown, self-tracking apps interfere with the very core of how humans understand the world around them. As self-tracking apps inhabit certain assumptions (which is partly the result of adherence to a human-centered design approach), it is no more than logic to investigate the process in which representations of bodies come into being: the designing of apps. As previously mentioned, the current approach of human-centered design is adopted to develop these apps. There seems to be a misconception, followed from the human-centered design approach, that there is a design solution to every (bodily) problem. The body is thought of as a problem area (with a default of being sick) that needs solution by design. Following from this, the human does not shape the design process, but rather the user does - indicating that 'human' in human-centered design is actually seen as a user of a product. A specific user that has been created to fit the product. Now, this seems an uninteresting slip-of-the-tongue, but the following will show that this has far-fetched implications for representing bodies when designing digital health tracking apps. Before going into the implications of these different perceptions, it is first needed to deepen the understanding of seeing and perception as these can reveal more about dynamics that occur when elements (in this case bodies) are perceived differently by

different actors.

How the body is viewed and represented provides a tremendous amount of power to the actors that can determine the view. The designing of a digital health tracking app is a display of a particular view of what a user should be, that has also been pre-given and affected by other actors within the process of designing the app. Every image that is created embodies a certain way of seeing reality (Berger, 2008).[8] In further conceptualising perspective as part of the process of designing digital health tracking apps, it is needed to call upon John Berger and his book (and tv-series) 'Ways of Seeing.' Berger addresses how every image ever created is a construction of how its creator is/was situated (also taking the available technologies into account), sees/saw and makes/made sense of reality. Berger refers to this as "the artist's experience of the visible" (Berger, 2008, p.10). Berger shows that vision is an ever-evolving and transforming element that is shaped within the context it is in. Seeing is affected by what humans believe and know, it is in the relational structure of things and humans that vision is created. "Our vision is continually active, continually moving, continually holding things in a circle around itself, constituting what is present to us as we are" (Berger, 2008 p.10). Berger argues that seeing comes before words, and while we try to explain the world around us with words, it never does away the fact that we are surrounded with the visual of the world, indicating that the perceptual focus of humans is most important for the shaping of knowledge. Images, in Berger's account, are richer than words, as they provide a historical and cultural context when being created, and also when being looked at. This shows that the representations created by adhering the human-centered design approach reveal something about the perspective of the historical and cultural context the developers are in. Berger (building upon Benjamin) argues for a conceptualisation of vision that should be understood in a relational structure between subject and object. With this, Berger demonstrates that perspective and seeing is something highly dependent on contextual, historical and spatial elements. To better grasp what this means, the following will address an elaborate example:

An illustration by Maria Michela Sassi who has written an essay (2019) questioning whether it is possible for modern-

8.Berger explains that an image can outlast what is represented as reality, it shows how something or somebody looked, and thus shows the subject of the image as how it was once perceived by other people in another time.

day society to ever grasp how Ancient Greek society saw and understood their world. She shows that within the entirety of Ancient Greek literature one can not find a single description of the sky or the sea as being 'blue' (in colouring). Their (people living in Ancient Greece) perception and experience of colour does not match current days understanding of color in the world. The Greeks viewed their reality differently than present-day Western society does. They were blind to blue, yellow and many other (today) known colours. For example, Homer (poet and writer of the Odyssey) described the sky as "big, starry, or of iron or bronze" and the sea as "'pansy-like', 'wine-like', or purple. […] The Greeks already knew, Goethe wrote, that: 'If the eye were not Sun-like, it could never see the Sun'" (Sassi, 2019, para.1 and para.5). For the Greeks, colour was a basic unit in making sense of the world, and especially the social world. Our understanding of colour is not commensurable with the way they saw the colour (and thus understood the world around them). It seems that there has been no stage in human history in which colours were not (yet) seen. This example shows how context and understanding are of extreme significance in making sense of the world around one. In describing the world differently than our current day descriptions, the (written) language shows that the Greeks had a different perception of the world. By focussing on movement and shimmer, Ancient Greek perception varies from current day perception. Thus, perception of the world is mediated by the context one is in.

Image 4: "The Greek colour experience was made of movement and shimmer. Can we ever glimpse what they saw when gazing out to sea?" (Sassi, 2019, para 1).

Sassi shows that how humans understand the world around them affects how they make sense of phenomena - and how this affects the representation of the world (as Homer described the sky as "big, starry, or of iron or bronze").This example shows that via the perception of reality rhetoric about the world is shaped. In tracing the rhetoric, the experience of the visible from the creator (and its historical and spatial context) can be revealed. Thus, in tracing the rhetoric used when designing digital health self-tracking apps it can be revealed what the perspective of the apps' developers is. As already mentioned, the human is defined as a user of a product: but tensions arise as users identify themselves differently. These tensions are possible to arise as the act of measuring is not neutral, and some norm has to be set and

derived from raw data. This is allowing some things to become visible while allowing others to become invisible.

Sensors and data allow for these representations to become more personalised and intimate. This is where existing notions are starting to wobble, as the interface between user and technology becomes less transparent due to intimate real-time interaction. The users 'get to know' its body via the eyes of the developers of the representation. Thus, understanding between subject and object is transformed due to alteration in technology and making sense of the world. This representation is (among other things) a manifestation of the way its creator [technology/developers/culture] see the world, following from this users thus understand their bodies via the perspective of the developers of the representation. The actors that can determine the view heavily rely on data (as a technological perspective) and usability (as a cognitive perspective) as information to base a representation of the body on.

But, due to the simultaneous and instantaneous interaction users' context also has an effect on the shaping of the interface. Currently, this is too narrowly taken into account when designing digital health tracking apps. "Digital data of themselves mean nothing, metrics can tell limited details about bodies. Data only makes sense in the context in which people decide to collect and analyse their data, and the social relations and expectations, places and spaces in which they do so" (Lupton, 2018, p.9). Every representation embodies a certain perspective of what bodies are and how they should function according to the context they were created in. In return, these representations also invoke a certain perspective when received by the user in a certain context, with a specific view acting as a (technologically constructed) eye via which the body is perceived. This allows for a perspective in which "humans have become digital data subjects" (Lupton, 2016, p.9). Consequently, the user is constantly on, continuously generating data. This has implications for the interaction between user and technology: due to the rise of sensors, the body is now a body that needs to be ready for immediate representation. This leads to a new form of interaction between human and computer, body and wearable, with both hanging onto each other in a feedback loop of information. The extension of the body as 'ready for representation' demands

a blurring between internal and external, self and others. In the case of the period tracking app (Natural Cycles) it was mentioned that a user felt more like a 'consumer' than a 'patient' (Sudjic, 2018). Seeing the user as a consumer or as a patient has a tremendous amount of impact on how the process of representing the body when designing digital health tracking apps is defined.

Rhetorical power of visualisations

The previous sections discussed the relation between the user and technology, as well as the relation between the creator and the technology. Following these discussions, it showed that there is a power of the developers that affects the user identifying themselves either via the representation in the technology or the resistance of the representation. Thus, there is a suggestion of power in the process of representing bodies when designing digital health tracking apps. Currently, data about and from the body are perceived (as well by its users as by its developers) as objective and pure sources of knowledge. As Gary Wolf, initiator of the quantified self-movement wrote in the New York Times (2010): "Electronic trackers have no feelings. They are emotionally neutral, but this very fact makes them powerful mirrors of our own values and judgments" (para.1). But, electronic trackers are not neutral. The body as a system of codes is central to contemporary designing of digital health technologies and a perspective of its developers using and creating a specific technological solution to (what has been identified as) a bodily problem.

This section wants to deepen the observation of the user that wants 'to better know him or herself' via tracking the self with digital health apps (ter Horst, 2019). This implies a rational self that can learn and understand, and that is disconnected from its embodied self (that needs improvement). Tensions arise as users wanting to learn more about themselves, feeling disconnected and alienated from the representation of their bodies. Developers use data in order to make translations of users' activities and use these translations to make the representation clear to the user. However, data of the world is perceived as neutral. But data has an objective appearance, which provides an enormous amount of power to representations based on data practices. Knowledge about

the world is always situated, and labeling data as objective is a technological myth especially if it concerns the human body as bodies are full of contradictions. The power of visualisations lies currently in their seemingly objective power, but this will start to wobble the more sensors become ubiquitous and tensions arise in the relation between user and technology. Due to the rise of sensors, suddenly bodies become a central actor in the interfacing process.

This section will argue for a view from the body - transforming the view of corporeal limitations into a story-telling perception of body. Only by incorporating the subjective and situated body, interaction can be designed according to sensors and data. As incorporating body in the design process of apps asks for a processual nature, as bodies are always evolving and acting. Haraway (1988) shows that a view from the body is always complex, contradictory, structuring and structured. She is arguing against 'the view from above' which she refers to as a view from nowhere (also: transcendent knowledge, the technological view) (p.589). Haraway is part of the feminist tradition that assumes that all knowledges should be regarded as socially constructed, and therefore the focus of analysis should be on the processes that legitimise certain hierarchies of knowledge and power between local and global (scientific) knowledges rather than dichotomies of static subject/ object distinctions. Humans can never be separated from the environment they are in. The following citation is an elaboration on what it means to have or be a situated body, written by Haraway: *"These are lessons that I learned in part walking with my dogs and wondering how the world looks without a fovea and very few retinal cells for color vision but with a huge neural processing and sensory area for smells. It is a lesson available from photographs of how the world looks to the compound eyes of an insect or even from the camera eye of a spy satellite or the digitally transmitted signals of space probe-perceived differences "near" Jupiter that have been transformed into coffee table color photographs. The "eyes" made available in modern technological sciences shatter any idea of passive vision; these prosthetic devices show us that all eyes, including our own organic ones, are active perceptual systems, building on translations and specific ways of seeing, that is, ways of life. There is no unmediated*

photograph or passive camera obscura in scientific accounts of bodies and machines; there are only highly specific visual possibilities, each with a wonderfully detailed, active, partial way of organizing worlds. All these pictures of the world should not be allegories of infinite mobility and interchangeability but of elaborate specificity and difference and the loving care people might take to learn how to see faithfully from another's point of view, even when the other is our own machine. That's not alienating distance; that's a possible allegory for feminist versions of objectivity. Understanding how these visual systems work, technically, socially, and psychically, ought to be a way of embodying feminist objectivity" (Haraway, 1988, p.583).

Haraway (1988) thus discusses the entitlement of eyes over the body. She offers an understanding of embodiment and objectivity via this metaphor, stressing the technological and collective character of building theories and knowledge. Following, she discusses the gaze as inscribing all the marked bodies, making the unmarked category "claim the power to see en not be seen, to represent while escaping representation" (p.581). All vision is specific and individual, thus the view from nowhere (objectivity) is an illusion, she refers to as 'the God trick.' It are the familiar notions of objectivity that support this false promise of transcendence (a view of infinite vision), and therefore is covering up the fact that all vision is subjective. The cognitive view is privileging the eyes and mind over the lived body, which is resulting in a perceived perspective of no-body, whereas actually the representation of the body in the design of digital health tracking apps is not objective nor a view from nobody. This allows visual design to become a tool with the power of inclusion and exclusion, as representations from data are perceived as objective and neutral (like Gary Wolf referred to). As representations are actually a manifestation of its developers' vision, it becomes troubling when they're perceived as a view from nowhere. This view invokes a seemingly objective truth to the user about their own body, explaining bizarre elements of body that wouldn't have been thought of before and reducing that body to its mere representation via data by developers. It is therefore needed to locate these representations, and allow for subjectivity in order to transform the interaction from a mirroring one to an

extension. By showing the perspective of the developers, and making the user aware of their power on the interpretation of the representation, these representations can be opened up and become more transparent.

The body is implicitly defined as material for data generation, from which the user can learn and understand (via representations) its own body with the aim of becoming healthier. Consequently, the question of what the body even is or does is being overstepped. In the case of the period-tracking apps there were multiple assumptions with which the women using the app couldn't identify, and because they couldn't identify the app gave feedback telling them their bodies are wrong. Some parts of experiencing a female body were rendered invisible, as this was something that could not fit the categories identified by the developers of the app. This provides an enormous amount of power to the developers. It has a focus on the experience of sexual health, reducing the woman to the female body. But, women were not able to log a shorter or longer cycle than 'average' or to log a pregnancy or abortion (letting the user experience her body via the app). This resulted in the app providing feedback to those women questioning their bodies functionality. The body is identified as malfunctioning, that needs to be translated into information in order to become 'better' - this is not a neutral process. Knowledge is only whole in its partiality, and representing data generated from the body to explain to that same body its workings, seems to undermine this partiality.

3.
Beyond human-centered design: exploring a transformative approach to designing

As every technology that measures bodies legitimates certain forms of knowledge and experience, while rendering others completely invisible - design is shaping rhetoric, as well as rhetoric is shaping design. As lived experiences are simplified

to commensurable data-points, self-tracking apps reduce subjectively and experience laden elements into numbers. Currently, this implies a view of bodies as temples of lucrative information. As human-centered design processes focus on end-products (solutions for problems), tensions arise. Assumptions about bodies are being built into the design solution, allowing for an interface to appear that acts as a mirror of users' understanding their bodies' representations. This becomes problematic as representations in apps are the construction of those that have created the image ("the artist's experience of the visible" (Berger, 2008, p.10)), allowing for a representation of bodies as temples of lucrative information.

The interface, as an active representational gateway is a revolutionary element in this process, as the interface is the site where representations of bodies come into being, as well as where interaction between technology and human take place. An interface indicates many different points of interaction between humans and machines. Points of interaction in which roles vary (designer can be user, user can be designer and so on). Interaction between the user and digital health tracking app is transformed, as sensors and data allow for a different feedback loop: an always on, continuously and constantly sensed body. Users are no longer merely users of a product but are (due to sensors and data) becoming a vital part of the process that partly determines the outcome of the interaction. As interfaces are transforming from screens and hardware into sensors and data, it becomes more pressing to re-analyse and re-conceptualise the notions that arise within an interfacing process. Sensors and data problematise existing notions, as users and designers simultaneously are providing the information needed for the interaction via an interface - in which tensions are more likely to arise.

This chapter intents at moving beyond current design practices and is an exploration of how to re-conceptualise representing bodies when designing digital health tracking apps. With the lens of interfacing, this thesis looked carefully at a selection of processes that occur when designing digital health tracking apps. Specific representations of specific bodies come into being in such a process with implications for users. In opening up this process, the previous chapter showed three distinguishing and underlying implications with guidance from

theory. The logical following step is connecting those theories with everyday practices. Thus, a different way of representing the body when designing digital health tracking apps is needed. In going beyond an assumption that technology can better feel pain than its user, the user of the app should be able to interrogate its bodily representation. In aiming at a transparent and open process, the view of the developers should be made accessible. And, following these two demands, the power distribution should be equal among all actors. Numbers derived from data stand for knowledge, stories and people, which are subjective, situated, perceptual and bodily entities (and definitively not objective nor a view from no-body). This asks for designing a processual infrastructure, rather than delivering a fixed end-product. The user should be able to interrogate, design, and understand the context of the product, as he/she is an object of enquiry. Thus, wearable technology should be redefined through design from transforming being a mirror of a body to an extension of the situated, story-telling body.

There seems to be a dominant technological and cognitive focus on interfaces, data and usability being key elements of this focus. Due to this focus, the perspective of bodies as a repository of knowledge has a tremendous amount of power. But, as a consequence of the transformation into sensors and data suddenly the fleshy body will start to play a role: sensors need to be put on the physical body. Existing notions such as user, designer, technology and human start to wobble as the designing of digital health tracking apps that make use of sensors and data are approached as if they are a linear interface. In re-conceptualising these notions, the processes entailed can become more transparent and users/designers should be enabled to interrogate the representations of their bodies. As shown, this subjective, situated and lived body should be taken into account while designing digital health tracking apps in order to provide an interaction in which the representation can be interrogated, opened up and contextualised by its viewer (and context of its creator is also transparent). In leaving behind the presumption of absolute control and objective universal truth and embracing subjectivity and appropriation, representing the bodies in digital health tracking apps could be opened up. The product is a means to an end (providing user insight with data), so it should be treated

as a means and not an end (generating user data). There is a need for transformation of the distribution of power, where power will go to the user-as-designer and not the creator of the product.

Allowing the user to interrogate its representation

In the previous chapter, it was discussed that digital health tracking apps have a built-in assumption that technology can better feel physical pain than the user of the technology. It is due to the specific use of sensors and data (allowing for representing the body as it being a mirror - telling the user what to do) that users' understanding of their bodies is informed. But, in going beyond the assumption that technology can feel pain better than its user, the user of the app should be able to interrogate its bodily representation. In questioning how to design such a thing, the following will illustrate an example and deepen the analysis by looking into research done by Paula Gardner and Barbara Jenkins.

Gardner and Jenkins researched the interface between people and the measured and visualised data about their bodies via biometric devices (EEG and ECG). They conducted a research project to investigate the 'intra-action' and people's interpretation of visualisations in order to create meaning of and via their bodies. While studies of digital representation and the relation between human are often considered as alienating the human from themselves, they want to consider the relation between human and representations as an unfolding narrative, rather than a unidirectional relationship (Gardner and Jenkins, 2015). By doing so, they show the porous boundary between technology and human and demonstrate how a narrative space is opened up when users are allowed to interrogate digital representations of and via their bodies. "Although we found considerable evidence in support of the alienating impact of digitized bodily representations, we also discovered that, when allowed to play and 'tarry' with these technologies, users created dynamic, reflective relationships with the machines that can be characterized as productive, affective, and intra-active" (Barad, 2006 in Gardner and Jenkins, 2015, p.2). Gardner and Jenkins argue that 'users' experience with these devices is also conditioned by stories told to us by science media, science policy, and health recommendations, where

biometric data is represented as 'the solution' – as always already a good, productive, and useful thing to remedy flawed bodies and behaviours" (Gardner and Jenkins, 2015, p.8). They argue that when looked at closely, devices are constructed in such ways that they tend to proscribe behaviours rather than allowing users to engage freely with the devices. Gardner and Jenkins also suggest that these devices advocate that corporeal limitations should be transcended by technological augmentation (Gardner and Jenkins, 2015).

Gardner and Jenkins show how by informing the user to resist/disobey the seemingly technological authority, users are able to interrogate and 'play' with the representation. By doing so, a different interaction arises. The relation of the user and the representation change, instead of a mirroring relationship as described earlier, the representation starts to become an extension of the body. And, the seemingly technological authority starts to break down, as users experience the technological limitations rather than the corporeal limitations. Thus, either by changing or being transparent about the suggestion that digital health tracking apps can transcend corporeal limitations the user should be able to interrogate and also deviate from the norm set by the app. (This immediately hints at the distribution of power when using digital health tracking apps, but that will be discussed later on.) For representing bodies when designing digital health tracking apps, this means a transformation in the approach of the technology as an objective and knowing entity to treating the technology as a situated and un-knowing entity. Which alludes to the following part: how to make the developers view accessible?

Access to the developers' view
Representations of bodies are designed with data derived from bodies via sensors (at least in the case of Runner Assist). Data is a snapshot of some reality, in the same way, a picture is a snapshot of another reality. It can only say so much about something in a specific time and at a specific place. It is in the context in which data is used and perceived that meaning is created. Therefore, metrics in themselves tell limited details about bodies, they are a specific way of tracing bodies. Meaning given to data is done by the context in which users

and designers decide to collect, analyse and interpret their data in the places and with the expectations in which they do so. One option of allowing users access to the developers' view, is to show how and what story data is telling. The following will provide insight into how some of the theory discussed in chapter two is already being connected to practice.

Giorgia Lupi, information designer at Pentagram (and formerly design director of Accurat) is concerned with designing data visualisations that represent qualitative information and that renders and presents its more nuanced and human aspects (Pentagram, 2019). She has initiated 'data humanism' (Image 5). Data humanism entails an acknowledgement of data as not objective nor as a hail grail to tell the truth, but rather acknowledge human imperfections of gathering data. In working with data, one should figure out how to visualise uncertainty, possible errors and its imperfections (as these make the story). Designers should do so, by keeping in mind that data is a powerful tool for designers in bringing stories to life (Lupi, 2017). Visual designers working with data have the power to transform the abstract and uncountable into something that can be experienced and directly connected to human lives and behaviours. This would become difficult if the obsession for the numbers and technology would be the leading factors in the process of design (Lupi, 2017).

Lupi argues for a first stage of visualising data without technology. In doing so, she wants to use data to explore the mind and the words used rather than the activities involved. Using data as the start of a conversation and not as an end, Lupi argues data is merely a lens through which reality is viewed, so it should not become an end. In order to show what Lupi's designs entail this paragraph will shortly discuss a project, she did with fellow information designer Stefanie Posavec (2017). 'Dear data' is the name of the project. In this project, both designers send each other a year long hand-drawn postcards in order to get to know each other better. Subjects on the postcards were for example: how often they laughed, negative feelings felt, music preferences etc. This resulted in cards that were displaying data, but not in the objective and dominant way this is usually done. With this project, Posavec and Lupi showed that there are alternative ways of making sense of data, and when done

Image 5: Data Humanism: a visual manifesto by Georgia Lupi

Image 6: Cards from the 'Dear Data' project

without technological tools, they can be much richer and transparent. They question the technological approach (and the impersonality that comes with it) and design data and connect numbers in what they actually stand for: knowledge, behaviours and people. Data is storytelling (Posavec, n.d: Davis, 2017: Lupi, 2017).

Another example is a project initiated by data science, design and development studio Accurat. Their 2018 project "Building Hopes" is an experimental augmented reality (AR) app that explores access to Google trends data in a way that invites its users to reflect critically on their interpretation of the data. In experimenting with visualising data in an AR environment, as well as implicitly letting users create their own frame of reference this project shows the importance of allowing the context of an interface to be interrogated. They build this project from the idea that Google trends will have a different meaning for everyone. By having people make a conscious decision on the reasons why a topic is important them, they want to create a more meaningful and personal experience of interaction as users will have to think critically about the framework they choose. (Accurat, 2018)

Image 7, 8: Stills from 'Building Hopes' app, different building blocks in different locations

Both examples, the Dear Data project, as well as the Building Hopes project, show how interaction with technology can be re-conceptualised. The Dear Data project shows that data is merely a lens through which reality is viewed, as each time two designers make data-visualisation from their situated perspective (one living in the United States, the other in the United Kingdom for example) it are 'views' of reality. By allowing the observer to also observe the framework of interpretation this project shows that it is possible to incorporate and be transparent about the developers' view. The Building Hopes project goes even further than being transparent about the developers' view, this project also incorporates the shaping of rhetoric. By letting users choose their own subjects and what is important to them, the app makes aware that users find themselves in a decision making, interpretive process. This also is a shift in interaction with the interface, as now the interface is acknowledged as being fuzzy and hybrid, and part of the process of designing an app.

Redistribution of power

In exploring how theory and practice could be connected the previous parts aim at a transparent process in which it is made clear that the user finds him/herself in a process of interpretation - as well as the perceptual nature of the representation itself. Now, the previous two paragraphs made were directed at two considerations: (1) the user of the app should be able to interrogate the representation and (2) the view of the creator should be made accessible. These two requirements intuitively allude to the third requirement: equal power distribution. As was discussed, there seems to be a technological authority (referred to by Haraway as the 'God Trick') as it is not acknowledged within the designing of these apps that numbers stand for knowledge, stories, and people. The following paragraph will be a conceptual exploration of how to take these requirements (and equally divide power) into account when representing bodies when designing digital health tracking apps.

Going beyond existing design practices: a conceptual exploration of designing

By allowing the user to interrogate the representation as well as the information provided, he/she has the power to create their own understanding of the representation of their body. As every representation embodies a certain perspective of what body is and how it should function, by being open and clear about these implications, designing of apps can become an interactive and simultaneous and instantaneous active process with a contribution by user, designer, and technology. By doing so, this app aims at moving beyond humans as digital data subjects in which user has more power and thus the ability to use the app as an extension rather than a mirror. Data from self-tracking practices allow for a body that is controlled by reason, it is seen as a body that can be transformed and improved in order to become happier and excel in being healthy (Ruckenstein, 2014). Thus, self-tracking in metric culture has an effect on the way bodies are perceived and understood. In regard to this perspective of body, the representations within the apps that provide recommendations for exercise, diet, or another aspect are viewed and perceived as objective and pure sources of knowledge of bodies. By giving power to the

subjective and situated body, the notion of human in human-centered design can be transformed. From a shift in focus on representing, and also incorporating a view from the body instead of merely a technological and cognitive focus, the user as a vital part of the process can become part of the interaction. This evolves from a representation that is alienating and privileging certain perspectives over others to a representation that can be interrogated by users themselves.

The previous examples (as well as discussions at TRIMM) were part of the inspiration and exploration for the following prototype. Resulting from the three considerations previously mentioned, the following requirements for designing the conceptual prototype came into being: (1) the app should provide a framework in which the user is aware that he/she is interpreting information that has been put in a framework, (2) the app should tolerate the user interrogating its representation, (3) the app should encourage the user to be part of the design process. Putting into effect these 3 considerations this app should aim at a transparent and interactive process. Also, in trying to overcome assumptions being build into the design process every assumption should be transformed into a question. This could take place in the process of representing or when fitted directly posed at the user. So that the user is able to express power and disagree with the representation, and should be able to alter the representation. This model[9] is built with the assumption that opening up the representation and allowing users to have more control and be part of the process of designing the representations of their bodies, will contribute to a more interactive and more transparent interface in which views from subjective and lived bodies fit. This model is a first attempt in operationalising the concepts discussed in this thesis, it is therefore not conclusive. In translating the considerations made and develop a model that adheres all requirements the following will, as detailed as possible, discuss considerations made when designing the model.

The model is based on the existing project Runner Assist. This project is currently in development and this model is an application of the concepts discussed in this thesis. The model is not used in the actual development of the project. Crafting the model of concepts discussed in the thesis started with several brainstorms on paper and some discussions with

9. The term used for the conceptual exploration is model, as this term seems best fitted. The model is not finalised. It should be considered as an indicative for how to apply the previously discussed theory in practice.

colleagues at TRIMM questioning how to best translate the concepts in this thesis into a visual model. These analyses were then further deliberated, and the first wireframe sketches with the conditions needed for the model were made. The first sketch shows how considerations are translated into actual functionalities - and shows the first three screens that are considered central to the design.

Figure 5: Exploring screens and functionalities in approaching the product as a process
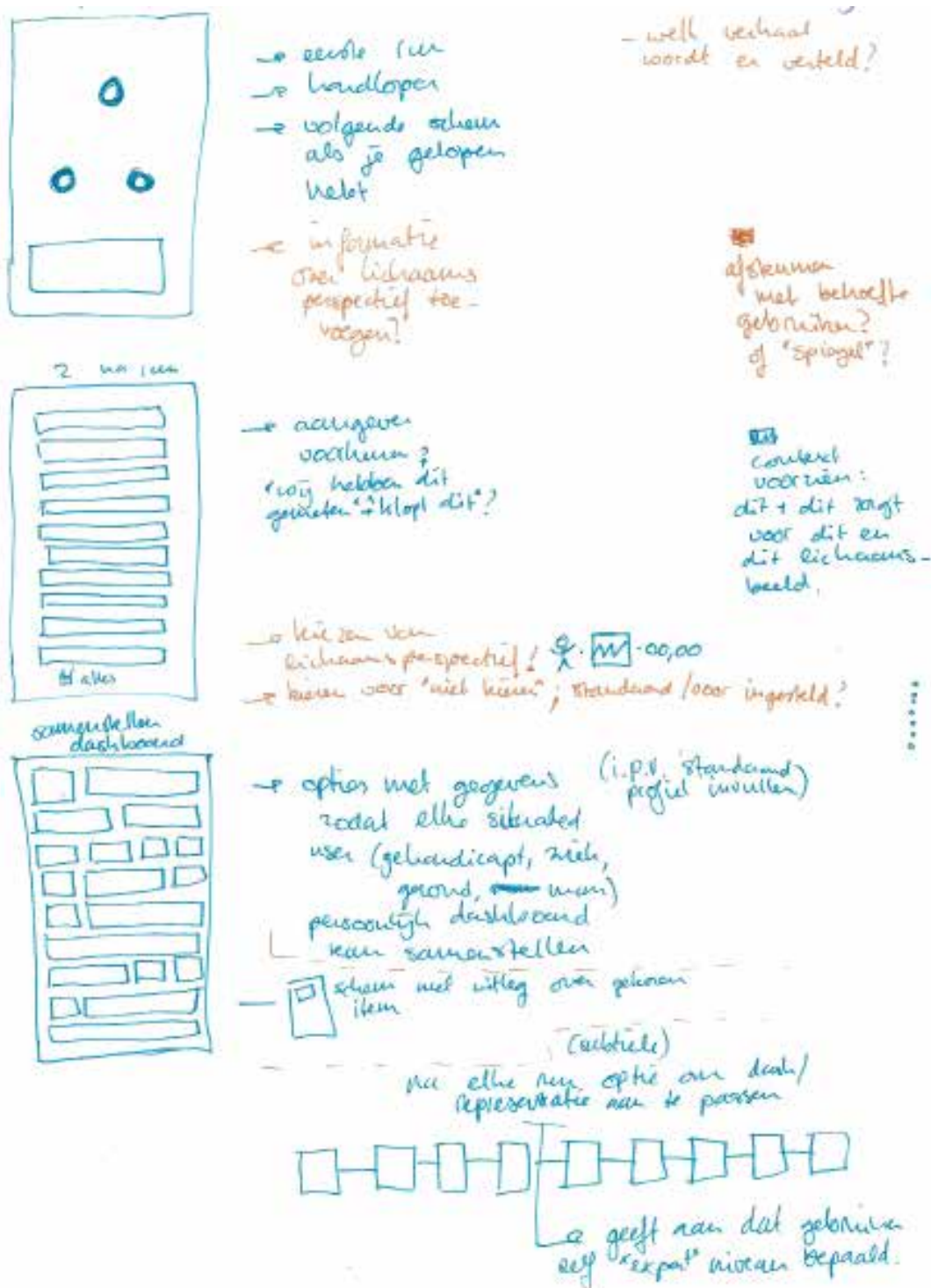
The following is a description of the model, exploring how an app with a processual nature could function.

When a user downloads the app on their mobile phone, a first 'set up' run should take place. This could be referred to as the 'building the app' run: think of it as a box full of possibilities and functionalities that can be used without selecting or preferring one over the other. (There might be a possibility of adding a little element that informs the user how this box is filled/what the possibilities are.) This is the first element that shows that the user has power over that box of elements. By starting with an 'empty box' the user has the possibility to understand the interaction with the app as a process in which he/she has the power to build and determine their own representation.

If this first 'building the app run' is completed, the app should show a 'checking' screen: 'the app measured this, do you think this is accurate?' and 'what are the things you want to monitor?'. (There might be a possibility in which the user can choose their visual representation of their body (i.e in numbers, graphs or an illustration) so that the user is provided with a certain context in which he/she can emphasize their preference. This is where the user finds him/herself in the process of interpretation, where he/she can critically reflect on the selections they make: do I want to focus on my blood pressure, or rather on my walking speed? The user can set their limitations, considering some as corporeal limitations, and some as un-important.

Now that the user has set up their framework of interpretation of their body, the dashboard can be created. This dashboard would exist of building blocks that can be moved around or altered at any time. Every situated user should be able to add new information, delete unwanted blocks or create new visuals. This screen also acts as what usually is referred to as a 'user profile.' (There might be a possibility with an extra information button, explaining the assumption of the building blocks.) The user should be able to suggest its preferences and therefore be able to design its dashboard and function of the sensors, allowing a personal dashboard for every user (disabled, pregnant, female, male or anything else). This is how power distribution remains equal, as the user is able to adjust the representation. This also indicates the processual nature of

interaction with technology, emphasising the continuing change in time and space.

Figure 6: Wireframing screens. From left to right: splash screen, setting up first run, running, questions for verification, option for choosing how to visualise, some information on developers' view, adjustable dashboard, new run, (second option) running and options for choosing how and which feedback to perceive.
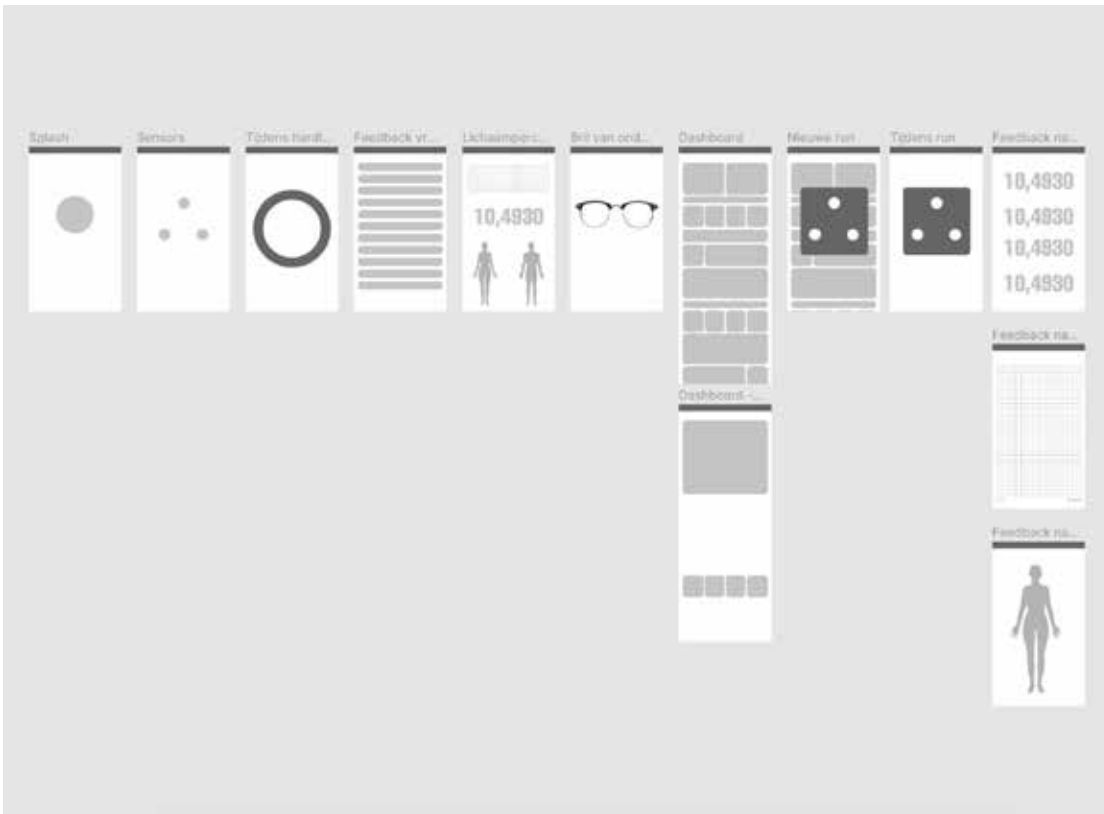
As the model is non-linear and infinite these sketches only entail screens, that should be accessible in any way the user wants to. By not drawing a user journey these sketches are trying to overcome any notions being set in stone and allowing the users themselves for defining their use and the role they want to partake in co-designing this application. The user journey should thus be considered as a non-linear and infinite journey in which the process depends on the interaction between user and technology.

The model shows that boundaries between notions of designer, users, and technology start to blur. The lens of interfacing showed that an interface should be regarded as a hybrid and multifaceted entity. In embracing this conceptualisation of the interface, it is possible to move beyond existing design practices that identify the human as user of

a product. Tracing the rhetoric used shows how and in why specific actors are defined by others. Embracing the interface as an obscure, hybrid and fuzzy term that is multifaceted with different meanings in different contexts allows for a new perspective on interaction. A perspective that goes beyond linearity, beyond identifying the user as user of a product, and beyond identifying the product as an end. The product is part of a process in which an enormous amount of actors (technological, human or spatial) take part.

Conclusion

By analysing certain implications that come into being when representing bodies as having an objective truth, this thesis has shown the pressing need for a transformative approach to designing digital health tracking technologies. The lens of interfacing that was developed in chapter 1 is a framework that provides new insight into existing processes of self-tracking applications making use of sensors and data designed with a human-centered design approach. This exploration of a transformative approach of designing digital health tracking apps, should in itself also be considered as a process that has taken time at a particular place with a particular goal in mind. Thus, also in my research assumptions and beliefs slip in, although I try to be as self-reflective and open as possible about these - so that the story of this thesis is transparent and accessible. The lens of interfacing showed that it is needed to re-conceptualise the notions of human-centered design as these are defining 'human' and in this case, 'health' for specific goals that might not always be of the human/users best interest.

By introducing the lens of interfacing that considers an interface not merely as a technological object but also something that is deeply embedded in culture and history this thesis allows for implicit assumptions to become explicit. Via the lens of interfacing this thesis has conceptualised interaction as a simultaneous process between bodies and

wearables. By taking a pressing example such as period-tracking apps it showed the importance of understanding the underlying implications of representations. As interfaces allow for a transformation of understanding between a user(s body) and technology, interfaces contribute to the interaction between those. An interface is an active gateway between and among users and technologies. Sensors and data affect the representation of the human body, as they allow for a different perspective on and interaction with body.

Sensors and data were what set the inspiration for starting this analysis in the first place, as these are the transformative elements that allow to see actors and relations in a new perspective. It is, because with the rise of wearable technology and data practices that users are able to keep track of their bodies at a much higher pace and larger volume than ever before, that the interaction between human and computer is changing too. These developments thus have an impact on the designing of apps that support these self-tracking practices. It is needed to take into account, in the design process, that technologies and users have a meaning making role in the process of interaction too. As was argued, a re-conceptualisation of the process of designing a digital health tracking app is needed.

In analysing the broader context in which sensors and data can have an effect on representations of bodies the thesis showed that development of apps do not happen in a vacuum. It is exactly because we live in a metric culture, with high emphasis on the objectivity of numbers and technology that allows for certain implications to arise. By showing how digital health tracking apps can interfere with users' understanding of their own bodies, as well as how dynamics arise that allow for users perceiving their bodies via the developers eyes, the basis for a transformative process was laid out.

As this thesis is about design and the process of designing, I strongly believe it was much needed to connect the theoretical deliberation with practice. Only by connecting theory and practice the understanding of an interfacing process can evolve and advance. New issues that arose while writing chapter 3 were (amongst others) on the act of resistance, user acceptance and authority of design. I would thus argue that for further research it is needed to elaborate on the subject

of user resistance in relation to design. To what extent is it possible to design resistance? Should this deliberation be incorporated in a transformative design process? What are the elements that should be incorporated in a design process in order to provide this transparency and interaction? These processes should be uncovered and looked at very carefully. Another recommendation for further research is to explore the actual use of products that assume a transparent and interactive process as a better design outcome. How do users actually take the design into account and relate to it? And how about authority of design: how to account for the affect that technologies have on the relation between user and developer? These are some example questions in the domain of design (that arose when putting theory into practice) that should be further investigated. Other recommendations for further research can be on the phenomenon of bodies on servers, datafying bodies and the representations that arise from that. The lens of interfacing could also be extended, allowing for highlighting and strengthening the processual nature of human-computer interaction.

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