IoT as Simple as *Do Re Mi*

A micro-figurational approach
to the social context
of Internet of Things skills
and digital inequalities

Alex van der Zeeuw

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prof. dr. ing. A.J.A.M. van Deursen
en assistent-promotor dr. G. Jansen

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There is nothing more difficult to convey
than reality in all its ordinariness.

— PIERRE BOURDIEU

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CHAPTER 1

Introduction

1.1 THE PROBLEM OF 'AS SIMPLE AS *DO RE MI*'

Do re mi could make you think of a song by The Jackson 5 or from *The Sound of Music*, or you might use it as slang for money. It could also make you think of the first three solfège syllables used to mentally hear pitches and intervals in a piece of music or to distinguish between notes on a musical scale. However, using *do re mi* as syllables in a solfège system might require aural skills or ear training. The solfège system can be very helpful to read music, but its benefits can be difficult to discern if you are not familiar with it. The Internet of Things (IoT) is not much different. On the one hand, the IoT consists of everyday objects that are simple to use, such as lamps, thermostats, activity trackers, pedometers, bicycles, doorbells, solar panels, curtains, washing machines, blenders, or coffee machines. On the other hand, these objects can become substantially more difficult to operate or comprehend when enhanced with an internet connection, artificial intelligence (AI), and algorithmic decision-making capabilities. Similar to the solfège system, the IoT requires familiarity or training, a social context to apply it, and more importantly, being able to recognize where and when it provides assistance to make it beneficial. As not everybody is able to benefit from new waves of technology, this research aims to gives us insight in how digital inequalities emerge as people are willingly and unwillingly subjected to the digitization of everyday life (Van Dijk, 2020). Specifically, in this research we aim to examine the influence of the social context on how the IoT is being used and why some people are more skilled to benefit from the IoT than others.

The IoT encapsulates a wide range of devices and an even wider range of options to apply these devices. These ranges can make it difficult to grasp what we mean when we refer to the IoT rom an technical perspective (Whitmore, Agarwal & Da Xu, 2015), and it leaves a gap in our understanding of how the IoT contributes to digital inequalities from a social science perspective. First, notably, this research only focuses on IoT devices available to consumers (in 2017, with the start of this research). Thus, IoT applications such as those used in agriculture, industry, or hospitals are excluded. To guide us any further on what the IoT is, we can define it using four aspects that are generally agreed upon in IoT research (Atzori, Iera & Morabito, 2010; Gubbi, Buyya, Marusic & Palaniswami, 2013; Van Deursen & Mossberger, 2018). First, the IoT includes everyday objects that can gather an understanding of their own environment through local sensing and storing and processing capabilities. Second, IoT devices can communicate information about themselves with identifying and networking capabilities. Third, these IoT devices involve communication networks between objects, objects and persons and from person to person. Fourth, the IoT can make autonomous decisions.

Another way of understanding the IoT is by using its own technological hierarchy, as outlined by Li, Da Zu and Zhao (2015). When Kevin Ashton coined the term IoT in 1999, the naming was based on wireless networks that use radio frequency identification (RFID), which are mainly networks of passive identification. In 2005, devices began to use wireless sensor networks (WSN) and low-energy communication between devices. The year 2012 marked the introduction of Smart 'things'. Mobile computing allowed for cooperating operations of objects and connected devices. Finally, Li, Da Zu and Zhoa predicted that by approximately 2017, the IoT would largely contain an advanced fusion of sensors, fast wireless connectivity, and predictive analysis. At this stage, it became possible to experience the IoT as an autonomous decision-making system and AI distributed through everyday objects. Most of the IoT uses different layers of sensors and devices that still use RFID but are also situated in networks with advanced decision-making capabilities.

With these aspects of the IoT, we can describe devices that are connected in a way that allows them to send small amounts of data to a connection hub that performs the computing, makes decisions, and communicates with other devices to make them work together. For example, solar panels may activate a dishwasher when the sun is shining. Similarly, a smart security system may send a message in case of registering an event and turn on the lights in a natural pattern starting from the bedroom to the bathroom, hallway, and living room. Moreover, the IoT allows people to interact with others they have never met before, such as when using a walking route sent to an activity tracker or by comparing energy consumption between households.

While it can be difficult to explain what the IoT is, it can be more difficult to explain what the IoT does. This is partly because subcategories of IoT devices do not always correspond well to how the IoT is being used. Do people use smart lamps to reduce their energy consumption, for security, or for comfort? Is a smart weight scale in the same category as a wearable activity tracker, or is it a stationary domestic product? What happens if people start considering privacy issues? Are security cameras that store pictures less intrusive than smart thermostats that track geographical locations? If we aim to compare how people can benefit from different IoT uses, predefined categories might limit our understanding of how the IoT is being used in a social context. Specifically, as a unique defining feature of the IoT is that it is ubiquitously situated and applied in a social environment.

Instead, we may take inspiration from the solfège. As a fixed-do system, *do re mi* always corresponds to C, D and E, regardless of whether the music is on a C major scale. However, what makes the solfège useful is that it can be used as a movable-do system where on a D major scale, for instance, *do re mi* corresponds to D, E and F#. Thus, the moveable-do allows one to notice the difference between the function of notes on a scale regardless of what key the music is in. It is a uniform skillset to approach different keys in music and how notes relate to one another. The overlap between IoT applications requires such a uniform approach to understand the relations between IoT applications and the context in which the IoT is applied. This approach would allow us to gain an understanding of a skillset in the function of IoT applications and devices coming together in a melody of every use. Consequently, such a skillset can tell us how the IoT is made to benefit people and how the IoT provides value in an applied context.

A uniform skillset for the IoT that gives meaning and value to the IoT by providing a context in which to apply it can greatly improve potential benefits from using the IoT. However, those skills might be easier to acquire for some, while for others may encounter great difficulty or might perceive such an endeavor as frivolous as the IoT. Fortunately, the solfège can inspire us once more. A large difference between using *do re mi* as slang or as a movable-do system is that the value of the latter is made accessible largely through music education, which is frequented more commonly by families with higher incomes and higher education (Bourdieu, 1984; Bennet, Savage, Silva, Warde, Gayo-Cal & Wright, 2009). In other words, those with a stronger socioeconomic position are more likely to have better knowledge about what *do re mi* can do and contextualize accordingly. That is, *do re mi* can be easy to use, but it is easier for a cultural upper class with training in such pursuits. Unfortunately, this pattern is observed not only for the solfège.

Those in higher socioeconomic positions generally have more access to knowledge and in turn, make better decisions or have things that benefit them more. This is commonly referred to as a knowledge gap (Tichenor, Donohue & Olien, 1970), and this may also describe what happens when people start using the IoT.

Although the IoT consists of everyday objects you can find at home or carry with you on your wrist or your bicycle, it is also very much a digital technology. Digital technologies, such as the internet, have often been studied in terms of a knowledge gap—mostly formulated as digital skills—to demonstrate that digital inequalities are continuing to increase (Wei & Hindman, 2011; Van Deursen & Van Dijk, 2014; Helsper, 2017). That is, digital inequalities increase not only by having access to the internet but also by how the internet is being used. Moreover, those with a better skillset are in better positions to translate internet use into tangible outcomes (Scheerder, Van Deursen, & Van Dijk, 2017). Moreover, elderly (Blažič & Blažič, 2020), poorer (Gonzales, 2016) and less educated people (Scheerder Van Deursen, & Van Dijk, 2019) are experiencing increasing difficulties catching up. With the IoT, we might expect a similar pattern of those who have more proficient skillsets to be in a better position to save on things such as their energy costs and consumption or to improve their health. As our preliminary research[1] shows that the IoT is being used more by younger and higher income people (Van Deursen, van der Zeeuw, de Boer, Jansen & van Rompay, 2021), the IoT promises to be the next frontier for digital inequalities with more than 50 billion IoT devices already in use (Alam, 2018).

In summary, the solfège teaches us three lessons to help define problematic relations between the IoT and digital inequalities we aim to resolve in this research. First, the social context wherein the IoT is being used is detrimental to how people can benefit from it. Second, a uniform skillset can help us understand how devices function relative to each other. Third, the skills used for the IoT are not easily accessible to everyone. While internet research has shown that digital skills can influence the gap in digital inequalities, the social context that influences how skillsets are acquired and in which they are applied is understudied. This lack of attention results from the fact that with technological advances, socio-contextual research can be slow to catch up. However, contextual research can be highly valuable, as shown by the work of Maria Bakardjieva (2005) on using the internet at

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1 Available in the appendix

home or the work of Rich Ling (2010) on new ties with mobile phones. In an effort to make such a seminal contribute, we aim to address the social context of inequalities with IoT use early.

Moreover, this research provides a unique perspective on digital technology as it is becoming more ordinary. For example, when the first study was conducted in 2017, Google Home was not yet available in the Netherlands, whereas now, in 2021, the Google Home box is given away with a paid subscription to YouTube or when purchasing Philips smart lights. Therefore, the concepts developed in this research are based on the IoT but will improve our conceptual understanding of the role of the social context with new waves of digital technologies; it builds a framework for societal change mediated by digital technology. Before delving into the social context we study in this research, we first discuss the IoT in a broader societal context and the overarching theory used to frame this research Then, we discuss our research approach, our research question, and provide a chapter overview with sub-questions.

1.2 THEORETICAL FRAMEWORK OF FIGURATIONS AND THE IOT

The solfège exemplifies how skills are valued culturally in society and how benefits are contextually defined. It also signals the use of theatrical metaphors that will be used throughout this research. The overarching theory used to frame the research was developed by Norbert Elias, who wrote about the civilizing process. Elias also used metaphors from theater, for instance, to describe how certain practices were pushed into the backstage to avoid others from experiencing the painfulness of certain behavior, such as moving slaughtering a pig for a feast to a kitchen area, or blowing your nose in a handkerchief and later excusing yourself (1994 [1939]). Elias based this shifting threshold of painful behavior and increased emotional regulation mostly on etiquette books. While etiquette books might be slightly challenging to find, etiquette is everywhere. Such norms include when to use the mobile phone at dinner, secret texting, or how to reply to text messages (Ling 2010). The IoT has similar social conventions and involves practices better left to a backstage area, such as not publishing your bike route within 500 meters of your home or updating software and fixing stability issues when other household members are asleep.

However, conventions are only used to set a stage. More important is how people move around different stage regions. For this topic, Elias used the metaphor of figurations. Social figurations are often compared to social networks but with an emphasis on changing relations and tensions. Or, in Elias's words:

> *By figuration, we mean the changing pattern created by the players as a whole—not only by their intellects but also by their whole selves—the totality of their dealings in their relationships with each other. It can be seen that this figuration forms a flexible latticework of tensions. The interdependence of the players, which is a prerequisite of their forming a figuration, may be an interdependence of allies or of opponents (Elias, 1978, p. 130).*

Elias (1983 [1969]) illustrated the tensions of tug-and-pull between allies and opponents using the example of the French court society during the reign of the Sun king, Louis XIV, at the palace of Versailles. With violence pushed to the backstage, members of the court were left to politics and the rules of etiquette and manners that dominated their playing field. Rather than reacting violently on the spot, they plotted possible future retaliations, sometimes even by creating temporary alliances with enemies, to gain an advantage or to mitigate a disadvantage later on. Moreover, in this era, personal and official regulatory functions were not yet divided, and neither were the corresponding interests. In effect, members of the court became interdependent on each other for in terms of their positions of power, services, and protection. The resulting network of interdependencies eventually held the king and the court hostage in its figurational dynamics, unable to reform tradition without jeopardizing their own position (Paulle, van Heerikhuizen & Emirbayer, 2012). As the king and the members of the court were impaired by collective fears of downward mobility and losing power, chains of interdependencies lengthened to gain political influence.

The court society's lack of distinction between personal and official businesses caused a mixing of what could be offered to establish alliances. In the context of our contemporary digital society, we can find similarities with companies such as Amazon and Google that have become intertwined with each other through the services they provide, partly through IoT products. Google and Amazon are two enormous companies with very different backgrounds: a search engine and an online bookstore. However, they sell products that provide similar services. Google has Google Home, Google assistant, and Chromecast, while Amazon has the Echo, Alexa, and Fire TV. Because they are competitors, they can help illustrate a latticework of tug-and-pull tensions. In 2015, Amazon and Google were in a stand-off when Amazon decided not to sell Google products through their webstore[2]. It might seem like a sound business plan to limit your competitor's platform. In 2017, however, Google responded by no longer making YouTube, a somewhat popular video platform they own, available on Amazon's hardware. In 2018, Amazon started to sell Google's Chromecast again, and in 2019, this feud ended with both Amazon and Google agreeing to give access to each other's services. One cannot simply outcompete the other without repercussions, even if the repercussions apply to different services or goods. These interdependencies keep their positions relatively stable.

When considering positions within these figurations, some players, such as Amazon and Google, are able to strengthen their position, whereas others are being tugged and pulled around, such as consumers. For those entangled in increasing chains of interdependence who hold less secure positions, the goal is not only about trying to keep up but also about prevent downward movement. When chains become longer, the risk for weak links in the chain increases. This is certainly the case with the IoT; as the IoT is a relatively new technology to connect objects to the internet, it can be difficult to assess how it can be exploited. Consider an example from 2017. An article reported that a fish tank became an unexpected but vital object in hacking a casino in North America[3]. The casino had a fish tank with sensors connected to the internet to regulate temperature and food and to measure the cleanliness of the water. IoT devices tend to lack adequate protection, and hackers used the IoT sensors to gain access to the network and send out approximately 10 gigabytes of data. In the same article, the FBI issued a warning for toys, namely that as part of the IoT, toys could disclose a child's name, location and other personal data. As the IoT can be used as a legal and illegal entry point into the home network, securing one's social position by increasing IoT benefits also requires minimizing unexpected exploitations.

While figurations in Elias's works do not encapsulate objects—explicitly by Elias using the term human figurations (1978)—, this does not mean that Elias was ignorant of how objects were used in power balances. A clear example of this understanding is Elias's (1994 [1939]) analysis of the fork in the

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2 Archived and available through: *https://web.archive.org/web/20210719122016/https://www.bbc.com/news/technology-48929892*

3 Archived and available through: *https://web.archive.org/web/20210719122101/https://www.washingtonpost.com/news/innovations/wp/2017/07/21/how-a-fish-tank-helped-hack-a-casino/*

civilizing process. Here, Elias explains how everyday objects are used for the tug-and-pull in social relations. Introduced from the Byzantine empire when a princess married a Venetian doge, the fork was first considered awkward until the upper classes adopted it (Goudsblom & Mennell, 1998). Now, the fork is considered to be more hygienic, but in the period between this shift of attitudes, eating without a fork began to be considered distasteful and awoke feelings of revulsion. The shame of being seen with soiled hands began to be permitted only for very young children. As such, the fork was used to mediate power balances social relations and draw distinctions between them, such as the civilized higher classes and the uncivilized children or poorer people.

The IoT may not shy away to define social relations either. Not only by indicating who is using or not using it but, as with the fork, through the visibility of how it is being used. And data from the IoT certainly is visible! To illustrate an excessive example, Forbes reported in 2019 that Jane Slater, an NFL network journalist, found out via Fitbit that her partner was cheating[4]. Jane Slater saw the data from her partner's Fitbit that showed an increase in heart rate at approximately four in the morning, without any other specific movements such as a step count. Fitbit stopped the option of tracking sexual activity in around 2011 when these data became publicly available on the internet by accident. However, Jane Slater still pieced together the clues. Although the interpretation of IoT data substitutes visible behavior, the IoT nevertheless evokes moral distinctions of permissible behavior similar to the fork. Both objects have a role in redefining power balances in social relations and social behavior; the difference is that with the IoT, certain behavior—including private behavior—becomes more observable through data.

What Elias showed through the court society of Louis XIV is that individuals' psychological makeup, their emotional regulation and thresholds of acceptable behavior, correspond to the structure of a society and that they change together (Elias, 1991 [1987]). This correspondence could be claimed for our digital society as well. The feud between Apple and Amazon could have played out at the palace of Versailles. Members of the court certainly would have found Fitbits and activity trackers useful to spy on each other and to regulate normative behavior in ceremonious rivalry. And, hacking a fish tank could have been the final knife in the back to eliminate an adversary.

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4 Archived and available through: *https://web.archive.org/web/20210719122147/https://www.forbes.com/sites/brucelee/2019/12/07/how-a-fitbit-told-jane-slater-that-her-partner-was-cheating/*

In other words, figurations, lengthening chains of interdependencies, and power balances in social relations are key concepts for understanding the social context of societal change, whether for the court society or our digital society.

1.3 A MICRO-FIGURATIONAL APPROACH

In a larger context, the court society of the Sun king might not be so different from our digital society. Importantly, power relations shift, but the balance of power is continually supported by all members of society, whether they are in strong positions of power or in weaker positions (Kuipers, 2018). From a broader societal perspective, positions of power may appear to rely on societal structures. However, people do have the ability to navigate and influence how power relations shift in a social context. For example, the skillful display of manners, etiquettes, or behaviors used to participate in ceremonious performances could help with upward movement and certainly protect against downward movement. Moreover, Elias is typically associated with research that studies longer periods of time (e.g., the civilizing process, 1994 [1939]), and similar research tends to focus on macroprocesses that involve centuries or decennia (Swaan 2001; Wouters, 2007). This approach can be daunting and ineffective for contemporary research. In this study, we propose an alternative approach that grants more power to individuals to influence figurations, examines shorter periods of time in which to observe empirical data, and adds objects to mediate social relations.

With this research micro-figurational approach, we make a specific distinction from macro-processes. The 'micro' is used to indicate that the durations of the processes are studied in considerably smaller intervals. Moreover, we add objects to figurations and analyze them on this micro-level of interaction. Much like the ballet has figurations of directors, principals, soloists, and the Corps de Ballet, individuals are interchangeable, but the figurations remain relatively stable. Elias (1983 [1969]) found that the court society succeeded common figurations in variations of the *knight-squire-priest-serf* and that a common figuration for the 20th century was that of the *employer-employee-manager*. When we add objects to figurations to emphasize social relations mediated by digital technologies, we may consider common figurations to be variations of *service providers-digital technology-user-proxy users*. Service providers can be manufacturers such as Google or Amazon, and digital technology can be whatever IoT objects or setup of IoT objects used by the IoT user. Proxy users are users who might not have immediate access to IoT devices or the main accounts tied to IoT devices, such as children or other members of a household who ask others to do things for them or on their behalf.

In our micro-figurational approach, we take three steps. First, we investigate a common figuration for the IoT in our digital society that involves everyday people. Second, we examine the interdependency chains that are established between units in this figuration. And third, we explain the maneuverability between interdependencies by the skillsets people have acquired or continue to develop. In this approach, differences in skillsets will account for the ability to change power balances between units in a figuration and give more agency to individual actors on a microlevel.

The impact of the lengthening of interdependency chains has been observed since the days of the King Louis XIV, but its hold on society in general may have been understated. With the IoT, we can certainly see another surge in the lengthening of interdependency chains. For instance, when someone turns on the heating at home, it typically involves a radiator button, a central heating unit, and a utility supplier. With the IoT, this connectivity would extend to a mobile phone, an internet connection, and an IoT manufacturer that ensures the software is stable and up-to-date. In turn, additional data are collected that can benefit more parties. Such a chain lengthens even more with proxy users, different IoT devices that work together, and overarching software structures. To emphasize the impact of interdependency chains, Elias wrote:

> *By virtue of this ineradicable interdependence of individual functions, the actions of many separate individuals, particularly in a society as complex as our own, must incessantly link together to form long chains of actions if the actions of each individual are to fulfil their purposes. And in this way each individual person is really tied; he is tied by living in permanent functional dependence on other people; he is a link in the chains binding other people, just as all others, directly or indirectly, are links in the chains which bind him (Elias, 1991 [1987], p. 16).*

Elias continues to explain that these chains are more elastic, variable, and interchangeable than those made of steel, yet they are real and strong. Moreover, these chains create networks of functions people have for each other, as they are socially bound to one another.

Elias defines three types of social bonds: economic, political, and affective. Economic social bonds emphasize exchange without emotion or personal conflict. These bonds are set up to operate autonomously from society and instead use rationally-perceived measures and focus on efficiency. As such, economic bonds tend to be contractual or involve agreements that facilitate collaborations between units in a figuration that do not necessarily share the same goals. In contrast, political social bonds broker power relations between units in a figuration that do share a common goal. Political bonds are used to regulate power resources that can increase productivity and efficiency, preferably without resorting to violence. Affective social bonds are used to describe emotional valences that bind units in a figuration together. More specifically, they can offer the gratification of emotional needs and feelings of emotional attachment. Within a figuration, affective bonds correspond to the warmer relations people have, relations that have cooled-off, or relations that are cold to begin with.

To understand digital inequalities with digital technology as ubiquitous as the IoT, it is important to understand how power balances shift in everyday economic, political, and affective bonds. In the last step in our approach, we focus on how these power balances can shift when people apply different skillsets to their own benefit. Research on internet inequalities has fabricated a useful catalog of skillsets for the digital environment (Van Laar, Van Deursen, Van Dijk, & De Haan, 2017). Much like etiquettes, manners, and political ingenuity were used at the palace of Versailles, internet skills are used to advance one's position on the internet. Internet skills can be classified as medium-related skills and content-related skills (Van Deursen & Van Dijk, 2011). Medium-related skills are the operational skills required to command media, and formal skills are required to use the formal characteristics of digital media, such as hyperlinks and action buttons. However, as the IoT is supposed to work automatically and unnoticeably with the aid of AI and algorithmic decision-making, medium related skills are expected to become less important after the initial setup (Van Deursen & Mossberger, 2018).

In contrast, content-related skills are expected to become more important to address the increased amounts of data generated by the IoT, which have become more ambiguous and complex (Van Deursen & Mossberger, 2018). Therefore, the information skills required to search and evaluate information become more important. Additionally, as the IoT communicates between devices and people, being able to manage communication also becomes more important. Communication skills are used to describe proficiency in the meaningful exchange of messages and managing contacts. Content-related skills also consist of strategic skills that are used to set personal or professional goals and to improve one's position in society. Internet skills are useful to understand digital inequalities with the internet, but we might also want to consider unique characteristics of the IoT. Accordingly, we would construct a skillset that build on internet skills but also account for the tension between operational skills and autonomy, data and information as economically viable resources and how the IoT is situated in a context of multiple users with different ratios of power.

1.4 RESEARCH QUESTION

The solfège system helped highlight the research problems for the IoT from an inequality perspective by underscoring that (1) the context wherein the IoT is being used is detrimental to how people can benefit from it, (2) we require a uniform skillset to understand how devices function relative to each other, and (3) skillsets used for the IoT are not easily accessible to everyone. To approach solfège problems, Elias's work provides a framework to demarcate our investigation of the social context in relation to the research problem in terms of figurations, interdependency chains, and skills that can be used to influence power balances in social bonds. While this explanation offers a conceptual understanding of this research, it might also make it difficult to follow what we intend to do. Therefore, to guide our research, let us simply phrase our main research question as follows:

> *Research Question: How can the social context in which the Internet of Things is used by everyday people explain the differences in IoT skills that perpetuate digital inequalities?*

This question reveals slightly more about what we are aiming to research. First, we aim to focus on skills used in the latticework of tensions, created partly by the IoT itself but certainly by the advancing digital society and its continuing digital inequalities. People tend to be stimulated or motivated to develop certain skills to achieve certain goals and must adapt when there are barriers that prevent them from achieving their goals. Based on our knowledge of the information gap, barriers might be more difficult to overcome or identify for the less educated (as a relatively stable indicator of cognitive ability (Erikson, 2016)) and, in effect, they may make it more difficult to develop certain skills. Thus, it can be more challenging to achieve goals or to understand how the IoT can benefit in the achievement of certain goals. That is, people can be less motivated to develop skills when they do not believe these skills are required.

Alternatively, certain skills can be valued as less important when interdependent relations compensate for them. Such is the case with AI and decision-making algorithms provided by IoT manufacturers that reduce the need for certain operational skills of the IoT user. Therefore, we understand educational levels to reflect patterns of cultural consumption and cultural values that are often associated with educational levels (Bourdieu, 1984; Bennet, Savage, Silva, Warde, Gayo-Cal & Wright, 2009). Educational level has consistently been a dividing factor in digital inequality research (Davies & Eynon, 2013; Hargittai, Piper, & Morris, 2019; Scheerder, Van Deursen & Van Dijk, 2017; Van Deursen, Van Dijk & Peters, 2011). Moreover, our preliminary research indicated that for education is not a decisive factor IoT ownership (Van Deursen, Van der Zeeuw, De Boer, Jansen & Van Rompary, 2021). Therefore, to sensitize our research to educational factors, we selected 15 higher educated and 15 lower educated participants. We followed these 30 participants and their households during a 15-month study through five rounds of interviews and two diary studies: one diary study using a mobile application and one diary study using log-entry data from IoT devices.

Second, we focus on IoT devices that can be used by everyday people. Earlier, we noted that we only included IoT devices available to consumers when this study started in 2017 but excluded other IoT applications, such as those used in agriculture, industry, and hospitals. While smartphones, smart television sets, or laptops may also be considered part of the IoT, we exclude them insofar as they are used for media entertainment or work-related activities. Phones and computers are included only if they are used as hubs to connect to IoT devices. To clarify, we focus on IoT devices that can generate tangible benefits in the domains of health, energy consumption, and security. In other words, we focus on devices and applications that generate data through everyday living, such as biometric data or aggregated household data, which can generate a technological feedback loop that influences everyday behavior. In the following chapters, we explore this research question with a series of sub-questions that aim to explain relations between concepts and broaden our conceptual understandings.

1.5 CHAPTER OVERVIEW

In Chapter 2, we first discuss the main methods used in Chapters 4, 5, 6, and 7. We use an abductive analysis approach that emphasizes an iterative process between theory, data, and analysis. Therefore, rather than repeating the methods section four times, it would be more practical to discuss our methods and methodological considerations in a separate chapter in greater detail. In Chapters 4, 5, 6, and 7, we study the same 30 households over a 15-month period. We visited each household five times for an interview with a main corresponding participant of this household. Each interview had a different theme that relates to each chapter: IoT adoption, affective bonds, political bonds, economic bonds, and IoT data risks and regulation. Additionally, we used two diary studies designed to complement each other ontologically and are therefore best described together. One diary study used a mobile application to measure intersubjective experiences using metaphors, and the other diary study used factually recorded practices via log-entry data from IoT devices. The method used in Chapters 3 is sufficiently distinct from the methods described in this chapter to justify describing their methods separately.

In Chapter 3, we start with a survey of the Dutch population. The aim of this survey is to test whether the IoT should be considered a collection of consumer or social objects, that is, if objects connected to the internet are used to make connections with others or if they are used as general consumer objects. The IoT platform can facilitate different manners of social communication that are easily overlooked when focusing on the novelty of smart "things." How people use the IoT socially will be crucial in understanding how people create, maintain, or dissolve social relations. Importantly, this inquiry assumes that the IoT will make us more connected through everyday objects. If nobody uses the IoT in this way, it would drastically influence our research approach. Rather than assuming a zero-sum situation, we ask:

Sub-Question 1: Who uses the Internet of Things socially?

We define the social use in terms of private use (which would imply no intentional social usage) and between sharing IoT data with strangers, with a partner, or with acquaintances. The who in this research question is captured by testing two frameworks for sociocultural backgrounds. First, we test how the social use of IoT devices is distributed as structural dispositions of economic, cultural, and social capital. Second, we test how this usage is distributed by internet-related skills. We discuss the inverse effects for social capital, income and education on private use and on sharing IoT data with a partner. Sharing with acquaintances and strangers is predicted by cultural activities. Sharing IoT data with acquaintances can be especially attributed to social relations beyond the immediate household. We conclude that varying figurations of capital and internet skills predict how the IoT is used socially. We also found that translating internet skills to the IoT does not yield significant results. Thus, we require a new framework for skills specifically related to the use of the IoT. We begin with the setup of this IoT-specific skillset in the next chapter.

In Chapter 4, we begin our micro-figurational approach by investigating how interdependency chains involving the IoT were established when our research participants started to use their IoT. The different ways that people start using the IoT ultimately determine its outcomes, benefits and how their IoT use can be exploited. As the IoT is socially embedded in a network of interdependencies and power balances between different parties, we examine how people positioned themselves in relation to others when they first started using the IoT. We begin by examining how everyday household activities become involved in an expanding IoT network of interdependencies with different organizations and stakeholders.

Sub-Question 2.1: How are interdependency chains established by IoT users?

With this question, we construct a common figuration of interdependency chains that will be used for the remaining chapters. Moreover, due to our results in Chapter 3, we propose an alternative skillset of IoT skills that emphasizes unique characteristics of the IoT. Using a digital skills framework, we adjust operational skills and collaboration skills to the IoT and construct choreographic skills to address the socio-materiality of the IoT. Then, we ask:

Sub-Question 2.2: How do interdependency chains influence which digital skills are used?

This question improves our understanding of people's ability to act upon power balances within interdependency chains. However, we also know that the lower educated continuously experience difficulties accessing information made available through higher education. As much of the research focus emphasizes educational repertoires, we tend to overlook alternative solutions by those who do not have access to higher education. Therefore, we pose our third research question to explicitly engage lower educational repertoires in interdependency chains of IoT use at home:

Sub-Question 2.3: How are interdependency chains coupled with lower and higher educational repertoires when starting to use the IoT at home?

With this final step, we employ education as a sensitizing concept to guide our findings toward alternative repertoires of action, specifically aimed at skills outside of the direct educational repertoire. We elaborate on

IoT skills by introducing collaboration skills, used to increase the effectiveness of IoT, and choreographic skills, used to increase the efficiency of IoT use. Choreographic skills are coupled with an alternative repertoire that utilizes skills outside of higher education. Self-reliance, consequently, will be discussed as an important distinguishing value for a cultural repertoire coupled with lower education.

In Chapter 5, we begin our analysis of different social bonds by examining how affective bonds and operational skills are related to vendor lock-in. Although Amazon and Google ended their feud in 2017 by agreeing to give access to each other's services, they would prefer to keep their customers for themselves, or better yet, lock-in to their products. Consequently, Google products work better with other Google products or Google-affiliated products; the same holds for Amazon, Apple or other large brands. We argue that access to most of the IoT and its benefits are hindered by vendor lock-in. However, people with an advanced set of operational skills relevant to the IoT are able to find creative ways to overcome vendor lock-in. As an antidote to vendor lock-in, we examine the interplay between creativity and operational skills by asking:

> *Sub-Question 3.1: Why are some people able to capitalize on the potential benefits of the IoT creatively, while others are hindered by vendor lock-in?*

To answer this question, we use a diary study via a mobile application that maps figurations of IoT devices and how they relate to their users in terms of metaphorical concepts of social proximity (distant-close) and social warmth (cold-warm). We discuss how users with the least access to IoT benefits are mainly task-oriented and consider IoT tools to solve specific problems. Users with a more playful approach are better positioned to access IoT benefits and further develop their operational skills. We elaborate on these differences with respect to the affective bonds between IoT users and their devices. For some users, using the IoT fulfills emotional needs as a hobby or an activity they enjoy. They consider their relations to their devices warm and close. For others, the IoT is more an apparatus used to solve problems in the background while they enjoy their time.

In Chapter 6, we continue our analysis of social bonds with political bonds and choreographic skills to make the IoT fit with preexisting structures of everyday life. The fish tank from the casino that was hacked in 2017 may have fit with the style of a casino, but unfortunately, it was not altered to fit the security level of that casino. As most IoT devices are ubiquitously placed in shared social regions, they require different social roles working together to be efficient or at least, to minimize their undesirable effects. By focusing on the political bonds used to knit people together for a common goal, we consider how inequalities within households are important for our understanding of digital inequalities perpetuated by smart-homes. As the continuing digitization of work-at-home, the IoT invokes tensions between stereotypically masculine roles in technology and stereotypical feminine gendered roles of household responsibilities. The IoT can also increase tensions between the role of parents and their children, as digital natives might be able to gain more influence in the household through their digital proficiencies. We specifically address different power relations between household members in relation to their IoT devices by asking:

> *Sub-Question 3.2: How do power dynamics in household routines influence IoT use at home?*

We answer this question in dimensions of materiality, accessibility, and harmony. We discuss how acceptance of the IoT's materiality by all household members is a key determinant of how well the IoT can operate. For accessibility, we discuss the politics of designating main accounts and their responsibilities regarding privacy. Parents can more precisely moderate their children, but data and privacy also require additional moderation. In terms of harmony, we observe that the IoT can benefit complex household choreographies. Finally, we note that traditional gender roles remain prevalent in smart-homes.

In Chapter 7, we discuss IoT data between parties with different goals—manufacturers and consumers—in terms of economic bonds. Similar to how Jane Slater figured that an increased heart rate logged on her partner's Fitbit was the result of cheating, people use their IoT data to draw conclusions and change behaviors. We use economic bonds to describe those relations that influence outcome-oriented strategies. In our analysis, we use two distinguishable strategies to highlight differences between IoT applications. The first focuses on the IoT as devices designed to work invisibly and autonomously. We call this strategy AI alleviation because it uses decision-making algorithms to reduce cognitive strain. In the second strategy, IoT data are used to motivate people by increasing their cognition of their behavior. That is, for Jane Slater's partner, the Fitbit was invisible enough to forget about during his activities at four in the morning, but for Jane, the data were highly visible. To emphasize these differences in how the IoT can be strategically implemented, we ask the following:

> *Sub-Question 3.3: How are strategic differences of IoT users influenced by the IoT as algorithmic decision-making tools?*

To answer this question, we are aided by log-entry data from IoT devices, which we use for log-entry diary studies. We address the IoT as a tool for cognitive alleviation; this usage can become more efficient with a better understanding of AI. IoT data can also cognitively motivate people. However, translating data into strategic behavior can be difficult if interpretation skills are lacking. Moreover, we elaborate on the differences that arise in how people assess the success of their IoT implementation, as sources that gain authority over truth have a defining influence on how digital inequalities take shape with the IoT.

CHAPTER 2

Methodology

2.1 RESEARCH STRATEGY

Before we collected the main body of data for this research, we collected novel survey data survey in the last week of January and the first week of February 2018 to test our assumptions of how the IoT was being used as a social object or as a regular object in Chapter 3. We also used this survey data in our preliminary research (Van Deursen, van der Zeeuw, de Boer, Jansen & van Rompay, 2021) available in the appendix. To the best of our knowledge, no other research in social sciences collected survey data on this topic. Therefore, we used a professional market research organization to obtain a sample representative of the Dutch population. The results from this survey determined how to proceed with our research strategy, particularly to aim for a theoretical sample based on education and what IoT devices we could expect as feasible selection criteria.

The research design for this project is greatly inspired by phenomenology, particularly phenomenology in the tradition of Heidegger (2010 [1927]), Merleau-Ponty (2013 [1945]), and Dreyfus (2014). While this research is not a phenomenological inquiry, it is meant to indicate our line of reasoning. We used methods that investigate how the IoT is *being* contextualized differently as being meaningful by different understandings of the IoT and how to use it. For some, the IoT can be nothing but a lamp connected to the internet, but for others, a smart-lamp is a device that creates ambiances of concentration or relaxation and offers protection against burglars. That is, its meaning is being constructed by how it is used. To emphasize this phenomenological character of how meaning is being made through IoT experiences, we use three methods inspired by phenomenological approaches to collect data from our sample of 15 higher educated participants and 15 lower educated participants over a 15-month period.

First, we investigate how meaning is being constructed during an interview process. This method allows us to consider how our participants construct meaning on their own terms. Second, we use figuration diaries to understand how participants position themselves according to intersubjective experiences with their IoT devices. These figuration diaries reflect how meaning is being constructed by how participants relate themselves to their devices. And third, with log-entry diaries, we gather factual representations of behavioral practices. This information shows us how meaning is being constructed by how the IoT is used in everyday practices. In unrefined terms, these three methods might respectfully be considered subjective, intersubjective, and objective. Alternatively, interviews are mostly based on language, figuration diaries are limited in their influence by language because they rely on sensational experiences reflected by broad metaphorical linguistic terms, and log-entry diaries mostly lack language interventions. Most importantly, these three methods are designed to collect data that are complementary to each other and will be discussed in more detail below.

The data were analyzed using an abductive analysis approach (Tavory & Timmermans, 2014). Rather than pursuing unattainable standards of deduction or induction, an abductive analysis is a more pragmatic approach to address empirical novelties and anomalies. It describes an iterative process that breaks with the distinction between a context of discovery and a context of justification and sees these as inseparable moments. The abductive analysis approach is guided by three iterative stages. The first stage involves revisiting the phenomenon. This stage highlights different experiences of a phenomenon that, in our case, entailed revisiting the interviews through memos written after the interview, audiovisual recordings of the interview, and interview transcripts. Initially, the data were organized with Atlas.ti based on the interview structure constructed beforehand. Transcripts and notes of the audiovisual recordings were then combined with the memos. These more extensive memos were key in summarizing surprising findings or irregularities during the interviews that were used as input for the next interviews. Consequently, much of the analysis occurred during the data collection process.

The second stage in abductive analysis can be described as data defamiliarization wherein data are being estranged from the familiar and dislocated from the taken-for-granted. For the interview data, this process means that excerpts were dislocated from the interview and compared to other incidents and cases (Glaser & Holton, 2004). To keep the analysis grounded in empirical data, incidents were first compared to other incidents to establish uniformity of underlying conditions and were generated into concepts. Concepts were then compared to more incidents for theoretical elaboration and saturation and with other concepts. Additionally, the figuration diary data and the log-entry diary data were used similarly as incidents. Thus, the diary data were compared with interview excerpts for elaboration and saturation of the theoretically emerging concepts.

A third stage of abductive analysis is used to apply different theoretical lenses for a more in-depth analysis attentive to gaps in existing theory and surprising findings (Tavory & Timmermans, 2014). The aim of this stage is not to falsify theory but rather to use novelties and anomalies to elaborate existing theories and build a better conceptual understanding of a phenomenon. The results of this analysis, in effect, are conceptually generalizable to other concepts and empirical cases.

2.2 SAMPLE OF PARTICIPANTS

In march 2019, we recruited 30 Dutch households with IoT devices to participate in our 15-month research, resulting in a theoretical sample of 15 higher educated and 15 lower educated. We use this theoretical sample based on our preliminary research (Van Deursen van der Zeeuw, de Boer, Jansen & Rompay, 2021) and education being a consistent factor for predicting differences in digital skills (Davies & Eynon, 2013; Hargittai Piper, & Morris, 2019; Scheerder, Van Deursen & Van Dijk, 2017; Van Deursen, Van Dijk & Peters, 2011). A lower education means that the highest level of education was no more than vocational training (Middelbaar Beroeps Onderwijs in Dutch), while a higher education can mean higher vocational training (Hoger Beroeps Onderwijs) and higher levels of education. As such, a lower educational level is mostly practical-based learning, whereas higher education is mostly theoretical-based. We limited our social categories by educational level to restrain our assumptions of predefined social groups and emphasize group formation instead (Latour, 2005). We recruited participants with at least one IoT device in their household (e.g., smart lights, thermostats, doorbells, locks) and who preferably had at least one device that measures biometric data (e.g., activity trackers). During our recruitment we prioritized household IoT devices because we found that most IoT users also measure biometric data with an activity tracker or a health-related application on their phone. Although these selection criteria proved rather constrained in 2019, we still aimed to maximize the variation in our participants by household size, number of IoT devices, rarity of IoT devices, field of work, or social influences by neighboring participants, family or colleagues.

We used flyers to recruit participants, and we used online platforms to spread our recruitment message. Furthermore, four schools distributed our recruitment letter via parents' newsletters. During the later stages of recruitment, we asked participants who had already signed up if they would know others willing to be contacted for our study. Additionally, we used the same recruitment agency for our survey to finalize our theoretical sample of 15 lower educated participants. Participants were invited to sign up via our website that explained our study in greater detail, how their data would be used and stored, and the agreement and conditions for their participation. To apply, participants completed a form with their name, contact information, and educational level. All participants were invited to sign up formally via

Table 2.1
Demographics of Participants

		Lower educated *n= 15*	*Higher educated* *n= 15*
Type of income	Single income	6	6
	Dual income	9	9
Children	None	5	5
	Below 12	3	3
	Above 12	6	6
	Moved out	1	1
Residential accomodation	Apartment	3	3
	Terraced house	9	9
	Attached house	1	1
	Detachted house	2	2
Household	1 person	1	1
	2 person	6	6
	3 person	4	4
	4 person	3	3
	5 person	1	1
	6 person	0	0

N= 30

our website, which included a more detailed description of our project, how their data would be used and stored, and conditions for their reward of 400,- euro's in participating. Table 2.1 shows an overview of our participants and their household compositions. For each household we interviewed the main participant who signed up for the research and met the selection criteria, but with 11 participants their partner did sit-in and contribute to the interview. Due to this limitation, our findings predominantly reflect how the IoT used from the embedded perspective of our main participants.

2.3. INTERVIEWS

2.3.1 Strategy of Interview Outline

Each planned interview covered a specific theme, so participants could answer without feeling limited by the justification of a previous answer. Most people answer according to certain scripts they have, including scripts constructed from before (Jerolmack & Khan, 2014; Lamont & Swidler, 2014). The aim of the interviews was to push beyond scripts and construct meaning in the situation of the interview, relying on the construction of meaning-in-the-making based on a foundation of cultural values. In a situation where people do not know what to do, they tend to rely on what is most familiar to them. That is, they anchor themselves to their culture. As such, by constructing meaning during the interview, participants reflect their habitual disposition, in the words of by Elias (1994 [1939]) and Bourdieu (1984), or habitude, in the words of Merleau-Ponty (2013 [1945]).

The first visits began by repeating the research aims as stated on the recruitment website, explaining how we handle input as sensitive data and emphasizing that participants could stop their participation at any moment during the research and could request to withdraw their participation after the research. The first visits also started with a house tour (Brown, Coughlan, Ploetz, Tolmie & Abowd, 2015; Mitchel, Mackley, Pink, Escobar-Tello, Wilson & Bhamra, 2015) where participants were asked to introduce and show their devices, device placement, and mobile apps they used. Participants guided the researcher through their devices, sometimes quickly demonstrating the main buttons or the accompanying mobile application. Each following visit started by asking participants if they had any questions or concerns about the research and were asked for permission to record the interview using a GoPro Hero 7 (for audiovisual data). The interviews began with a set of recurring questions that were separated from the overall themes. These were a set of questions that asked about changing things to their IoT setups, learning or noticing anything new about their IoT devices, and experiencing problems or having to ask for help. During the remainder of the interviews, participants were stimulated to 'show and tell' (Woordward, 2007) and to offer short re-enactments of their device usage (Pink & Mackley, 2014). The added visual component during the interviews helped to keep the interview open for the free flow of conversation while being supplemented with structured interview questions.

The interview questions on the themes of affective, political, and economic bonds were structured according to research topics on internet domestication (Berker, 2005), digital skills (Van Dijk & Van Deursen, 2014; Hargittai & Shaw, 2015), learning practices in parental mediation (Plowman, 2015; Ito, Baumer, Bittanti, Cody, Stephenson, Horst & Perkel, 2009), influences of family and friends inspired mainly by social learning in supportive networks (DiMaggio & Garip, 2012), and influences by 'warm' experts, those critical of IoT use, and the supporting role of organizations and manufacturers (Bakardjieva, 2005). At the end of the visits, participants were asked if they had questions about the interviewer, the research, or if there was anything else they would like to address. These responses provided additional information for the next visits. Total interview time for each household lasted on average 2:18 hours (Min= 1:24, Max= 3:14) and on average 28 minutes (Min= 11, Max= 69) for each visit, but we found this to be highly dependent on the complexity of the IoT devices and the system used. To protect the anonymity of the participants, all names were pseudonymized, and citations are only used when they are insightful and concise but do not include too many identifiable markers. Additionally, pseudonymized names are different for each chapter.

2.3.2 Elucidating the Intentional Arc with Interview Themes

The main goal of the interviews is to investigate the social context that facilitates the acquisition and development of skills by the intention of using IoT devices in line with the cultural values of the household that require those skills to achieve certain goals. In this approach, we rely on the phenomenological work of Merleau-Ponty (2013 [1945]) and Dreyfus (2014), wherein the acquisition of skills is explained by the process of skillful coping whereby similar situations occur repeatedly and continually require more selective responses. As such, the acquisition of skills is embedded in a feedback loop between the person learning and their environment. Merleau-Ponty and Dreyfus refer to this feedback loop as an intentional arc.

An intentional arc describes the involved way someone can project activity into the future and already learn from the projected results. It allows someone to determine from their habitual disposition what would be the next possible position to take. Merleau-Ponty (2013 [1945]) describes an intentional arc as when standing in front of a painting, constantly adjusting to improve the optimal distance from which the painting is to be seen, by making minor adjusting movements that oscillate around the optimum.

During the interviews, we aimed to address skills and skillful coping with the IoT by focusing on certain achievements people might have that would gratify affective, political or economic needs. However, the IoT is not as explicit in what it can help achieve, and its outcomes can be difficult to categorize. For example, it is unclear if participants would use a smart-lamp for comfort, to reduce energy consumption, or for security, or all three aims together at once. Without clear goals in mind, using the IoT might seem less purposeful. However, through the gratification of social needs, using the IoT is still purposive. That is, people are drawn to respond to situations in a way that might increase their sense of gratification and lessen their sense of tension or disequilibrium (Dreyfus, 2014). By framing the intentionality of the IoT in terms oscillating around an optimum of affective, political, economic social bonds that are used to gratify social needs, we obtain an understanding of skills that are acquired in a social context. Moreover, this framing allows us to investigate how the IoT is made meaningful by skillfully mitigating tensions in affective, political, or economic social bonds without having to define specific goals.

Using this phenomenological approach, the interviews on the affective theme were specifically dedicated to gratifying feelings of creativity and playfulness when using IoT devices that could facilitate emotional attachment. We asked participants if they believed they could be creative with their IoT devices, if they could think of any uses other than those intended, if the IoT offers more than function, and if their IoT contributes to creating an emotional atmosphere or ambiance. The interviews on the political theme were dedicated to the needs of a sense for productivity, efficiency, and equality by shifting power balances and responsibilities in the household. We started the interviews by asking about the general distributions of household roles, tasks, and responsibilities. We then focused on using the IoT as technology in the domestic sphere. Additionally, concerning children, we asked parents to imagine a future when their children have grown into adolescents or adults to evaluate if they felt prepared in their role as parents. This question also helps to contrast their expectations with memories of their own childhood and how they give meaning to their present actions.

(Livingstone & Blum-Ross, 2019). The interviews on the economic theme were focused on the needs for a sense of progress and returns. We asked about the economic rationalizations and dealings to increase returns they could measure, the strategic implementation of action, their ability to bookkeep with IoT data, and data privacy.

2.4 DIARY STUDIES

In addition to the interviews, we used two novel types of data in Chapters 5 and 7 to study the digitized home and its digital technologies. With the data generated by IoT technology itself, we are able to monitor behavioral practices through logged data points and button-press events of everyday interactions with digital devices, physically, digitally, or by algorithmic intervention. These data are used to illustrate the factual and precise ethnographies of household practices without having participants rely on memory or self-report methods. While an advantage is that the data have been collected without bias from the participants, two disadvantages are that variables are determined by the manufacturer of the devices and that devices can be difficult to compare. Another disadvantage is that these data can be difficult to access. Therefore, we used a performance task to test whether participants were able to access their data and, if retrieved, gave them the option to share their data with us.

Because log-entry diaries are highly factual in reflecting behavioral patterns without bias from the participant, we used a second type of diary study to complement the log-entries. As log-entry diaries reveal little about using IoT devices as experienced by our participants, we developed a mobile application to measure metaphorical parameters of social distance and social warmth for household members and their IoT devices as figuration diaries. By utilizing the 'drag & drop' features of a touchscreen, we asked participants to chart pictograms of people and devices in their household figurations for six months. We found that charting socio-sensical dimensions of distance and warmth utilizes a linguistic simplicity that induces confidence while participating. Using a device that is already used on a daily basis is less demanding in a practical sense, push-notifications make it easier to remember to create entries, and metadata automatically register additional information. Participants generally found the app intuitive to use, but technical or operator errors disrupted their sense of intuition. The combined data helped us cluster participants based on their phenomenological experiences that are otherwise hidden in interview data alone. Moreover, the combined data give us qualitative access to digital inequalities otherwise overlooked.

2.4.1 Figuration Diaries

The mobile application for our diary study was designed to measure social parameters based on Lakoff & Johnson's (2008) notion that the structure and experiences of everyday basic activities correspond to metaphorical concepts. That is, we define our functional environment by our own embodied properties. We use social proximity (close-distant) and social warmth (cold-warm) as they gratify social needs in affective bonds (Elias, 1978). First, we take figurations of devices in their social proximity of their user to indicate changing patterns of affectual gratification, e.g., feel more or less dependent on IoT devices for comfort. In embodied realism, proximity and other notions of social distance are used to indicate a sense of attachment to persons, objects or experiences not necessarily present in the direct experience of reality (Cf. Williams & Bargh, 2008; Liberman, Trope, & Stephan, 2007). We use the notion of warmth to signify competence and add emotional value that fosters creative use (Cf. Fiske, Cuddy, & Glick, 2007; Kumari, Singh, Mehra, & Mishra, 2018). Warmth tells us whether IoT devices are considered something more than purely cold and functional in gratifying affective needs. Moreover, social warmth is commonly associated with creativity in embodied realism (Fiske et al., 2007; Kumari et al., 2018) and with playfulness (Goodwin, Piazza, & Rozin, 2014; Kouchaki, Gino, & Feldman, 2019). Therefore, we consider warmth a notion that indicates something more than 'just a machine' that is being operated.

During the 15-month research project, participants used a mobile application for six months as a diary study between the third and fifth visits. The aim of the diary study is to group participants together by their views on metaphorical parameters of social proximity (close-distant) and warmth (cold-warm) rather than using preconceived notions of creativity or researchers' definitions of creativity. Moreover, complementary to our goals for abductive analysis (Tavory & Timmermans, 2014), using a statistical method to group participants could highlight otherwise overlooked and surprising findings. We developed a mobile phone application for two main reasons. First, it made our diary study less demanding. Participants were asked to fill in a figuration diary once every two weeks. This interval was chosen because we expected relatively small changes in IoT uses over time (e.g., thermostat changes when weather changes). Instead of requiring participants to remember to fill in their diary, we could send notifications and nudges. Participants could immediately fill in the diary without using other material (e.g., pen and paper). The application also allowed us to log exactly when they accessed their diaries.

Second, metaphorical concepts are intuitive to use, but they are not necessarily intuitive to define in a numerical or linguistic format. By utilizing the 'drag & drop' mechanism of touchscreens, we aimed to bridge this gap. Social proximity was indicated by orbits in which participants could drop items. Social warmth is indicated by color: blue indicates cold, and red indicates warm. As a starting exercise, we asked participants to first apply metaphors of social proximity and warmth to other household members when they filled in their diaries and then try to extend these concepts to their IoT devices. Additionally, we asked respondents to place devices together if they felt they were connected in any way or place them apart from each other if they did not feel connected. Participants first used the app in the researcher's presence to ensure that the instructions were clear. After three months, we conducted a mid-term evaluation of the diary application with the participants. This evaluation was directly followed by interviews on the theme of affective bonds.

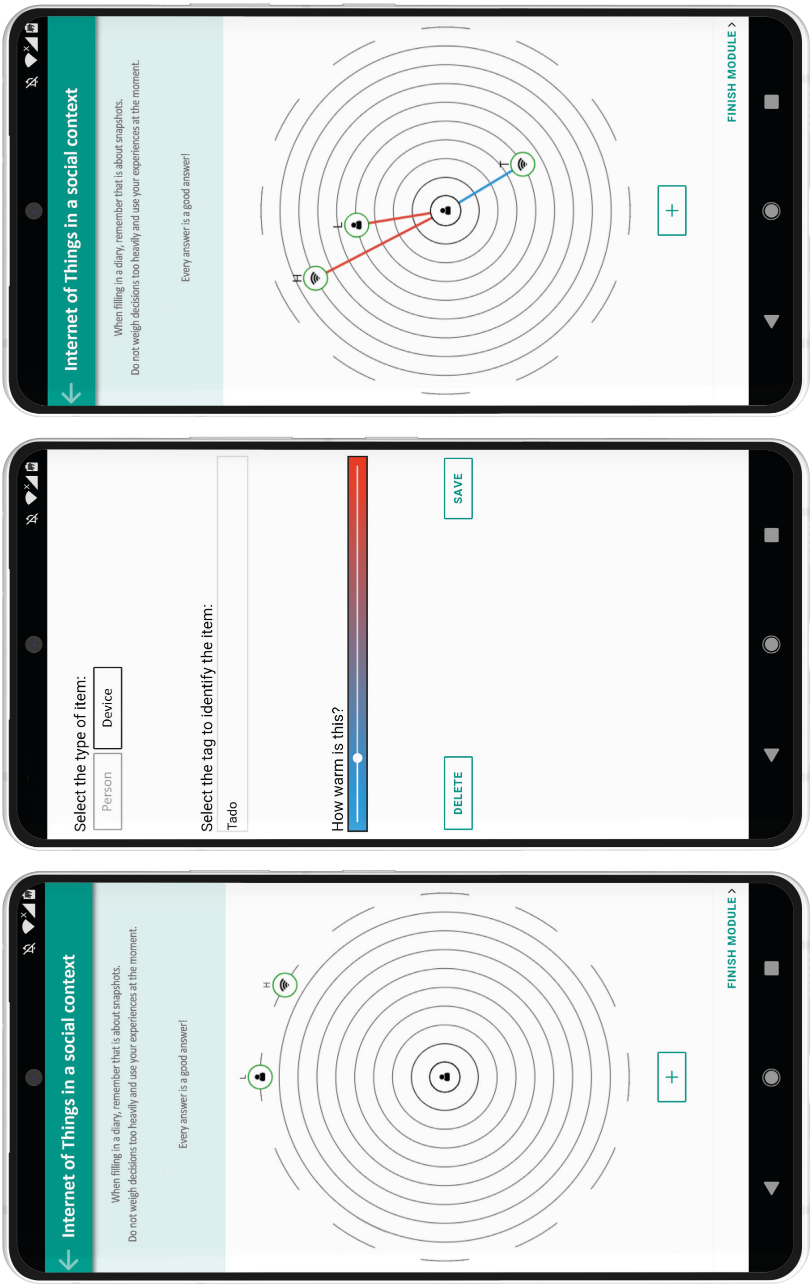
2.4.1.1 Mobile Application

Figure 2.1 shows screenshots of the diary application as it is being filled in. At the top of the application, participants could see the title of the study "Internet of Things in a Social Context", and the middle bar shows the last part of an explanation on how to use the app, of which a more elaborate version was given to the participants on a laminated handout. When the participants received a notification to fill in another figuration diary, they saw screen A in Figure 2.1, with their devices on the outermost orbit. They could place their items with a "drag & drop" mechanism into orbits to represent social proximity. With the plus (+) button below the orbits, they could add an item, and screen B would appear. Here, participants were asked if the item would be another person or device, name the item, and indicate how warm this item felt to them on the gradient from blue (cold) to red (warm). Warmth is indicated by the connected line shown on screen C along with the device's location.

Of the 30 participants, 27 made at least ten entries into the diary app, and these entries were used for the analysis. Three participants had difficulties with the application on their phones that we were unable to resolve with technical support.

Figure 2.1

Setting up a Figuration Diary



C: Placing the items on orbits

B: Adding an item

A: Start up with previous items

2.4.1.2 Measurements and Analysis of the Diary Study

The scales for the metaphorical parameters of social proximity and warmth were limited and maximized to the size of common mobile screens. Social proximity was measured on an orbital scale from 1 to 8 (with a 9th orbit reserved for inactive devices, comparable to a 'never' option). Social warmth was measured on a larger scale from 1 to 11 to maximize the effect of the gradient ranging from blue to red. After using the Shapiro–Wilk criterion to reject normality if *P*-values were less than .05 (Shapiro & Wilk, 1965), social proximity (*P*= .53) and social warmth (*P*= .10) were transformed to z-scores for comparability. As a third and fourth measurement, we investigated how much scores for social proximity and warmth change; therefore, we took the standard deviation of each device and then calculated the average standard deviations over the devices in both measurements to achieve commensurability between participants with fewer or more devices.

To group participants together who had similar viewpoints toward their IoT devices, we used an inverse principal component analysis as a guide. Stephenson (1935) first proposed clustering participants rather than variables by transposing the data table, which has been a staple in Q methodology (Watts & Stenner, 2012). While Q methods typically conform to a pyramid-shaped distribution of statements, Watts and Stenner (2005) suggest different forms of distributions and let participants freely assign (multiple) items to ranking positions as long as they do not violate the linear assumption of correlation (Kleine, 1994). For factor reliability, we extracted only those factors with at least four factor loadings greater than .60 (Guadagnoli & Velicer, 1988) and an eigenvalue higher than 1.00 as per the Kaiser Guttman criterion (Kaiser, 1960; Guttman, 1954). A varimax rotation extracted three factors that satisfied these criteria. The first factor had an eigenvalue of 13.67 and explained 50.61% of the variance. This factor grouped participants with common IoT uses by average proximity and warmth. The second factor had an eigenvalue of 9.07 and explained 33.59% of the variance; it grouped participants with a higher score for proximity and a lower score for warmth. The third factor had an eigenvalue of 4.30 and explained 15.80% of the variance; it positioned participants with a lower average standard deviation against participants with a higher standard deviation.

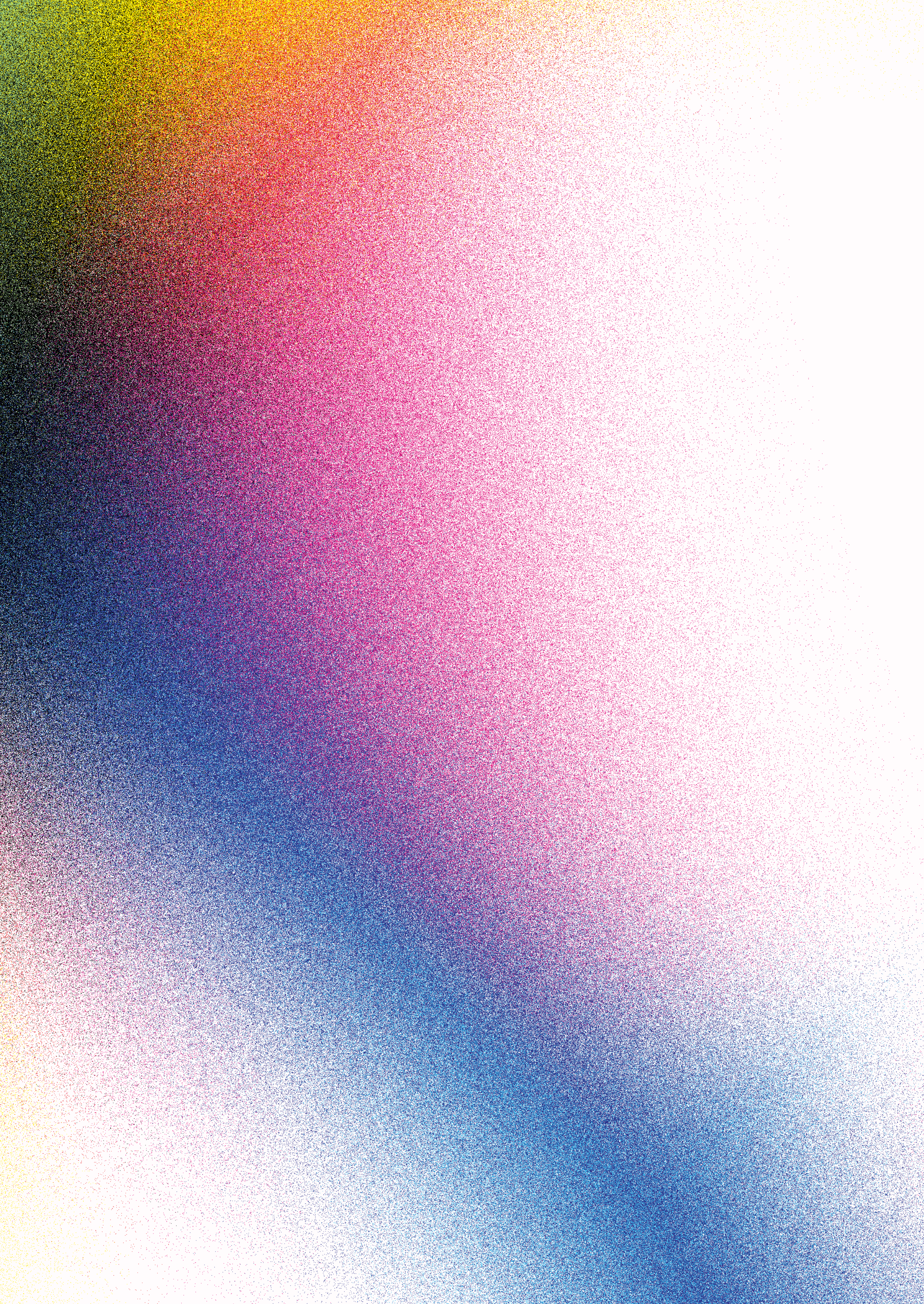
The use of figuration diaries is not without limitations. First, although the process relies on statistics, the statistical power does not warrant conclusive remarks applicable to a larger population. Second, we specifically selected these variables beforehand, and the resulting factors are highly predictable, as they correspond to differences in proximity and warmth and standard deviation. However, the strength of this method is that it guides us to group certain participants together, which we could not do based on interviews alone. Consequently, participants are clustered in closer alignment according to their viewpoints on IoT use with extracted factors. The reverse also occurred, where two participants strongly described their IoT devices as cold and distant during the interviews, while their diaries showed otherwise. In these two cases, we used the interview results. Moreover, the figuration diaries have strength in illustrating polarizing differences in user profiles. In the findings, we show higher loaded participants for factors that illustrate variations in uses. In addition to social proximity and social warmth, we also found how IoT devices are placed on orbits to be important through the interviews. In presenting our results in Chapter 5, the placements of IoT devices have been replicated by their most occurring figurations, but these placements are not measured by precise coordinates.

2.4.2 Log-Entry Diaries

As a performance task between the fourth and final visits, we asked participants to retrieve their personal log-entry data from at least one device and interpret their data. These log-entry files were used as diaries for our research. We started the task by explaining that per EU regulation (General Data Protection Regulation), IoT manufacturers must make all data tied to an account available in a readable format within one month when requested. Then, we asked participants to perform the following tasks. First, determine where to request personal data. This information might be a specific email address or by a general info email address or contact form. We asked participants to try to be explicit in the type of data they wanted to receive so that manufacturers would not only send their account data but all data tied to that account, such as the logged 'button-press events'. Second, determine how to read or open their files. Not everyone knows what to do with a .CSV file or a .JSON file, particularly when manufacturers do not provide instructions on how to open these formats. And third, read the data, and understand how the data have been categorized. Data can be difficult to read without a codebook for its abbreviations, so this understanding would be a first step to interpretation.

We allowed participants to opt out of this performance task if they chose to but asked them to share their data for us to analyze as a log-entry diary of their IoT use. If participants became stuck during the task, they could email the principal researcher of this study for help. In total, only 14 participants managed to retrieve their data, and they all shared the data with us. Three participants were explained that their IoT manufacturers did not store such data and the 13 other participants stopped trying due to uncooperating manufacturers and the growing annoyance this task brought them. Only three participants indicated that they could interpret the data but were not motivated to do so extensively. In particular, raw .csv formats and .JSON formats were considered unreadable, and participants did not know how to open them correctly.

The log-entry data of 14 participants were cleaned with R to increase comparability between devices. In the findings, we selected log-entry diaries from the same manufacturers for clear comparison of data, as collected data vary greatly between manufacturers. We retrieved log-entry diaries from six activity trackers, four thermostats, three log-entry diaries from IoT software used to regulate a wide range of devices such as sensors, and one log-entry diary from Philips Hue. Philips Hue was specifically interesting because only one participant managed to retrieve its data, whereas five others did not because they were repeatedly told that Philips did not store this type of data. In presenting our results in Chapter 7, we aimed to keep the intervals of the log entries similar because summer holidays or new-year resolutions can influence how IoT devices are used strategically.



CHAPTER 3

Inequalities in the Social Use of the Internet of Things

a Capital and Skills Perspective

Based on:
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3.1 INTRODUCTION

Before we start with our solfège problems, we must address the how the increase of ubiquitous technologies used in everyday life by the IoT can signify a change for digitally mediated communication. Additionally, in this chapter we give an test how IoT is distributed in a sample representative of the Dutch population. The IoT platform is a network of ubiquitous everyday consumer objects that contains sensors, information processing, and networking capabilities that allow them to communicate information about themselves and their users through the internet (Li et. al., 2014; Van Deursen and Mossberger, 2018; Whitmore et. al., 2015). However, through devices such as activity trackers, thermostats, home security, or other assistive devices connected to the internet, digital information can (unwittingly) be distributed online and be used as internet-connected social objects as well. So far, the IoT has received little academic attention in the social sciences as a social platform. We argue that the IoT as a collection of social objects can have a large impact on the advancement of the network society at two discrete levels: by propelling the information economy, which commodifies information as a separate resource that is dislocated from its services or production processes (Mandl and Kohane, 2017; Rayport and Sviokla, 1999; Van Dijk, 2012;), and by network individualization, where social structures are formed with the individual as the center of connectivity (Van Dijk, 2012; Rainie and Wellman, 2011).

Research on the social use of the IoT bequests theoretical positions on Computer Mediated Communication (CMC) that has been polarized since the 2000s. From one side, the core of social life and its structure would be weakened by CMC (Kraut et. al., 1998, Nie, 2001). Although people can interact more easily when face-to-face interactions are substituted by the faster and less intensive CMC, emotions would be eroded from social life (Turkle, 2011). CMC would only facilitate the illusion of companionship, without the authenticity of everyday social life and its emotional experiences. A viable solution, nonetheless, to meeting the demands of working life and social life combined. Similarly, in a digitized society that becomes more demanding of individual participation (Knijn and Hopman, 2014; Mossberger, Tolbert, and McNeal, 2007), people can bring the IoT into their lives for comfort or efficiency. The IoT carries great potential for individualizing services and everyday tasks, albeit algorithmically and with less human interference (Kulkarni and Sathe, 2014; Rayes and Salam, 2017; Van Deursen and Mossberger, 2018). Information collected by IoT devices, in effect, becomes dislocated from the actual services they provide and act more directly as a resource in an information-oriented economy. Especially in healthcare, the adoption of IoT devices and other assistive technologies has raised concerns about human detachment (Alaiad and Zhou, 2017) while catering to profitable health IT systems (Mandl and Kohane, 217). Here again, digital connectivity allows for a more efficient exchange of information but without the emotional responses of face-to-face interactions.

From the other side, however, existing social bonds become stronger when interactions with acquaintances carry over seamlessly to different social settings throughout the day by using CMC (Ling, 2008). According to this side, CMC supplements or enhances already existing social bonds (Katz and Rice 2002; Ling 2008; Van Dijk 2012). Rather than weakening the structure of social life, CMC would create diverse social structures with the individual as the primary unit of connectivity (Baym, 2010; Lin, 2002; Rainie and Wellman, 2011 Van Dijk, 2005). Additionally, the use of the IoT can become an incentive for people to initiate face-to-face interactions. Introducing new technologies has been observed to strengthen social bonds by becoming a mutual focus of attention for different people and by shaping their identity as a collective (Weenink, Broër and Boersma, 2015); for example, by easing the interactions between medical professionals and their clients or with sporting activities.

Instead of choosing one side over the other, it is more important to gain an understanding of who might be more predisposed for exploitation by the information economy at the cost of eroding emotions out of social interaction, and of who, in using the IoT socially, might be enhancing social relations through network individualization. We expect the social use of the IoT to follow a pattern of consumption determined by socio-cultural backgrounds. This is, to our knowledge, the first empirical study on the social use of the IoT via the collection and analysis of unique large-scale survey data on IoT users. In this survey-based research, sociocultural backgrounds are reflected in economic, social, and cultural forms of capital by Bourdieu (1986). A well-established three-dimensional framework that can provide insights into the differences between the structural dispositions and the social use of IoT devices. In addition to forms of capital, the social use of the IoT also engenders an internet-skills framework specified to a sociocultural background of the internet (Van Deursen, Helsper and Eynon, 2016). While internet skills are not independent of forms of capital, they express a more fluid capital-enhancing pattern of consumption in relation to digital technologies. Thus, in this chapter, two frameworks on sociocultural backgrounds are tested: the effects of who you are in terms of structural position in relation to capital and the effects of what you can do in terms of acquired internet skills. Based on a survey of the Dutch population, this research poses the question:

Sub-Question 1: Who Uses the Internet of Things Socially?

The social use of the IoT is categorized in terms of the private use of the IoT, sharing IoT data with strangers, with a partner, or with acquaintances. To define the *who* in this research, two frameworks on sociocultural backgrounds are tested in the subsequent research questions. First, how is the social use of IoT devices distributed among sociocultural backgrounds determined by the structural dispositions of capital? And second, how is the social use of IoT devices distributed among sociocultural backgrounds determined by internet-related skills? By posing these questions, the research aims to contribute to the literature on CMC by adding different types of social uses and its dissemination in society. The research is positioned to gain an understanding of the how network society advances according to different societal groups.

3.2 THEORY

3.2.1 Social Communication of IoT Data

The social interconnectivity of the IoT platform becomes easily overlooked when focusing on the novelty of smart 'things'. However, the connectivity of the *internet* to the IoT should not be neglected when trying to understand how people create, maintain, or absolve social bonds in a networked society.

CMC has often been framed in terms of weak or latent ties, primarily based on (semi-)anonymous chatrooms and mailing lists (Haythornthwaite, 2002). However, we argue that the IoT also entices unique manners of social communication. Not only do devices communicate by the somewhat conscious allowance of their users by sharing data through the internet autonomously, *what* is being communicated is often set by the parameters of the device, with little or no editing by the user. Additionally, sharing with the IoT tends to be more continuous, as IoT-users can befriend, follow or use other subscription formats. We categorize the social use of the IoT in terms of *private use* or by using the IoT socially with *strangers* to define the asymmetrical relationship when (un)wittingly sharing data; using the IoT socially with a *partner* highlights the domestic setting, and using the IoT socially with *acquaintances* is used to describe reciprocal relationships.

First, *private use* is the baseline for the information economy regarding the datafication and, in effect, commodification of everyday activities. The IoT is situated between monitoring self-services and individualizing those services through algorithmic feedback; it invokes the simultaneous social processes of individualization and depersonalization. With internet-connected heart-rate monitors and smart thermostats, for example, personal information becomes of value to the data-oriented information economy. Due to the ‘always online’ characteristic required for many IoT devices to work properly, the private use of IoT devices often includes sharing data with companies, and data analytics wittingly *and* unwittingly to users. Either way, as a more efficient alternative for the mundane tasks of everyday life, the private use of the IoT is ideal for dislocating face-to-face interaction from the services substituted by IoT devices.

Second, using the IoT socially with *strangers* consists of interactions in the online domain where audiences are unknown or uncontrollable. These are interactions where users willingly communicate personal data without expectations of reciprocity or mutual acquaintanceship. For instance, health-monitoring devices can offer a great opportunity for personalized care (Mandl and Kohane, 217). As a substitution for face-to-face visits to an actual doctor, however, the IoT might impair the cognitive and affective functions of healthcare (Alaiad and Zhou, 2017). Similarly, users share personal information of favorite running routes, for instance, through mobile applications that thrive on user-generated content. Or, let utility companies adjust their boiler settings from a distance. Other -more intense- forms of CMC would be considered detractions from face-to-face interactions (Nie, 2001), but have been used to compensate for a lack of strong ties, especially amongst socially anxious individuals (Valkenburg and Peter, 2009; Weidman et. al., 2012). Insofar using the IoT socially with strangers is in the extension of weak and latent ties, it would suggest a type of social use that compensates for human attachment in everyday activities.

Third, using the IoT socially with a *partner* mainly involves the coordination of tasks and activities; for instance, controlling robot vacuum cleaners and smart thermostats, monitoring the health status of a partner, or by scheduling exercise activities. Through IoT devices, the connectivity of individual networks can become closer and more continuous rather than place- and time-located. Haddon (2006) showed the domestic sphere to be crucial to the use of communication technologies. Assistive technologies have been integrated into emancipated domestic settings to compensate for the everyday tasks women usually performed at home (Fortunati, 2017). In other words, advancing processes of emancipation and network individualization are yoked together. While a household is not the center of connectivity, it remains an intensive node in the network because many computers or other digital technologies occupy physical space which, coincidentally, tends to be the home. Consequently, if households are without an internet connection, individuals are sufficiently impaired in their use of CMC by costly and time-constraining alternative ways of access (Robinson, 2018). The IoT can ease the coordination of everyday tasks and activities in a time-efficient manner and mediate network individualization between partners.

Lastly, the IoT can be used socially with others with whom individuals share feelings of mutual *acquaintanceship*, such as friends, family, or colleagues. For example, sharing IoT data for health- or sports-related ctivities might boost social support while also enriching the entertainment value of certain activities, such as tracking the bicycling routes of friends or colleagues. As such, using the IoT socially can strengthen social bonds and create a more individualized network based on shared activities. Even with more infrequent instances, the IoT can supplement social networks more easily; for example, in exchanging temporary digital keys or in comparing and discussing energy consumption with friends. In research on CMC, most of the positive effects have been on how the internet supplements social networks by maintaining social bonds (Ellison, Steinfield, and Lampe, 2007; Valkenburg and Peter, 2007). While CMC interactions are generally less intense on an emotional level, the continuous flow of interaction throughout the day creates strong social bonds (Ling, 2008). Existing social bonds even become stronger to such a degree that prolifically users of CMC receive more help and social support from core network members than non-users (Boase et al, 2006). A similar strengthening type of use might be expected when the IoT is used socially with acquaintances.

3.2.2 Forms of Capital as Predictors for the Social Use of the IoT

In this article we set out to explain different types of social use of the IoT. Our first set of expectations depart from the assumption that the social use of IoT devices would be dependent on the relative position of individuals within a social structure. An established method to reflect social structure is by relating individuals to the dispersion of different forms of capital. Capital, according to Bourdieu (1986), is accumulated labor which can be used to appropriate reified or living labor. Capital predominantly recurs in three forms: economic capital, which is most directly convertible to money; cultural capital, that when institutionalized reflects qualifications in education, and when embodied reflects the cultivation of taste and patterns of consumption and is objectified in cultural goods; and social capital, by which mutual acquaintances and group memberships entitles individuals to credit on the basis of solidarity. Because it is time-costly to accumulate capital, including extensive periods of socialization with embodied cultural capital, its distribution has come to define social structure. Consequently, differing configurations of accumulated economic, cultural, or social forms of capital determine an individual's position within a social structure (Bourdieu, 1984).

Starting with economic capital, Robinson (2018) explored the effects of income on CMC among adolescents using what she called the 'identity curation game'. She found that adolescents without internet at home are limited in social media use because their access time is primarily focused on activities such as schoolwork. These adolescents experience the high cost of internet access, and using the internet socially is also costly in terms of time allocation. On the other hand, emancipated households desire assistive technologies, such as the IoT, to compensate for household tasks traditionally reserved for women in the domestic sphere (Fortunati, 2017; Haddon, 2006). Higher household incomes deriving from more than one fulltime wage-earner, in effect, would increase the usefulness of social IoT devices to coordinate domestic tasks effectively among partners. If the IoT were to mirror these effects of limiting social use for lower household incomes and increase social use for higher household incomes, we hypothesize:

H1. Economic capital contributes positively to using the IoT socially with (A) partners; (B) acquaintances; and (C) strangers.

The effects of cultural capital on the social use of the IoT can be explained by opposing a 'need for necessity' (Bourdieu, 2000; Bourdieu, 1984). The appreciation of necessity is often related to people with less cultural capital, whereas people with more cultural capital foster things without immediate use. This distinction in cultural appreciation is also reflected in cultural activities, such as going to the opera or ballet, which are more dislocated from society and its contemporary problems (Bourdieu 1998). In relation to internet use, Ignatow and Robinson (2017) have used *skholè* (as serious play) to describe how the culturally rich use the internet for learning and exploration without the need for a direct use. Most of the IoT consists of functional devices with an added internet connection to enhance their primary functions. The exploration of IoT devices beyond their functions is therefore limited compared to the internet. This leads us to expect that skholé, as an effect of cultural capital, in relation to the internet of things quickly becomes a social endeavor:

H2. Cultural capital contributes positively to using the IoT socially with (A) partners; (B) acquaintances; and (C) strangers.

Social capital is extensively used and contested in CMC research, albeit mostly as a dependent variable (e.g., Nie 2001; Putnam 2001; Quan-Haase and Wellman, 2004). However, social capital is also the accumulated sum of mutual acquaintances that, due to its durability, becomes a structural resource embodied by one's social network (Bourdieu and Wacquant, 1992). Social support, social contact, and forms of group membership are general indications of social capital (Bourdieu 1986; Bourdieu and Wacquant, 1992; Dubos, 2017). Rainie and Wellman (2012) found that people who are more socially active are also more socially active online. Moreover, CMC is primarily used to maintain mutual feelings of acquaintanceship (Ellison, Steinfield & Lampe, 2007; Ling, 2008). The IoT can be used to strengthen social bonds in a similar manner by engaging others online with sports, health, or domestic activities.

Alternatively, using the IoT socially with strangers can be used to compensate for a lack of social capital. For instance, Nowland, Necke and Cacioppo (2017) give an overview of the bidirectional relation between the internet and loneliness. They show that CMC increases loneliness when used to withdrawal from face-to-face interactions, and lonely people use CMC to reach out to strangers online. Therefore, if loneliness predicts CMC with strangers, people with less social capital might also be more inclined to use the IoT socially with strangers.

H3. Social capital contributes positively to using the IoT socially with (A) partners; (B) acquaintances; and (C) strangers.

H4. Social capital contributes negatively to using the IoT socially with strangers.

3.2.3 Internet Skills as Predictors for the Social Use of the IoT

In addition to figurations of capital to measure the distribution of the IoT and its social use, people possess skills in the context of the internet. We expect that the internet and its related skills are strong sociocultural determinants for the social use of the IoT. Internet-related skills can be considered important assets specified to social contexts with newer technologies that make use of the internet. Internet skills are not independent from different forms of capital because structural dispositions enhance the acquisition of skills and affect how skills are appreciated, e.g. as important, fun, or unnecessary. However, the accumulation of capital is time-consuming by nature (especially in the case of cultural capital) due to its robust structural dispersion, whereas skills can be acquired more fluently. Therefore, we use acquired internet skills to specify sociocultural backgrounds in relation to the internet.

In response to the variety of emerging internet-related skills, Van Deursen et. al. (2016) developed the Internet Skills Scale (ISS) as a reliable measure of skills that are theoretically, empirically and cross-nationally consistent. The ISS measures operational skills, a set of basic technical skills for the internet platform; information navigation skills, required for using technology for information needs; social skills, required for sharing content online and behavior appropriate to the content of different sites, including forms of social media; creative skills, required to change or create content online, including its design and understanding of creative licenses; and mobile skills, operational and navigational skills in using mobile devices. Acquired internet skills can help individuals shift from the exploitation of information economy to the advantages of network individualization.

The ISS contains two medium-related skills: operational skills and mobile skills (Van Deursen, et. al., 2016). While operational skills are fundamental in relation to the internet, the IoT would require less attention to the operational skills of its users apart from the initial set-up (Van Deursen and Mossberger 2018). In fact, the IoT is in many ways designed with the explicit notion of working autonomously and unnoticeably, including sending and receiving data. Therefore, operational skills should not have an effect on using the IoT socially. Mobile phones, on the other hand, have become an axial medium for collecting and representing data, such as activity graphs, geolocation, or achieved goals aided by IoT devices. In contrast to computer-based internet, mobile phones have diffused internet access across socioeconomic status (Marler, 2018). Mobile skills are extensively used and acquired in adolescent social groups to maintain an updated and active reputation online, which is important to remaining socially active (Robinson, 2018). Consequently, acquired mobile skills facilitate civic and political socialization at an earlier age (Hargittai and Hsieh, 2010) and can help younger people transgress their family's sociocultural position (Park 2015). Therefore, we formulate the following hypothesis based on medium-related internet skills:

H5. *Operational skills do not contribute to using the IoT socially with (A) partners; (B) acquaintances; and (C) strangers.*
H6. *Mobile skills contribute positively to using the IoT socially with (A) partners; (B) acquaintances; and (C) strangers.*

The remaining three content-related internet skills in the ISS are information navigation skills, to guide users through the internet information highway; social skills, that sensitizes users to online social norms; and creative skills, to create content and understand how online contents is licensed. These combined skills affect the social use of the internet, as users obtain a greater understanding of online content and their online privacy. As such, early research on the internet shows that exposure to the online exchange of information diminishes privacy concerns (Bellman et. al., 2004), especially as consumers and experiences increase. Similarly, Boyd and Hargittai (2010) found that young adults who spend more time on Facebook also have more confidence in Facebook's privacy settings. Furthermore, social networking sites (SNS) bring together a complex variety of social norms and social circles, e.g., colleagues, family and friends, which creates difficulties in online sharing (Hogan 2010). This can act as a deterrent for users to share content online. Higher social skills, when people become better at managing their privacy, would also result in increased activity (Hargittai and Litt, 2013); for example, having multiple fake accounts on Instagram ("*Finsta*" accounts) while hardly posting on primary accounts (Carey, Chapman, Chai, Jake-Schoffman, Carreiro, Nader, & Pagoto, 2018). By extension, knowing what the IoT generates as data, what users can share online on safe platforms and who to share it with, would predict a positive effect in using the IoT socially. Therefore, based on content-related internet skills, we hypothesize that:

H7. *Information navigation skills contribute positively to using the IoT socially with (A) partners; (B) acquaintances; and (C) strangers.*
H8. *Creative internet skills contribute positively to using the IoT socially with (A) partner; (B) acquaintances; and (C) strangers.*
H9. *Social internet skills contribute positively to using the IoT socially with (A) partner; (B) acquaintances; and (C) strangers.*

As much as the IoT promises to be a next stage in internet use (Rayes and Salam, 2017), it also promises an unequal diffusion of skills to operate IoT devices, manage the data generated by the IoT, and exploit its social functions. Whoever uses the IoT socially, therefore, is also expected to be familiar with skills specific to the IoT. To explore those skills, we adjusted the skills from the ISS to the IoT and predict that:

H10. *IoT skills contribute positively to using the IoT socially with (A) partners; (B) acquaintances; and (C) strangers.*

3.3 METHOD

3.3.1 Sample

To test our hypotheses we collected novel survey data on IoT users that, to our best knowledge, no other research in the social sciences has collected on this topic . We conducted our survey in the last week of January and the first week of February 2018 in two parts among same panel of respondents through a professional market research organization to obtain a representative sample of the Dutch population. The first part of the survey focused mainly on internet use and the internet skills scale (Van Deursen et. al., 2016), whereas the second part focused explicitly on the IoT. Both parts contained questions of social determinants and forms of capital (Bennet, Savage, Silva, Warde, Gayo-Cal & Wright, 2009), and each part of the survey was estimated to be completed within 20 minutes (variations relied largely on the amount of IoT devices respondents had). In total 1,359 respondents finished both surveys. A slight weigh has been added to match the representativeness to the standards of Statistics Netherlands (CBS), a Dutch governmental statistics agency. Table 3.1 shows the demographic profile of the Dutch IoT user sample, including respondents using IoT devices and respondents using IoT devices socially.

3.3.2 Measures

To measure IoT use, respondents were asked whether they used one or more of 52 IoT devices available to consumers in 2017. Respondents were instructed to select only devices connected to the internet, yet some still selected offline devices, such as non-smart toothbrushes, as IoT devices. Therefore, we verified IoT use with a question about how frequent their

Table 3.1

Demographic Profile of the Dutch IoT User Sample

	Sample		*IoT users*		*IoT social users*	
	N	*%*	*N*	*%*	*N*	*%*
Gender						
Male	650	48.5	306	22.9	186	13.9
Female	689	51.5	292	21.8	179	13.4
Age						
16-25	133	9.9	72	5.4	40	3.0
26-35	211	15.8	131	9.8	86	6.5
36-45	211	15.7	112	8.3	63	4.7
46-55	257	19.2	119	8.9	71	5.3
56-65	225	16.8	91	6.8	57	4.3
66-75	179	13.4	50	3.7	34	2.5
75+	124	9.3	24	1.8	14	1.0
Education						
Low	431	32.2	160	11.9	103	7.7
Middle	513	38,3	240	18.0	137	10.2
High	395	29.5	198	14.8	125	9.3

N= 1356, Weighted N= 1339

devices made an internet connection. In a few cases, respondents sometimes reported their wearable device was not connected to the internet, while they did use an app that required an internet connection to control their device. In the case of wearable IoT devices, we controlled with frequent internet and app connection. When respondents own IoT devices but not use them as such, for example thermostats not connected to the internet, it is not measured as IoT use.

Using IoT socially is measured by asking with whom the respondents shared the information data generated by their devices. *Private use* (*N*= 360) is measured when respondents do not wittingly share their IoT data with others. Using the IoT socially with a *partner* (*N*= 280) is measured by asking respondents if they shared IoT data with their partner (if any); sharing data with *acquaintances* (*N*= 171) is measured by asking respondents if they shared IoT data with people with whom they share mutual feelings acquaintanceship, i.e., family, friends, acquaintances, colleagues, and social groups; and sharing IoT data with *strangers* (*N*= 82) is measured by asking respondents if they shared IoT data explicitly with strangers, on social media where the audiences are uncontrollable, or with specialists who are limited to asymmetrical social relations by professional guidelines.

We measured economic capital by *employment* status (*N*= 707) and yearly household *income* in three categories (*<30.000 euro*, *30.000-60.000 euro*, *>60.000 euro*). We measured cultural capital by its institutional state—the *educational level* (low, middle, high)—and its objectified state—the frequency of cultural activities—on a 5-point scale from *never*, *yearly*, *quarterly*, *monthly* to *weekly*. Following Bennet et al. (2009), cultural activities consist of visits to the theater, opera and ballet, art museums, historic museums, classic musical concerts, library, playing a classical instrument, or listening to classical music. A mean score for cultural activities was computed for eight items (*Cronbach's* α= .77; *Mean*= 1.66; *Standard Deviation*= 0.78).

We measured social capital by *social support* and *social contact* to represent mutual acquaintanceship and by group membership in *political* and *community* membership categories to distinguish between utilitarian complexity and engagement. For *social support* we used Shelbourne and Stewart's (1991) measure for support availability, ranging from *never* (1), *very occasionally* (2), *sometimes* (3), *usually* (4), to *always* (5) (e.g. if respondents have someone they can trust, to have fun with, to help out when needed, or to get advice from). We computed a single sum scale with 12 items (α= .97; *M*= 3.75; *SD*= 1.07). For *social contact* (*M*= 3.17; *SD*= 1.47) we measured the sum score of five categories if respondents called or met with family and friends, or met with neighbors, in the last two weeks. *Political membership* (*N*= 222) was measured by belonging to either a political party, union, or environmental association. *Community membership* (*N*= 525) was measured by belonging to either a neighborhood association, voluntary work association, elderly association, scouting, sports club, or a school parent association. Because the accumulation of capital is a time intensive process, capital needs to be distinguishable in its consequence from *age*. Therefore, *age* has measured by year of birth with seven categories.

The internet skills scale (ISS) measures agreement on knowing how to do certain task on the internet, ranging from not at all *true* (1), *not very true* (2), *neither true nor untrue* (3), *mostly true* (4), to *very true* (5) (Van Deursen et. al., 2016). The ISS consists of questions like "I know how to bookmark a

Table 3.2
Items for IoT Skills (α= .96)

I know how to:	*M*	*SD*
connect smart devices to the internet	3.49	1.29
share information from smart devices on the internet	3.35	1.27
operate smart devices by using applications	3.57	1.31
interpret data from smart devices	3.41	1.29
connect smart devices to my Wi-Fi-network	3.50	1.34
change on a smart device with whom I share data	3.09	1.26
read data from smart devices	3.40	1.24
change how often data is gathered by smart devices	3.09	1.27
I feel confident operating smart devices	3.24	1.22

N= 1339

website", "I know which apps are safe to download", and "I can find websites I visited before". We computed operational skills (α= .88; *M*= 4.36; *SD*= .98), information navigation skills (α= .84; *M*= 3.84; *SD*= .88), social skills (α= .82; *M*= 4.16; *SD*= .94), creative skills (α= .85; *M*= 2.91; *SD*= 1.10), and mobile skills (α= .88; *M*= 3.92; *SD*= 1.15). IoT skills are measured by adjusting 9 items from the ISS to fit the use of IoT devices (α= .96; *M*= 3.35; *SD*= 1.10) shown in Table 3.2.

3.3.3 Data Analysis

The result of four binary logistic regression analysis on IoT use, individual use, sharing IoT data with a partner, with acquaintances, and with strangers are shown in table 3.3. The results are presented by the odd ratios of a capital model and a skills model. Gender and age are controlling variables.

Table 3.3

Binary Logistic Regression

Predictors variables	IoT use[a]	Private use[b]	Sharing strangers[b]	Sharing partner[c]	Sharing acquain-tances[b]
	Exp(B)	Exp(B)	Exp(B)	Exp(B)	Exp(B)
Constant	0.121	0.251	0.022	0.167	0.150
Gender (ref. male)	1.119	1.150	0.672	1.062	1.131
Female					
Age (per category)	0.870**	0.984	1.067	0.856	0.918
Economic capital					
Income (ref. low)					
Middle	1.537**	0.535*	1.291	2.039*	1.131
High	2.340***	0.815	0.519	1.797	0.848
Employed (ref. unemployed)	1.138	1.043	0.617	0.756	0.812
Cultural capital ed. (ref. low)					
Middle	1.057	2.014**	1.424	0.383**	0.668
High	0.923	2.475**	1.718	0.401*	0.556
Cultural activities	1.242*	0.954	1.534**	1.259	1.279*
Social capital					
Political membership	1.136	0.580*	1.166	2.429**	1.299
Community membership	1.107	0.818	1.454	1.044	1.657*
Social support	1.046	0.772**	1.116	1.407**	0.936
Social contact	1.046	1.018	0.877	1.021	1.210**
Internet skills					
Operational skills	0.770*	0.950	0.591**	0.944	0.862
Mobile skills	1.327**	1.047	1.275	1.834**	1.041
Information nav. skills	0.761**	1.152	1.403	1.297	1.043
Creative skills	1.106	0.912	1.327	0.915	1.067
Social skills	0.828*	1.132	1.111	0.703*	0.965
IoT skills	2.204***	1.591***	0.977	0.864	1.189
Nagelkerke R^2	0.291***	0.133***	0.157**	0.183***	0.088**

[a]IoT use: N= 1129
[b]Social use: N= 461
[c]Social use among non-single respondents: N= 319

****p < .001*
***p < .01*
**p < .05*

3.4 RESULTS

The odds ratio from the binary regressions shown in Table 3.3 shows that gender has no significant effect on IoT use or on its social use. Age has a significant effect on IoT use, but not on using the IoT socially. Therefore, we consider capital and skills as independent predictors for the social use of the IoT.

3.4.1 Capital

Economic capital has a large effect on IoT use when predicted by household income however, only middle-class income (compared to those with lower income levels) is significantly associated with private use and using the IoT socially with a partner. Respondents from middle-class income households are less likely to use IoT devices privately than lower household income classes. In contrast, sharing with a partner is positively predicted by middle-class-income households. Cultural capital is split between education and cultural activities. Education is not a significant predictor for IoT use in general, but does have a large effect on private use. Middle- and higher-educated IoT users are more likely to use the IoT privately than lower-educated users, while lower-educated users are more likely to share IoT data with their partner. Cultural activities positively predict IoT use and the social use of the IoT with acquaintances and strangers. Social capital has no significant effect on IoT use and a significant negative effect on private use by political group membership and social support. The inverse is true for sharing with a partner, where respondents are more likely to be associated with political groups and have more access to social support. Sharing with acquaintances is predicted by community membership and social contact.

3.4.2 Skills

Operational internet skills have a significant and negative effect on IoT use and sharing IoT data with strangers. Mobile Internet skills and IoT skills, however, do have a positive effect on using the IoT, but in relation to social use, mobile skills are only significant predictors for sharing with a partner and IoT skills are only significant predictors for private use. Content-related skills are more diffused. Information navigation internet skills are negative predictors for IoT use but have no effect on using the IoT socially.

Creative internet skills positively predict sharing IoT data with strangers. Lastly, respondents with greater social internet skills are less likely to use IoT devices and to share IoT data with their partner.

3.4.3 Hypothesis

The tested hypotheses are summarized in Table 3.4 Based on the above model, we are able to reject H4, H7, H9 and H10: social capital does not have a negative effect on using the IoT socially; respondents with information navigation skills are not more likely to use the IoT socially; social internet skills have a negative effect on the social use of the IoT; and IoT skills do not predict the social use of the IoT. H2 is supported, cultural capital predicts IoT social use, albeit separately for education and cultural activities. Other hypotheses are partly supported.

Table 3.4
Hypothesis Results

	Hypothesis: contribution on using the IoT socially	Validation for (A) with their partner, (B) with acquaintances, or (C) with strangers
H1.	Economic capital	Partly supported (for (A))
H2.	Cultural capital	Supported
H3.	Social capital	Partly supported (for (A) and (B))
H4.	Social capital	Rejected
H5.	Operational skills	Partly supported (for (A) and (B))
H6.	Mobile skills	Partly supported (for (A) and (C))
H7.	Information navigation skills	Rejected
H8.	Creative internet skills	Partly supported (for (C))
H9.	Social internet skills	Rejected
H10.	IoT skills	Rejected

3.5 DISCUSSION

3.5.1 Main Findings

While an innovate area of technology to advance the network society, the IoT system has been uncharted territory in the social sciences. This chapter set out to study who uses the IoT socially and with whom, and to what extent the IoT inherits theoretical positions on CMC. Based on our result we find that using the IoT platform can mainly be attributed to the more fluently acquired (operational, mobile, information navigation, social, and creative) internet and IoT skills over forms of capital, aside from household income in economic capital. However, we find that the social use of the IoT platform is better attributed to the relatively stable forms of capital by Bourdieu (1986).

We found inversed effects on both private use and sharing IoT data with a partner for household income, education, political membership, and access to social support. This suggest that using the IoT privately or sharing IoT data with a partner is strongly dependent on variables that remain relatively stable over time and are related to household dynamics. Therefore, we encourage more research on how households differ in their contextual demographics and IoT use. More specifically, concerning our findings on access to social support, attention might be giving towards the availability of other household members that can qualitatively contribute to using the IoT.

The main differences between private use and sharing IoT data with a partner are attributed to IoT skills, and mobile and social internet skills. Our research suggests that IoT skills might be contributing factor to using the IoT privately. We raised concerns that private IoT use could (unwittingly) advance processes of individualization and depersonalization that serve the information economy (Van Dijk, 2015; Rayport and Sviokla, 1999). Follow up studies might address especially if higher educated users and users prolific in IoT skills, that use their IoT privately, are aware or impartial to those concerns. The sociocultural background of those users specifically might be suggestive for a greater awareness of the information economy in relation to data sharing. Mobile internet skills are positively attributed to sharing IoT data with a partner, suggesting that partners are more likely to share IoT data when they are proficient in finding and installing relevant mobile applications for their IoT devices (Van Deursen et. al., 2016). Additionally, social internet skills contribute negatively, suggesting that acquiring internet skills to share data publicly online might be less of a priority when sharing IoT data with a partner. Insofar IoT sharing remains largely inside the households of their users, it dovetails with the suggestion that the IoT aids the coordination of task and activities in the domestic sphere (Fortunati, 2017; Haddon, 2006). Considering the everyday life applications of the IoT, our findings on social use suggests that future research would benefit from domestication frameworks of technology adoption (Bakardjieva, 2005; Silverstone and Haddon, 1996).

Sharing IoT data with acquaintances and with strangers are both predicted by cultural activities. Community membership and more social contact also contribute positively to sharing IoT data with acquaintances. This suggests that users who are more socially active outside of their immediate household are also more inclined to share IoT data outside their household. As such, it mirrors the hypothesis that users who are rich in social capital are also more prolific in the accumulation of social capital by strengthening and maintaining existing social bonds (Ellison et. al., 2007; Ling 2008; Valkenburg and Peter, 2009). However, based on our study we cannot conclude that the IoT is used to establish reciprocal social bonds with strangers.

While we did not find internet skills to be significant predictors for sharing IoT data with acquaintances, creative internet skills contributed positively to sharing IoT data with strangers. Suggesting that knowing what is safe to download, understanding licenses that apply to content, and having experience with writing comments online, seem to diminish concerns related to sharing IoT data with strangers as well (Cf. Hargittai and Litt, 2013; Bellman et. al., 2004). Simultaneously, IoT users with better operational skills are less inclined to share IoT data with strangers. This suggests that sharing with strangers can also be attributed to a lack of skills required to adjust internet settings themselves after the initial setup (Van Deursen and Mossberger, 2018).

3.5.2 Limitations

The IoT is in its early stages of development and integration. While our results show that the IoT parallels CMC in multiple aspects, we suggest that newer devices, further integration of the IoT into society and political intervention require an ongoing inquiry as to how the IoT is used socially and to determine its effects on society. The findings of this research can be extended, matched, and critiqued, for which we suggest four main points.

First, this chapter is based on a cross-sectional survey, and any indications of causality can be reversed. Our survey was only conducted among the Dutch population, one with high internet access and relatively high income and educational levels. Cross-cultural research might help to establish to better define variable effects. Additionally, our findings are expected to be stronger in countries where forms of capital are more diversely and unequally distributed, comparing to research on the digital divide (Wijetunga, 2014), but this begs for empirical enquiry.

Second, we aimed to measure the IoT as a whole by conceptualizing the IoT as a sum of IoT devices. One the one hand, this limited the methods for analysis because using multiple devices per capita disqualifies mutual exclusiveness on categories of social use. It also raises questions about device-specific differences in social use that parallel the differences between Facebook and Google+ or Instagram and Snapchat, or between iPhone's and BlackBerry's in CMC research. On the other hand, the IoT platform promises to be more than the sum of IoT devices, for instance, by emphasizing its connectivity and novel interfaces, such as the use of virtual assistants by Google, Apple, and Amazon.

Third, forms of capital have invoked discussion about whether the content of different forms of capital is fixed or floating (Prieur and Savage, 2013). Bourdieu's concept of culture is equally contested (see Lizardo (2011) for an overview). Yet, all-encompassing conceptualizations of capital make the analysis almost tautological. Therefore, we limited capital to stable measures based on Bennet et al. (2009). We hope to inspire different conceptualizations of capital to research the effects of the IoT in society.

Fourth, we presumed a certain awareness of data-sharing among IoT users. This presumption can be overstated, especially between private use and sharing with strangers. We also used a large range of variation in sharing with acquaintances and colleagues. Qualitative research might provide a stronger understanding of subjective awareness and social distances in the social use of the IoT.

For future research, we suggest attention to be given to specific IoT skills, or lack thereof, that produce the effect of individualization and depersonalization. In our measurement of internet skills, the ISS, we found that they do not significantly attribute to using the IoT socially in a uniform manner. Qualitative research might better explain the social dynamics between the IoT and internet skills, and make an insightful transition from internet studies to IoT studies. Furthermore, we suggest more qualitative research to be directed to how skills emerge or are acquired in social context when internet skills are not immediately transposable to the IoT. And, akin to frameworks of domestication of technology adoption (Bakardjieva, 2005; Silverstone and Haddon 1996), how social use of the IoT affects social dynamics within a household with partners, children, parents, or a lack thereof. Lastly, we approached the IoT system by comparing it to CMC literature however, the IoT might also compare well to research on social bots and robots in their use, especially concerning to what we described as private use.

CHAPTER 4

Figurations and the IoT

Inequalities in cultural repertoires and its interdependency chains

Based on:
Van der Zeeuw, A., Van Deursen, A.J.A.M. & Jansen, G. (2019).
How to Apply IoT Skills at Home, *Poetics, 83*, 101486.

4.1 INTRODUCTION

As a network of everyday devices connected with the internet the IoT network can help individuals reduce their energy consumption, live healthier lives, and secure their homes by enhancing conventional physical world objects with web-based services (Kulkarni & Sathe, 2014; Rayes & Salam, 2018; Van Deursen & Mossberger, 2018). Consequently, IoT networks show tremendous promise for skilled users, yet it can be a conduit for new digital inequalities for lesser skilled IoT users. As such, IoT skills proliferate effectiveness and efficiency in its everyday use (De Boer, van Deursen & van Rompay, 2019; Van Deursen & Mossberger, 2018). In Chapter 3 we found that the IoT is being used as social products, but our findings also suggest that there are significant differences between households and their IoT use. In this Chapter we take three steps we begin to address our solfège problems by unravelling the social context as interdependency chains that influences how the IoT is being implemented at home and we start developing a uniform skillset for the IoT.

We begin by examining how straightforward household activities become involved in an expanding IoT network of interdependencies with organizations and stakeholders. For example, The IoT can automatically shut down the central heating when you leave your home, but to do that it needs a stable WiFi-connection and internet service, extracted data (for geofencing) from utility companies and IoT manufacturers, and operating software (mobile applications) with an operating device (e.g., smartphone). That is, in the words of Elias (1983 [1969]), interdependency chains become longer with IoT use. Organizations and stakeholders in these interdependency chains however, pursue goals that may contrast the goals of IoT users. IoT data, for instance, can strategically be implemented to construct more profitable deals for utility companies or insurance companies (Mandl, Mandel & Kohane, 2015; Shah, Nasir, Fayaz, Lajis & Shah, 2019), streamline healthcare and insurance costs (Kulkarni & Sathe, 2014), or increase security and control (Hoque & Davidson, 2019). New forms of digital inequalities, in effect, emerge from the power balances between interdependent parties involved with everyday IoT devices. Therefore, from a user-perspective, we first need to ask:

Sub-Question 2.1: How are interdependency chains established by IoT users?

Consequently, we need a greater understanding of people's ability to act upon power balances within interdependency chains. People, generally, have different tools in their cultural repertoires to call upon when required (Swidler, 1986; Lamont, Small & Harding, 2010), and these cultural repertoires provide them with possible modes of action and meaning (Hannerz, 1969). Moreover, a greater diversity of repertoires place people in a better position to situate their actions (Garret, 2016). Previous research on digital inequalities has shown that digital skills can be regarded as such cultural tools that contribute to beneficial internet use (e.g., Hargittai, 2015; Van Deursen, van Dijk & Peters, 2011). While proficient IoT use is likely to follow the same trend (Van Deursen, van der Zeeuw, de Boer, Jansen & van Rompay, 2021), less is known about the social context to provide a meaning to stimulate and develop digital skills. In the current contribution, we propose that interdependency chains could explain why some digital skills are stimulated in cultural repertoires of action where other skills are not. For instance, skills to store and protect IoT data become redundant with third-party assistance, while skills to manage home networks become important when household members need assistance. Therefore, we ask:

Sub-Question 2.2: How do interdependency chains influence which digital skills are used?

Lastly, research has strongly coupled internet-related skills with higher education (Hargittai, Piper and Morris, 2019; Van Deursen, van Dijk & Peters, 2011) and higher educational institutions give considerable attention to the repertoire of skills that involve digital information, internet communication, and strategic internet use (Davies & Eynon, 2013; De Haan & Huysmans, 2002). While we continued to couple IoT skills with cultural repertoires of education in Chapter 3 (Van der Zeeuw, van Deursen & Jansen, 2019), we are interested to add alternative cultural repertoires for IoT skills. As those with lower levels of education are constrained in the diversity of their cultural repertoires (Garret, 2016), selective sampling by educational level can give us a better understanding of different approaches in digital technologies (Scheerder, van Deursen & van Dijk, 2020). A sensitivity to alternative repertoires can give a more saturated understanding of IoT skills and its potential for emerging digital inequalities. Therefore, we pose our third research question to explicitly engage lower educational repertoires in interdependency chains of IoT use at home:

> *Sub-Question 2.3: How are interdependency chains coupled with lower and higher educational repertoires when starting to use IoT at home?*

With this final step we employ education as a sensitizing concept (Blumer, 1954; Denzin, 2017 [1970]) to guide our findings towards alternative repertoires of action; specifically aimed at skills outside of the direct educational repertoire.

4.2 THEORY

With the IoT people become dependent on one another in different ways from before. Interdependencies flow between IoT users, other family members, companies and service providers, and others with maintenance responsibilities. In the advancing network society (van Dijk, 2012), the IoT can be considered a medium for generating a dynamic and complex system. Such a system is characterized by individuals who are tightly coupled with one another and with the natural world, while accessible information is limited and ambiguous (Sterman, 2006).

To gain a better understanding of how the IoT is being integrated digitally and socially in a dynamic network society, we turn to the work of Elias (1983 [1969]) on interdependency chains in social figurations. Figurations are the changing pattern of how people relate to one another, socially and physically. This pattern creates a ‘flexible lattice-work of tensions’ between allies and opponents who are dependent on each other within such a figuration. As figurations become more complex, interdependency chains tend to become longer and more divided. Consequently, interdependent relations of mutual benefit and competition shape how power balances shift between parties

(Goudsblom & Mennell, 1998; Kuipers, 2018). By extending this social tug-and-pull to the IoT, Elias helps us to obtain a perspective on digital inequalities and IoT use, where IoT users are exploiters and exploited simultaneously but with different proportions of power in a figuration of *service providers-digital technology-user-proxy users*.

Digital inequalities have been considered on three levels. The first level concerns physical or material access and typically distinguishes between *haves* and *have-nots* (Van Dijk, 2006). The second level digital divide focuses on a repertoire of technological skills and uses (Hargittai, 2001) and the third on outcomes (Wei, Teo, Chan & Tan, 2011). Research has shown that digital skills are implemented as cultural tools by their compound and consequential effects (Van Deursen, Helsper, Eynon & Van Dijk, 2017). Moreover, digital skills are frequently linked with higher education (Hargittai, Piper, & Morris, 2019; Van Deursen, van Dijk & Peters, 2011) and educational repertoires (Davies & Eynon, 2013; Robinson, 2018; Scheerder, van Deursen & van Dijk, 2020). While the variation of digital skills is extensive (e.g., Van Laar, van Deursen, van Dijk & de Haan, 2017), in Chapter 3 we found that they do not automatically translate to the IoT (Van der Zeeuw, van Deursen & Jansen, 2019). Our theory, then, follows the empirical peculiars of the IoT through abductive analysis by which we emphasize the more prominent skills when people start using the IoT. Here, operational skills used to set up IoT systems are considered a starting point to study IoT use. To obtain advanced services and support from third parties and increase effective IoT use, however, collaboration skills become more influential. Collaboration skills have been used to describe digital teamwork skills towards a common goal (Van Laar et al., 2017), but with the IoT these skills underscore the conflicting goals between parties while they are collaborating. Additionally, choreographic skills emerged inductively to describe the skills used to adjust physical space, social space, and time available to increase efficient IoT use.

4.2.1 Operational Skills

Operational skills are considered the starting point for using the internet and internet connected devices. Operational skills refer to a set of technical competencies and user control (Van Deursen & Van Dijk, 2011), mostly with regard to the different layers of digital technologies such as drives, folders, files, scripts, and programming in a basic 'if-this-then-that' structure. As consumers start using the IoT, operational skills are used in the initial setup of IoT devices. After the initial setup, one of the more notable features of the

IoT is that it works autonomously and unnoticeably (Van Deursen & Mossberger, 2018). However, operational skills are used with different levels of sophistication. For example, a new IoT device can be installed simply by pushing a button on a gateway that automatically recognizes the new device within the same digital radio network. Setting up multiple devices of different brands and services while integrating them into a single operating system requires considerably more effort. More advanced and personalized IoT systems even require programming skills to work fluently. Therefore, prolific or absent operational skills are important to establish the interdependency chains involved and how power balances are distributed for continuous IoT use.

While education has a positive effect on operational skills, these skills are often acquired and developed outside of educational settings (De Haan & Huysmans, 2002; Van Deursen et al., 2011). Moreover, operational skills are generally taken for granted in education, even though variation in such skills does exist (Ng, 2012; Hargittai, 2010). This notion gives the important realization that the use of the internet- and internet-related skills is not uniform (Bennett, Maton, & Kervin, 2008). A similar pattern can be expected when setting up IoT systems, especially for the more advanced operational skills that require programming.

4.2.2 Collaboration Skills

Collaboration skills describe social competencies that consist of being able to ally with third parties to help install complex IoT hardware and software, to store and protect data, or to use advanced support and services that sufficiently improve IoT use according to personal needs. It also means being able to compromise and tolerate the conflicting goals that can be pursued by the parties involved. Unique to the IoT are the continuous or subscription-based services provided by organizations (e.g., utility companies and manufacturers) for everyday use, for example, by regularly updating their IoT devices, storing data, and analyzing data to help consumers strategically use the IoT. Having good collaboration skills is crucial because the IoT is vulnerable to vendor lock-in (Roman, Zhou, Lopez, 2013). That is, consumers can become locked-in with manufacturers because they are dependent on the software and services needed to operate their IoT devices on a daily basis. Additionally, consumers can become locked-in with manufacturers when they aim to upgrade their IoT systems with new devices because brand-specific connection hubs and gateways do not communicate with off-brand devices.

Moreover, collaboration skills can turn to proxy use by third parties when other skills are lacking (Reisdorf, Axelsson, & Maurin Söderholm, 2012; Eynon & Geniets, 2016; van Deursen Courtois & van Dijk, 2014). Proxy use of the IoT can range from professionals installing smart thermostats or medical professionals interpreting biometric data via wearables to neighbors assisting in setting up an IoT system. As such, collaboration skills provide a viable strategy to be less involved with the initial setup of IoT devices or maintaining an IoT system, but it does increase a dependency on other parties.

While uniquely directed at the IoT, collaboration skills are influenced by underlying internet-related skills that involve understanding what information is being collected and who has access to it. Educational level is an important resource for developing such skills, with increasing significance for data literacy and protecting privacy (Van Dijk & van Deursen, 2014). Moreover, Lamont (2009) describes that collaborative orientation is an esteemed personal value among higher educated individuals which stands in sharp contrast to the cultural repertoires of the working classes, who are more easily frustrated by a dependency on others and favor self-reliance. Overall, it will be easier for the higher educated to access collaboration skills as part of a cultural repertoire.

4.2.3 Choreographic Skills

Choreographic skills refer to a set of embedded competencies to adjust physical and social space to IoT devices. Whereas collaboration skills are coupled with higher educational repertoires, choreographic skills poses an alternative repertoire for IoT use. Inspired by Loke and Kocaballi's (2016) socio-material framework on the domestication of technology, choreographic skills consist of three main components. First, being able to fit IoT devices within a preexisting material structure with other domestic technologies. The general conception is that the material properties of devices influence their potential use (Latour, 1992). For example, by keeping wires and other small items off the floor so that robot vacuums can run without supervision (Sung, Guo, Grinter & Christensen, 2007). Additionally, the relation between IoT devices and software updates continues to enhance devices, which are otherwise relatively static in their use, and affects their placement potential.

Second, being able to use IoT (devices, apps, and accounts) with multiple people. People are choreographed by the social formal and informal rules of conduct that describe who has access or participates with IoT use depending on expectations for the primary functions of the device (e.g., Loke & Kocaballi, 2016; Plowman, 2015; Bakardjieva, 2005). For instance, Rainie and Wellman (2012) argue that more choreography is needed when computers are shared, and therefore, several email accounts are created to keep messages separate. IoT devices and related mobile applications are similarly shared within household ensembles, and users need to tie multiple accounts together to share IoT devices.

Third, being able to fit the IoT within existing patterns of behavior. People are choreographed by their possibilities of movement in terms of effort, motivation, and time. For example, wearables and biometric data motivate people to become more active and schedule daily exercises accordingly, keeping them in a technological loop (Parviainen, 2016). That is, choreographic skills are used to fit the IoT with the time and effort available.

Choreographic skills specifically address IoT as systems with extendable hardware and software features that change how the IoT is being used over time in social and material dimensions. Thus, where operational skills are used to set up IoT, choreographic skills are used to increase the added value of an IoT setup and use it efficiently in a social context.

4.3 FINDINGS

4.3.1 The IoT as a Medium of Interdependencies

When IoT devices connect with the internet, they enhance everyday devices with internet services. It makes the IoT at home a medium that gives material means to internet services. Consequently, individual users are continuously dependent on manufacturers for the everyday use of their devices. Manufacturers are tied to their customers longer after the initial sales of their products because the information-driven economy makes user data a valuable resource. To gain an understanding of how interdependency chains influence how IoT skills are stimulated as cultural repertoires of action, it is important to first consider the material means of IoT services. What follows is that IoT systems are set up differently to enhance or restrict interdependency chains, and power balances shift accordingly. The dependency on IoT services becomes apparent when users, such as Alfred, question whether devices work without support. As Alfred explains:

> *Well, my [smart] lock, for example. Suppose that tomorrow the manufacturer goes bankrupt or something. And then? Can I still use it or do I have to throw it out and buy another one? So, the usability depends on the manufacturer, it feels like. Maybe I can still use it*

with the app. But it feels like the manufacturer actually decides how long such a product can be used. Also, for how long does it remain profitable for a manufacturer to continue support with such a product? When they stop supporting, then you'll just have a problem. Then, I have a worthless thing.

Alfred's concerns highlight the material basis for services in profitability for the manufacturer and tied to the usability of the device itself. Without the skills to rewrite the software and make the IoT work locally, there is a continuous risk of being locked-in with manufacturers who maintain IoT software. Nevertheless, being locked-in is not one sided, as mediated services can enhance smart products even further. An illustration is given by Peter, who has a smart doorbell. This doorbell includes a camera, sends mobile notifications when someone rings the bell or appears in front of the camera, and makes live video accessible with an app on his mobile phone. Peter explains the added value of a subscription:

They are very clever by giving you the first 30 days for free, free in parentheses, to store the images, and after 30 days they ask if you want a subscription so that all the images are stored longer. That was a consideration for me not to do it, the Ring [doorbell]. But in the end, with all the other advantages, I said yes. Then you pay 30 euros a year, I think, and get a subscription that includes everything. I kinda felt like that would be the best option. And then I also consider it as a piece of security. That is, how I could justify it for myself. Because at first, I had something like, for only the doorbell? I was like: "mmh, mmh." But if you look at it a bit broader, then it is not so bad. And then your images are saved and you can see something back again.

In exchange for an annual subscription, the function of a doorbell can be enhanced to function as a security device. It saves Peter from having to store data and secure it digitally on a private server. More importantly, by having control over storing and protecting sensitive data, it increases the power balance in favor of the manufacturer, who then also has control over it and will use it for different goals than Peter.

In contrast to enhancing features, the constant mediation of the IoT can also be disruptive. Even when most of the maintenance is in the hands of IoT users themselves, software constantly evolves through updates. Some people, such as Robert, start using the IoT and become more actively engaged. Robert considers it a hobby to integrate extensive IoT systems; this integration, aside from searching for a cheaper alternative to IoT devices, consists of actively personalizing software. However, IoT devices are still tied to software updates, for instance, to improve the stability of the software. These updates can be quite disruptive, as Robert explains:

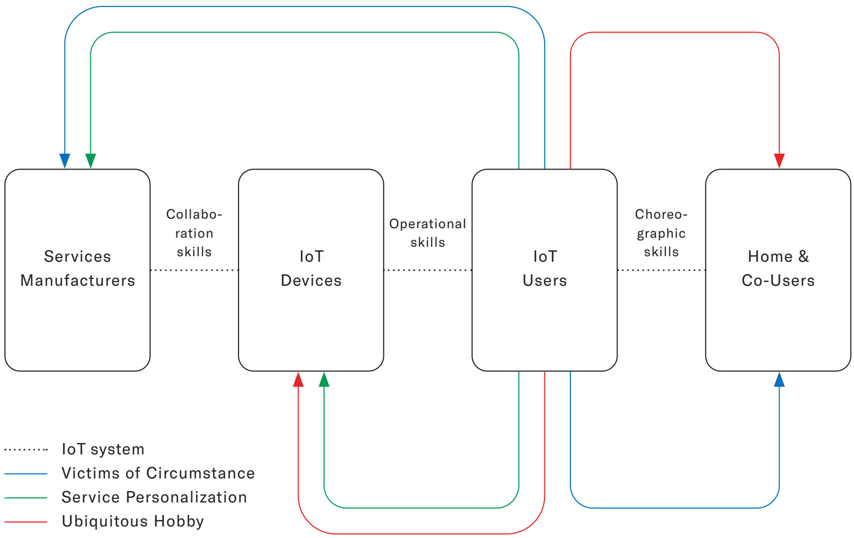
> *Sometimes with an update, it might not work for a while. Then I'll have to see where it comes from. Sometimes they change things a little bit. Then you'll have to ask questions differently in the system. Yeah, then they have changed something which makes you have to set your own script a bit differently. But usually it's only a little while before it works again. Well, an update in the morning, that can be bad. Certainly if you have to go to work. That's when it doesn't work for a little while longer. It also depends on what it is exactly. Sometimes it can take a while but no longer than an hour.*

As a result, when Robert has not updated scripts because he is out at work, it means that other family members are without working lights in the morning. Or, they are not being notified when windows are still open upon leaving. The habitual dependency on the IoT working properly also mediates a dependency on maintenance. Meaning that without the reliability that third parties offer, IoT systems can be less stable and more easily disrupted. Moreover, while the power balance favors Patrick in storing his own data and writing his own scripts, his IoT system still mediates interdependencies with other parties who occasionally want to improve their overall software stability.

4.3.2 Interdependency Chains When Lower and Higher Educated Start Using the IoT

As described in the previous section, how people start using the IoT is partly determined by material means of IoT services and how the IoT has been set up. Based on our empirical data we can provide an IoT variation to a common figuration of *service providers-digital technology-user-proxy users*. Figure 4.1 shows a figuration of interdependency chains an IoT system at home ranging from service providers and manufacturers to IoT devices, IoT users, and the homes where the IoT is set up with its co-users. We now turn to our second research question: How do interdependency chains influence which digital skills are used?

Figure 4.1
Interdependency Chains of the IoT System at Home



Our empirical findings suggest three interdependency chains shown in blue, green, and red in Fig. 4.1. The chains are based on compensation strategies that emerge from applying operational, collaborative, and choreographic skills shown in Table 4.1. First, the chain *Victims of Circumstance* illustrates the ubiquitous penetration of the IoT in everyday life as the most common type of IoT use. The influence of educational repertoires is limited in this chain due to its circumstantial character, and power imbalances appear to be hidden to most users. In the chain of *Service Personalization*, users are working in alliance with service providers to maximize effectiveness. However, there is also much exchange with third parties in terms of personal data and security, intensifying an interdependency between services and user-generated data. This is an interdependency chain that relies on a cultural repertoire typically associated with higher educational levels. In the chain of *Ubiquitous Hobby*, most of the responsibility is on the main IoT user at home for maintenance and ease of use for other family members; an alternative cultural repertoire that is more accessible and typical for the lower educated. Users in this interdependency chains have a relatively high proportion of power relative to service providers and manufacturers but are also left without advanced services and benefits to make their IoT use more effective.

Table 4.1

Interdependency Chains When Lower and Higher Educated Start Using the IoT.

	Operational skills	*Collaboration skills*	*Choreographic skills*	*Educational repertoire*
■ Victims of Circumstance	-	+	+	Higher and lower
■ Service Personalization	+	++	-	Mostly higher
■ Ubiquitous Hobby	++	-	+	Mostly lower

N= 30

4.3.2.1 Victims of Circumstance

As everyday devices break down and are replaced by IoT devices, many are introduced to the IoT by circumstance. Mobile phones come with preinstalled health apps waiting to be discovered. Or, people move into newly built houses with a 'smart' infrastructure for power plugs, solar panels, and thermostats connected with the internet. Generally, this infrastructure is a casual use of the IoT where individuals have been assisted in their process to start using the IoT, and therefore, the influence of education as a cultural repertoire is limited. Simply put, the IoT has been skillfully fitted within choreographies of daily life by collaborating with other parties.

What characterizes this chain of IoT use is its dependency on others for operational skills. For instance, when IoT devices are installed and maintained by a mechanic, as is the case of Mike, who "believe[s] that the thermostat is linked with the email address of the mechanic, also in the case of any malfunctions." Consequently, when pressure in Mike's boiler falls below a certain threshold, his mechanic is automatically notified. This type of use can be expected from the IoT, as it aims to work invisibly after it is set up and operational skills are less prioritized in continued use (Van Deursen & Mossberger, 2018). Moreover, lacking operational skills for the initial setup can have a deterring effect on IoT use. Roza, for instance, is very capable of using smart light settings, including a disco-mode that reacts to sound for her children, and knows where to place her lights to make the most efficient use out of it. However, in regard to more technical operational skills, Roza explains:

> *I can't use it as well as my son and my partner. The connecting and that stuff, that would not work for me. No, I'm not that handy. If I had been alone with my children, I would not have bought it. Maybe I would have asked my father if I really wanted it. But then you don't purchase it because you have to bother someone for the installation. So, I would not have bought it myself. To install all of that and how it all works, no. And yes, I get frustrated when things don't work and he's not here, then I'll call him.*

Individuals such as Roza are perfectly capable of using the IoT in their daily life and making choreographic adjustments but rely on collaboration skills, knowing who can install IoT for her and where to find help, to get over operational thresholds. With ongoing support in social networks or proxy use, informally by friends and family or formally by manufacturers and mechanics, having good collaboration skills can be used to compensate for lacking operational skills.

As the IoT has been made to fit into the choreography of daily routines with the help of others, more advanced operational functions are neglected or remain undiscovered. This outcome is what happened to Luke, whose smart thermostat was installed three years ago. Luke finds that turning the heating on and off with his app is such an easy procedure that other functions were not discovered until the interview: [I've] no need for a program, so I didn't really get into it. ((Picks up his phone)). I see you can monitor all sorts of things. Energy consumption? Oh, that's new to me. Oh, I can even see the use of gas this week. Operational skills, while perhaps not absent in Luke's cultural repertoire, are not stimulated or needed within such a chain of interdependency. After the installation, Luke's choreographic skills bypass the need for operational skills and more advanced functions. Consequently, the absence of operational skills impairs strategic use of the IoT, as Luke has not been monitoring his energy consumption. However, this absence does not mean that those without operational skills are without strategic benefits of the IoT. In fact, no requirement of having operational skills is part of the attraction for using the IoT. As Elise explains, well-implemented IoT devices help with the cluttered choreographies in daily life:

> *In the beginning, we had some difficulties with our lamps because we simply forgot about them very often. And then I would get another message from him saying: "you have forgotten the lights upstairs again." So yes, I think it is very handy that we have [smart] lights. Also, with the [smart] thermostat. If you no longer have to think about something because it happens automatically, then you have more space to think about other things, like groceries or something. I think you have more room in your head. Also, because you can do so many things with the internet that you don't have to think about everything anymore. I sometimes like that. And then I can happily focus on my children, or on my work. Then, I'm really at work.*

For Elise, the IoT helps with household responsibilities while she is occupied with other tasks. Moreover, the IoT can offer cognitive elevation from everyday clutter and stress. In such interdependency chains, it can be a greater advantage to not having to use operational skills than it is a disadvantage of not having them.

4.3.2.2 Service Personalization

At first, IoT devices allow people to obtain similar devices more easily because only one bridge or gateway is needed to connect those devices with the internet. For example, one smart light is a motivation to get more smart lights because there is already an IoT structure in place. Other times, people become familiar with health apps on their phone, and they want more features or better accuracy with wearable activity trackers. In other words, with good collaboration skills, they seek manufacturers and companies to match their operational skills and personal needs. By utilizing specific mobile applications, certain functions are more advanced. However, specific apps are generally not integrated into one IoT 'ecosystem'.

With an interdependency chain between collaboration skills and operational skills, the difficulty is in getting a system that becomes choreographically autonomous. The Service Personalization interdependency chain is characterized by each user having its own responsibility on how he or she uses the IoT. Devices are set up and apps are installed but not used by everyone. This lack of use can cause some confusion as to which apps and devices are coupled, as shown by Mary during the interview:

> *We don't have a Google home or something. Let me think, yes, part of that is also in this one app. What is that called again... ((Picks up the phone)). I think it's in the [...] app. I think that one can do things... Like show your lights and stuff. Well there are a number of things, that's what makes it a bit tricky of course. That you have a number of apps and not a single app that can do everything. I'm just thinking, because there should be an app that you can also use to do the lights and the heating and all kinds of things together. But I just don't use it, so I don't know what it's called. ((Puts the phone down)).*

Specific apps advance service personalization and provide collaboration benefits, but it also establishes a dependency on service providers and manufacturers. Such interdependency chains are broken when using alternative software to tie apps and devices together. Therefore, choreographic skills to fit an IoT system into their lives are less prevalent. Tying multiple apps and devices together requires effort, motivation, and time that is not available to everyone.

Moreover, as household members are individually responsible and capable of their own IoT use, it becomes more apparent that nonusers are disruptive to the IoT. For example, a household consisting of two higher educated individuals with good operational skills, Ellen and Kevin, describe sharing their IoT at home with a housekeeper that has no interest in developing operational skills:

> *We have a housekeeper in the morning once a week. And then in the morning I am sometimes confused about why the lights don't go on. Well, of course... But yes, she may turn the lights on as well, only she does not have the app to turn them on differently. We can't let her work in the dark, no, so when we go on a holiday and we don't want the light to turn off with the switch, we put some adhesive tape over it. So, it can't be turned off or on.*

Ellen and Kevin's lights are set up to simulate living when they are on holiday to provide a sense of security. This is a preset function on the app that comes with the lights. However, this function does require that old fashioned light switches, which Ellen and Kevin hardly ever use, remain switched on.

As their choreographic skills are at a lower level for figuring out access for multiple people, an impromptu solution became adhesive tape.

Similar to security settings on smart lights, people seek out devices specifically for IoT services. As the case with Cassian, whose installed smart thermostat helps monitor and eventually reduce gas output. As it is more common among higher educated individuals to be skeptical about internet use and privacy (Scheerder, van Deursen, & van Dijk, 2019), Cassian's selection was influenced by his weariness of intrusion by large corporations and concerns of what is being stored in the cloud and where:

> *Well, the reason that I have chosen to install Tado is that it is a European company. It is based in Germany. And they also say that all data are stored within Europe. That they meet a certain security level, certain ISO standards for data security. And you know that they also use the data anonymously to improve their entire ecosystem.*

Cassian also based much of his knowledge on privacy on peer testimonies of friends who work in ICT. Meaning that he acquired some of his information informally by other higher educated individuals, a common effect of homophily of social networks in social learning (DiMaggio & Garip, 2012). Cassian, however, stumbled on a choreographic problem because he already had a floor heating system installed on both levels and wanted to use Tado only on the ground level. As the existing material structure does not match the IoT qualities, Cassian explains:

> *Well, tried it twice [with the Tado helpdesk], and it failed twice. They said: 'What you want is not possible or you should buy thermostat faucets for 100 euros each.' With five groups, I think that's a bit too expensive. So, with Arduino, a programming board, I have programmed an if-this-then-that program. So, the moment I have a heat demand here, Tado sends a signal to the boiler: there must be hot water. But what it actually does is give Arduino a signal that it needs to get warm in the living room.*

Rather than keeping Tado out of his IoT system, Cassian relied on his operational skills to make it work while continuing to use the monitoring services of Tado. For the future, however, Cassian wishes to create a more extensive IoT system that fits his personal needs. He continues to develop operational skills but is beginning to look towards open-source alternatives to use IoT devices.

4.3.2.3 A Ubiquitous Hobby

The initial IoT setup quickly becomes an ongoing activity when IoT devices keep getting added to an IoT ecosystem. The IoT usually uses ZigBee, a digital radio network that allows for wireless communication between devices. To connect the IoT devices with the internet, companies have their own bridges or gateways, which also restrict devices from other companies to tap into the same network. Theo, after first using lights by Philips, saw on YouTube how to connect IKEA lights in the same network. He explained that he could use ZigBee2mqtt software on a usb-stick to bypass bridges or gateways from companies and control ZigBee devices directly. Adding devices and managing the IoT system in his home has become somewhat of a hobby since then:

> *I have everything on one system now, so I no longer need different gateways. I enjoy that. I can manage everything myself and adjust it to my needs. And then, it depends, sometimes I am busy for a whole week reinstalling everything, setting everything up. Other times I leave it for a month as it is. So it's just when I get new ideas about what I want to change. Now I have bought a Raspberry Pi. Just need to think about what I will do with it. I still have to flash it [the SD drive] and put other software on it. And then I have to find a place where it is handy to use it.*

Theo shows that his choreographic skills are continuously needed in tandem with his operational skills. Advanced operational skills increase the flexibility of using devices for different functions and, in effect, create different possibilities for daily life choreographies. Additionally, Theo shows an interest in new devices for operational use first and using it choreographically second. Most of the skills to establish a network of devices that is stable and protected are self-taught using peer-to-peer internet communities. Moreover, collaboration skills are hardly used in this interdependency chain, and they tend to fall outside the boundaries of a higher educational repertoire. Instead, self-reliance, as shown by Theo, is an esteemed alternative moral worth (Lamont, 2009). The IoT gives users such as Theo more autonomy and control instead of less, as predicted by Van Deursen and Mossberger (2018). While considered a hobby, it remains a priority to make it easy to use for their partners and children who tolerate their IoT enthusiasm "as long as everything works", socially and materially.

Consequently, as IoT users in this interdependency chain aim to be more self-reliant, others turn to them for help. This is the case for Jonathan, whose repertoire of digital skills have created such a reputation among his friends and family, that "if they have a problem and are unable to fix it then I am often one of the first to be called." When asked if he enjoys or dislikes it when others ask for help, Jonathan laughs:

> *Hee-hee, no I do enjoy it somewhat. I'm just too helpful and I think it's just something you do for friends. But sometimes you do think that maybe I should ask something for it. It also depends on the problem, and you get better at being able to analyze what makes sense to solve and check.*

Operational skills have made Jonathan a dependable figure for problems related to the internet and IoT. In this chain of interdependency, users are often asked for help by others but also tend to be a little wary not to become their "personal helpdesk". A sentiment close to Bourdieu (2001: p. 174) insofar as the dominant are dominated by their own dominance.

4.4 CONCLUSION

4.4.1 Main Findings

While some choose to start using it, the IoT can happen to anyone. Whether via biometrics and health apps that come with a smart watch or the boiler stops working and with its replacement they find themselves connected to an IoT network. Following digital inequality research, skills are expected to be crucial in transforming IoT use into tangible outcomes. Foremost, Elias' (1983 [1969]) framework has provided us with a better understanding of how interdependency chains determine what skills are required or stimulated by compensation strategies and composites of other skills. As IoT mediates interdependency chains, users cope with varying degrees to being locked-in with manufacturers by enhancing services via subscription formats and adding functions or by trying to reduce the degree that mediation is being disruptive to their IoT setup. Continuing our analysis, we can draw two main conclusions based on the selection of skills used in the interdependency chains we identified.

First, Van Deursen and Mossberger (2018) predicted in an earlier study that the IoT would lessen the autonomy and control of its users. However, our findings suggest that autonomy and control are largely mediated by the IoT services and the materiality of IoT devices. The material means of the IoT and operational skills activated can give people who start using the IoT more autonomy and/or more control. In other words, less autonomy and control comply with our interdependency chain on Victims of Circumstance. However, in two other interdependency chains, Service Personalization and Ubiquitous Hobby, we found that cultural repertoires stimulate operational skills that can wager more control and autonomy for everyday activities.

Second, the absence of operational skills in one's repertoire is not enough to deter IoT use. With this regard, we (re)constructed skills specifically to address the IoT and its social relations. With collaboration skills, individuals are able to obtain advanced services and support from third parties, which may have conflicting goals to maximize the service potential of the IoT. This conflict becomes a wager of trust and privacy against effective IoT use. With choreographic skills, individuals maximize IoT use at preferable low costs. They have to adjust physical space, social space, and time available to increase efficient IoT use. Therefore, the IoT can provide a substantial benefit to its users with composites of collaboration skills, choreographic skills, and operational skills.

Moreover, we have extended our empirical findings to cultural repertoires of action. On the one hand, collaboration skills tend to be compatible with a higher educational repertoire on the skills needed to reflect on digital information and digital communication. Higher educational repertories provide the skills to navigate between service providers and decide which are more beneficial or reliable over others for effective IoT use. On the other hand, a lower educational repertoire seems more prone to value self-reliance, supported by operational skills. However, self-reliant IoT users also tend to feel a greater responsibility to make their IoT systems accessible and non-intrusive for other family members. Additionally, it is within the aims of this repertoire to increase IoT efficiency by actively seeking cheaper solutions to what is available on the general market.

4.4.2 Limitations and Future Research

Due to the qualitative nature of this study, we used education as a sensitizing concept rather than a structural disposition. Our participants were particularly selected to form a theoretical sample based on educational levels to present an alternative to higher educational repertoires. Readers should be careful not take remarks on education as conclusive but at theoretical considerations for future research. Additionally, socially constructed categories other than education can highlight different relational dynamics in IoT use. Therefore, we hope to inspire future research to be attentive to structural categories such as income and available monthly spending's, gender, age and the relations between categories. While we found no reason to suspect that the IoT is exclusively gendered, attention to household responsibilities tends to shift from traditional gender roles as the devices become digitized. However, this research has been limited to setting up IoT systems and its maintenance, whereas gender differences might become more important during its actual use. Similarly, age is often important, while older users in the sample show that the IoT is not exclusively for younger people. While consumer IoT use is at its earliest stage, research might be directed to the variety of tangible IoT outcomes and quantify the measures of these outcomes.

CHAPTER 5

Affective Bonds and Operational Skills

How vendor lock-in hinders and playfulness creates IoT benefits in everyday life.

Based on:
Van der Zeeuw, A., Van Deursen, A.J.A.M. & Jansen, G. (*in review*). The Orchestrated Digital Inequalities of the IoT: How Vendor Lock-in Hinders and Playfulness Creates IoT Benefits in Everyday Life.

5.1 INTRODUCTION

In Chapter 4 we started to address our solfège problems by (1) defining the context wherein the IoT is being used as a figuration and three variations of interdependency chains; (2) proposing a uniform skillset of operational skills, choreographic skills, and collaboration skills to understand how devices function relative to each other; and (3) by elaboration how IoT skills are stimulated or compensated differently according to the interdependency chains IoT users are able to establish. In Chapters 5, 6 and, 7 we pose our sub-questions more specifically to the empirical problems with the IoT we outlined with our solfège problems. We do this by concentrating on the interdependency chains of affective, political and economic bonds in each subsequent Chapter, respectively, and how they influence the operational, choreographic, and collaboration skills in our IoT skillset.

In this Chapter we mainly focus on the *IoT devices-IoT users* figurational units in our figuration as affective bonds and its relation with operational skills. The IoT can be a promising tool for extending the internet to everyday applications and providing newer functions and services to everyday practices (Shouran, Ashari & Priyambodo, 2019; Al Sheyadi & Sohail, 2019; Aheleroff, Xu, Lu, Aristizabal, Velásquez, Joa & Valencia, 2020; Aldossari & Sidorova, 2020). However, by addressing our solfège problems in Chapter 4 we already found that interdependency chains are detrimental to how people can benefit from the IoT, that people require different skills to use the IoT in their social context, and that these skills can be coupled with repertoires of higher and lower education. We also found that with a combination of creativity and operational proficiency, some people are able to connect IoT devices to one another and tap into endless possibilities for use and function. For example, when the doorbell rings, lights can flash in a different color but only if music is playing above a certain volume; locking the front door can also switches off electronic devices and lowers the temperature on the central heating; solar panels can switch on the washing machine when the sun is out and the window shades are activated; and, when a person leaves to go on vacation, lights can work together to simulate natural activities in the evenings as a security measure.

While the IoT can offer endless possibilities in theory, users are met with the reality that the IoT can be limited by vendor lock-in. Vendor lock-in is caused by competitive market relations that prevent consumers from migrating to another competitor due to either financial costs or the costs of having to relearn and re-personalize products and services (Amit & Zott, 2001; Smith, Bailey, & Brynjolfsson, 1999). Vendor lock-in is an issue with the IoT when people try to standardize their IoT to a single operational system (Pal, Rath, Shailendra & Bhattacharyya, 2018). For instance, a smart lock and doorbell are tied together with Google Home, but heating and lights are installed on Apple's home assistant. In such cases, navigating through various apps and settings can take more time and effort than the actual physical button presses. Additionally, IoT devices are plagued by interoperability issues (Noura, Atiquzzaman & Gaedke, 2019). People might want to update or extend their smart light setups but might find this expensive, as adding new or alternative brands also requires connection hubs and additional mobile applications.

In other words, competitive market dynamics appear to hinder IoT potential. In Chapter 4 we found that collaboration skills can mitigate the limitations of vendor lock-in if IoT users find the right IoT manufacturers to cooperate with for their personal needs. However, where some people experience the limitations of the IoT, others find creative solutions to circumvent vendor lock-ins altogether. Therefore, as an antidote to vendor lock-in, in this Chapter we examine the social context through affective social bonds with the interplay between creativity and operational skills. Finding creative uses and playfulness beyond necessity are crucial for stimulating digital skills (Robinson, 2009). Simultaneously, operational savviness is needed to explore digital technologies and maximize their outcomes (Purushothaman, 2017). We explore inequalities in IoT potential more conductively to the affective bonds in our solfège problems by asking:

Sub-Question 3.1: Why are some people able to capitalize on the potential benefits of the IoT creatively, while others are hindered by vendor lock-in?

In this Chapter, we aim to explore vendor lock-in in the IoT as an important aspect of the continuing digital divide (see Van Dijk, 2020). The operational proficiencies that relate to vendor lock-in, however, often concern creative practices that emerge from everyday IoT practices. This means that creative IoT uses emerge out of one's relation to their device and their socio-structural environment rather than following distinct definitions for creative use. Instead, we approach creativity as a concept that has relational parameters for creative IoT use (as experienced by our participants). To assess these parameters, we use metaphorical concepts of 'social proximity' (distant-close) and 'social warmth' (cold-warm) based on the notion that concrete physical and perceptual experiences ground abstract concepts (IJzerman & Semin, 2009; Barsalou, 2008). We study these metaphorical parameters for creativity in IoT use with a novel diary study using a mobile application among 27 participants for 6 months explained in Chapter 2. In the next section, we discuss social proximity and social warmth in greater detail as they relate to our diary measures and detail why they are important parameters. In the findings section, we illustrate the factors that were identified through the diary study using interview data.

5.2 THEORY

While vendor lock-in has been identified as a hindering factor for IoT use (Aliero et al., 2020; Noura et al., 2019; Pal et al., 2018), little is known about its effect in shaping digital inequalities. We aim to fill this gap by focusing on the abilities needed to overcome vendor lock-in hindrance, specifically by examining the interplay between creativity and operational skills. Consequently, as people are hindered by vendor lock-in to varying degrees, we argue that vendor lock-in is an important component of the continuing digital divide. Research on the digital divide has been prolific in studying gaps between access, use, and outcomes (Hargittai, 2002; Van Dijk, 2020; Wei, Teo, Chan & Tan, 2011; Blank & Lutz, 2018). In Chapter 3 we have shown that the digital divide can extend to the IoT in terms of access and use (Van der Zeeuw, van Deursen & Jansen, 2019). A crucial difference between the regular internet and the IoT, however, is that the role of operational skills as a predictor of digital inequalities becomes disputable as we shift towards the IoT. Operational skills start with basic button knowledge, the ability to install applications and use software settings to match personal use (Van Dijk & Van Deursen, 2014). As the IoT is designed to work less visibly and more autonomously after the initial setup, operational skills are not considered to have an effect in the long run (Van Deursen & Mossberger, 2018). However, in Chapter 4 we have shown that operational skills are embedded in a network of interdependencies (Van der Zeeuw at al., 2020). With minimal operational skills, people still find proficient uses for their IoT devices, but more proficient users continuously use more advanced settings and third-party apps. The most operationally advanced users fully exploit digital technologies by modifying software scripts, usually in the fundamental 'if-this-than-that' or hardware to redesign the original use. In other words, the practical role and necessity of operational skills when using the IoT is debatable.

What constitutes creative IoT use is even more debatable. For any sort of creative use of the IoT to take place, we consider two parameters. First, users should feel that their IoT devices are in close enough proximity to use actively. Presumably, experiencing the IoT as distant—invisible devices that mainly work autonomously in the background—does not stimulate exploration or playfulness that might lead to creative uses. Moreover, much like any ecosystem (Cf. Fligstein & McAdam, 2012), experiencing a stable or changing IoT ecosystem can indicate stagnation or growth, respectively, in creative potential. Second, users should consider their IoT devices to be something more than purely cold and functional in order to find other uses that exceed devices' initial functions. We presume that warm, in contrast to cold, signifies competence and added emotional value that fosters creative use (Cf. Fiske, Cuddy, & Glick, 2007; Kumari, Singh, Mehra, & Mishra, 2018). In this Chapter, we measure these two criteria using an innovative diary study based on Lakoff & Johnson's (2017) notion that the structure and experiences of everyday basic activities correspond to metaphorical concepts, e.g., social proximity (close-distant) and warmth (cold-warm).

5.2.1 Keep Your Friends Close, but Your IoT Closer

We use the metaphorical concept of social proximity because IoT users need some degree of closeness to their devices to operate them, be creative with them, and in turn, develop their operational skills to lessen the hinderance of vendor lock-in. For a better understanding of social proximity, we turn to the work of Elias (1978) and his understanding of human figurations. Human figurations are often described as networks of people. However, social networks are commonly quantified by the number of relations between units, structural holes (Burt, 2009), or strong or weak ties (Granovetter, 1983) to describe overlaps among connections. Human figurations, on the other hand, emphasize changing patterns of social and physical relations rather than their topology. Figurations, in other words, are the 'flexible lattice-work of tensions' between those who are interdependent on each other (Elias, 1978).

In our diary study, we aimed to encapsulate change by focusing on human-IoT figurations rather than human-to-human figurations as a flexible lattice work of interdependencies. Proximity or other notions of social distance are generally considered indications of attachment to persons, objects or experiences not necessarily present in the direct experience of reality (Cf. Williams & Bargh, 2008; Liberman, Trope, & Stephan, 2007). Therefore, according to the corresponding spatial orientations we give to embodied properties in our functional environment (Lakoff & Johnson, 2017), we take figurations to indicate changing patterns by notions of proximity, e.g. feel more or less dependent on IoT devices for comfort. The main difference between human figurations and human-IoT figurations is that the latter is defined by one direction in terms of feelings of attachment, as most devices do not (yet) feel. Additionally, in Chapter 4 we have shown that the network of interdependencies behind IoT devices is mostly invisible to its users (Van der Zeeuw, van Deursen & Jansen, 2020). What is clear, however, is that users need to operate their IoT devices to experience their benefits. Users are flexibly tied to their IoT devices by operational necessity, either by their practices or by the cognitive strain IoT devices put on users. Our diary study, in effect, is a pragmatic but relatively simplified approach to figurations as well as to human-object relations.

5.2.2 Cold Necessity and Warm Playfulness

For social warmth, we turn to Ignatow and Robinson's (2017) '*theorizing the digital*' and their use of Bourdieu's framework. This framework revolves around the differences in the internalized digital habitus when using the internet as a necessity versus using it as a luxury (Ignatow & Robinson, 2017; Robinson, 2009). As people experience constraint and temporal urgency due to limited access to economic resources and temporal urgency, Bourdieu argues that "necessity imposes a taste for necessity which implies a form of adaption to and consequently acceptance of the necessary" (1984: 372). Not only does a taste for necessity become deeply ingrained in one's lifestyle, people who internalize such a taste also develop stronger feelings against squandering. Consequently, rather than seeing implicit benefits, such as investing in social capital with engagement parties, a taste for necessity prefers the practical or technical. The antithesis to a taste for necessity is formulated by Bourdieu more clearly in '*Practical Reason*' (1998) and later in '*Pascalian Meditations*' (2000), where he discusses the formation of an ideal academic habitus. Bourdieu describes the academic habitus as a contrasting disposition that allows someone to invest and divulge in activities that people constrained by urgency and necessity might perceive as wasteful. Rather, Boudieu describes a taste for playful interest, after Plato's *skholé*, distanced from necessity and urgency but allowing oneself to be interested in problems that "serious and truly busy people" ignore (Bourdieu, 1998: 128).

Robinson uses this Bourdieusian framework to argue that inequalities in internet-related skills originate in inequalities of access but ultimately emerge from cultural values related to total life contexts. While studying digital technologies among lower- and middle-income families in the agricultural belt of California, Robinson (2009) found two versions of an information habitus: a *task-oriented* information habitus common among the disadvantaged, based on enacting the Bourdieusian taste for necessity, and a contrasting *playful* information habitus common among upper-middle-income families. Just as squandering engagement parties are indirect investments of social capital, playfulness and creativity with digital technologies indirectly promote skill development (Robinson, 2009). More importantly, those with a taste for necessity do not acquire the same skills and benefits as those engaged with a playful interest in digital technologies, and, in effect, a task-oriented information habitus ultimately reinforces digital inequalities.

Inspired by Ignatow and Robinson's (2017) use of the information habitus as a socio-contextual factor for digital inequalities, we consider playfulness and creativity investments that can actualize a greater potential for IoT use and stimulate operational proficiency, which can be hindered by vendor lock-in . In our study on figuration diaries, we conceptualize these investments by using the metaphorical concept of social warmth. Social warmth is commonly associated with creativity in embodied realism (Fiske, Cuddy, & Glick, 2007; Kumari, Singh, Mehra, & Mishra, 2018) and with playfulness (Goodwin, Piazza, & Rozin, 2014; Kouchaki, Gino, & Feldman, 2019). We consider warmth a notion that indicates something more than 'just a machine' that is being operated, thereby placing a taste for necessity on a socio-sensical scale along with playfulness and creativity. Additionally, creativity and playfulness are also generally associated with higher academic competences, similar to Bourdieu's academic habitus (1998).

5.3 FINDINGS

5.3.1 The Issue of Vendor Lock-in: The IoT as a Functional Tool

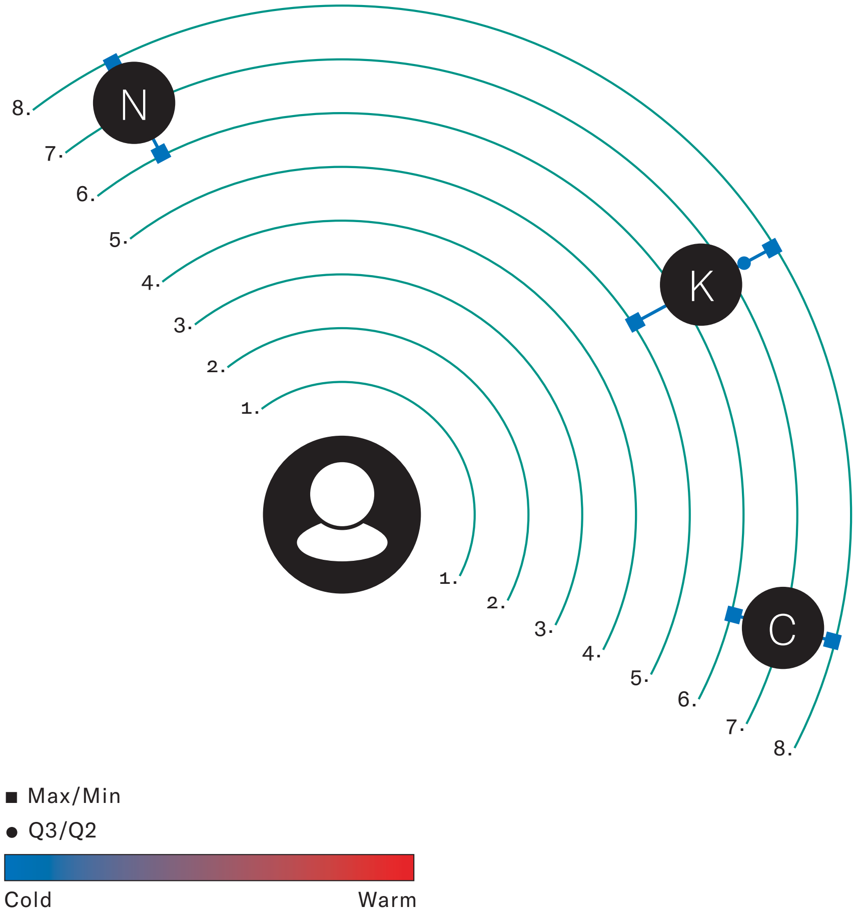
The figuration diary in Figure 5.1 shows the boxplots of the IoT devices as viewed by Ash, a married and middle-aged father of two girls. In interviews, Ash initially seems to approach the IoT as a hobby-like activity. His figuration diaries, however, prompted a revision of the interview data to acknowledge what sets him apart from other hobbyists—namely, the absence of playful or frivolous tinkering with IoT hardware or software. **N** denotes Ash's Nefit thermostat. The minimum distance, indicated by the rectangle, is only 6.00, and the maximum distance is 8.00. Moreover, to Ash, his Nefit thermostat is a cold device, indicated by the blue color. Ash's KlikAanKlikUit system, denoted by **K** in Figure 5.1, is blue and cold as well. KlikAanKlikUit is a Dutch home automation system consisting of devices connecting electrical outputs and appliances (e.g., lights) to allow them to connect to the internet. While cold, the KlikAanKlikUiT system is slightly less distant, with a min of 5.00, and as indicated by the dot in Figure 5.1, the third quartile is more variable in its proximity. In contrast, a smart IP camera for security denoted by **C** has the smallest standard deviation. Overall, all IoT devices are continuously placed distant from the user and described as cold. Figure 5.1 also shows that the IoT devices are placed distant from one another.

During the interviews, IoT users with figuration diaries similar to that of Ash in Figure 5.1 were specific in pointing out how the IoT should be functional. They prefer their IoT to be invisible or unnoticeable. However, as much as IoT devices should be functional, users such as Ash really do enjoy functional devices. Thomas, another IoT user with similar viewpoints, explains the following:

> *To me they are just devices, they are tools. But I am someone who loves tools. Things have to be functional. Well, if they are beautiful also, I mean, I have a coffee machine which I think looks nice, but that is in sight. It is nice if it is also beautiful, but otherwise tools just have to fulfill their function well. It doesn't have to feel nice or warm to me.*

To users like Thomas, aesthetics come second. The primary concern is that the IoT has a function to fulfill, i.e., there is a necessity to its use. However, a wider spectrum of functions with an IoT device can still be preferrable for their creative potential. Thomas continues,

Figure 5.1
IoT as Tools



N= Nefit Thermostat (Length: ■Max= 8,00; ●Q3= 8,00; M= 7,25; ●Q2= 6,75; ■Min= 6,00; SD= 0,75; Warmth: M= 2,00; SD= 0,00);

K= KlikAanKlikUit (Length: ■Max= 8,00; ●Q3= 7,25; M= 6,25; ●Q2= 5,00; ■Min= 5,00; SD= 1,13; Warmth: M= 1,33; SD= 0,44);

C= Camera (Length: ■Max= 8,00; ●Q3= 8,00; M= 6,92; ●Q2= 6,00; ■Min= 6,00; SD= 0,76; Warmth: M= 1,33; SD= 0,44)

I do always check which things are possible, though. And I would rather choose a device that offers a wide spectrum of possibilities of which I only pick a piece. Because then maybe I can pick up other pieces later if I want to. Well look, with my sport watch you can go very far in the interface and create all kinds of sports programs and add training programs. So you can use that creatively. But that is not the way I use it, because it is outside my field of interest.

What troubles Thomas is whether his IoT devices can fulfill functions in the future or if being locked-in now could ultimately cost more later when switching devices. Moreover, such a perspective places the potential of the IoT largely within the device, which itself remains to function as a whole and separate tool, rather than accessing the networked potential of the IoT.

Other IoT users also show a primary interest in the functionality of IoT devices but prefer the directness of using the IoT. While this notion contrasts with viewing the device as having broader potential, it is similar in the simplistic necessity that IoT devices should fulfill. This is the case with Arthur, who has a wide variety of IoT devices, including a smart doorbell, a smart lock, two IoT setups for his lamps, and various connection hubs. However, Arthur still prefers the IoT for its functionality and, as he explains, preferably only that:

It just has to work, and it has to do what I bought it for. But it is not like I spend six hours going through the menu. That is not the case. Let's say I want something, I look for a functionality, and then I look for a device that can be used for that. And then it is not the case that I will also use all those additional functionalities. It's more like, it has to do what I want, and that's that.

Here, the potential of the IoT device is solely related to the solutions it can offer. While both Thomas and Arthur look primarily for a necessity to use IoT devices, users such as Thomas look for the greatest potential in software functions. Users such as Arthur, on the other hand, find this to be cumbersome and prefer to have a direct interface. That is, IoT devices are considered solely for their ability to provide necessary solutions to current problems or for their ability to provide future necessary solutions as well.

The trouble with choosing devices solely on the basis of necessity is that, as Ash puts it, "devices do not talk to each other". Especially when people use devices from different manufacturers, vendor lock-in hinders interoperability. As a result, and as shown in Figure 5.1, Ash's devices are relatively separated from each other. This problem is described in more detail by Arthur:

Well, how do you make sure…? Imagine standardizing it on Apple home kit, and then you pick up a doorbell, but it works with Google and not with the home kit, and vice versa. There are also products that do not work together. How do you integrate KNX…? Well, you can go on like this. There is no overarching standard. I think that's the problem, not the device itself. Usually, that is very simple. But to have everything talk to each other and just get one system where you don't actually have to do anything. That is difficult!

Choosing the highest functionality for specific everyday necessities at the level of IoT devices, as described by Thomas, Arthur and Ash, uncovers the main issues inherent in vendor lock-in. Vendor lock-in gives users such as Thomas a reason to seek the greatest potential within the device. This is usually a costlier option, and in effect, the costs of switching become higher. Another option is to select devices that are chosen solely for specific functions. However, vendor lock-in prevents the use of overarching standards for operating the IoT. This option would require more operational skills to use and integrate IoT devices within the household context.

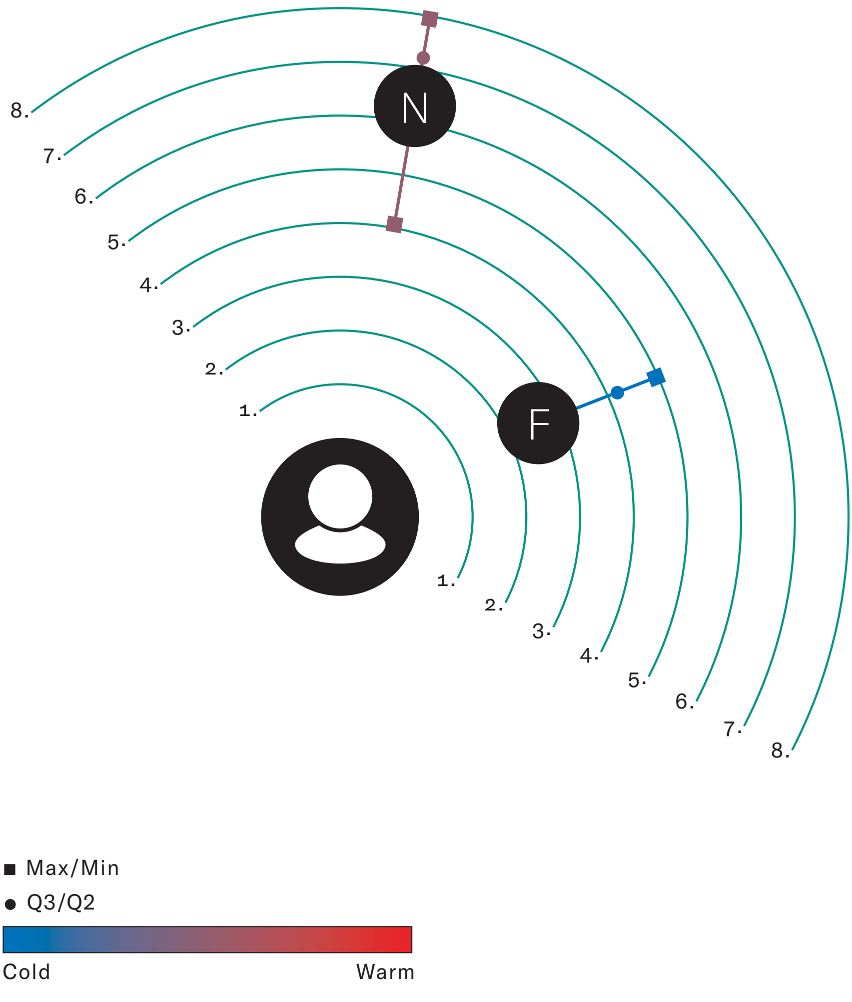
5.3.2 Locked-in Creativity: Finding Different Uses than Intended

A more common use is shown in Ellen's figuration diary in Figure 5.2. Ellen uses the same thermostat as Henry but has a warmer overall evaluation of the device and positions the device closer to her with the minimum at 4.00 and second quartile at 6.00. She occasionally forgets to lower the thermostat when she leaves, so an internet-connected thermostat can be a great help. Even warmer still, indicated by the red color, is Ellen's Fitbit activity tracker, which she obtained to track her sleep, monitor her heartrate and count her steps during the day. Used daily, Ellen placed her Fitbit close to her and relatively warm. Moreover, both devices are standardized to Apple's software environment.

While IoT devices are generally limited in openness and their creative uses, IoT users such as Ellen have found additional functions on their devices which are different than they initially expected. However, ease of use appears to be an important factor to stimulate creativity. Ellen, who praises Apple products for their stability in the interviews, explains how an overarching operational standard is inviting and allows for the exploration of additional functions:

When I look at the app, it is all pretty self-explanatory. In the past, you could still break something if you pressed something, but on an

Figure 5.2
Common IoT use



N= Nefit Thermostat (Length: ■Max= 8,00; ●Q3= 7,25; M= 6,36; ●Q2= 6,00; ■Min= 4,00; SD= 1,03; Warmth: M= 6,00; SD= 0);

F= Fitbit (Length: ■Max= 5,00; ●Q3= 4,25; M= 2,42; ●Q2= 2,00; ■Min= 2,00; SD= 1,13; Warmth: M= 9,17; SD= 1,53) *iPad, you can just push and if you don't want something, you just go back. Nothing can go wrong. You can just turn on something to see what happens. For example, recently, my daughter was in the shower for very a long time. So, we thought about the app and if you could just turn off the hot water. Well, I looked with the iPad, my husband with the iPhone. "How are we going to do that?". "Oh, I can set this up". "Oh, here is the button for the hot water". ((Screams: mimicking daughter)). "Hey it works". So yeah, you can just discover how things work in a playful way.*

Ellen's perceived stability of Apple products gives her more confidence in applying basic operational skills and adding a degree of playfulness to their IoT use. The downside is that she uses a relatively closed software environment that is generally more expensive and, in effect, more susceptible to vendor lock-in. Moreover, Ellen's operational proficiency is mediated by her collaborations skills and her familiarity with the limited environment of Apple products. However, for people such as Ellen, this vendor lock-in inspires confidence that stimulates exploration and finding creative solutions.

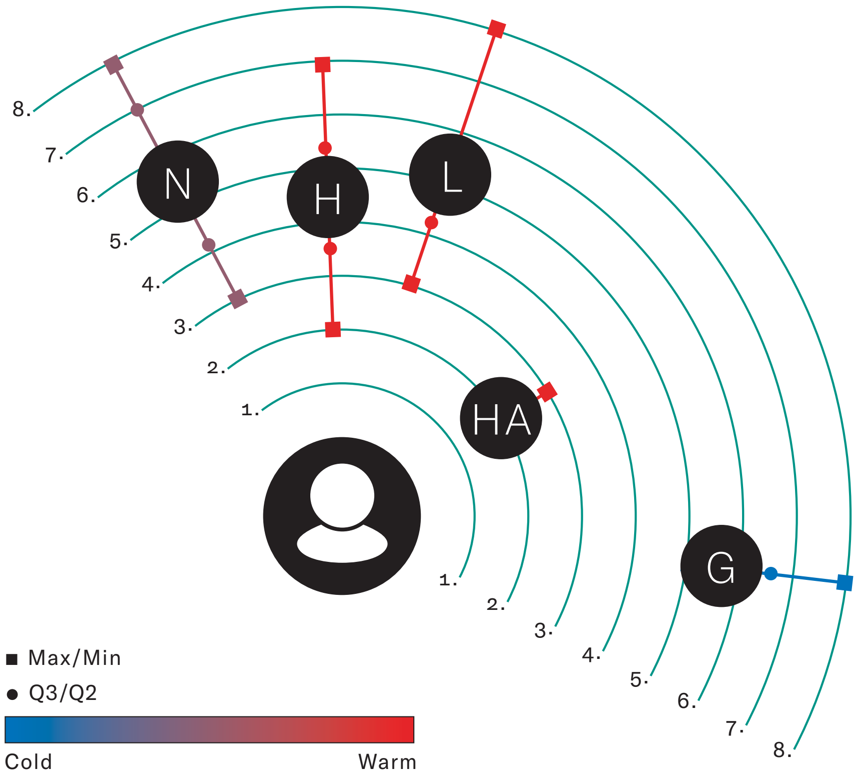
Similarly, the ease of use and system integration that comes with vendor lock-in can inspire reusing devices for applications that differ from those previously intended. Such is the case with Joan, who used an IoT device as a smart solution for an older product. Like Ellen, Joan and her partner are common IoT users, as they have a Fitbit and a series of Philips smart products. One of these products is a smart power plug, advertised to connect normal lights to Phillips Hue lights and its software environment. However, Joan uses the plug for an old-fashioned radio instead. As Joan explains:

We have not had this smart power plug for very long, and we had that radio there for a long time, but we never actually used it. Well, because you have to get up each time to use it. Now we really use it a lot. We actually had the plug connected to the robot vacuum cleaner at first but that just was not practical. So, we opted for the radio and I must say we really use the radio a lot more now.

Being familiar with one overarching software environment generally improves the operational ease of use for IoT devices. Consequently, as Joan demonstrates, the ability to shift IoT devices around to different applications is based on one's ability to explore unexpected practical matters. The ease of exploring functions and applications appears to depend on one's familiarity with

Figure 5.3

Changing IoT uses



N= Nest Thermostat(Length: ■Max= 8,00; ●Q3= 7,00; M= 5,66; ●Q2= 4,25; ■Min= 3,00; SD= 1,56; Warmth: M= 7,93; SD= 0,76);

H= Harmony (Length: ■Max= 7,00; ●Q3= 5,50; M= 4,43; ●Q2= 3,50; ■Min= 2,00; SD= 2,41; Warmth: M= 9,63; SD= 2,41);

L= Lights (Length: ■Max= 7,00; ●Q3= 7,00; M= 4,86; ●Q2= 4,00; ■Min= 3,00; SD= 1,40; Warmth: M= 10,21; SD= 1,34);

HA= Home Assistant (Length: ■Max= 3,00; ●Q3= 3,00; M= 2,21; ●Q2= 2,00; ■Min= 2,00; SD= 0,49; Warmth: M= 9,93; SD= 2,40);

G= Google Home (Length: ■Max= 8,00; ●Q3= 6,25; M= 5,25; ●Q2= 5,00; ■Min= 5,00; SD= 1,50; Warmth: M= 2,63; SD= 0,66);

the overarching software, especially when operational proficiencies are limited. As such, the locked-in creativity experienced by users such as Ellen and Joan is expressed in their confidence in exploring the potential of IoT devices.

5.3.3 Creativity vs Lock-in: DIY Work-arounds and Personal Solutions

Samuel's figuration diary, shown in Figure 5.3, is distinct from the larger spread and standard deviations for IoT devices. This is typical for IoT users who constantly update and tweak their home setup. Samuel is a young adult who lives with his girlfriend and considers his interest in IoT devices a hobby. What stands in out Samuel's figuration diary in Figure 5.3 is the distance, location and color of Samuel's Google Home device (**G**) compared to his other devices. This Google Home device is often used as a central connection hub. Instead, Samuel has found an alternative in Home Assistant (**HA**) as an open-source hub to connect with his Harmony (**H**), a programmable remote control, and smart lights (**L**), which are made by Philips and IKEA. Consequently, Google Home is experienced as cold and distant, whereas Home Assistant is labeled warm and close.

Vendor lock-in can create a bounded playing field that inspires confidence for users such as Ellen and Joan. For users such as Samuel, however, vendor lock-in is more like a barrier to overcome. Working with the complexity of IoT infrastructures at home, tech savvy users such as Samuel find ways to limit the number of different connection hubs and create a more streamlined infrastructure. Additionally, financial expenses also motivate do-it-yourself methods. This appears to be a viable combination, as Samuel explains:

> *Officially, you need a hub for this, but I didn't feel like buying an extra hub, so I bought a USB stick online for ten euros. And that can just read the protocol, regardless of what brand it is.*

The effect of Samuel's operational savviness is shown in Figure 5.3, where the USB stick with Home Assistant creates a more integrative overarching IoT environment, while it simultaneously pushes Google Home outwards. Consequently, the open environment Samuel has set up holds the potential for more DIY projects. One such project is described by Samuel as follows:

> *I have that remote for the smart speaker from IKEA. I don't use it for the speaker but for the lamps. I bought it last week, and it is a dial that is actually for the speaker. It has a wireless protocol, and with that, you can also operate the lamps. Well, that is what we want, of*

course. That is not officially intended, but you can use it however you want with the Home Assistant. I had the predecessor of this from IKEA *that was made for the lamps. Only, that thing does not work so well. That was just a poorly designed product.*

Somewhat similar to Joan, Samuel finds different applications for his IoT devices. However, Samuel's device requires some reprogramming in order to fit the practical use of his home system. The IoT is generally a closed system, and users need some confidence to open it and adjust its software. Moreover, Samuel's emphasis on the device's functionality echoes remarks made by Thomas, Arthur and Ash. The difference is that Samuel lets his IoT devices "talk to each other," improving on it as he sees fit rather than letting vendor lock-in be a hinderance.

The DIY approach to the IoT not only strikes a balance between the need for necessity and the potential of software environments but also it is cost effective as issues of interoperability, like the lamps of Philips and IKEA, are solved by creative solutions. Samuel's remarks show how his DIY approach is partly motivated by a financial incentive. This is also the case for Dennis, another IoT enthusiast, who enjoys tinkering with open-source single-board microcontrollers such as Arduino to modify IoT devices and tie them together. According to Dennis, finding a cheaper solution is part of the goal itself:

It is a bit of a sport to me. So, I also want to be challenged a bit creatively in that. It is a sport for me to get the most out of it and not go for convenience and spend three hundred euros more.

Remarkably, Dennis' approach places the potential of IoT devices in opposition to convenience and expense, unlike the approach adopted by most IoT users. Moreover, such a disposition requires a rather technical level of operational proficiency. Consequently, IoT home ecosystems fluctuate greatly for users such as Samuel and Dennis, as functions are constantly added and made redundant. While users such as Arthur emphasize that their IoT "just has to work", it is striking that Samuel and Dennis approach IoT devices as not fully actualized to begin with. In fact, this is where they find much of their enjoyment.

5.4 CONCLUSION

5.4.1 Main Findings

In this Chapter, we argue that vendor lock-in will be an important component of the continuing digital divide. As the IoT is projected to expand to general households (Aliero, Ahmad, Kalgo & Aliero, 2020; Aheleroff et al., 2020; Aldossari & Sidorova, 2020; Van der Zeeuw et al., 2019), it is important to recognize that different aspects of vendor lock-in are common for IoT infrastructures (Pal et al., 2018, Noura et al., 2019). We explored vendor lock-in as a market-orchestrated component of digital inequalities by asking why some people are limited by vendor lock-in while others are able to creatively capitalize on the potential benefits of the IoT. In our methods, we used interviews and a diary study for statistical guidance. We would note again that our statistical results are not conclusive in terms of generalizing the findings from our sample to a larger population. Instead, evaluating relative positions to IoT creativity by using metaphorical parameters gives us a conceptual understanding of IoT use that is generalizable or, better yet, transferable to future studies on digital inequalities related to the IoT.

By exploring sub-question 3.1, we find three distinct perspectives. First, the limitations caused by vendor lock-in become more apparent when people use their IoT as a separate tool for specific problems rather than considering the IoT as a whole initially. Therefore, one solution is to choose devices with more functions they might use because it can be difficult to switch devices in the future. Second, we find that vendor lock-in actually promotes confidence that stimulates exploration and, in effect, operational skills. Thus, vendor lock-in is a component that actually provides an environment similar to a protected playground, albeit with a relatively higher entrance fee and dependency on collaboration skills. However, this does imply that vendor lock-in can be stimulating rather than hindering, but only if people have sufficient financial resources in the first place for integrating their IoT systems; a 'rich-get-richer' effect that was emphasized by Ignatow and Robinson (2017) and is common in regard to digital inequalities (Lutz, 2019; Helsper, 2017). Third, vendor lock-in can be considered a boundary but also a challenge. Creative and operationally proficient people are able to reduce financial costs by reprogramming hardware and software to their liking and by investing more time and effort.

When we relate these findings to one another, we find a pattern of logical exclusion. Namely, the broader potential of IoT devices is mostly accessible for people with more financial resources and collaboration skills or people who excel in operational skills and creative problem solving.

Thus, the people who are most excluded from the potential of the IoT are those who perceive IoT devices as tools that are necessarily tied specific problems. In the experience of such users, IoT systems tend to become more expensive due to the additional costs of restructuring overarching standards and interoperability. Moreover, IoT use does not seem to stimulate operational proficiency or creativity in these users. This means that this type of users would not only experience additional costs, but are also more likely to be set back by impoverished digital skills.

5.4.2 Future Research and Limitations

While our findings are not conclusive with respect to socio-structural determinants, they do suggest a 'taste for necessity' that is often observed with educational and income inequalities (Bourdieu, 1984; Robinson, 2009; Ignatow & Robinson, 2017). Moreover, abstract concepts such as warmth are commonly associated with other competences in higher education (Fiske, Cuddy, & Glick, 2007; Kumari, Singh, Mehra, & Mishra, 2018; Goodwin, Piazza, & Rozin, 2014; Kouchaki, Gino, & Feldman, 2019). In other words, using the IoT creatively is also partly determined by inherent motivations and attitudes. If we follow the general sociological reasoning that people classify themselves through their own classifications (Durkheim & Swain, 2008; Bourdieu, 1984; Beckert & Aspers, 2011), as our participants did with their figuration diaries, evaluations of warmth and proximity might indicate determinants based on socio-structural disposition.

Our contribution is not without limitations, and some of our considerations may raise some concerns. First, one might ask if our figuration diaries test how willing people are to use metaphors rather than test metaphorical parameters themselves. At the very least, we would argue that an unwillingness to use metaphors, rather than viewing their IoT as devices cold and distant, coincides with perceiving the IoT as 'nothing but' a functional tool. This concern also relates to a second limitation: that we have forced answers in the figuration diaries by using only two parameters. Here, we emphasize that our diary study was embedded in interviews. However, we hope to inspire future research to use abstract concepts to reveal social phenomena.

CHAPTER 6

Political Bonds and Choreographic Skills

How the IoT shifts power balances and reinforces household values

Based on:
Van der Zeeuw, A., Van Deursen, A.J.A.M. & Jansen, G. (*in review*).
The Irony of the Smart Home: How the IoT Shifts Power Balances
and Reinforces Household Values.

6.1 INTRODUCTION

In our second instrumental step in addressing our solfège problems, we shift towards the political bonds by focusing mainly on the *IoT users-home* & *co-users* figurational units in relation to choreographic skills. The IoT, as a collection of everyday devices that are connected to the internet (such as lamps, doorbells, thermostats, vacuum cleaners, and washing machines), is becoming more ubiquitous in everyday households (Aheleroff, Xu, Lu, Aristizabal, Velásquez, Joa & Valencia, 2020; Aldossari & Sidorova, 2020; Aliero, Ahmad, Kalgo, & Aliero, 2020; Van der Zeeuw, van Deursen & Jansen, 2020). Ideally, the use of household machines can help elevate certain tasks and distribute responsibilities more evenly while balancing work-at-home and work-away-from-home (Fortunati, 2018; Wajcman, 1991). The IoT could be particularly promising due to its remote control and automation capabilities to help elevate and distribute labor in the smart-home. However, research on digital inequalities has shown that the positive and negative outcomes of digital technologies are unequally distributed in society (Van Dijk, 2020) and that this gap is relatively increasing due to different skill levels (Helsper, 2017). Consequently, as the digitization of society advances, individuals who have been less able to develop crucial digital skills such as those in lower economic positions (Gonzales 2016), with lower education (Scheerder, van Deursen & van Dijk, 2019), and the elderly (Blažič & Blažič, 2020) experience increasingly fewer positive outcomes via digital technologies.

With the IoT, we might suspect a similar pattern (Van der Zeeuw, van Deursen & Jansen, 2019; De Boer, van Deursen & van Rompay, 2020) but also something new: most IoT devices are not used on an individual level as with laptops or phones but on a household level as everyday household devices.

While most IoT devices in the smart-home are still tied to the main account of an IoT user, this user is dependent on other household members for accepting and using the IoT. The intentions for using the IoT might not fit other household members. Moreover, other household members become dependent on the main IoT user for using everyday household devices. If the IoT does not fit the routines of their everyday lives, this dependency can become particularly inconvenient. Therefore, it is not only how far one is able to adjust the IoT to everyday routines on an individual level with operational skills, but also how everyday routines of multiple people can be made to fit to the IoT with choreographic skills. The argument then follows that, for research on the IoT, studies should focus not only on the individual but also how the individual is embedded in its household. Therefore, before comparing individuals, the first contributing factors for inequalities should be established by examining how individuals are imbedded within households.

In this chapter we approach the social context through political bonds in the household as the ability to knit people together towards a common goal. First, we argue that embedding individuals in their households for IoT analysis greatly improves the understanding of digital inequalities between the individual level and the household level. We will explore IoT use embedded within households so that future research can properly assess how inequalities are distributed between households. Second, we explore how power dynamics in the domestic sphere can be made supportive of IoT use. By adjusting to the smart-home, two power balances within the household are poised to shift. First, there is a power balance between stereotypically masculine roles in technology and stereotypical feminine gendered roles of household responsibilities (Fortunati, 2018; Strengers, Kennedy, Arcari, Nicholls & Gregg, 2019; Wajcman, 1991). Men might become more involved with household tasks via an interest in the IoT as a technology, or the IoT could help elevate certain tasks and distribute responsibilities more evenly. The second expected change is between the role of parents and how they deal with their children as digital natives. Although the term 'digital native' and the digital skill level of younger people are highly debatable (Selwyn, 2009), increased exposure to the internet does increase digital proficiency (Hargittai, 2010; Helsper, 2020). With early exposure to living with IoT, digital natives might be able to gain more influence in the household as well via their digital proficiencies. Therefore, we argue that the ability to proficiently use IoT devices is determined by the ability to navigate between normative roles in the household.

To explore how such digitally mediated power dynamics are tied to household routines, we use the notion of choreographic skills together with other metaphors of a dramaturgical perspective as the scaffolding of our analysis. We use these metaphors to determine how inequalities in the household affect IoT use. Therefore, we ask conductively to the political bonds in our solfège problems:

> *Sub-Question 3.2: How do power dynamics in household routines influence IoT use at home?*

In this Chapter, we will explore these household routines with the three dimensions of choreographic skills. We will discuss the material dimension first and how the materiality of IoT devices affects social roles within households. Second, we will discuss the dimension of accessibility and how access to IoT devices and IoT data is moderated. This also involves the designation of main accounts and their responsibilities regarding privacy. Third, the dimension of harmony and how the IoT is made to fit into existing patterns of behavior with the time and effort available. This dimension underscores practical everyday experiences in using the IoT.

6.2 THEORY

6.2.1 Household Routines in a Dramaturgical Perspective.

With the IoT's promise for assistance in the smart-home (Aheleroff, Xu, Lu, Aristizabal, Velásquez, Joa & Valencia, 2020; Aldossari & Sidorova, 2020; Strengers, Kennedy, Arcari, Nicholls & Gregg, 2019), we might expect a redistribution of household tasks aided by the IoT. However, such expectations are generally based on technological characteristics but leave out much of the social relations between people and their everyday lives when implementing IoT devices. These relations are defined as the social roles that are established, affirmed, and repaired to make life at home coherent, such as the 'parent' and 'child' or the 'husband' and 'wife'. Consequently, some people are more flexible in their social roles to make the IoT fit with their everyday routines, while others are better dispositioned for the smart-home to start with. To address the ability to adjust to the demands of the IoT, we will refer to choreographic skills. We base the need for a choreographic skills on two assumptions. First, that the IoT demands human input to create output into the human world, by the simple fact that it needs to be installed, programmed, and applied within the already existing structures of the household, including its social aspects, to work effectively. Second, the ability to adjust social life between people is limited to varying degrees due to aspects such as work schedules or the number of people in the household. Moreover, the flexibility of social roles is restrained by the mutual dependencies involved in establishing social roles, reaffirming roles, and repairing each other's roles to meet expected impressions of one other (Butler, 2011; Goffman, 1959). For example, the household politics when partners arrange homemaker responsibilities between them and their working lives. Or, that parents have rules and responsibilities for their children, who, in turn, have an expectancy for rules and responsibilities from their parents.

To match our notion of choreographic skills, we will use the concepts from a dramaturgical perspective. The dramaturgical perspective has most famously been developed by Goffman in his "presentation of self" (1959). The notion of impression management has been especially popular in using digital technologies (e.g., Djafarova & Trofimenko, 2019; Maares, Banjac & Hanusch, 2021). However, Goffman also gave considerable attention to shifting power ratios between performers, or teams of performers, and by using the stage and its arrangements in gaining an upper hand[5]. Many of these power ratios play on expectations of how people are supposed to act, through tact or etiquette, to safeguard their social position (Kuzmics, 1991). Consequently, Goffman's prime motivator for performers is their fear of losing face—or the mask of a role—together with the embarrassment that comes with it. We can find this with the IoT enthusiast promising to deliver the comforts of the IoT, but other household members finding it a hindrance or too demanding to be comfortable. We can also find this with parents whose children gain a taste of power over them by being more proficient in controlling the IoT. And, we can find this with homemakers who feel that their roles are under threat of being overtaken by IoT devices. Losing face, in other words, exposes the discrepancy between reality and the power assigned to the performer.

All of these everyday performances at home, particularly where it involves interactions with the IoT and (re)affirming social roles, invoke dramaturgical concepts we will call household routines. The framework of choreographies itself has been inspired by Loke and Kocaballi (2016). To match a dramaturgical perspective, we can describe choreographic skills in dimensions of materiality, accessibility, and harmony.

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5 Like Goffman's discussion of Kafka's Trial in 'The Presentation of Everyday Life' (1959)

6.2.2 The Materiality of Regions and Arrangements

For the materiality of choreographic skills for the IoT we can use the metaphor of regions or arrangements of a stage. Most commonly used is the notion of a backstage, for relaxation or to prepare for the front stage as a behind-the-scenes region. In her study on the internet in everyday life, Bakardjieva (2005) describes the use of wired spatial arrangements, where internet users designate an area, like a basement or a corner of the living room, for a desktop computer and all computer related tasks. Similarly, Scheerder, van Deursen & van Dijk (2019) found that lower educated often have their wired spatial arrangement in the form of a game room, whereas higher educated have it in the form of a home-office space. Such regions are loosely tied to social roles, whether for leisure or work, and the ability to retreat from their other roles in family life to accommodate individualized cultural practices (Lincoln, 2013; Livingstone, 2007). However, with the IoT this is different. The influence of the IoT is experienced by the family as a whole by its ubiquitous intrusion in the household, rather than having specific wired spatial arrangements or specific social roles. Instead, IoT often revolves around the living room which is a region which *several* performers thoroughly identify themselves with (Goffman, 1959; Tutt, 2005). Where the internet allows someone to retreat to a spatial arrangement to perform different roles, the materiality of IoT invites all household members to integrate the IoT in their everyday choreographies.

Moreover, there is no spatial arrangement designed for particularly for IoT devices, rather they need to be fitted within a pre-existing material structure with other domestic technologies. Often this means that the household needs to be adjusted accordingly to meet the new material demands of the IoT. Such is the case with a smart robot vacuum cleaner, for example, that works better remotely when the floor has been cleared off wires and other small items beforehand so it cannot get stuck (Sung, Guo, Grinter & Christensen, 2007). The potential use of a technology, in other words, is inscribed within the material properties of the device by an integrated in a web of social relations (Latour, 1992). Moreover, the material potential of IoT devices is enhanced continuously by software updates. Whereas non-digital devices have a relatively static place in household choreographies, software updates continuously inscribe IoT devices with new potential. That is, the stage not only has to be arranged for and by all the performers in the household, it has to be maintained continuously.

With distinct spatial arrangement for the internet, power ratios are distinct between specific roles as well. For instance, a powerful office worker turns into a subservient and caring parent to its children, or a digital native that ranks high with online-videogames in the gaming room turns into a dishwasher in the kitchen. With the ubiquitous materiality of the IoT the power ratios of household roles are more convoluted. Accordingly, power with the IoT (mostly accumulated by one's digital skills) carries over to the distribution of power ratios in the household. As such, the digital native or office working might suddenly find more power at home in relation to the more traditional homemaker role, by controlling the devices that make the home. However, the IoT enthusiast can lose face when the otherwise simple tasks do not work due to cluttered IoT-setups. For instance, when lamps cannot be controlled digitally because they have been switched off manually. This would be the digital equivalent to a house in disarray and the embarrassment people have when visitors enter messy parts of their home (Warren, 2010). Moreover, power ratios that are mediated by materiality of the IoT can still be regulated by moderating access to the IoT and its responsibilities.

6.2.3 Accessibility of the Stage and Stage-Time

For the dimension of accessibility in choreographic skills we can find a metaphor in access to the stage or access to stage-time. As much as materiality can make things clutter, too many performers on stage at the same time can also confuse a performance. As digital devices are often tied to accounts, sharing these devices can be a bit more difficult than non-digital devices. Rainie and Wellman (2012), for instance, illustrate that more choreography is needed when a computer is being shared several email accounts are used to keep messages separate. Most households are choreographed by formal and informal social rules to deal with things like privacy, screen time, or costs for online services per individual (Bakardjieva, 2005; Plowman, 2015). Such rules tend to reflect important moral values of the household (Haddon & Silverstone, 2000; Silverstone, Hirsch & Morley, 1992). Access to the device, in turn, is regulated by the expectations of its primary functions (Loke & Kocaballi, 2016) and by the ongoing negotiations of rules about the device (Tutt, 2008). However, regulating access with the IoT often translates to the accessibility of common household appliances or devices needed in everyday household tasks. Therefore, rather than switching between accounts within household ensembles, multiple accounts need to be tied together to share IoT devices conveniently.

Sharing access to the IoT has two main implications for social roles in household routines. First, the contention of access or time of access. With the IoT, access to everyday devices can be regulated online. For instance, parents can set bedtime lights, regulate shower temperature to reduce long showers, or set their radiator buttons to not physically work during certain time intervals as a Child-Lock feature. Using the IoT for such a more precise moderation of parental power simultaneously reaffirms parent-child roles in the household. However, digital natives might find themselves with equal power and control as parents when they outperform them in digital savviness. For example, children might turn of hot shower water when they feel it is their time. Secondly, the data gathered and distributed is usually regulated by the main account but this is not necessarily going to be the main user. This means that the effects of the digital spotlight, and its nebulous effects on algorithmic decision-making processes, are mostly affecting the person tied to the main account rather than the persons using it. Therefore, household members need to decide who is going to be in the spotlight and carry new responsibilities that arise out of privacy concerns and data protection for other household members. Consequently, household members in the spotlight might lose face when IoT data exposes something that they rather kept in their private sphere. This can happen between household members who share accounts and account data (Ur, Jaeyeon & Schechter, 2014) or, when considering household members as teams of performers, when data is being exposed to other audiences and third parties, like insurance companies (Amaraweera & Halgamuge, 2019).

6.2.4 Harmony

When the stage has been arranged properly and the performers do not all access the stage at once, it might improve the performance. However, a good performance still needs all parts to come together harmoniously. We use this dimension of choreographic skills to describe that even if the materiality and accessibility has been sorted out, the IoT still needs to come together with pre-existing patterns of social behaviour. An example of a resonating harmony can be found with active people becoming more motivated to exercise with IoT wearables and create a stimulating feedback loop generated by biometrical data (Parviainen, 2016). In such cases the effort put into the device to work properly is matched with the expected output of the device (Loke & Kocaballi, 2016). The opposite happens when the possibilities of movement with the time and effort available are in harmonic dissonance with the demands of IoT devices. For instance, when vacuuming cleaning a small area takes less time using a phone and program the robot vacuum cleaner towards a specific area.

Moreover, the IoT needs to resonate with the impressions of social roles and the abilities in carrying out those roles while using the IoT. For example, homemakers may find the precision of IoT devices inadequate in carrying out their tasks compared to their homemaking skills. This would happen either by unrealistic expectations about the capabilities of their IoT capabilities or by errors in programming their IoT devices. As such, the limitations of the IoT reaffirms the value of their traditional domestic labour and its homemaker role. When traditional homemaker roles are less strong and with less expectations, it would be easier to fall in harmony with the IoT.

For digital natives, IoT use would fall into harmony more naturally with their patterns of behaviour, simply because they grow up with IoT devices and they have yet little expectations to uphold. This can become a source of embarrassment for the parent who, in contrast, would need to put more effort in using the IoT effortlessly. However, the roles of digital natives in the context of the smart-home are usually filled by children. And children can be a lot less harmonious with the household routines than parents would want them to be. Even by simply making a mess out of their room, children can intentionally be inharmonious with the smart-home and the IoT. In such cases, preparing the household for the IoT could result in more work for the homemaker. Meaning that technologies that should help elevate household work, only increase it (Wajcman, 1991).

6.3 FINDINGS

6.3.1 Materiality

6.3.1.1 Ubiquitous Materiality of IoT

The IoT is unique as it is more intrusive in the household than the regular internet because using the IoT affects more people directly than using a computer. While interest in the IoT by enthusiasts can introduce a household to the IoT, its ubiquitous materiality in the household makes it difficult as a hobby alone. The difficulty between the arrangement of its materiality and social life is illustrated by Peter, who, when moving into his newly built home, decided to go without light switches. He has 12 groups of dimmable lamps, and individual light switches would not be an option. Instead, all the lamps are connected to the internet and operated via Apple HomeKit. This is an approach that dovetails nicely with his interests in digital technologies.

However, because it is situated in the home, not having light switches is not without its consequences for other members of the household. As he explains when working on his IoT system:

> *I do enjoy it too, but that is some of the problem. It is not just a hobby project because it is in our home after all. Recently, I changed something in the HomeKit, the position of the button for the on and off for the lights. Right away my wife goes: "Hey, what is that, it does not work". That is it. She finds it quite difficult to deal with, but once it works, using an app and pressing a button, it immediately becomes the default. All light switches are immediately forgotten, which is very easy. But, if it does not work, it is also immediately a problem. So that makes it from a hobby... Well, it is fun, I can have fun with it, but if it does not work or the server goes down, then I immediately have a problem.*

The main difference between the IoT and desktop computers lies in intrusiveness in everyday life. Because the IoT is materially intrusive, it is more affected by household power dynamics and vice versa. Whereas a regular internet enthusiast can retreat to another region, such as an office or game room, to work on its potential, IoT devices are limited because they are used in shared regions. As Peter continues, "The WAF, you know—the wife acceptance factor—must be quite high. So, it just has to be a button on and off and for the rest it does not matter that much". Regardless of gender or idiomatic expressions that play on stereotypical gender roles, the IoT has to be accepted by other household members. However, Peter says little about a 'child acceptance factor', giving us the impression that the power to veto the materiality IoT—the absence of light switches—is absent with Peter's children. A similar view of acceptance can be found with Anna and Bernard, who both work in IT, have one child and are generally fond of digital technologies:

> *When we get something new, it depends a bit on who buys it or who picked it. But Bernard does that more than I do and when it is new, he will find out how it works and sets it up. But then I am the one who continues to use it. Usually, in that order and not so much that I figure it out and set it up and he just uses it. He's more of the tinkerer to get it working and I am truly the consumer.*

While both Anna and Bernard are accepting of the IoT, Anna makes a distinction in their roles as the 'tinkerer' and the 'consumer'. This is not so different from Peter, including its alignment with gendered roles. The role of the 'tinkerer' is tied to the IoT, and generates new forms of power in the household through the IoT. The 'consumer' role, in turn, is tied to regions of the household, such as that of the homemaker. In other words, the IoT is materially divided between household members. Typically, the 'tinkerer' keeps the IoT—the generator—running stable with operational skills, while the 'consumer' distributes power through the household via dynamics of acceptance, expectations and choreographic skills. However, these roles do overlap. The role of children is still mostly passive.

6.3.1.2 Material Programming of the Household

As the IoT is materially ubiquitous in the household, the consequent material factors to facilitate IoT use become a joint effort. While children are passive in accepting the IoT as household material, they are expected to contribute to keeping the household IoT friendly. Peter, for instance, operates his lamps with the internet without light switches. This arrangement also has a practical reason, as you cannot control the lamps via the internet if the power to the lamps is turned off. If one of the household members turns off the lights with the switch, Peter would then have to switch it on again before being able to use it remotely. That is, the average household is filled with clutter in its material structure, such as light switches, which could hinder the potential of IoT use and let the 'tinkerer' lose face. Therefore, the 'tinkerer' is motivated to develop choreographic skills and mobilize a joint effort of all household members, including his children, to deal with this clutter. The shift from operational skills to choreographic skills can be illustrated with the smart vacuum cleaner. Robert, a father of two, explains:

> *So, we have a robot vacuum cleaner from LG. We use it downstairs and upstairs for closed spaces. How it works is that you have to make sure that there are no cables or shoes with laces because they will get stuck in them. What also makes it more difficult is a carpet, say a thick carpet. It gets stuck there too. For the rest, it can simply vacuum independently.*

The simple if-this-then-that programming structure used with operational skills takes a more material form with the IoT. For example, if the vacuum cleaner comes across shoelaces, then it will eat them and become stuck. The IoT works best if everybody commits to some degree of material programming.

This makes the programming of household regions to optimize the IoT a joint effort. Peter's decision to remove light switches and ensure that all the lamps have electricity and a connection all the time is one way of ensuring that everybody is on board with its wired spatial arrangement.

The alternative becomes more explicit when certain aspects of the household are unprogrammable. This can be illustrated by Anthon, who has a background in plumbing and is well aware of the risk of using household appliances when away from home. While Anton has some IoT devices, such as smart lights, he is cautious about using other household appliances. The added benefits of IoT devices would break with household rules that have been established to reduce the risks of using household appliances:

> *We have the approach here, only turn the washing machine on when you are at home. Yeah, because should something happen, it is usually with the washing machine. If there is a fire, how often is it that the washing machine or dryer has not been working properly. Or a leakage, I have also had that once. If someone is home, you can immediately press the button.*

Most importantly, the household rule to not use the washing machine when the possibility for physical intervention is absent overrides the possibilities for IoT programming. This is where the operational skills run up against choreographic skills. Not only are most IoT devices designed to limit physical intervention, as illustrated by Peter and Robert, but physical interventions also need to be limited for IoT to work effectively. For Anthon, however, reprogramming the household rules to fit the material aspects of IoT—by uncluttering the household of physical intervention—is not worth unprogrammable risk of leakage or a fire. Peter, Anna and Bernard, Robert, and Anthon illustrate to us that the IoT ought to be invisible and directed by automated decision-making processes, but it invites household politics as a joint effort because of material intrusion. Accordingly, as shown by Peter, access to the IoT is continually contested by updates and sharing spatial regions.

6.3.2 Accessibility

6.3.2.1 Operational Access

One of the most prominent aspects of the IoT is that it makes the household more comfortable. Generally, this means fewer button-press events, more automation, in effect, lesser need for operational skills. Such is the case with Peter, who decided not to have 12 lamp switches but rather to operate his lamps through the IoT. The operational ease of IoT use has been reduced to near absence, apart from some buttons on a mobile application. Consequently, this affects his children, who are growing up in a household without access to light switches. Thus, when asked if his children would ever complain about the lack of light switches, Peter responded:

> *No, but recently they were staying with my parents and they leave the lights on everywhere. Well, I cannot truly blame them because they do not have to think about it at home. They just go to the toilet; the light comes on and after one or two minutes when they are gone it goes out. So, there are no complaints, except from other people: "your children leave the light on everywhere".*

Exposure to digital technologies early on emphasizes how intuitive IoT operations can be in everyday life, especially when they are mostly absent. As such, the IoT brings new light to the notion of 'always online' (Turkle, 2017) to the degree that offline access events, such as light switches, are easily forgotten. However, when children first obtain access to the IoT, it can be met with childlike exploration, including exploring its social boundaries. Such is the case with Chris and his children, who also have their lamps connected to the internet. As Chris explains:

> *In the beginning, they just had great fun to switch lights on and off from their bedroom. That got pretty annoying, but that was already a few years ago. Maybe they would use it slightly more sensibly now. But they do not ask for it either.*

Access to the lamps via the internet was quickly revoked because it became slightly too annoying for Chris. Access via mobile phones and tablets or access to accounts to operate the IoT can be more precisely moderated than a switch, that is, if parents have those skills, for instance, by giving access between certain times digitally or with third-party applications that regulate digital access time for certain apps. Where the IoT is perhaps just as intuitive to operate for digital natives, examples such as Chris show that with remote access, it also quickly asks for more moderation and choreographic skills to distribute power in household dynamics. This reinforces power balances between the roles of parents and children as the rule-maker/enforcer and the rule-follower, respectively, regardless of digital proficiency but tied to the home as a domestic region.

6.3.2.2 Access of Accounts and Data Responsibility

The operational ease that digital natives might experience seemingly naturally with the IoT might also be a cause for concern to parents. That is, the IoT can also be so easy to operate to the point that it makes its users vulnerable. This is explained by Kristine, who has two children who need extra care when she started to use a Fitbit:

> *I have one of those Fitbits and they say, "Oh, we want that too!" but then I think that they do not see what the consequences are if you share your data, for example. It is so easy, you just have to move one slider back and forth, and everyone can watch… I think that is a very worrying thing. It is so easy for them. In terms of user-friendliness, I think that many people with a disability benefit a lot from it because it is truly made a lot easier. It is easier to scroll back and forth in an app than having to read a whole manual. I do not see either of them doing that. But on the other hand, I think there is also many dangers in them. They are very easy prey…*

The sharing of data Kristine refers to is the geofencing data she learned about accidentally by exploring the settings on her Fitbit. Remarkably, this concern was only voiced explicitly by Kristine during the interviews. Perhaps because she has children with special needs where she is more exposed to their cognitive availabilities. In contrast, the presumed knowledge of digital natives, especially by their own parents, is often less than realistic (Helsper, 2020). Together with the operational ease that allows people to use the IoT without having to read a manual, sharing access to the IoT usually also means access to the main account and the entirety of IoT settings. Unlike Kristine, responsibilities other than IoT use for the 'consumers' in the household may not be shared with the 'tinkerer' who takes control over the settings, even though each user has access to those settings.

Moreover, without exposure to vulnerabilities, such as in the case of Kristine, people are generally unsure what harm IoT data can do, especially as IoT data tend to reflect mundane everyday household activities. The difference between IoT data and personal data is explained by Anna, who uses the account to control the smart heating of her husband Bernard:

> *With personal data it is of course really very different than data about whether I turn up my central heating in the morning between seven and eight or something. I think that if they want to know that,*

be my guest! I do not understand why they would want to know that, but I also cannot think of many problems with that if someone knows that about me.

When asked if that would not be personal data, Anna responded: "I mean, it is not personal data but it is data that comes into your personal life a little bit, you know." Accordingly, different perspectives on personal data and privacy translate into different assessments on risks and vulnerabilities. However, for choreographic skills the shared responsibility—or shared vulnerability—of the IoT, much like the material dimension, is adjusted to lowest common denominator. When people are more aware of risks and third-party audiences, data responsibility becomes more of an issue. Again, turning to Kristine, she explains how reluctant she is to share her device because she is unsure about who is looking at the data:

I think: "Nice, I will go and see how I sleep and then I have an image with that" and then I say to my husband: "I think you have a sleep apnea, maybe you should put it on for a few days to look of how many… "But if you know that a health insurer is looking at that data and it might see some very serious ailment… Then, I think: "Do not do that".

Kristine's privacy concerns started from her role as a parent but became concerns about sharing IoT devices between partners. By being the 'tinkerer' and 'consumer' of her Fitbit simultaneously, Kristine controls who has access to the device and, in effect, who gets to be in the spotlight when data are being collected from her household. The similarity between Chris and Kristine is that they both distribute access from other household members, either to reduce operational access or to reduce data access. Such decluttering, in other words, means less sharing between devices or sharing devices with fewer people within the household.

6.3.3 Harmony and Second Nature

6.3.3.1 Expectations of the IoT and Household Roles

Once material arrangements and access have been made to fit with their household routines, there is still the final aspect of using the IoT, where it benefits everyday life. That is, the household has been arranged to use the IoT, and each household member can have access to the IoT, but they still need to find a way to use the IoT where it resonates harmoniously with their daily lives. The IoT can be very useful for complex household routines because of its remote control and access capabilities, in addition to its predictive programming by algorithmic decision-making. Routines become more complex when homemaker roles are divided between household members rather than being fulfilled by one person. The IoT, consequently, can be used as a tool to facilitate shifting power distributions between partners in households with higher degrees of emancipation. An illustration can be given by Edward and Jane, who both work full time. When asked if his Nest thermostat helps with that, Edward responds:

> *Yes, that is also an important reason we have it. We both work in jobs where we sometimes have to continue working, but sometimes that is till eight o'clock in the evening. So, it is useful to be able to postpone the program. That happens a few times a week. I think that is handy.*

Not heating an empty house is a goal for Edward and Jane to reduce costs but also for environmental reasons of not using energy unnecessarily. Being able to adjust the program from a distance is something they both use regularly and resonates with their goals. Not only do Edward and Jane have a dual-income household, they can also save on energy costs. The IoT, as such, can help mitigate the complexity of dual-income households. However, household routines that are too complex can also hinder IoT, especially for predictive programs. Such is the case with Alphonse and Marie with their two children who also have a smart thermostat:

> *Those programs for the heating do not work here because I work in three shifts. Look, if everyone leaves at eight in the morning and at home at five, you can say between eight and five turn the temperature to nineteen degrees and at four o'clock turn the temperature to twenty. But that does not work here because of my three shifts.*

With too many users in household schedules changing rapidly, any automated or algorithmic decision-making is left unused. Boldly put, some households are just too cluttered with people for the IoT to work harmoniously. In the Alphonse household, people come and go irregularly and change the temperature with a central tablet that controls all IoT devices in his house. In other words, the IoT aids complex working schedules, yet household routines that are too complex can limit IoT potential. Consequently, the need for choreographic skills in a dimension of harmony is more required for complex households.

Moreover, the ability to control the household is also an important aspect in household routines where traditional homemaker roles are mostly fulfilled by one person. For example, Judith explains why she does not have any IoT devices other than her smart thermostat and activity tracker:

> *Maybe it is also because I'm more of a person who likes to be in control myself. Yes, I think we are already handing over so much. I have the same with the self-driving cars. I'm skeptical about that too. That I think "well, would you really want all that?" What's left for yourself then? I think that it also makes you very lazy as a person. That you no longer think about things for yourself, because a thing is already doing that for you. Yes, why do you have to hand over everything? You would still want to keep control over something yourself.*

Judith's hesitance to give too much control, and therefore distribute her power, to 'things' suggests the notion that the IoT intrudes on the claimed region of the homemaker. A similar sentiment of harmonic dissonance can be found with Erik, an IoT enthusiast, when asked why he did not invest in household products to help his wife, Ellen, to alleviate household tasks. Here, the vacuum cleaner is used as an example to contrast the complementary tone for his wife's rigorous standard for a properly cleaned home:

> *I do not know if such a vacuum cleaner gets into all the nooks and crannies. I would like it, but I think my wife has something like: "I will just do that myself. I want to know that it is done properly".*

Erik's impression of Ellen as a homemaker reaffirms traditional gender roles and control in the household, but also helps to safe face as a team; it safes Erik's face by not having to take responsibility for inadequate IoT devices, and it safes Ellen's face by taking responsibility for a clean home. In contrast to Peter, who explained that the IoT is not just a hobby, Erik makes a clear distinction between the IoT as a hobby and the seriousness of household labor. Interestingly, while the IoT can elevate homemakers in their household labor, Judith and Erik find that they are skeptical and distrusting of the IoT for such tasks. That is, in cases with strong impressions about homemaker roles and the household as their region of work, the IoT can signal a loss of control over these roles and regions when choreographic skills are lacking.

6.3.3.2 Motivations to Keep in Harmony

The issue of digital distrust could be mitigated by exposure to the IoT and learning how to operate IoT devices proficiently. Such would be the case for children, and the operational ease discussed in the section above, make using the IoT seem like second nature when it comes to choreographic skills. However, as with Chris, whose children kept switching the lights on and off at inconvenient times, most parents responded similarly by saying that their children show little interest or motivation in using the IoT after they have played with it for a while. This is mirrored by Elliot, who makes this observation about his younger colleagues and his two children:

> *The younger generation are sometimes not that preoccupied with it. It seems as if they missed that. We are still setting up our own networks or installing a router by ourselves, but many people cannot even do that anymore because everything seems to work apparently. No, and sometimes you get "Oh, I do not have any internet". Okay, but no one will think, "Well, I will just pull the plug to start over" or something.*

The harmony between the IoT and household routines can be close to second nature for digital natives; however, the motivation to control the IoT and shift from a 'consumer' to a 'tinkerer' role seem lacking. Additionally, the always being online aspect seems to be taken for granted, much like Peter's children who grow up without light switches. Peter, however, does value the idea that his children develop digital skills. As he explains:

> *Programming is slowly coming into view. The oldest is eight. I do not know when she will get that at school. I have not seen that yet. But I would find it important that they can program. That they at least have the idea that there is something behind it and that they can influence it.*

Here, the motivation to learn skills is mainly to gain control over the IoT system that fits naturally with its household routines and, in effect, would otherwise be invisible. Moreover, while most parents expect the idea of more technologically proficient digital natives, some parents aim to develop skills to match the competencies of their children in the future. As Mike explains:

> *I might still want to learn to program myself because I also see that it is becoming increasingly... That a technical knowledge of what is being developed in IT, that that is quite useful. Yes, that will certainly be important for the children.*

The difference between Mike and Peter is how active or passive they consider their children in acquiring digital skills. For Mike to apply choreographic skills in the household, not only would he need to reprogram the house, the house rules, and the balance of power between his partner and with their children, but he would also need to reprogram his own abilities to keep a sense of control or power in the future. This is different for Peter, who already has used considerable programming skills in setting up his smart-home. Accordingly, parents such as Mike would first have to learn how to program to properly assess the digital skills of their children.

6.4 CONCLUSION

6.4.1 Main Findings

This study aims to provide a better understanding of IoT-related digital inequalities within the household. Therefore, we asked how power dynamics in household routines influence IoT use at home. Through abductive analysis, we found that the IoT affects members of the household differently by unequal distributions of power in the household. This is a crucial step before expanding to inequalities between households. We, therefore, showed that using the IoT should be considered a household practice, rather than just an individual practice, and as a unit of measurement for digital inequalities. We can conclude our main findings along the three dimensions of choreographic skills we used in our analysis.

Based on the materiality of the IoT, we can contrast households by the acceptance factors of partners who have 'consumer' roles with regard to the IoT. Because IoT use relies much on the joint effort of all household members, the lowest common denominator in IoT 'consumption' determines the complexity of IoT setups and, in effect, the range of IoT-related outcomes. While the power to accept the IoT is not observed as formally with children, informally, they can object to the IoT by not programming their environment for proper IoT use or by cluttering the household. Moreover, household rules about safety and risk can override the material structures of the IoT. For example, the rule for not using household appliances when away overrides the IoT's remote access capabilities. In other words, the ability to adapt to materiality determines how well the IoT can be implemented and the extent to which benefits can be maximized.

When considering accessibility, households are divided by operational access and data access. The IoT needs to be accessible for everyone because they often replace common household devices, but accessibility to the IoT is easily exploited through operational access or data access. The exploitation of operational access to the IoT, as with pranks, calls for more mediation between parents and their children. Here, it is implied that digital skills take a crucial role in terms of operating IoT devices and understanding what they can do. Additionally, most IoT devices are shared between members of the household, yet data responsibilities tend to be reserved for the role of the 'tinkerer' even though they address the region of 'consumer'. Exposure to risk plays an important role because the exploitation of IoT data is still vague to most people. Consequently, differences arise between households considering how well they are able to avert exploitation by the IoT and manage to take ownership of their devices operationally and by the data it generates.

Third, households differ in how well their everyday routines are in harmony with the expectations of IoT devices. Remote access and programming of the IoT can provide flexibility often called for by dual-income households (Fortunati, 2018). However, routines that are too complex limit the effectiveness of IoT devices, such as working in shifts. Additionally, not all household members are enthusiastic about losing control over the domestic sphere by IoT interventions. Whether it reflects on the homemaker as a lazy person or because the quality is not up to standard, some households have an aversion to too much IoT and digitization. The ability to embrace the IoT is somewhat hindered by cultural values, and this is also projected into the future. That is, how far people are willing to learn new skills to keep control over the smart-home for themselves and their children.

By analyzing different shifts in power relations in the smart-home, we find that some choreographic skills, rather than individuals and their operational skills alone, determine how well-equipped people are to use the IoT in their everyday routines. However, the relation between household routines and the IoT is very reciprocal. This means that as much as power relations affect the IoT, the IoT also affects power relations in the smart-home. We hope our contribution inspires future research to consider the importance of power relations within the household and of new technologies.

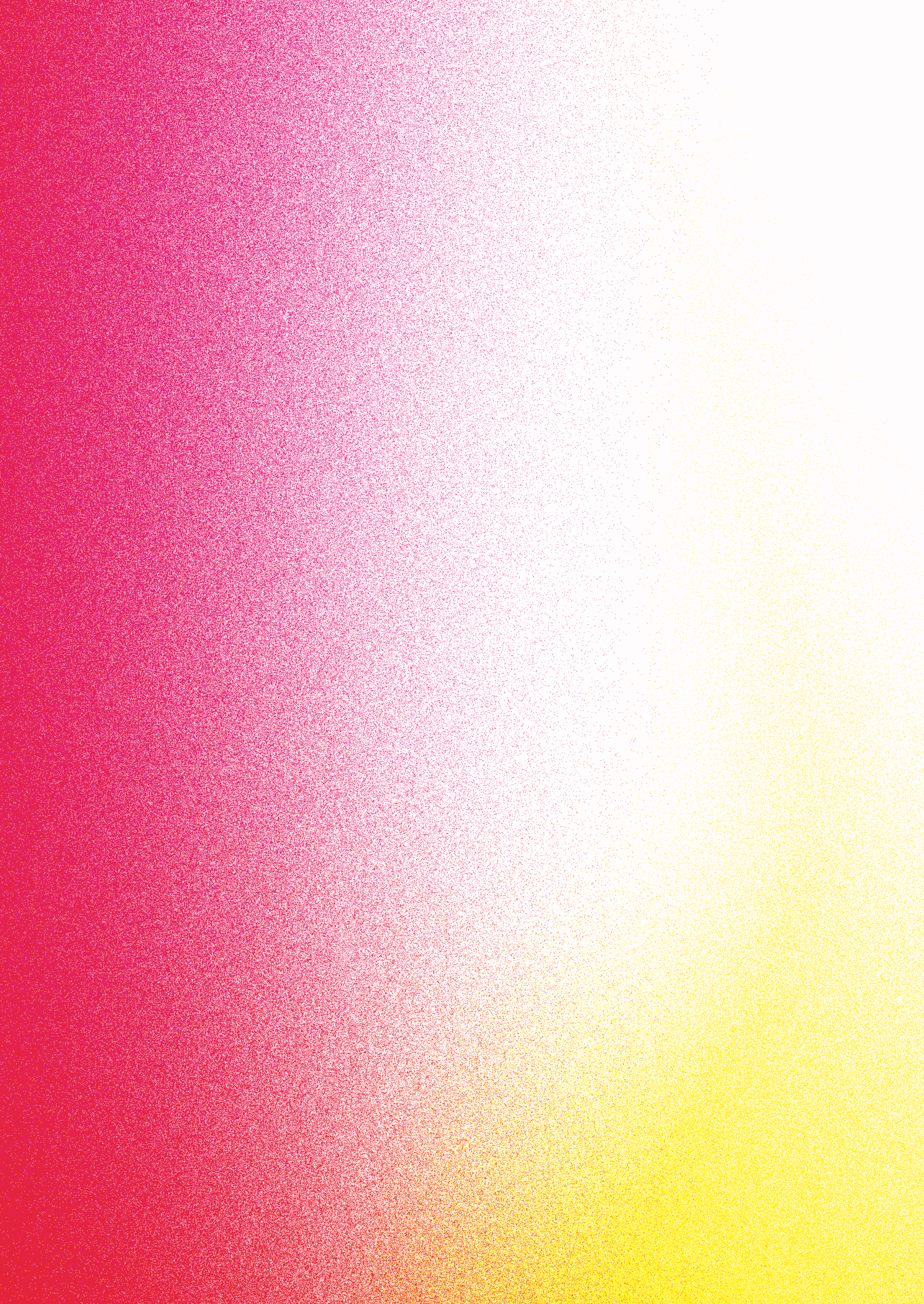
6.4.2 Limitations and Future Research

Our contribution is limited by making conclusive remarks about a larger population. However, we did find indications of larger cultural patterns. With the limitations of this study, we hope to inspire future research. A recurring pattern, in particular, was that lifestyles are typically associated with educational levels. First, future research could better connect our findings to differences in educational levels as the implied cause. Educational levels could increase the acceptance factors of all household members or create more awareness of the risks of digital data and the ability to protect oneself. Research on the ability to protect others with the IoT in the smart-home could stress the importance of how digital inequalities are given shape.

Furthermore, IoT-related inequalities between households could be caused by differences in white-collar jobs and blue-collar jobs. The difference for IoT outcomes with working a 9-5 job with overtime might be greater than working in shifts. Similarly, the ability to adjust to the smart-home by acquiring digital skills, such as programming, is more commonly associated with white-collar jobs and higher educational levels. Additionally, safety assessments of household appliances through blue-collar jobs that expose risks might unnecessarily restrain the potential of IoT use and outcomes.

Our analysis relies on the framework we introduced. However, if we remove this scaffolding, two additional points that occur throughout this contribution become more evident. First, the exposure of young children to the IoT and how this could give an advantage over unexposed children. Acts of cleaning up and decluttering, for example, expose children to an if-this-then-that programming structure that blends the material with the digital via the IoT. The ease of making the IoT fit through choreographic skills with their everyday routines, as an effect of early exposure, could provide benefits later on by being more attentive to the strategic potential of digital devices than nonexposed children. In particular, parents have learned digital skills and have more awareness of digital data.

Second, in our analysis, we have tried to remain gender neutral in our implication of allowing space for alternative cases. However, notions of gender differences in relation to the IoT remain prevalent, whether by the 'wife-acceptance-factor' or by the impressions of traditional homemaker roles in contrast to the capabilities of the IoT. In our sample, only two women out of 29 households (disqualifying the single-person household) had more of a 'tinkerer' role over their husbands instead of a 'consumer' role. Our sample would imply that control over the IoT and the smart-home remains gendered towards men, whereas control over the household and its domestic sphere remains gendered towards women as normative gender roles. Finally, we find that the IoT exuberates the effects of household politics and inequalities within the household. Strong gender roles are reaffirmed by the IoT, while for others, the IoT helps manage routines in their work-away-from-home. This suggests that the relative outcome gaps increase between households.



CHAPTER 7

Economic Bonds and Collaboration Skills

What IoT log-entry diaries tells us about strategic IoT use.

Based on:
Van der Zeeuw, A., Van Deursen, A.J.A.M. & Jansen, G. (*in review*).
Digital Inequalities of Internet of Things algorithms and (AI) Cocnition:
What IoT Log-Entry Diaries Tells Us About Strategic IoT Use.

7.1 INTRODUCTION

In this Chapter we take our final instrumental step in address our solfège problems by focusing mainly on the *services & manufacturers-IoT users* figurational units in relation to collaboration skills. With the IoT, everyday objects such as lamps, doorbells, watches, and thermostats are enhanced with artificial intelligence (AI) and autonomous algorithmic decision-making capabilities (Atzori, Iera & Morabito, 2010; Gubbi, Buyya, Marusic & Palaniswami, 2013). Classical notions of AI can be found with digital assistants such as Alexa, Siri, or Google Assistant in the form of smart-speakers (Brill, Munoz & Miller, 2018; Zimmerman, Schmidt & Sandkuhl, 2020), but it is increasingly more common for AI to be distributed through everyday smart-objects (Kuzlu, Fair & Guler, 2021; Merenda, Porcaro & Iero, 2020). Moreover, AI in the IoT is less focused on impersonating human characteristics and more on providing autonomous decision-making tools. However, a problem with using AI is that it tends to require people to sacrifice their control, dependency and power over decision-making processes (Anderson & Rainie, 2018).

While little might be known about how IoT devices come to their decisions or which data they use to make decisions, using the IoT does offer benefits. With the help of AI, the IoT can help people strategically change their behavior and produce tangible outcomes, such as helping to reduce costs and save energy (Tipantuña & Hesselbach, 2021), provide security (Ahanger, Tariq, Ibrahim, Ullah & Bouteraa, 2020), comfort, and increase health or well-being (Amaraweera & Halgamuge, 2019). However, there are large differences in their understanding of how algorithms make decisions for them and how they can be used strategically (Cotter & Reisdorf, 2020; Klawitter & Hargittai, 2018). That is, IoT users need to collaborate with different parties and decide which manufacturers generates data or uses algorithms that meets their needs. Therefore, in this Chapter, we approach the social context through economic social bonds in relation to collaboration skills to explore differences in strategic uses of the IoT. To develop a better understanding of how differences in using the IoT strategically can increase digital inequalities, we ask conductively to the economic bonds in our solfège problems:

> *Sub-Question 3.3: How are differences between strategic purposes of IoT users influenced by the IoT as an algorithmic decision-making tool?*

We use three steps to explore our research question. First, we examine how the IoT and IoT data are being used strategically as a cognitive tool. As the IoT functions largely as a black box, how is it used cognitively to achieve certain goals that IoT users establish for themselves? Second, the ability to use the IoT for strategic purposes is determined by how well people can read and understand their data. This starts with using collaboration skills with IoT manufacturers to generate personal data, retrieve data, and finding a use for it. Therefore, we ask: How does people's collaboration skills affect their ability to achieve their strategic goals with IoT use? Third, when dependent on the IoT to generate data and IoT manufacturers to retrieve data, it is important to understand the different ways in which people validate the accuracy of their data. That is, by what authority do individuals consider their IoT data to be correct. Therefore, we ask: how do people justify the accuracy of their data for their strategic goals?

7.2 THEORY

The IoT can help people achieve varying goals related to greener energy (Reyes-Campos, Alor-Hernández, Machorro-Cano, Sánchez-Cervantes, Muñoz-Contreras & Olmedo-Aguirre, 2020), provide security (Ahanger, Tariq, Ibrahim, Ullah & Bouteraa, 2020), comfort, and increase health and well-being (Amaraweera & Halgamuge, 2019). Moreover, single actions might result in a multitude of benefits; for example, turning devices off automatically increases comfort, reduces costs or helps with environmental goals. The IoT can be very useful for compensating for a faulty memory by using AI to turn off lights or heating. Otherwise, the connectivity of the IoT makes it easy to check at a distance whether devices are turned off or on. As such, one of the main strategies for IoT use is reducing button press events. Generally, pressing buttons in digital inequality research has been described as a type of operational skill (Bawden, 2001; Hargittai, 2002; Van Deursen & Van Dijk, 2009). After the initial setup of IoT devices, however, operational skills tend to be less required (Van Deursen & Mossberger, 2018). In contrast, skills that revolve around information tend to be more pressing as the importance of data increases.

However, in constructing an IoT Skills Scale (IoTSS), Van Deursen, van der Zeeuw, de Boer, Jansen & van Rompay (2021) found that traditional distinctions between digital operational skills and information skills have become convoluted in IoT environments. Instead, strategic IoT skills stand apart as a separate factor. This is comparable to the early stages of research on internet skills, distinguishing between medium skills and content skills (Van Deursen & Van Dijk, 2011). Additionally, we argue that strategic uses of the IoT are influenced by the consequential effect of collaboration skills for the IoT, particularly those related to algorithms and AI, data literacy, and collaborations with manufacturers that determine what data are collected, returned by algorithms, or can be retrieved. To explore strategic uses with the IoT in the social context of economic bonds, we found two distinctive strategic patterns in our data that can be substantiated by previous research. On the one hand, we underscore strategic patterns that utilize the invisible design character of most IoT devices. We call this strategic pattern *AI alleviation* because it aims to reduce cognitive strain and button press events. On the other hand, people make their IoT more visible by actively seeking out and responding to the data it generates. We call this strategic pattern *cognitive motivation*, as IoT data make people more cognitively aware of behavioral patterns and motivate them to make changes. Both strategic patterns are applied independently from each other and can differ by device.

7.2.1 AI Alleviation

As a collection of algorithms and a series of mathematical instructions for data processing and decision-making, the IoT tends to operate as artificial intelligence. However, not everyone is able to critically assess the effectiveness of the IoT as AI. Klawitter and Hargittai (2018) called algorithmic skills a domain for a few selected users who understand how algorithms impact digital activities. However, Chapter 4 shows that for digital technologies such as the IoT, which are designed to operate in the background, there is not always much interest in developing these skills (Van der Zeeuw, van

Deursen & Jansen, 2020). Established platforms such as Google are considered arbiters of truth (Gillespie, 2014), suggesting that to give answers to all there is to know, platforms such as Google judge the significance and trustworthiness of information for its users. Accordingly, algorithms concern individual autonomy because they undermine the user's ability to make judgments about information (Cotter & Reisdorf, 2020). Building knowledge about algorithms, being critical and, in turn, reclaiming individual autonomy are developed through experience with algorithms. Here, again, the IoT is positioned as a collection of devices for people who generally do not want to build on their experiences but rather forget about them as shown by Elise in Chapter 4, section 4.3.2.1 (Van der Zeeuw et al., 2020). By AI alleviation, the IoT follows a strategic pattern that has been common among wealthier and higher educated households that have been able to substitute capital for labor by buying appliances that save time (Hamill, 2003).

The IoT, in more positive words, helps to alleviate cognitive overload. Similar to how a calculator drastically reduces the cognitive strain of arithmetic calculations or using a mobile phone to access an infinite encyclopedia of facts helps to reduce the strains of a limited memory, the IoT helps reduce the strain of thinking, deciding, and judging on everyday activities such as turning down the thermostat, locking the door, or standing up and walking a few steps each hour. For many IoT users, the aim of the IoT and its AI, the black box of algorithmic decision-making, is to ensure that cognitive tasks are removed from the mind of the individual. That is, the IoT suggests a model of cognition distributed over artifacts (Turner, 2016) or extended across humans (Pramanik & Choudhury, 2018). Rather than seeing algorithmic interference as taking away autonomy, by distributing cognitive strains externally, the IoT can help to give its users more autonomy in other places. For example, having door locks, central heating, and lamps operated by AI alleviates the need to worry about those things, allowing IoT users, instead, to experience themselves more in the moment with their children or engaged with work (Van der Zeeuw et al., 2020).

7.2.2 Cognitive Motivation

Different from the AI alleviation strategies that the IoT can help with by being invisible to its user, for some people, the IoT and its generated data can motivate them to achieve certain goals. Parviainen (2016) describes this by showing how data returned from wearables to its users create a technological feedback loop that motivates its users to achieve goals with incremental steps and generate more data. For instance, people who enjoy walking may start to measure their steps, distance and time and try to improve those measures incrementally by setting certain goals that are also reflected in those measures. In such a strategic pattern, data can increase the cognitive aspects of behavior that help to motivate IoT users. Moreover, in transforming certain digital uses into tangible outcomes by the measures returned to its IoT users, together with nudges, the IoT becomes more visible as it is caught in a feedback loop of data entrainment that will continue to make the IoT more visible over time.

Using the IoT strategically in a pattern of cognitive motivation generally requires collaboration skills. Collaboration skills can be described in three steps. First the skills to cooperate third parties that may have different goals. Much like choosing a proper search platform as gatekeepers of information (Gillespie, 2014), such as Google or Google Scholar, or alternatives such as DuckDuckGo or Semantic Scholar, the IoT offers different opportunities to choose between manufacturers and their algorithms that affect the data IoT users can strategize with. Second, the skills required to retrieve collected data. It may be sufficient to operate and navigate IoT devices to retrieve data within the interface of the IoT application. However, in other cases, such as retrieving raw data, advanced operational skills or even programming skills are needed. Third, skills that are required to read and interpret the data. While ubiquitous computing, such as the IoT, has greatly increased the number of data points that can be collected (Pangrazio & Sefton-Green, 2019), interpreting data can become more difficult. For instance, an activity tracker can help monitor sleep patterns and provide a motivational tool to improve one's sleep, but it still requires knowledge about the causal relations between data points.

7.3 FINDINGS

7.3.1 The Strategic IoT

For many IoT users, the IoT is a black box that hides most operational events and decision-making processes behind autonomously working algorithms. However, rather than experiencing the IoT as diminishing autonomy, the IoT offers the ability to reduce cognitive strain. As such, the IoT can be used as a cognitive tool. This can be illustrated by Edward, who has a smart thermostat. When asked what he thinks is a great benefit of having a smart thermostat, Edward replied:

Well, often at night you lay in bed and you think: "oh yeah, shit! The thermostat still has to be turned off." Or that at a certain point that the central heating comes on again and 'shit, the thermostat is not off'. And now it just turns itself off, so you do not have to think about it anymore. You can also quickly turn it off via your phone if it is not turned off.

What Edward illustrates is the convenience of not having to think or make decisions about changing the program of the thermostat. This is a common pattern for IoT use. However, a stark difference is illustrated by Hendrik, who has a Home Wizard IoT system that integrates several lamps, sensors, cameras and other electronic switches into one operating system. Much like the naturalness of forgetting about the IoT, Hendrik explains the ordinary process of becoming entrained by IoT data:

Because they show it so nicely and discernible, you think, "Hey, damn it.." Well, then you are going to pay attention to those things. So, with your Home Wizard, you will adjust the times that the lamps go on and off. Or your heating, because the thermostat also connects to the internet, so you are also going to pay attention to that. Well, and gradually you will become more aware of it and then you will start using it less.

The small shock when confronted with data when first presented with it in an understandable manner can make IoT users pay attention to things they had not previously thought about. Moreover, as Hendrik explains, greater cognition of IoT data helps fine-tune the setup and further reduce unnecessary uses. IoT users such as Hendrik become slowly entrained with the IoT data. The IoT not only alleviates cognitive tasks but also motivates behavior through the cognitive processes of data literacy.

While the pattern of reducing cognitive strains might seem like a prominent aspect for the smart home, with wearables of the IoT, we notice a similar effect. Generally, IoT wearables are used to motivate behavior, but they also offer cognitive alleviation, such as the need to remember to move. Such is the case with Charlotte and her Garmin:

What I do like is that if you have not moved for too long, at a certain moment it will notify you of that. And my colleague sitting across from me, on the same work island, has the same one and we are on the same cycle. Because if mine goes at eleven that I have to move, *hers was at five past eleven. So that is really funny to see. Sometimes you get up and other times you do not. It just works out that way. If I'm on the phone, then I cannot. But it does remind me that I have to walk to the coffee machine in a while. Or, to stretch my legs. So, it is a nice tool.*

For Charlotte and her coworker, having an IoT wearable is not just about tracking activities but also as a reminder to be active. Rather than making people 'forget' about the IoT, the IoT makes people remember to use the IoT in assisted behavior. Nevertheless, deciding to be 'reminded', much like the ability to 'forget', is reliant on AI. Charlotte's use of her Garmin is relatively casual compared to many of the sportier Garmin userbase. The log-entry diaries in Figure 7.1 illustrate Charlotte's casual activity compared to the sportier Robert, who has a lower resting heart rate and more moments of vigorous intensity. Especially in the first four months, Charlotte has longer periods without the vigorous intensity or any indication of a strategic purpose compared to after January 1, 2020. This suggests that, like Hendrik, it can be difficult to avoid entrainment by IoT data, particularly when certain goals are put on the agenda.

Data literacy can turn alleviation by AI, whether to remind or to forget, into cognitive motivation when strategic goals become more prominent. This is aptly shown by Robert, who uses multiple IoT devices to track his sporting activities. Being relatively active, except for a break between August and September 2019, Robert specifically uses the IoT to track his achievements. Additionally, data can become more motivating when shared with others. As explained by Robert:

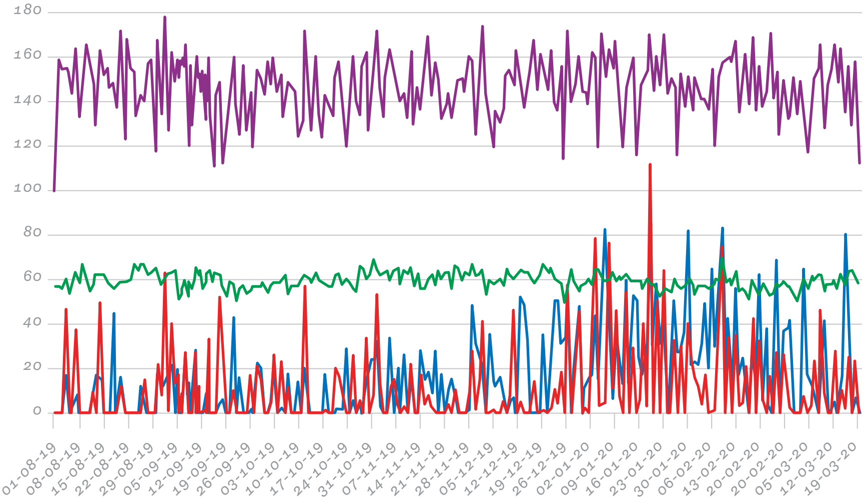
Through my devices and the apps I use, my achievements are made visible in an app to the people around me. And they can respond. And now you have a whole overview: per kilometer, how fast you have been; your heart rate, how fast it has been. All of that. Then you can even display the weather and add things like that. In that respect, you can keep an eye on others and get a little motivation out of how others react or whatever. There is a fixed group of people who always respond to it or give it a thumbs up or whatever, so that is nice and then also if you talk to them in person, it is often about that.

The embeddedness of data into social relations is not something to neglect. For Robert, this is to improve exercise metrics; for Charlotte's relative casual use, it is about sharing movement routines with coworkers. A large difference,

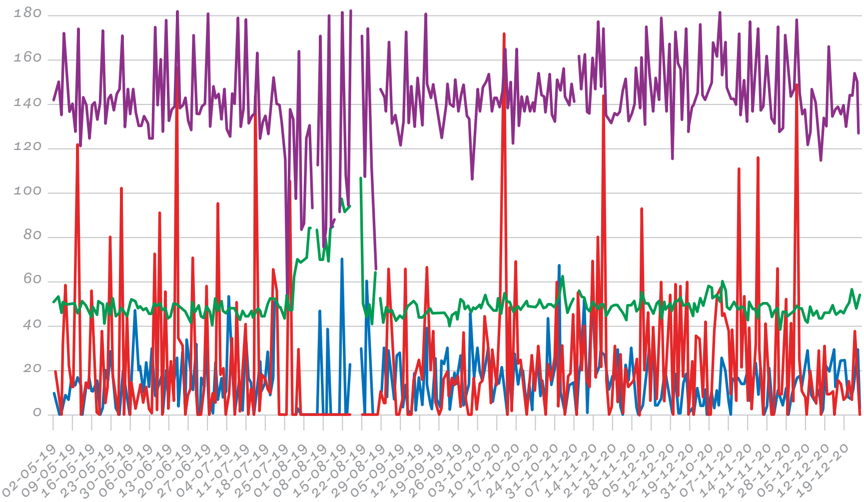
Figure 7.1

Activity Tracker Log-Entry Diary

Charlotte



Robert



Moderate Intensity
Vigorous Intencity
Min Average Heartrate
Max Average Heartrate

however, is how the IoT is implemented strategically to provide AI alleviation through external decision-making processes, such as with Edward and Charlotte, or cognitive motivation through data, such as with Hendrik and Robert.

7.3.2 Hidden Data and Data Literacy

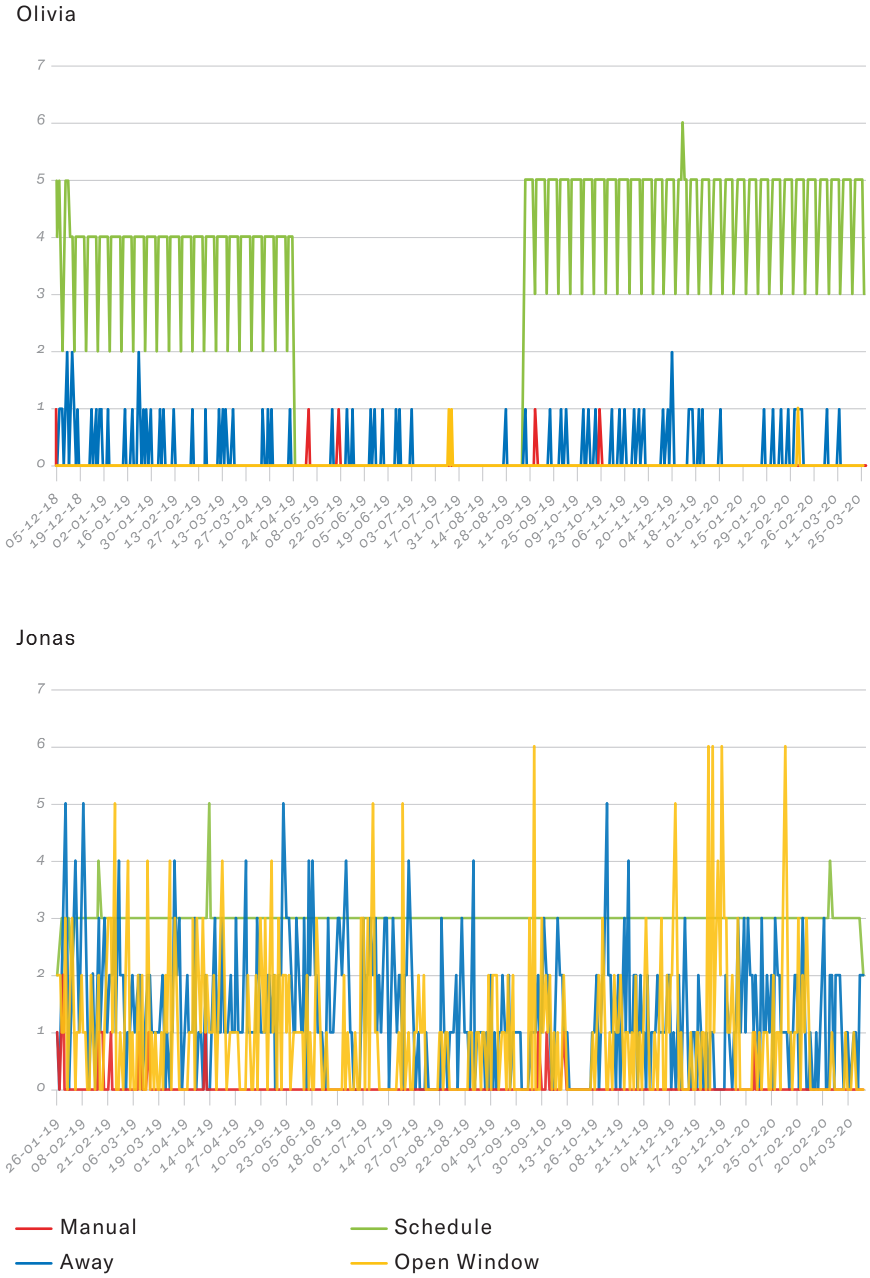
Similar to AI alleviation, which refers not only to the IoT in smart homes but also to wearables, the aspect of cognitive motivation with the IoT is not reserved for wearables. This can be illustrated by comparing log-entry diaries of the Tado thermostats used by Olivia's household and Jonas' household in Figure 7.2. Compared to Jonas, Olivia's heating schedule is more extensive, and together with geofencing (Tado's auto-assisting Away mode), it is hardly used by manual control. Olivia's thermostat is exemplary of an IoT device set to work invisibly and autonomously. Nearing the end of our 15-month study, Olivia and her husband started collaborating with an energy coach to strategically reduce their environmental imprint. Olivia notes that "With all those systems that measure and that you can control digitally, it can yield interesting results if you combine them". Such a strategic shift can make data literacy more important. However, when trying to retrieve data (before our explicit performance task), Olivia explains:

> *I happened to have looked at the Tado app to see if there is any more statistical information about what time your heating system was using a lot of energy, or whatever. I mean, they do say something about energy saving, but that is an algorithm so you cannot figure out what exactly is behind it. If it does exactly what it is supposed to do, then everything is fine. Then, the simple interface is very useful, but if you want to know more about it, you won't be able to find out.*

The black-box of AI and algorithms become apparent for Olivia when she wants to turn her casual use into strategic use. Without proper collaboration skills to find manufacturers that generate and publish data fitting to personal needs, the step from AI alleviation toward cognitive motivation can be difficult. AI alleviation works best without too much user interference, so interfaces are kept simple. Collecting IoT data into a combined file can create a better understanding of consumption; however, the difficulty people face when interpreting data when such literacy skills are lacking can be compensation through collaboration skills and the use of an energy coach.

Figure 7.2

Thermostat Log-Entry Diary



Different from Olivia, Jonas received a Tado thermostat from his utility company but left it uninstalled until he had strategic use for it. The use of a smart-thermostat became clear when Jonas set a goal to start using a heat exchanger and to stop using natural gas. As he explains his motivation for using his Tado:

> *You have to dimension the heat exchanger very much to the house and the heat demand that there is. So you must have very good insight into your gas consumption, because then you can calculate how much you need. To measure your gas consumption, you should not start heating with an open window, because then the number will be too high and you will therefore over-dimension your entire heating system. So, I want real insight into our gas consumption and our heat demand.*

Jonas used a Tado thermostat to gain insight into the heat insulation of his house, specifically by collaborating with Tado and its Open-Window detection. With two kids and a door in the living room toward the garden, the Open-Window detection is frequently active, as is geofencing shown in figure 7.2. While the scheduling is less extensive than Olivia's, the natural data generated provides cognitive motivation for strategic use: switching to a heat exchanger.

For Olivia and many others, IoT data are limited at first; they might know that there are more data generated, but they only receive algorithmically analyzed and prepared data such as savings reports. Consequently, gaining control over data often requires a better understanding of how the IoT works on a programming level. Jonas, primarily interested in IoT data, also has a solar panel system that can provide him with data on when to increase energy use when the sun is out. However, the data provided by the solar panel manufacturer do not meet Jonas' expectations. As he explains:

> *The manufacturer does offer some monitoring with solar panels. There is a small computer in between that collects the data traffic between my solar panels and the manufacturer and puts it in a database. The manufacturer gives you a lot of data via an app, but they do not give you all the data generated by their solar panels. So, to catch that, I have put a Raspberry Pi in between myself and set up a database where all data per solar panel is stored. What you see from the manufacturer is the yield per panel per day, but not per 5 minutes per panel, you do not get the temperature from the panels,*

which also affects how well a panel does its job; how efficient it is. I have not managed to get a front-end running yet. But, they are my panels, so I think I'm also entitled to that data.

Similar to Olivia, Jonas is interested in retrieving more data, not only to obtain a real-time reading but also to monitor efficiency. More importantly, Jonas has voiced his being entitled to access the data, which was remarkably absent from other participants. The completeness of the data is key in how behavior is being influenced, and a large aspect of using the IoT for cognitive motivation relies on receiving data. Consequently, moving from AI alleviation to using the IoT for cognitive motivation requires a sufficient level of collaboration skills and data literacy but, as shown by Jonas, also requires advanced operational skills to retrieve data.

7.3.3 Authority of Certainty

IoT data can help alleviate cognitive strain or motivate people to achieve certain goals in the social context of economic bonds. This entrainment of IoT data is explained by Hendrik and demonstrated by Charlotte, Robert, Olivia and Jonas, who create different variations of technological feedback loops. While obtaining data can be one hurdle to overcome, another is to assess the correctness of the data. As people respond to the data they receive, it is important to consider by which authority they consider their data to be accurate. That is, who do IoT users consider arbiters of the truth? The distinction between AI alleviation and cognitive motivation can also help explain the differences in how IoT users determine by which authority they consider their IoT data to be correct. Within the pattern of cognitive motivation, seeking out collaboration with additional parties and using their data to enhance cognition appears to be logical. This is illustrated by Robert. Being interested in his achievements in sports, Roberts compares the data of his Garmin devices to a medical examination:

I have done a medical examination. Where you have all those stickers and things. So, that is very accurate. I am confident that it is accurate. Let me put it this way: whoever did it, knows more about it than me. My Garmin, my watch, will also assign zones based on my sport activities. It can see that how high my heart rate is and how high my heart rate has ever been, and things like that. And they matched well. So yes, that confirms that it is alright, I would say.

Robert recognizes the authority of the most knowledgeable arbiter of truth he has had access to—a medical examiner—and relates it to the accuracy of the algorithms of his IoT wearable. To Robert, his data shown in Figure 7.1 would be comparable to the data he received from a medical examination. While both the algorithm and the examiner might appear as a black-box, by triangulating data, the authority of one justifies the use of the other.

A similar method can be found with Peter, who also uses triangulation to assess the correctness of the data he uses to change his behavior. Peter uses a '*huisbaasje*' (little landlord), a device to measure energy consumption in real-time and promoted by the Dutch Consumers Association. Peter uses his *Huisbaasje* in a technological feedback loop to reduce energy consumption. When asked how he knows it is accurate, Peter replied:

> *You can compare a bit, of course, because I also just have Greenchoice, the app from my energy supplier, which also shows your consumption. And that corresponds reasonably well. So yes, you have to start from something and I assume that the smart meter is right of course, because that is the reality. They also send it to my supplier. So yes, it must be the same.*

Peter triangulates between his IoT data and the suppliers from his energy supplier. Although both are presented as black-boxes, the decisive authority is placed directly in the hands of his supplier because they are the ones he needs to pay. The arbiter of truth, in this case, is the one with the greatest consequence.

In contrast to enhancing cognition by seeking out more data, AI alleviation is more dependent on data made available through experiences such as how the IoT can be integrated within habitual patterns, feelings of naturalness or a natural flow of everyday life. An important distinction is that with a pattern of AI alleviation, using IoT is not necessarily about achieving quantifiable measures, such as Olivia's aim of reducing energy consumption or Robert's achievements in sports. Such is the case with Mark, who owns several IoT devices in his smart-home, including smart lamps:

> *If the lights are left on in the house unnecessarily, I think that is a shame. Mostly, just a shame. It does not matter much in terms of energy, but that it just switches off when it has to be switched off and is not switched on unnecessarily. So yeah, I'm not fond of waste, so in that respect it is nice that it… That if you are not there and the lights should go out, that makes sense.*

To Mark, habitual patterns dictate that empty rooms should not have lights on or be heated regardless of cost reduction or an interest in using less energy. When seeking AI alleviation, such as smart lamps helping you forget about the lights being turned off or on, triangulation between data is precisely what people do not want. Instead, the authority of determining the correctness of the IoT is provided by experiences of natural living. Similarly, Anna uses the results of her activity tracker to check what she experienced:

> *I had walked from here to the city and that was less far than I thought, actually. So, I thought: 'Oh, is that right?' And it was further in terms of distance, but it did not take me as long. So, I wanted to check if that distance measurement was correct. But it was indeed the same via Google Maps. Google is always right.*

Anna's previous walking experiences make her question the data returned to her. However, Anna's joking remark that 'Google is always right' also refers to a series of experiences that give authority to Google as an arbiter of truth, a prevalent data source that has previously been shown to provide correct information. Whether people use triangulation between sources of data or between experiences, it is important to note which sources obtain authority over truth and how they influence behavior.

7.4 CONCLUSION

7.4.1 Main Findings

In this Chapter, we aimed to obtain a better understanding of how differences in using the IoT strategically can increase digital inequalities by using collaboration skills in the social context of economic bonds. We find that digital inequalities can increase in three steps. First, the differences in how the IoT and IoT data are being implemented strategically as a cognitive tool determine how people can transform their IoT use into tangible outcomes. Implementing the IoT strategically to maximize AI alleviation for certain tasks requires a good understanding of how external decision-making processes are made. Additionally, responding to IoT devices when they request action is made more efficient by a better understanding of the AI in the IoT. Likewise, extending a cognitive awareness of behavior to change it or improve upon it requires an understanding of how to use the data that is being tracked and what it means. This is where algorithm skills can make a significant contribution

(Klawitter & Hargittai, 2018). Moreover, a motivational aspect can be found in how well people are able to situate the IoT data in a social environment.

Second, using the IoT for strategic purposes is determined by how well people are able to read their data. On the one hand, the completeness of the data is crucial in how accurate decisions can be made. If the interface of the IoT application does not show enough information or information processed in a limited way, the completeness of data is reliant on programming skills. On the other hand, interpreting data can be a threshold to strategic IoT use. With data becoming more important in everyday life (Couldry & Mejias, 2020), gaps in data literacy can be expected to widen. When data are presented after being processed by standard algorithms with IoT applications, readability is usually easier compared to combining data from different sources into a single spreadsheet. Nevertheless, translating data into strategic behavior changes can be difficult if interpretation skills are lacking.

Third, users are dependent on different authorities to assess the quality of their data. As the IoT is a black box for many users, different strategies are used to triangulate data. A common pattern in using the IoT for cognitive motivation is seeking out additional sources of data. In contrast, when using the IoT for AI alleviation, IoT data and use are more commonly triangulated with previous experiences. Consequently, the benefits of strategic IoT implementations are determined by the success of their measurements. Therefore, the sources of authority of truth that are powerful in influencing behavior in general (Gillespie, 2014) also apply to the IoT.

Moreover, this research has been framed according to previous research on how people benefit differently from digital technologies (Gonzales, 2016; Hargittai, Piper & Morris, 2019; Watkins & Cho, 2018). While much research has shifted from the distinction between the *haves* and the *have nots* in digital technologies toward skills and tangible outcomes (Lutz, 2019; Scheerder, van Deursen & van Dijk, 2017), retrieving data falls in between access and skills. While skillful people might be better able to access their data and benefit from it, they are also largely dependent on the access provided by manufacturers. That is, digital inequalities are increasing not only by people with different abilities but, as we have shown in Chapter 4, also by being situated in a network of interdependencies (Van der Zeeuw et al., 2020).

7.4.2 Limitations and Future Research

Being entitled to data does not always translate into receiving data. With regard to skills related to collaboration with manufacturers, our performance task has made clear that the compliance of manufacturers with the GDPR is problematic. This could be because the understanding of personal data is limited (Pangrazio & Sefton-Green, 2019). However, as arbiters of truth, the lack of transparency combined with increased authority over data is a dangerous mix (Zuboff, 2019). This also resulted in an incomplete dataset that restricted our findings due to this selection process. That is, IoT users who have not been able to receive their data may show surprising log-entry diaries. Nevertheless, we hope to inspire future research to utilize log-entry data from digital devices. Moreover, as data become more public, self-regulating behavior might be greatly influenced by the stream of data and information that is being made public.

Additionally, our aim has been to improve our conceptual understanding of digital inequalities with regard to the strategic implementation of IoT and IoT data. While our findings are suggestive of patterns of socio-structural dispositions, especially regarding skills and socioeconomic positions, our sample does not warrant us to make these claims. However, we hope that future research becomes sensitive to the conceptual dynamics we describe and how they influence digital inequalities.

CHAPTER 8

Conclusion

8.1 REVISITING THE SOLFÈGE PROBLEM

At the beginning of this dissertation, we used the solfège system to explain the problematic tensions of the IoT. Being able to sing '*do re mi*' is quite simple for most people (regardless of quality), but without any knowledge of how to use it, the solfège system has little value or meaning. Consequently, as more is known about the do re mi syllables, such as how they can be used as a movable system that utilizes aural skills to relate notes to one another regardless of what key the music is in, their value and meaning increase. The IoT is very similar to that. For some people, the IoT consists of everyday appliances that incidentally happen to be connected to the internet; this characteristic does not drastically increase its use-value, nor does connectivity provide much added meaning. For others, mostly those who are more skilled in digital technologies, the IoT is a platform for connected devices in their optimal network where the communication between devices allows for autonomous decision-making capabilities or can provide tactical information. That is, with the right skills, the value increases and continues to become more meaningful, especially as socio-contextual skills such as choreographic skills and collaboration skills continue to develop.

Unfortunately, this can also have negative consequences, as the outcomes of using digital devices are unequally accessible and digital inequalities remerge with waves of new technologies. Moreover, differences in understanding how digital devices can provide benefits increases digital inequalities even further. The goal of this dissertation has been to examine the influence of the social context on how the IoT is being used and explain why some people are more skilled to benefit from the IoT than others. To meet our goal we used the solfège system to exemplify the problematic relations between the IoT and digital inequalities in three ways: first, to gain an understanding of the context wherein IoT is being used to understand how people can benefit from it; second, to develop a skillset that can be applied uniformly over IoT devices and to allow us to gain a better understanding of how devices relate to each other; and third, to explain how people are more or less stimulated to acquire or develop certain skills. To emphasize variation in skills, we focused on habitual dispositions reflected by patterns of education. We used education as a rough indication for cognitive ability (Erikson, 2016) and to reflect patterns of cultural consumption and cultural values that are often associated with levels of education (Bourdieu, 1984; Bennet, Savage, Silva, Warde, Gayo-Cal & Wright, 2009). Moreover, educational levels have consistently been used to predict dividing factors in digital inequalities (Davies & Eynon, 2013; Hargittai, Piper & Morris, 2019; Scheerder, van Deursen & van Dijk, 2017; Van Deursen, van Dijk & Peters, 2011).

Before we started with our main body of research, we used a survey in Chapter 3 to test to what extent the IoT can be considered an internet-connected social object or a regular consumer object. We found different considerations for the IoT as a platform for social objects according to relatively stable forms of economic, cultural, and social capital by Bourdieu (1986). IoT users who are more socially active outside of their immediate household are also more likely to share IoT data outside their households. This means that IoT users who are rich in social capital are also more prolific in using the IoT as an internet-connected social product. Moreover, we found that within a household, partners are more likely to share IoT data when they are proficient in finding and installing relevant mobile applications for their IoT devices. This dovetails with the suggestion that the IoT aids the coordination of tasks and activities in the domestic sphere (Fortunati, 2018; Haddon, 2006).

As the keystone of our analysis, we first applied our micro-figurational framework in Chapter 4 to gain a better understanding of interdependency chains that determine what skills are required or stimulated by compensation strategies and composites of other skills. Moreover, by identifying an interdependency chain of the IoT system at home, we found a figuration of *services & manufacturers-IoT devices-IoT users-home & co-users*. This figuration mediates three alternative interdependency chains that utilize the different skills and social bonds we explored in the subsequent chapters. As the IoT mediates different interdependency chains, users use skills to oscillate around an optimum equilibrium of gratification and are dependent on being locked-in with manufacturers for enhancing services via subscription formats and new functions or by trying to reduce the degree to which mediation is disruptive to their IoT setup. Additionally, we identified operational skills, collaboration skills, and choreographic skills as a digital skillset that corresponds to unique characteristics of the IoT.

With the assumptions tested in Chapter 3 and by identifying the first theoretical leads in Chapter 4, we set out the answer to *how the social context in which the Internet of Things is used by everyday people can explain the differences in IoT skills that perpetuate digital inequalities*. In the following sections, we use our findings to answer our research question in terms of skills, the social context, and accessibility. Similar to the scaffolding that is removed when the building is finished, we present our conclusions without relying too much on the framework we have used to come to our findings and focus instead on its practical implications.

8.2 HOW CAN THE SOCIAL CONTEXT IN WHICH THE INTERNET OF THINGS IS USED BY EVERYDAY PEOPLE EXPLAIN THE DIFFERENCES IN IOT SKILLS THAT PERPETUATE DIGITAL INEQUALITIES?

8.2.1 A Uniform Skillset for the IoT

The solfège system teaches us the value of a uniform skillset to deal with the wide range in IoT devices and the context wherein in which the IoT is applied. As the abductive research approach has been an iterative process between research, data, and theory, the skills in our main research question became more defined throughout the research. Before going into the social context and its influence on IoT skills, let us discuss what these skills are in their final iteration. When this dissertation was started, it was assumed that the IoT would lessen the autonomy and control of its users, and therefore, operational skills would be less required after the initial setup of IoT devices (Van Deursen & Mossberger, 2018). This is consistent with our interdependency chain on *Victims of Circumstance* in Chapter 4, where we found that the absence of operational skills in someone's skillset is not enough to deter IoT use. However, in two alternative interdependency chains, *Service Personalization* and *Ubiquitous Hobby*, we found that operational skills can wager more control and autonomy for everyday activities. In this regard, we (re)constructed operational skills, choreographic skills, and collaborations skills as the final skills in our skillset to specifically address the unique characteristics of the IoT and its latticework of social relations. Moreover, as we aimed for a uniform skillset to relate between the functions of the IoT, the final skills in our skillset also relate to each other.

Operational skills for the internet are used to describe user control with different layers of digital technologies such as drives, folders, files, scripts, and programming in a basic 'if-this-then-that' structure (Van Deursen & Van Dijk, 2011). As the initial interface of the IoT is relatively easy, fewer operational events are required, and the competency level can be limited to basic operational skills. This level describes applying the basic functions of a device, such as turning it off and on via a mobile application or changing regular programming. An intermediate level of operational skills describes the ability to use the software to make advanced schedules and tie IoT devices together into a network. In Chapter 5, we elaborated more on an advanced layer of IoT skills that utilizes the IoT infrastructure with programming skills. Below the easy-to-use layer of the IoT, options can be revealed with advanced operational skills, and initial functions can be repurposed. Because the IoT is a network of smaller devices, advanced operational skills also describe the tinkering of IoT hardware, which usually involves the same if-this-then-that structure in an offline format. This means that advanced operational skills describe the ability to repurpose IoT software and hardware.

Where operational skills are used to program the IoT device to fit their environment, choreographic skills describe the ability to program preexisting physical space, social space, and time available to fit their IoT. *Choreographic skills* can be used to use the IoT efficiently at preferably low costs and specifically address the 'things' part of the IoT in terms of how it embodies ubiquitous internet connectivity in everyday life. In Chapter 6, we elaborated on choreographic skills by describing the ability to create a joint effort for IoT use as devices that request material input, moderating the accessibility of accounts and the effects of data, and the harmony between the expectations of IoT devices in relation to expectations of social roles. On the material level, choreographic skills describe the ability to deal with preexisting structures that require physical input, such as light switches that can complicate IoT programming. On the accessibility level, choreographic skills describe dealing with multiple users sharing one account, how information is being stored, and the ability to mediate responsibilities through the IoT. On the level of harmony, choreographic skills describe the ability to change expectations of social roles to fit the expectations of the IoT and deal with the general routines of everyday life. On all levels, choreographic skills require some political negotiation to knit people together toward a common goal.

With the IoT lengthening interdependency chains for every activity, there are also skills required to deal with parties that have different goals than the IoT user. To use the IoT effectively, *collaboration skills* are used to ally with third parties that can help install complex IoT hardware and software, store and protect data, or use advanced support and services that sufficiently improve IoT functions according to personal needs. It also means being able to compromise and tolerate the conflicting goals that can be pursued by the parties involved, which can become a wager of trust and privacy against effective IoT use. In Chapter 7, we elaborated on collaboration skills by addressing their reliance on algorithm skills (Klawitter & Hargittai, 2018), data and information skills, and strategic skills (Van Deursen & Van Dijk, 2011). At a minimum, collaboration skills describe the ability to pick an IoT manufacturer that provides the means to achieve certain goals, such as returning the right data to improve exercise results or algorithms to make decisions autonomously and save on energy costs. At a higher level, collaboration skills describe the ability to evaluate the reliability of IoT manufacturers for software stability, storing data, and complying with EU regulations in requests to retrieve raw data. Advanced collaboration skills describe the ability to engage with third parties, such as third-party apps, energy coaches and insurance companies that use IoT data. This means that collaboration skills are not only used to improve the effectiveness of the IoT but also to minimize risks and exploitations set up by third-party involvement.

While these IoT skills can imply practical benefits for its users with composites of operational skills, collaboration skills, and choreographic skills, this skillset is uniformly required for all IoT devices. That is, all IoT devices need to be operated by their users as they request input, all IoT devices need to be placed and made to fit within preexisting social structures, and all IoT devices are connected to service providers and manufacturers. Moreover, as IoT devices require more or less of each of these skills, they carry practical implications: IoT skills reflect the maneuverability of IoT users in their respective figurations and their ability to transform IoT use into tangible outcomes. That is, while IoT users become chained in figurations of interdependencies, IoT skills allow them to favorably change their positions.

8.2.2 The Influence of the Social Context

Next, the solfège exemplified to us that the social context wherein the IoT is being used is detrimental to how people can benefit from it. We first explored the social context through its affective social bonds and its influence on IoT skills in Chapter, 5 were we focused on the limitations caused by vendor lock-in. These limitations become more apparent when people use their IoT as separate tools for specific problems rather than considering the IoT as an integrated platform. We find differences in people not fully exploring their

IoT devices and different limitations for the playfulness by which the IoT is being applied. Both exploration and playfulness can increase the future application of previously unintended functions and, in effect, increase the benefits that the IoT can offer. Consequently, digital inequalities arise when people do not have the to explore or play around with the IoT.

Having all devices from one manufacturer or from manufacturers that work well together, as a common effect of vendor lock-in, can actually promote confidence that stimulates exploration and the operational skills used for exploration. However, in the short term, this option is usually more costly than buying devices separately to deal with specific problems. Only if people have sufficient financial resources in the first place to integrate their IoT devices into one system is it implied that vendor lock-in is stimulating rather than a hindrance. In contrast, too many different software environments or a lack of trust in software may not inspire the confidence needed to explore other ways in which the IoT can provide benefits. As an alternative to buying in at high cost, creative and operationally proficient people are able to reduce financial costs by reprogramming hardware and software to their liking and by investing more time and effort. Thus, the people who are most excluded from the potential of the IoT are those who perceive IoT devices as tools that are necessarily tied to specific problems. In the long term, such IoT systems tend to become more expensive due to the additional costs of restructuring overarching software standards and interoperability. Moreover, using the IoT only for specific problems does not seem to stimulate operational proficiency or creativity. Consequently, with vendor lock-in, the aim is to use the IoT as nothing but a tool that can lead to additional costs; it also describes a type of use that might impoverish digital skills.

In Chapter 6, we explored the social context through its political social bonds and examined differences in the ability to knit together a joint effort for IoT use. Corresponding to the materiality requirement to make the IoT operate, households differ by the acceptance factors of proxy users. IoT use relies significantly on the joint effort of all household members, which creates a threshold for the complexity of IoT setups. Consequently, the ability to adapt to the materiality of the IoT determines how well the IoT can be implemented and the extent to which benefits can be maximized. Moreover, remote access and programming of the IoT can provide flexibility often called for by dual-income households (Fortunati, 2018). The inverse is also true; when households are inflexible, they hinder the efficiency of their IoT devices. For instance, when working multiple shifts, predictive programming quickly becomes too complex to catch up on. Additionally, some households have an aversion to too much IoT and digitization when it reflects on the homemaker as a lazy person or because the quality is not up to standard. The ability to embrace the IoT is somewhat hindered by cultural values, and this is also projected into the future. That is, to what extent people are willing to learn new skills to keep control over the smart home for themselves and their children. As such, strict social roles hinder the flexibility needed to knit together a joint effort for IoT use.

In Chapter 7, we explored the social context through its economic social bonds and suggest that the basis of digital skills or knowledge of how digital devices operate is limited to begin with. This might seem tautological, but the IoT creates a social context wherein differences arise in how people respond to IoT devices when they request action. Prior knowledge about digital devices can help in how the IoT is being implemented strategically and determine how people can transform their IoT use into tangible outcomes. For instance, implementing the IoT strategically for the alleviation of certain tasks requires a good understanding of how AI can make autonomous decisions. This is where algorithm skills can contribute significantly (Klawitter & Hargittai, 2018). Similarly, the IoT requires cognitive awareness of behavior to change it or improve upon it. Information skills and an understanding of how to situate IoT data in the social environment increase data-motivated behavior. Moreover, if the interface of the IoT application does not show enough information or information is processed in a limited way, the completeness of data will rely on programming skills. We have also observed that users are dependent on their social context to assess the quality of their data. Particularly when using the IoT for alleviation of cognitive strain with the help of AI, IoT data and use are more commonly triangulated with previous experiences. A common pattern in using the IoT for cognitive motivation is to seek out more sources of data and involve different manufacturers or service providers as authorities over truth.

8.2.3 Improving the Accessibility of IoT Use

To answer our final part of the problem defined by the solfège system, that skills are not equally accessible to everyone, we used a theoretical sample based on 15 higher educated and 15 lower educated participants. Consequently, most of our described effects have been sensitized to educational differences. When we consider how the IoT is used differently because people apply different skills in different contexts, we can identify patterns in our research that reduce access to acquiring or developing skills that can increase the benefits of using the IoT. While our research sample does not warrant us making any conclusive remarks, we can situate our findings as extended cases of other research. In general, people are not very stimulated to develop skills because the IoT Interface is easy, most of the data is returned in easier to understand formats with the help of algorithms, and manufacturers make it easy to overcome the difficulties of the initial setup. However, IoT skills are not the only thing that increases digital inequalities. Through our interdependency chains, we have repeatedly observed a manufacturer side in limiting IoT use. Therefore, the practical implications for improving the accessibility of the IoT have two sides: the consumer side and the manufacturer side.

On the one hand, when we focus on the demand side of the consumers of the IoT, improving operational, choreographic, and collaboration skills can make the IoT more accessible. Collaboration skills are influenced by underlying internet-related skills that involve understanding what information is being collected and who has access to it. Educational level is an important resource for developing such skills, with increasing significance for data literacy and protecting privacy (Van Dijk & van Deursen, 2014). Additionally, education has a positive effect on operational skills. While more advanced operational skills are often acquired and developed outside of formal education, basic operational skills are generally required to follow the curriculum and increasingly so at higher levels of education (De Haan & Huysmans, 2002; Van Deursen, van Dijk & Peters, 2011). Although operational skills are usually required, they are generally taken for granted in education, and variations in such skills do exist (Ng, 2012; Hargittai, 2010; Van Dijk & Van Deursen, 2014). To improve accessibility, therefore, it is strongly advisable to implement digital skills at all stages and levels of education (including vocational education and training), especially those that build toward collaboration skills such as data literacy and algorithm skills. The IoT is becoming more ubiquitous in everyday life, and the need for digital skills does not discriminate on an educational level. In other words, while the limited attention given to digital skills might suggest that the lower educated require fewer digital skills on a daily basis, this certainly does not hold true for the IoT.

Outside of the formal setting of education, we can still notice educational effects through our IoT skills. In particular, the collaborative orientation—crucial for collaborative skills—is a highly valued personal characteristic by higher educated individuals (Lamont, 2009). Individuals from the working class, in contrast, tend to be more easily frustrated by a dependency on others and favor self-reliance. This might seem somewhat contradictory, as less-educated individuals tend to rely more on 'experts', but they can also be a source of frustration. The difference is that higher educated individuals may consider IoT manufacturers to be more equal parties in helping them achieve goals, whereas lower educated individuals tend to be negative in their relations with powerful corporations. Consequently, the higher educated may find it easier to access collaboration skills as part of a cultural repertoire, while lower educated are limited by cultural boundaries that dissuade them from engaging with IoT manufacturers.

The informal effects of education can also be found with choreographic skills. When considering digital skills not by one person but by a household, power disparities within the household and strict gender-role attitudes hinder choreographic skills. Consequently, higher-educated households tend to be more egalitarian (Giani, Hope & Skorge, 2021; Kolpashnikova, Zhou, & Kan, 2020), which can make it easier to improve choreographic skills. For instance, two people with 9 to 5 jobs who share tasks in their household choreographies might find it easier to use and improve choreographic skills whenever they deviate from their routine, and both use the IoT to coordinate and control their smart-home at a distance. This is more difficult with a blue color job that involves multiple shifts and stricter divisions between household tasks because routines are more complex and coordination is limited. This can make it more stimulating for the higher educated to develop choreographic skills, where the lower educated are, again, dissuaded.

We notice a final informal effect of education through income inequality. Education has been a persistent predictor of income (Bourdieu, 1984; Bennet et al., 2009; Coady & Dizioli, 2018), and digital skills are stimulated by the affordance of playfulness (Ignatow & Robinson, 2017). This is especially true for developing operational skills when the costs for a confidence-inspiring software environment for the IoT that stimulates exploration and developing operational skills are considerably higher than the alternative. This means that if the higher educated have not already acquired operational skills, they are more stimulated to acquire them in a safer software environment. In contrast, cheaper IoT devices with software that does not integrate well with other IoT platforms can discourage individuals from exploring other IoT functions and limit the development of operational skills. While improving IoT skills can be regulated relatively easily through formal education, acquiring IoT skills outside of formal education can be difficult, as it is more dependent on motivational and encouraging aspects in social life.

On the other hand, focusing on the supply side of manufacturers, practical implications suggest that the IoT can become more accessible if suppliers improve the design of the infrastructure of the IoT and improve their compliance with policy regulations. Limitations of the IoT infrastructure are apparent with vendor lock-in, where manufacturers discourage consumers from shifting between brands. Navigating the IoT becomes more difficult if the IoT structure is limited by vendor lock-in, which creates the practical effect of having functions and features locked behind brand loyalty. Moreover, the infrastructure of the IoT influences the stability of IoT systems at home. Chapter 6 discussed the increasing need to stabilize an IoT system, as it involves multiple devices that are ubiquitously placed in shared regions of the household. Unfortunately, much of the stability of IoT systems is facilitated only by manufacturers through vendor lock-in. As the IoT is a service platform with increasingly more subscriptions for additional features, the consumer's financial costs or effort invested by the consumer to bypass vendor lock-in is more likely to rise. Hindrances of vendor lock-in might decrease when manufacturers are financially incentivized to improve their IoT infrastructures with other brands, for instance, by offering IoT software separately from IoT devices.

Similarly, IoT manufacturers also appear to lack incentives to comply with EU laws and regulations. With our performance task, only a few manufacturers complied with GDPR law, while receiving data is crucial in assessing accuracy or for strategizing IoT-assisted behavior. While collaboration skills can help mitigate such digital inequalities, a significant part is still uncontrollable for the consumer. Moreover, our participants became frustrated, as it was unclear where to go to when manufacturers did not comply. Therefore, the transparency on valorizing IoT data must improve, the ability to fine manufactures when failing to comply should be made easier, and policing manufactures should be more accessible when IoT users are being stolen of their data. Additionally, there is considerable ambiguity in the GDPR about the definition of personal data. This means that IoT users are sometimes unclear about what to ask for, and helpdesk services may also be uncertain about the correct responses. This is particularly troublesome when one helpdesk employee might give access to IoT data, whereas another does not. That is, access to IoT data should not be based on luck.

8.3 THEORETICAL IMPLICATIONS

8.3.1 Micro-Figurational Framework

Since we separated our framework from our conclusions, we are in a good position to reflect on the framework itself and its theoretical implications. We started the research by emphasizing a micro-figurational approach that would be shorter in time span than common figurational research (e.g., Elias; Swaan (1994 [1939]; 2001; Wouters, 2007), and we would add objects as units to our figurations. To characterize figurations in a digital society, we showed that digital objects can mediate relations and power balances in these figurations. We proposed that digital society, wherein social bonds are also mediated through internet-connecter objects such as the IoT, has a common figuration of *service providers—digital technology—user-proxy users*. This figuration appeared useful for finding different variations in interdependency chains and defining corresponding IoT skills. Together with interdependency chains and the skills to maneuver along these chains, we obtain a greater understanding of how power balances can be distributed in our figuration for digital societies.

Moreover, in our micro-figurational approach, we have outlined three steps. First, we investigated a common figuration for the society being studied. Second, we examined the interdependency chains that are established between units in this figuration. Third, we explained the maneuverability between interdependencies by the skillsets people have acquired or continue to develop. By following these steps, we found a common figuration of *services & manufacturers-IoT devices-IoT users-home & co-users*; three interdependency chains that focused on affective, political, and economic social bonds; and an IoT skillset consisting of operational skills, choreographic skills, and collaboration skills. While the flexibility of our micro-figurational approach is yet to be put to the test, our result certainly show promise. Additionally, for our study making a distinction in the social context as affective, political, and economic social bonds has been useful for our overarching framework, but also instrumental as specific chapters. That is, withing our micro-figurational approach is it feasible to focus only on a certain type of social bond or interdependency chain. However, the social bonds we have used is not exhaustive. Other types of social bonds that can broaden our view of a social context may be considered to extent this micro-figurational framework.

8.3.2 Digital Skills

As a theoretical consideration, we have also found that households are becoming increasingly more important as a level of analysis. In this research we have approached the household level as individual are embedded in household power dynamics. We found that the IoT affects members of the household differently based on unequal distributions of power within the household. We showed that using the IoT should be considered a household practice, rather than only an individual practice, as a unit of measurement for digital inequalities. This could certainly be applied to digital technologies other than the IoT, we the household level can be considered a unit of analysis. Additionally, the household can be studied through the myriad of relations within the household by all household members.

Finally, we showed that there is sufficient explanatory power between digital skills and hierarchies of digital skills. While there are a wide variety of digital skills available, the sequential and conditional nature of digital skills is equally important. This has already been shown by Van Deursen, Helsper, and Eynon (2017), but the findings in this research underscore this point. We have found that in our skillset operational skills, choreographic skills, and collaboration skills function as umbrella skills, which emphasizes the conditional nature of digital skills.

8.4 LIMITATIONS AND FUTURE RESEARCH

8.4.1 Practical Limitations

Our results, including our statistical results, are not conclusive in terms of generalizing the findings from our sample to a larger population. Instead, the aim of this research has been to generate a conceptual understanding of digital inequalities that involve the IoT and generalize these concepts.

These concepts can be from the empirical cases described and applied to other cases. Moreover, we aimed to explain the relations between concepts rather than the relations between people. However, our concepts could have been saturated better with more participants or by using as main selection criteria different than education, such as income, gender, or age.

With this research, we studied interdependence chains, but we also experienced them, especially when we were the dependent party. Our dependency was most apparent with the mobile application we used for our figuration diaries and the performance task of requesting log-entry data for the log-entry diaries. With the figuration diaries, we experienced technical difficulties that eliminated three participants. This was mainly the cause of difficulties between software updates and the updates of operating systems of mobile phones, including updates in user agreements and access to app stores. In 16 cases, IoT manufacturers did not return data as required by the GDPR. In both cases, this meant that the missing data limited the saturation of our data.

Additionally, we were very dependent on the truthfulness of our participants when they could have opted for more socially acceptable answers. We do take it as an objective fact that our participants have uttered their utterances. Utterances may not have been completely truthful to themselves or their own situation, but it does correspond to their understanding that their the utterances could have been socially acceptable according to the cultural values they wished to reflect. Moreover, the utterances have been logically consistent within a series of utterances that also reflect perspectives on the matter. To varying degrees, these conceptual perspectives are certainly truthful for some people and for some more than others. That is the function of a concept. Accordingly, how many people would agree with the concepts that are on an agenda for future research. However, concepts might not have been saturated as well due to this filter of social acceptability in the answers of the participants.

The other limitations of this research fall on my abilities as an interviewer, as an analyst, and as a researcher. First, as an interviewer, I found difficulties in asking about the everydayness of things. For instance, the research entailed phenomena that might seem mundane. This could be similar to asking about a detailed morning routine and whether brushing one's teeth or putting on one's clothes comes first. At some points, I did notice frustration from my participants, which pushed my ability as an interviewer to achieve a balance between getting the data and frustrating the participants. While I commend the incredible patience my participants had with me, the research has been limited by my abilities to navigate the interview setting.

Second, as a data analyst, the data have been analyzed from my perspective. In general, the analytical process can be described as putting together pieces of data and then explaining, to the best of my ability, why. This dissertation is the result of this process. We set out to explain a combination of possible circumstances with the facts we collected as data. The results, in effect, suffer from some degree of contingency. That is, they may need not be the explanation nor the complete explanation. However, the totality of objective facts we collected as data have become objective facts through the process of developing this dissertation, an objective fact anyone can agree or disagree with, to varying degrees.

Third, this research has been limited by my abilities as a researcher in relation to other research. To explain our results, we used an abductive analysis approach that relies on gathering different theories as lenses to examine the data. However, theories and available literature are almost inexhaustible, whereas my understanding of all social theories might be modest. Therefore, the research has been framed according to the literature available to me and my understanding of it.

8.4.2 Conceptual Limitations and Future Research

We have set up our micro-figurational approach to study and observe the role of the social context in relation to new technologies as they become part of everyday life. Therefore, we build a micro-figurational framework based on the IoT, for societal change mediated by digital technology. Societal change, in our case, is mostly reflected by the digital inequalities that increase as not everybody is able to benefit equally from new waves of technology. However, the boundaries of new technologies are not always explicit. For instance, Google Home was not yet available in the Netherlands in 2017, but the IoT started out as simple networks of devices 20 years prior to the writing of this dissertation. New waves of digital technologies tend to focus on hardware changes, such as the radio, television, desktop computers and the internet, and the mobile phone. Perhaps this is the case because changes in software are harder to grasp and more frugal, such as the influence of short-lived Myspace or Vine platforms. In either case, there is considerable risk involved in being too close to the technology for social science research. It also emphasizes the need for a framework to compare between new waves of technologies, however small they might be. Our micro-figurational approach can greatly improve our understanding of the societal influence on these technological changes if applied in comparison.

Additionally, in our micro-figurational approach we limited our focus on the social context of everyday life and households in particular. However, the IoT also becomes more ubiquitous in other contexts which we previously excluded, such as agriculture, industry, and hospitals. These contexts are unlikely to be resilient to digital inequalities. Our micro-figurational approach can be applied to these different contexts to compare shifting power balances in affective, political and economic bonds mediated by the IoT. For instance, when dairy farmers are willingly or unwillingly under pressure of digitization to use IoT tags on their cows to monitor their behavior (Taneja, Jalodia, Malone, Byabazaire, Davy & Olariu, 2019) and health (Prabowo, Mauliadi, Alanda & Rozi, 2020), little is known about their skills to adapt or influence power balances with different parties involved. Much like we observed our research, it is likely that some farmers are in a better position to benefit from the IoT in this context.

Moreover, research has also noticed pressure from one social field to another (Fligstein & McAdam, 2012). The lengthening of interdependency chains can pressure certain fields, like that of agriculture, to digitize their modus operandi. These external pressures have not been addressed in our study. Likewise, our study has been limited to the Dutch context, a country with a considerable high internet saturation of 96% at home in 2020 (Van Deursen, van der Zeeuw, de Boer, Jansen & van Rompay, 2021). Differences in other countries with more pressure to have people become connected to the internet can help saturate our findings, especially concerning the unwillingness to digitization of everyday life. Consequently, future research can address the influences of countries on one another, especially concerning regulations such as the GDPR, and the ways they are tied together through interdependency chains.

8.4.3 Increased Need to Understand Negative Outcomes

We hope to inspire future research to continue our efforts in understanding digital inequalities. However, most of the research on digital inequalities deals with the differences in how people benefit from digital technologies. Typically, this has been studied on three different levels (Lutz, 2019). The first level describes material access, the second describes access through skills (such as this dissertation), and the third level describes how uses of digital technologies can be transformed into tangible outcomes such as financial gains. Digital inequalities with these levels describe how almost everyone benefits from digital technologies, but some benefit a great deal more than others, and increasingly so.

To extend our understanding of the digital skills framework, we advise future research to test the effects of digital skills on social relations and cultural values. On the one hand, our research implied that digital skills provide a sense of self-reliance and lessen the need to establish a dependency in relation to others. Self-reliance can be an esteemed cultural value that also reduces the risk of exploitation and unfavorably skewed power balances. On the other hand, digital skills can give confidence to increase relations to become increasingly interdependent and egalitarian, which can also be an esteemed cultural value. We have shown this effect with operational skills and collaboration skills, respectively, but other skills are likely to have such an effect as well. Consequently, rather than a unidimensional approach to digital skills in relation to tangible outcomes, digital skills ought to be tested according to a multidimensionality of cultural values and justifications, such as described by Boltanski and Thévenot (2006).

Moreover, we hope to inspire future research to utilize data collected in natural settings by everyday devices. The figuration diaries can be set out in groups to collect network data and analyze the networked effects of digital technologies. Additionally, with more activities being logged we can obtain better data to study what goes on in the lives of everyday people. Log-entry data can be useful to study in relation to financial interventions and conciliators of lifestyle choices. We have seen this in Chapter 7 with the use of an energy coach, but log-entry data can also be utilized to monitor and improve lifestyle choices in health and monitor geolocations. The need for this research can be considered especially urgent in relation to the risk of social credit scores in interdependency chains. As most of the data collected at the moment is from higher-income users, lifestyles from lower-income users are more likely to be deviating from the norm currently established in the data and algorithmically penalized unfairly.

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APPENDIX

INTRODUCTION

This appendix gives an edited overview of the preliminary research on the Internet of Things (IoT) in the Netherlands by conducting a survey among a representative sample of the Dutch population focused on health, home, and security related IoT also described in Chapter 3. A full version of this research was published by Van Deursen, van der Zeeuw, de Boer, Jansen & van Rompay (2021) as 'Digital inequalities in the Internet of Things: differences in attitudes, material access, skills, and usage' and was guided by resources and appropriation theory. In this appendix we only give an overview of *IoT attitudes* and the actual *ownership* of (health, home, and security) IoT devices in the Netherlands in 2018. Here, Internet connection rates are high (96% in 2018) and the IoT was available for the general public, especially in relation to health, home, and security appliances.

SAMPLE

We relied on a data set that was collected in February of 2018 that was also used in Chapter 3. The IoT survey was pilot tested with eight users over two rounds. Modifications were made based on the feedback that was provided. In the second round, no major comments were made. The survey started with an introduction and explanation of what we considered the IoT (smart everyday devices connected to the Internet that can be controlled by apps such as smart thermostats, smart meters, Fitbits, smart cameras, etc.). The time needed to answer the survey questions varied due to the number of IoT devices that the respondents owned. On average, it took 20 minutes to complete the survey.

The sampling and fieldwork were performed using PanelClix in the Netherlands. Respondents were recruited from an online panel containing over 100,000 people comprising a highly representative sample of the Dutch population. The members received a small monetary incentive for every survey in which they participated. We conducted our survey in the last week of January and the first week of February 2018. In total, 1,356 respondents finished the survey. In terms of gender, age, and educational level, the sample was highly consistent with the official statistics, and only a slight weight was needed post hoc to match the representativeness to the standards of Statistics Netherlands (CBS), a Dutch governmental statistics agency. See Table 1 for the demographic profiles of the total sample and of the IoT users.

Table 1

Demographic Profiles

	Overall		*IoT users*	
	N	*%*	*N*	*%*
Gender				
Male	705	52.0	297	52.8
Female	651	48.0	266	47.2
Age				
18-35	277	20.4	162	28.8
36-50	267	19.7	137	24.3
51-65	381	28.1	154	27.4
66+	431	31.8	110	19.5
Education				
Low	956	70.5	380	67.5
High	400	29.5	183	32.5

N= 1356

MEASURES

IoT attitude was measured by adapting eight items of the Internet Attitude Scale to the IoT. All the items were balanced for the direction of the response and averaged together to create a single construct (M= 3.21; SD= 0.69; α= .76; 5-point agreement Likert scale). See Table 2.

Table 2
Items Used for Measuring IoT Attitude and Skills

	M	*SD*
IoT attitude (α= .76)		
Using Internet-of-Things...		
makes life less social (R)	2.41	1.05
makes people servante of technology (R)	2.35	0.97
will control our lives (R)	2.42	1.02
makes people too dependent (R)	2.50	0.99
is inflicted on us (R)	2.60	1.05
dehumanizes society (R)	2.69	1.01
makes it difficult to protect my privacy (R)	2.34	0.98
causes mental instability (R)	3.02	0.93
IoT skills (α= .93)		
I know how to connect a smart device to the internet	3.39	1.31
I know how to share information from smart devices on the internet	3.26	1.31
I know how to how to operate smart devices by using applications	3.46	1.34
I know how to interpret data from smart devices	3.32	1.30
I know how to connect smart devices to my WiFi-network	3.39	1.35
I feel confident operating smart devices	3.15	1.22
I know how to change on a smart device with whom I share data	3.00	1.27
I know how to read data from smart devices	3.30	1.26
I know how to change how often data is gathered by smart devices	3.01	1.27

N= 1339 *Note: R= reversed*

Material IoT access was measured by asking respondents to indicate what IoT devices they owned. An extensive list of 27 health, 20 home, and 10 security appliances was provided (all available to the public in shops). Because in the IoT system, multiple devices are often combined, access and use are somewhat conflated. As material access concerns IoT in its totality, we considered owning any of the devices and created binary variables for each domain: health (46%), home (43%), and security (32%). See Appendixes A, B, and C.

IoT skills was measured among those with material IoT access by using a set of items that was constructed by Van der Zeeuw, van Deursen & Jansen (2019) who proposed an instrument that was inspired by the Internet Skills Scale (Van Deursen, Helsper & Eynon, 2016). To respond to the items, a 5-point Likert-type scale was used that ranged from one, 'Not at all true for me', to five, 'very true for me', with 'neither true nor untrue for me' as the neutral response. When respondents did not understand the item, they could respond with 'I don't understand this statement,' which was coded as 0, thereby creating a 6-point Likert scale. The set of nine items in total covered respondents' knowledge of how to address smart devices and how to deal with the information that they gather (M= 3.39; SD= 1.05; α= .97). See Table 2.

IoT usage was measured among those with material IoT access. We first checked whether the IoT devices that were owned were also used in an IoT manner, which means that they were connected to the Internet and controlled by an app. We then summed the number of unique IoT devices that people use. The underlying idea is that the number of devices corresponds with more activities being performed. We differentiated between three types of IoT usage: health, home, and security. For each type, dichotomous items were summed into a single scale that reflected the number of IoT devices that were used for health (M= 1.43; SD= 1.59), home (M= 0.90; SD= 1.26), and security (M= 0.37; SD= 0.77) activities.

Income was initially coded as a categorical variable that reflected the total annual family income in the last twelve months. There were three categories of low (<30,000 Euro), middle (30,000-60,000 Euro), and high (> 60,000 Euro).

For *social support*, we used the medical outcomes social support survey to evaluate support availability. The respondents completed 12 items covering emotional (e.g., "Someone you can count on to listen when you need to talk"), informational (e.g., "Someone to give you good advice about a crisis"), and tangible (e.g., "Someone to help you if you were confined to bed") support. All the items were rated on a 5-point scale with the anchors none of the time (1) and most of the time (5). We computed an aggregate measure of support availability for all items (α= .97; M= 3.75; SD= 1.07).

The data on *education* were collected by degree as one of eight categories. These data were subsequently divided into three groups of low, middle, and high educational levels being attained. *Employment status* was coded as dummy variables into the following categories: employed (53%), retired (23%), disabled (8%), homemaker (6%), unemployed (4%), and students (6%). *Marital status* was coded into dummy variables, as follows: single (35%), married or living together in a relationship (50%), divorced (9%), and widow(er) (6%).

Gender (male: 49%) was included as a dichotomous variable. *Age* was computed by subtracting the reported year of birth from the survey year and was subsequently categorized into the age groups of 18-35, 36-50, 51-65, and over 66.

RESULTS

Overall, 44.7% of the Dutch adult population owns at least one IoT device. For *health* specifically, 31.3% use at least one IoT device. See Figure 1 for an overview. The most popular devices are activity trackers (10.5%), heart rate monitors (10.2%), and sports watches (8.8%), followed by smart blood pressure monitors (6.7%), sleep trackers (5.9%), scales (4.4%), and thermometers (4.0%). IoT devices for improving living conditions in the *home* are used by

Figure 1

IoT Devices (Smart) Used for Heath Purposes (% of Dutch Adult Population)

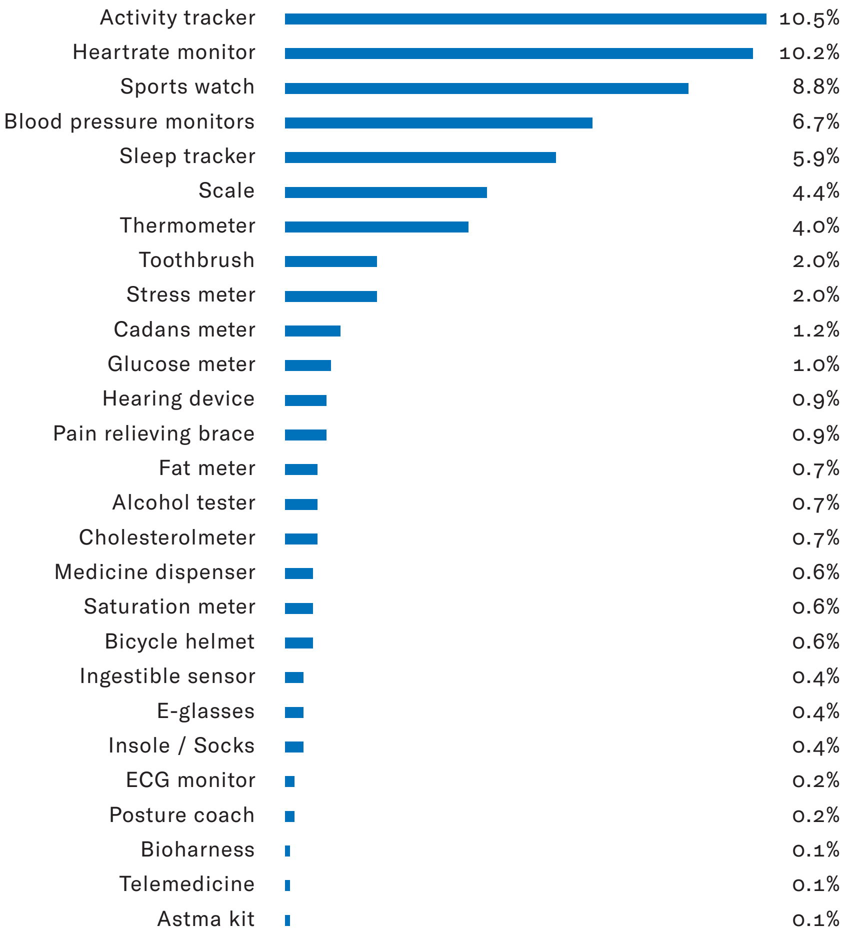

Figure 2

IoT Devices (Smart) Used for Home Purposes (% of Dutch Adult Population)

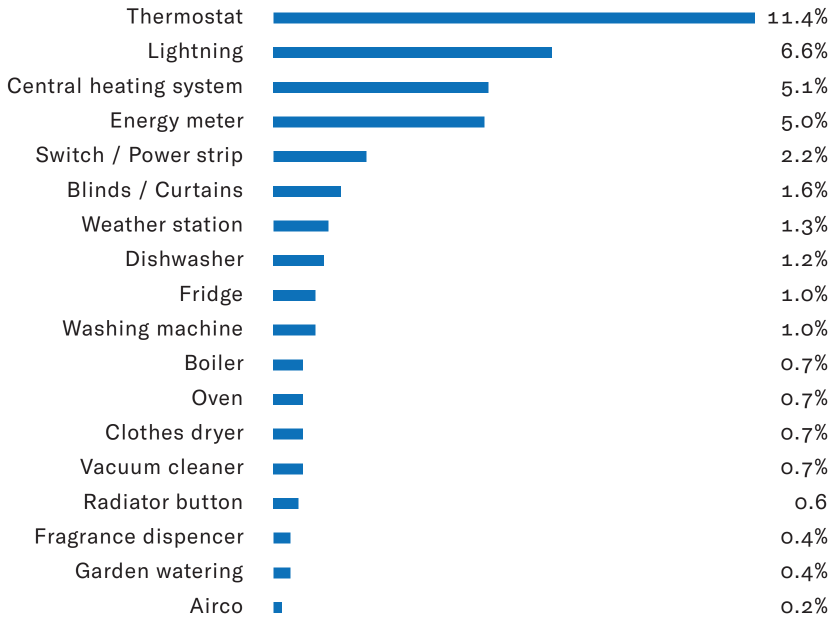

Figure 3

IoT Devices (Smart) Used for Home Purposes (% of Dutch Adult Population)

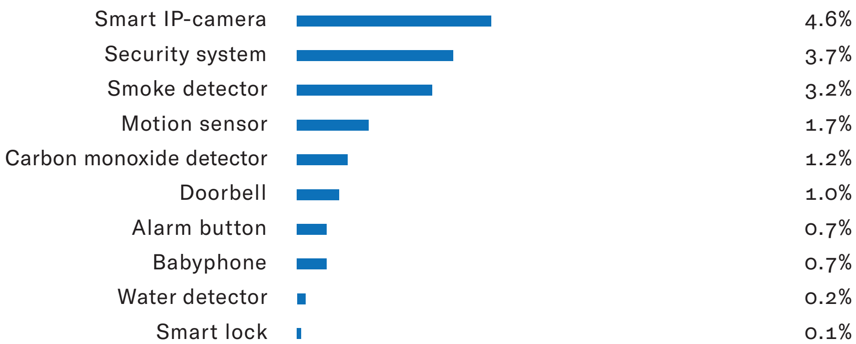

Table 3

Regression Analysis to Predict Attitudinal (OLS) and material IoT acces (Logistic)

	IoT attitude (ß)	Material IoT access (odd ratio)			
		Any	Health	Home	Security
Gender (M/F)	-0.03	0.94	0.93	1.03	0.57**
Age (ref. 18–35)					
36–50	-0.07	0.59*	0.67	0.62*	0.70
51–65	-0.07	0.38***	0.39***	0.44***	0.59
66+	-0.14	0.20***	0.33**	0.13***	0.16**
Employed (ref. employed)					
Unemployed	-0.03	0.75	0.75	1.15	0.47
Retired	-0.04	0.77	0.61	1.48	1.31
Disabled	-0.01	0.86	0.89	0.77	0.55
Homemaker	-0.03	0.60	0.66	0.52	0.67
Student	-0.01	0.83	1.37	0.39*	0.57
Education (ref. low)					
Middle	-0.03	1.09	1.06	1.21	0.99
High	-0.01	1.05	1.38	1.17	0.87
Maritial status (ref. married)					
Single	0.00	0.56***	0.69*	0.54**	0.96
Widow	-0.03	0.84	0.98	0.63	1.21
Divorced	0.03	0.88	1.05	1.12	1.63
Income (ref. low)					
Middle	0.08**	1.31*	1.30	1.57**	1.69*
High	0.10**	1.74**	1.51	2.15***	2.30**
Social support	0.05	1.02	1.00	0.94	0.83*
IoT attitude		2.03***	1.96***	2.29***	1.56**
Constant		0.20**	0.09**	0.04***	0.19*
Nagelkerke R^2		0.19	0.16	0.18	0.11
Chi-square		199,94***	158.39***	171.21***	78.27***
R^2	0.03				
F	2.33**				

N=1339 *p < 0.05, **p < 0.01, ***p < 0.001

24.3%. Figure 2 shows the devices that people own, the most popular one being the smart thermostat (11.4%), which is followed by smart lightning (6,6%), smart central heating (5.1%), and smart energy meters (5.0%). Concerning the IoT for *security* purposes, a total of 11.7% own at least one device. Figure 3 shows that most popular devices are smart cameras (4.7%), followed by smart security systems (3.7%), smart smoke detectors (3.2%), and smart motion sensors (1.7%).

Table 3 reveals that IoT attitude is an important contributor to all types of material IoT access. IoT attitude among the general population is determined by income. Income is also important for material IoT access in general, and specifically for home and security IoT. The resource of social support contributes negatively to having security related IoT. Education did not emerge as significant predictor. Those who are employed are more likely to own home IoT devices compared to students. Married people or those in relationships are generally more likely to own IoT devices, specifically health and home IoT devices, when compared to single people. Concerning individual characteristics, Table 1 shows that men are more likely to own security-related IoT devices, and that age contributes negatively to all material IoT access types.

MAIN FINDINGS

Almost half of the Dutch adult population owns an IoT device. Although this may sound like the IoT is firmly rooted in people's daily lives, ownership can be ascribed to a relatively limited set of devices: activity trackers, heart rate monitors, sport watches, smart thermostats, and lightning systems. Taking a step back, in the current contribution, resources and appropriation theory was used to study inequalities in the use of IoT in the Netherlands.

Following the appropriation process, we can first confirm the important role of IoT attitude. A positive attitude towards IoT increases the likelihood of IoT ownership and IoT skills and eventually leads to a wider diversity of IoT use. IoT skills, in turn, are important for IoT usage, although we did not find an effect for security related IoT activities. The adoption of security devices and related activities might be undertaken (regardless of skill levels), as they are important to wellbeing of one's self and family members, issues which relate to basic needs. Income surfaces as an important resource in relation to IoT attitude. People with low incomes that cannot afford IoT devices are less likely to develop favorable attitudes. Income remains important for material IoT access, especially for home-related IoT that appeals to (less basic) hedonic needs that are related to comfort and luxury, and safety-related IoT. The resource of social support only played a role in relation to security. Those with fewer support networks are more likely to buy security related IoT devices, maybe because they feel more insecure.

Among the IoT owners, next to the income resource, the position of educational attainment is associated with IoT attitudes. Education is also important for health related IoT uses. Both income and education were important predictors in Internet research that studied initial attitudes and uptake. As resource and appropriation theory posits IoT attitude at the start of the appropriation process, followed by material access, those with higher incomes and education will be the first to develop the necessary IoT skills and engage in diverse use of IoT devices. They are more likely to benefit from IoT developments. In terms of inequality, those that are already in more privileged positions are the first to further strengthen their resources by using the IoT or, in other words, to improve their health, living conditions at home, and security. Similar conclusions can be drawn for age: younger people tend to have the most material IoT access and have higher levels of IoT skills.

The current investigation presented sufficient evidence to support beginning to focus digital inequality research on the IoT. In relation to Internet use, it took a long time before the emphasis started to shift away from having a connection to more elaborate explanations of skills and usage. For studying inequalities in the IoT, we stress that we should start incorporating these steps in research and policy at the start, even though material access rates are far from being saturated. Our results reveal that several inequalities emerge among those already using IoT devices.

SAMENVATTING: IOT AS SIMPLE AS *DO RE MI*

Met het Internet-of-Things (IoT) wordt het heel makkelijk om alledaagse apparaten te verbinden met het internet. Denk aan de slimme thermostaat, slimme verlichting, slimme deurbel, of de activity-tracker. Het bedienen van deze apparaten kan vaak op afstand of door automatische instellingen, zoals bij het aanpassen van de verlichting of verwarming. Het gebruik van slimme apparaten gaat ook gepaard met het verzamelen van een enorm aantal metingen. Van je hartslagfrequentie tot hoeveel je verbruikt aan calorieën, gas of elektriciteit.

Door de toenemende flexibiliteit om apparaten (op afstand of automatisch) in te stellen en de toenemende data die het IoT genereert, kan het mensen helpen met belangen van het alledaagse leven. Bijvoorbeeld, als mensen het belangrijk vinden om beide aan hun carrière te werken en daarmee minder tijd hebben voor werk in huis, dan kan het IoT daarmee helpen om taken over te nemen of helpen om het huishouden te organiseren. Zo kan het programma van een slimme thermostaat van twee overwerkende mensen automatisch uitgesteld worden door geofencing. Hiermee wordt minder geld uitgegeven terwijl er meer geld wordt verdient. Echter kan niet iedereen zo hun IoT apparaten gebruiken. Als gevolg van ongelijke digitale kennis en vaardigheden ontstaat er een patroon van ongelijkheid waarbij een kleine groep mensen een relatief grotere voorsprong kan krijgen bij elke nieuwe golf van technologie.

In deze dissertatie richten we ons op IoT apparaten die door gewone mensen worden gebruikt en die beschikbaar waren voor consumenten toen dit onderzoek in 2017 begon. Daarbij richten wij ons op IoT apparaten die tastbare voordelen kunnen opleveren op het gebied van gezondheid, energieverbruik en veiligheid. Dit zijn de IoT apparaten en applicaties die gegevens genereren via het dagelijks leven, zoals biometrische gegevens of geaggregeerde huishoudgegevens, die een technologische feedback loop kunnen genereren die het dagelijks gedrag beïnvloedt.

Om het IoT vanuit een ongelijkheidsperspectief te benadrukken onderzoeken wij in deze dissertatie specifiek (1) de context waarin het IoT wordt gebruikt voor de manier waarop mensen ervan kunnen profiteren, (2) de uniforme vaardigheden die mensen nodig hebben om IoT apparaten te gebruiken zodat wij beter kunnen begrijpen hoe apparaten functioneren ten opzichte van elkaar, en (3) hoe de vaardigheden die voor het IoT worden gebruikt niet voor iedereen even toegankelijk zijn om te verkrijgen of te ontwikkelen. Om deze problemen te benaderen gebruiken wij het werk van Norbert Elias als kader om ons onderzoek af te bakenen in termen van sociale figuraties, wederzijdse afhankelijkheidsketens, en vaardigheden die kunnen worden gebruikt om machtsbalansen in sociale banden te beïnvloeden. In onze kwalitatieve analyse maken we vooral gebruik van economische banden, affectieve banden, en politieke banden in wederzijdse onafhankelijkheidsketens waarbij wij ons laten leiden door de vraag: Hoe kan de sociale context waarin het IoT door gewone mensen wordt gebruikt de verschillen in IoT-vaardigheden verklaren die digitale ongelijkheden in stand houden?

In deze dissertatie willen wij aandacht geven aan de vaardigheden die worden ingezet in een netwerk van sociale spanningen, deels gecreëerd door het IoT zelf, maar zeker gecreëerd door de oprukkende digitale samenleving en de aanhoudende digitale ongelijkheden. Mensen hebben de neiging om gestimuleerd of gemotiveerd te worden om bepaalde vaardigheden te ontwikkelen als zij bepaalde doelen willen bereiken en moeten zich aanpassen wanneer er barrières zijn die hen ervan weerhouden om hun doelen te bereiken. Als alternatief kunnen bepaalde vaardigheden als minder belangrijk worden beschouwd wanneer wederzijdse afhankelijke relaties deze compenseren. Dat is bijvoorbeeld het geval als AI en besluitvormingsalgoritmen van IoT-fabrikanten de behoefte aan bepaalde operationele vaardigheden van een IoT-gebruiker verminderen. Op basis van onze kennis van voorgaand onderzoek naar digital ongelijkheid weten we dat barrières moeilijker te overwinnen of te identificeren zijn voor lager opgeleiden (als een relatief stabiele indicator van cognitieve vaardigheden). Daarbij nemen wij aan dat opleidingsniveaus patronen van culturele consumptie en culturele waarden weerspiegelen die vaak worden geassocieerd met opleidingsniveaus. Om ons onderzoek extra aandacht te geven aan eventuele educatieve factoren hebben wij 15 hoger opgeleide en 15 lager opgeleide deelnemers geselecteerd. We volgden deze 30 deelnemers en hun huishoudens gedurende een onderzoek van 15 maanden door middel van vijf interviewrondes en twee dagboek-onderzoeken: één dagboekonderzoek met een mobiele applicatie en één dagboekonderzoek met de log-gegevens van IoT apparaten die gebruikt worden de deelnemers zelf.

We beginnen ons onderzoek in **Hoofdstuk 3** met een enquête onder de Nederlandse bevolking. Het doel van dit onderzoek is om te testen of het IoT beschouwd moet worden ofwel als een verzameling algemene consumenten objecten ofwel als sociale objecten die op internet zijn aangesloten en tevens worden gebruikt om verbindingen met anderen te maken. Het IoT-platform kan verschillende manieren van sociale communicatie mogelijk maken en hoe mensen het IoT sociaal gebruiken zal cruciaal zijn om te begrijpen hoe mensen sociale relaties creëren, onderhouden of ontbinden. Echter, als niemand het IoT op deze manier gebruikt, zou dat onze onderzoek aanpak drastisch beïnvloeden. In plaats van uit te gaan van een alles-of-niets-kwestie, definiëren we het sociale gebruik in termen van privégebruik (wat geen opzettelijk sociaal gebruik zou impliceren) en tussen het delen van IoT data met vreemden, met een partner, of met kennissen. Eerst testen we hoe het sociale gebruik van IoT-apparaten kan wordt verdeeld onder structurele disposities van economisch, cultureel en sociaal kapitaal. Ten tweede testen we hoe dit gebruik wordt verdeeld onder internet-gerelateerde vaardigheden. Onze resultaten laten omgekeerde effecten zien van sociaal kapitaal, inkomen, en onderwijs op privégebruik en op het delen van IoT data met een partner. Het delen van IoT data met kennissen en vreemden kan worden voorspeld door culturele activiteiten. Het delen van IoT data met kennissen kan vooral worden toegeschreven aan sociale relaties buiten het directe huishouden. We ontdekken ook dat het vertalen van internetvaardigheden naar het IoT niet direct significante resultaten oplevert. We hebben dus een nieuw raamwerk nodig voor vaardigheden die specifiek verband houden met het gebruik van het IoT. We beginnen met het opzetten van deze IoT-specifieke vaardigheden in het volgende hoofdstuk.

In **hoofdstuk 4** beginnen we met onze micro-figuratieve benadering door te onderzoeken hoe wederzijdse afhankelijkheidsketens met betrekking tot het IoT tot stand kwamen bij de 30 deelnemers van ons onderzoek toen zij hun IoT zijn gaan te gebruiken. De verschillende manieren waarop mensen het IoT zijn gaan gebruiken hebben uiteindelijk een enorme invloed op de resultaten, de voordelen van het IoT, en hoe hun IoT-gebruik kan worden benut. Omdat het IoT maatschappelijk is ingebed in een netwerk van wederzijdse afhankelijkheden en machtsverhoudingen tussen verschillende partijen, onderzoeken we hoe mensen zich positioneren ten opzichte van anderen met hun eerste IoT gebruik. We beginnen met te onderzoeken hoe dagelijkse huishoudelijke activiteiten betrokken raken bij een groeiend IoT-netwerk van wederzijdse afhankelijkheden met verschillende organisaties en belanghebbenden. Hiermee construeren we een gemeenschappelijke figuratie van wederzijdse afhankelijkheidsketens die voor de navolgende hoofdstukken zal worden gebruikt. Bovendien stellen we, dankzij onze resultaten in Hoofdstuk 3, een alternatieve set van IoT-vaardigheden voor die de unieke kenmerken van het IoT benadrukken. Met behulp van een kader voor digitale vaardigheden passen we operationele vaardigheden (*Operational skills*) en samenwerkingsvaardigheden (*Collaboration skills*) aan voor IoT gebruik en construeren we choreografische vaardigheden (*Choreographic skills*) om de socio-materialiteit van het IoT te benadrukken. Vervolgens kijken we hoe interdependentieketens beïnvloeden welke van deze IoT vaardigheden worden gebruikt en hoe mensen in staat zijn om te reageren op machtsevenwichten in zulke wederzijdse afhankelijkheidsketens.

In **hoofdstuk 5** beginnen we onze analyse van verschillende sociale banden door te onderzoeken hoe affectieve banden en operationele vaardigheden verband houden met *vendor lock-in*. We stellen dat veel van het gebruik van het IoT en de voordelen ervan worden belemmerd door *vendor lock-in*, terwijl mensen met geavanceerde operationele vaardigheden creatieve manieren vinden om *vendor lock-in* te omzeilen. Daarom vragen wij in dit hoofdstuk waarom sommige mensen in staat zijn om creatief te profiteren van de potentiële voordelen van het IoT, terwijl anderen worden gehinderd door *vendor lock-in*. Om figuraties van IoT apparaten in kaart te brengen gebruiken we een dagboekstudie via een mobiele applicatie dat laat zien hoe deelnemers van ons onderzoek zich verhouden tot hun IoT apparaten in termen van metaforische concepten van sociale nabijheid (ver-dichtbij) en sociale warmte (koud-warm). We bespreken hoe gebruikers met meeste hinder van *vendor lock-in* voornamelijk taakgericht zijn en IoT apparaten vooral als gereedschap zien om specifieke problemen op te lossen. Gebruikers met een meer speelse benadering, daarentegen, zijn beter gepositioneerd om IoT voordelig te gebruiken en hun operationele vaardigheden verder te ontwikkelen. Voor sommige gebruikers vervult het gebruik van het IoT emotionele behoeften zoals hobby of als activiteiten die ze leuk vinden. Ze beschouwen hun relaties met hun IoT als warm en hecht. Voor anderen is het IoT meer een apparaat dat wordt gebruikt om problemen op de achtergrond op te lossen terwijl zij met andere dingen bezig zijn.

In **hoofdstuk 6** gaan we verder met onze analyse van sociale banden door aandacht te geven aan politieke banden en de choreografische vaardigheden die nodig zijn om het IoT te laten passen bij reeds bestaande routines van het dagelijks leven. Aangezien de meeste IoT apparaten worden geplaatst op plekken die gedeeld worden met anderen, vereisen ze verschillende sociale rollen die samenwerken om efficiënt te zijn of op zijn minst om hun ongewenste effecten te minimaliseren. Door middel van de politieke banden die worden gebruikt om mensen samen te brengen voor een gemeenschappelijk doel, bekijken we hoe ongelijkheden binnen huishoudens belangrijk zijn voor ons algemene begrip van digitale ongelijkheid. Zo roept het IoT spanningen op tussen stereotiepe mannelijke rollen in technologie en stereotiepe vrouwelijke genderrollen van huishoudelijke verantwoordelijkheden. Daarbij kan het IoT kan ook de spanningen tussen de rol van ouders en hun kinderen vergroten, aangezien zogenoemde *digital natives* mogelijk meer invloed in het huishouden kunnen krijgen door hun digitale vaardigheden. We bespreken onze resultaten door middel van dimensies van materialiteit, toegankelijkheid en harmonie. We bespreken hoe de acceptatie van de materialiteit van het IoT door alle leden van het huishouden een belangrijke bepalende factor is voor hoe effectief het IoT kan werken. Voor toegankelijkheid bespreken we de politiek van het aanwijzen van hoofdaccounts en de verantwoordelijkheden met betrekking tot privacy. Ouders kunnen alledaagse activiteiten van hun kinderen nauwkeuriger bemiddelen, maar data en privacy vereisen ook extra bemiddeling. In termen van harmonie zien we dat het IoT voordeel kan bieden bij complexe huishoudelijke routines. Ten slotte merken we op dat traditionele genderrollen nog steeds voorkomen in slimme huizen.

In **hoofdstuk 7** bespreken we IoT data tussen partijen met verschillende doelen—fabrikanten en consumenten—in termen van economische banden. We gebruiken economische bindingen om die relaties te beschrijven die resultaatgerichte strategieën beïnvloeden. In onze analyse gebruiken we twee onderscheidbare strategieën om verschillen tussen IoT toepassingen te benadrukken. De eerste richt zich op het IoT als apparaten die zijn ontworpen om onzichtbaar en autonoom te werken. We noemen deze strategie AI-verlichting (*AI-alleviation*) omdat het besluitvormingsalgoritmen gebruikt om cognitieve belasting te verminderen. In de tweede strategie worden IoT gegevens gebruikt om mensen te motiveren (*Cognitive motivation*) door hun kennis van hun gedrag te vergroten. Om deze verschillen te benadrukken in hoe het IoT strategisch kan worden geïmplementeerd, vragen we hoe strategische verschillen tussen IoT-gebruikers worden beïnvloed door IoT als algoritmische besluitvormingstools. In dit hoofdstuk maken we gebruik van log-entry data van IoT-apparaten van de 30 deelnemers die meedoen aan ons onderzoek, die we gebruiken als log-entry dagboekstudies. We zien dat het IoT als een verlichtend hulpmiddel efficiënter gebruikt kan worden met een beter begrip van AI. Het vertalen van gegevens naar strategisch gedrag kan echter moeilijk zijn als interpretatie vaardigheden ontbreken. Dit zorgt voor een drempel als mensen IoT gegevens willen gebruiken als cognitief motivatie. Bovendien gaan we dieper in op de verschillen die ontstaan in hoe mensen het succes van hun IoT-implementatie beoordelen, aangezien verschillende bronnen autoriteit verwerven over de correctheid van IoT gegevens en daarmee een bepalende invloed hebben op hoe digitale ongelijkheden vorm krijgen met het IoT.

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